formulas Documentation

Release 1.2.7

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https://github.com/vinci1it2000/formulas

https://pypi.org/project/formulas/

http://formulas.readthedocs.io/

https://github.com/vinci1it2000/formulas/wiki/

http://github.com/vinci1it2000/formulas/releases/

https://donorbox.org/formulas

excel, formulas, interpreter, compiler, dispatch

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EUPL 1.1+

CHAPTER

ONE

WHAT IS FORMULAS?

formulas implements an interpreter for Excel formulas, which parses and compile Excel formulas expressions.

Moreover, it compiles Excel workbooks to python and executes without using the Excel COM server. Hence, **Excel is not needed**.

CHAPTER TWO

INSTALLATION

To install it use (with root privileges):

```
$ pip install formulas
```

Or download the last git version and use (with root privileges):

```
$ python setup.py install
```

2.1 Install extras

Some additional functionality is enabled installing the following extras:

- excel: enables to compile Excel workbooks to python and execute using: `ExcelModel`.
- plot: enables to plot the formula ast and the Excel model.

To install formulas and all extras, do:

```
$ pip install formulas[all]
```

2.2 Development version

To help with the testing and the development of *formulas*, you can install the development version:

```
$ pip install https://github.com/vinci1it2000/formulas/archive/dev.zip
```

2.2.1 What is formulas?

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2.2.3 Basic Examples

The following sections will show how to:

- parse a Excel formulas;
- load, compile, and execute a Excel workbook;
- extract a sub-model from a Excel workbook;
- add a custom function.

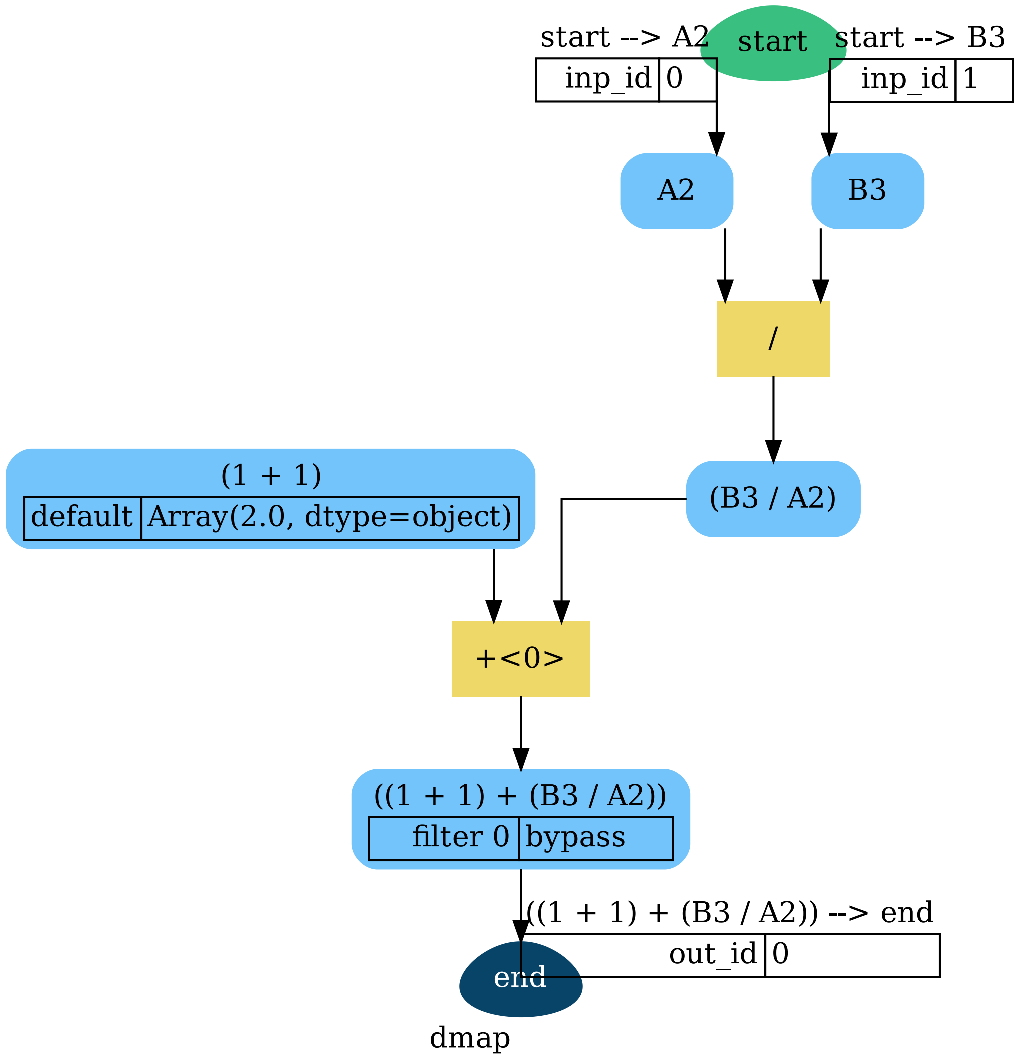
2.2.3.1 Parsing formula

An example how to parse and execute an Excel formula is the following:

```
>>> import formulas
>>> func = formulas.Parser().ast('=(1 + 1) + B3 / A2')[1].compile()
```

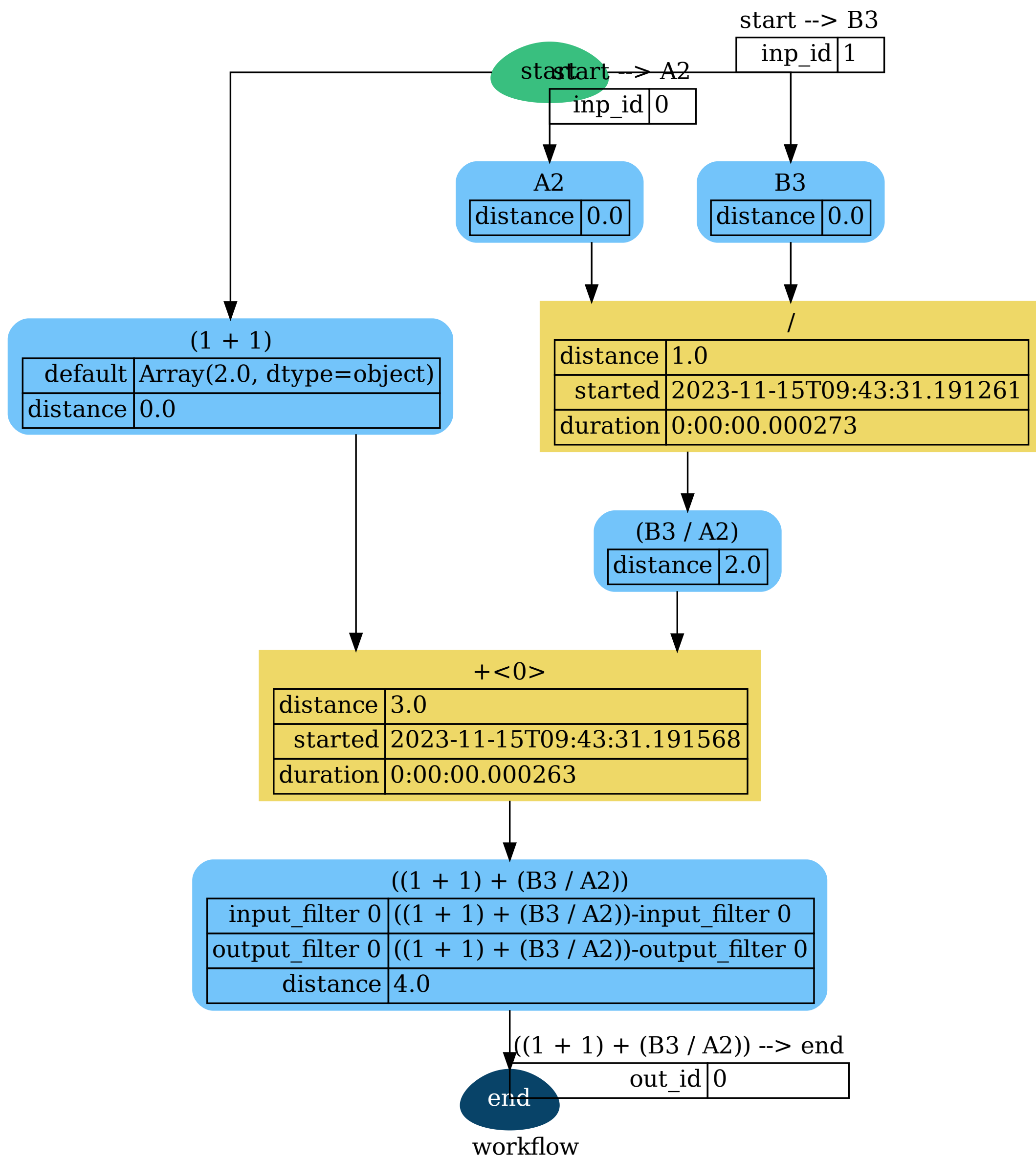
To visualize formula model and get the input order you can do the following:

```
>>> list(func.inputs)
['A2', 'B3']
>>> func.plot(view=False)  # Set view=True to plot in the default browser.
SiteMap([(=((1 + 1) + (B3 / A2)), SiteMap())])
```



Finally to execute the formula and plot the workflow:

```
>>> func(1, 5)
Array(7.0, dtype=object)
>>> func.plot(workflow=True, view=False)  # Set view=True to plot in the default browser.
SiteMap([(=((1 + 1) + (B3 / A2)), SiteMap())])
```



2.2.3.2 Excel workbook

An example how to load, calculate, and write an Excel workbook is the following:

```
>>> import formulas
>>> fpath, dir_output = 'excel.xlsx', 'output'
>>> xl_model = formulas.ExcelModel().loads(fpath).finish()
>>> xl_model.calculate()
Solution(...)
>>> xl_model.write(dirpath=dir_output)
```

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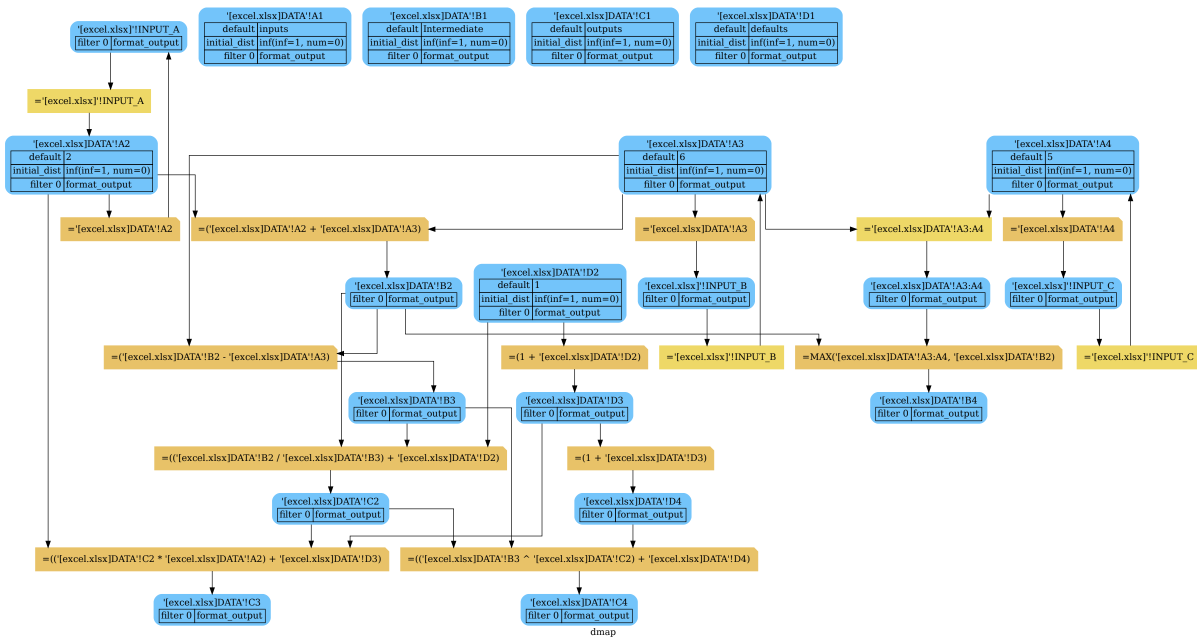
```
{'EXCEL.XLSX': {Book: <openpyxl.workbook.workbook.Workbook ...>}}
```

Tip: If you have or could have **circular references**, add *circular=True* to *finish* method.

To plot the dependency graph that depict relationships between Excel cells:

```
>>> dsp = xl_model.dsp
>>> dsp.plot(view=False)  # Set view=True to plot in the default browser.
SiteMap([(ExcelModel, SiteMap(...))])
```



To overwrite the default inputs that are defined by the excel file or to impose some value to a specific cell:

```
>>> xl_model.calculate(
...     inputs={
...         "'[excel.xlsx]'!INPUT_A": 3,  # To overwrite the default value.
...         "'[excel.xlsx]DATA'!B3": 1  # To impose a value to B3 cell.
...     },
...     outputs=[
...        "'[excel.xlsx]DATA'!C2", "'[excel.xlsx]DATA'!C4"
...     ] # To define the outputs that you want to calculate.
... )
Solution([("'[excel.xlsx]'!INPUT_A", <Ranges>('[excel.xlsx]DATA'!A2)=[[3]]),
          ("'[excel.xlsx]DATA'!B3", <Ranges>('[excel.xlsx]DATA'!B3)=[[1]]),
          ("'[excel.xlsx]DATA'!A2", <Ranges>('[excel.xlsx]DATA'!A2)=[[3]]),
          ("'[excel.xlsx]DATA'!A3", <Ranges>('[excel.xlsx]DATA'!A3)=[[6]]),
          ("'[excel.xlsx]DATA'!D2", <Ranges>('[excel.xlsx]DATA'!D2)=[[1]]),
          ("'[excel.xlsx]'!INPUT_B", <Ranges>('[excel.xlsx]DATA'!A3)=[[6]]),
          ("'[excel.xlsx]DATA'!B2", <Ranges>('[excel.xlsx]DATA'!B2)=[[9.0]]),
          ("'[excel.xlsx]DATA'!D3", <Ranges>('[excel.xlsx]DATA'!D3)=[[2.0]]),
```

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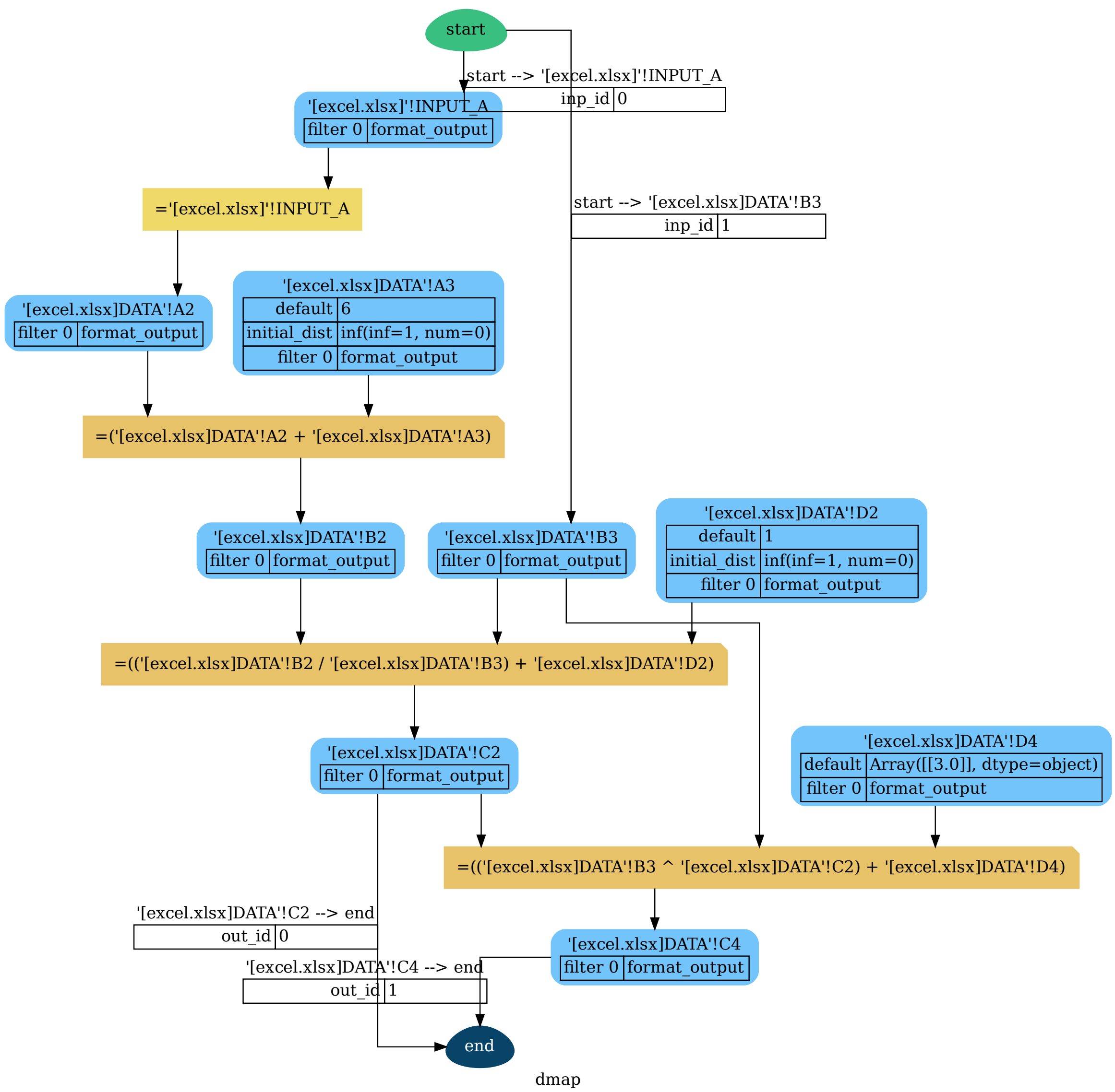
```
          ("'[excel.xlsx]DATA'!C2", <Ranges>('[excel.xlsx]DATA'!C2)=[[10.0]]),
          ("'[excel.xlsx]DATA'!D4", <Ranges>('[excel.xlsx]DATA'!D4)=[[3.0]]),
          ("'[excel.xlsx]DATA'!C4", <Ranges>('[excel.xlsx]DATA'!C4)=[[4.0]])])
```

To build a single function out of an excel model with fixed inputs and outputs, you can use the *compile* method of the *ExcelModel* that returns a DispatchPipe. This is a function where the inputs and outputs are defined by the data node ids (i.e., cell references).

```
>>> func = xl_model.compile(
...     inputs=[
...         "'[excel.xlsx]'!INPUT_A",  # First argument of the function.
...         "'[excel.xlsx]DATA'!B3"   # Second argument of the function.
...     ], # To define function inputs.
...     outputs=[
...         "'[excel.xlsx]DATA'!C2", "'[excel.xlsx]DATA'!C4"
...     ] # To define function outputs.
... )
>>> func
<schedula.utils.dsp.DispatchPipe object at ...>
>>> [v.value[0, 0] for v in func(3, 1)]  # To retrieve the data.
[10.0, 4.0]
>>> func.plot(view=False)  # Set view=True to plot in the default browser.
SiteMap([(ExcelModel, SiteMap(...))])
```



Alternatively, to load a partial excel model from the output cells, you can use the *from_ranges* method of the *ExcelModel*:

```
>>> xl = formulas.ExcelModel().from_ranges(
...     "'[%s]DATA'!C2:D2" % fpath,  # Output range.
...     "'[%s]DATA'!B4" % fpath,  # Output cell.
... )
>>> dsp = xl.dsp
>>> sorted(dsp.data_nodes)
["'[excel.xlsx]'!INPUT_A",
 "'[excel.xlsx]'!INPUT_B",
 "'[excel.xlsx]'!INPUT_C",
 "'[excel.xlsx]DATA'!A2",
 "'[excel.xlsx]DATA'!A3",
```

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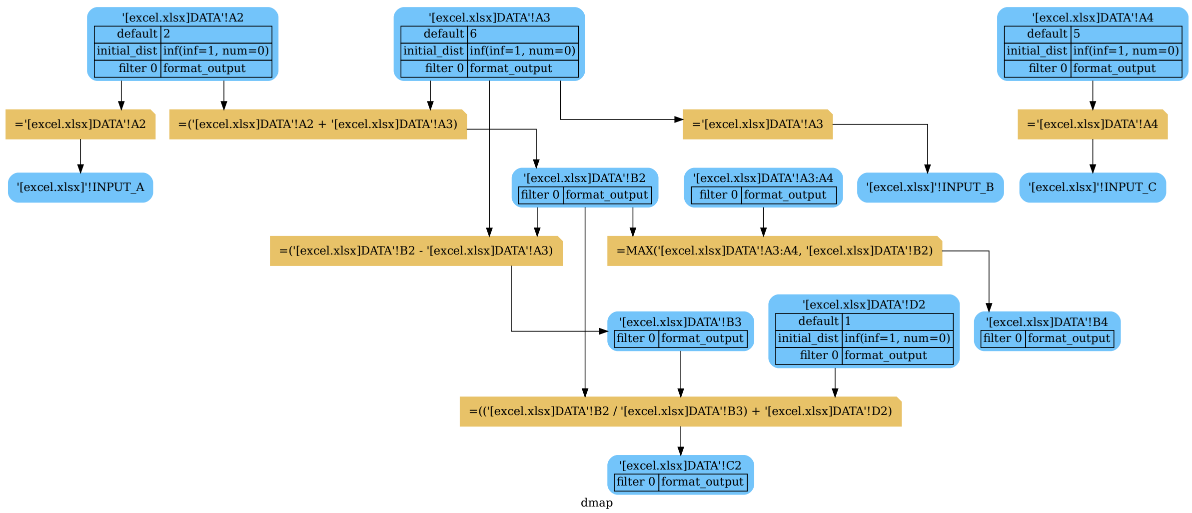
```
 "'[excel.xlsx]DATA'!A3:A4",
 "'[excel.xlsx]DATA'!A4",
 "'[excel.xlsx]DATA'!B2",
 "'[excel.xlsx]DATA'!B3",
 "'[excel.xlsx]DATA'!B4",
 "'[excel.xlsx]DATA'!C2",
 "'[excel.xlsx]DATA'!D2"]
```



JSON export/import

The *ExcelModel* can be exported/imported to/from a readable JSON format. The reason of this functionality is to have format that can be easily maintained (e.g. using version control programs like *git*). Follows an example on how to export/import to/from JSON an *ExcelModel*:

```
>>> import json
>>> xl_dict = xl_model.to_dict()  # To JSON-able dict.
>>> xl_dict  # Exported format.
{
 "'[excel.xlsx]DATA'!A1": "inputs",
 "'[excel.xlsx]DATA'!B1": "Intermediate",
 "'[excel.xlsx]DATA'!C1": "outputs",
 "'[excel.xlsx]DATA'!D1": "defaults",
 "'[excel.xlsx]DATA'!A2": 2,
 "'[excel.xlsx]DATA'!D2": 1,
 "'[excel.xlsx]DATA'!A3": 6,
 "'[excel.xlsx]DATA'!A4": 5,
 "'[excel.xlsx]DATA'!B2": "=('[excel.xlsx]DATA'!A2 + '[excel.xlsx]DATA'!A3)",
 "'[excel.xlsx]DATA'!C2": "=(('[excel.xlsx]DATA'!B2 / '[excel.xlsx]DATA'!B3) + '[excel.
↪xlsx]DATA'!D2)",
 "'[excel.xlsx]DATA'!B3": "=('[excel.xlsx]DATA'!B2 - '[excel.xlsx]DATA'!A3)",
 "'[excel.xlsx]DATA'!C3": "=(('[excel.xlsx]DATA'!C2 * '[excel.xlsx]DATA'!A2) + '[excel.
↪xlsx]DATA'!D3)",
```

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```
 "'[excel.xlsx]DATA'!D3": "=(1 + '[excel.xlsx]DATA'!D2)",
 "'[excel.xlsx]DATA'!B4": "=MAX('[excel.xlsx]DATA'!A3:A4, '[excel.xlsx]DATA'!B2)",
 "'[excel.xlsx]DATA'!C4": "=(('[excel.xlsx]DATA'!B3 ^ '[excel.xlsx]DATA'!C2) + '[excel.
↪xlsx]DATA'!D4)",
 "'[excel.xlsx]DATA'!D4": "=(1 + '[excel.xlsx]DATA'!D3)"
}
>>> xl_json = json.dumps(xl_dict, indent=True)  # To JSON.
>>> xl_model = formulas.ExcelModel().from_dict(json.loads(xl_json))  # From JSON.
```

2.2.3.3 Custom functions

An example how to add a custom function to the formula parser is the following:

```
>>> import formulas
>>> FUNCTIONS = formulas.get_functions()
>>> FUNCTIONS['MYFUNC'] = lambda x, y: 1 + y + x
>>> func = formulas.Parser().ast('=MYFUNC(1, 2)')[1].compile()
>>> func()
4
```

2.2.4 Next moves

Things yet to do: implement the missing Excel formulas.

2.2.5 Contributing to formulas

If you want to contribute to **formulas** and make it better, your help is very welcome. The contribution should be sent by a *pull request*. Next sections will explain how to implement and submit a new excel function:

- clone the repository
- implement a new function/functionality
- open a pull request

2.2.5.1 Clone the repository

The first step to contribute to **formulas** is to clone the repository:

- Create a personal fork of the formulas repository on Github.
- Clone the fork on your local machine. Your remote repo on Github is called `origin`.
- Add the original repository as a remote called `upstream`, to maintain updated your fork.
- If you created your fork a while ago be sure to pull `upstream` changes into your local repository.
- Create a new branch to work on! Branch from `dev`.

2.2.5.2 How to implement a new function

Before coding, study the Excel function that you want to implement. If there is something similar implemented in **formulas**, try to get inspired by the implemented code (I mean, not reinvent the wheel) and to use `numpy`. Follow the code style of the project, including indentation. Add or change the documentation as needed. Make sure that you have implemented the **full function syntax**, including the array syntax.

Test cases are very important. This library uses a data-driven testing approach. To implement a new function I recommend the test-driven development cycle. Hence, when you implement a new function, you should write new test cases in `test_cell/TestCell.test_output` suite to execute in the *cycle loop*. When you think that the code is ready, add new raw test in `test/test_files/test.xlsx` (please follow the standard used for other functions) and run the `test_excel/TestExcelModel.test_excel_model`. This requires more time but is needed to test the **array syntax** and to check if the Excel documentation respects the reality.

When all test cases are ok (`python setup.py test`), open a pull request.

Do do list:

- Study the excel function syntax and behaviour when used as array formula.
- Check if there is something similar implemented in formulas.
- Implement/fix your feature, comment your code.
- Write/adapt tests and run them!

Tip: Excel functions are categorized by their functionality. If you are implementing a new functionality group, add a new module in `formula/function` and in `formula.function.SUBMODULES` and a new worksheet in `test/test_files/test.xlsx` (please respect the format).

Note: A pull request without new test case will not be taken into consideration.

2.2.5.3 How to open a pull request

Well done! Your contribution is ready to be submitted:

- Squash your commits into a single commit with git's interactive rebase. Create a new branch if necessary. Always write your commit messages in the present tense. Your commit message should describe what the commit, when applied, does to the code – not what you did to the code.
- Push your branch to your fork on Github (i.e., `git push origin dev`).
- From your fork open a *pull request* in the correct branch. Target the project's `dev` branch!
- Once the *pull request* is approved and merged you can pull the changes from `upstream` to your local repo and delete your extra branch(es).

2.2.6 Donate

If you want to support the **formulas** development please donate and add your excel function preferences. The selection of the functions to be implemented is done considering the cumulative donation amount per function collected by the campaign.

Note: The cumulative donation amount per function is calculated as the example:

Function •	Donator 1 150€	Donator 2 120€	Donator 3 50€	TOT •	Implementation order •
SUM	50€	40€	25€	125€	1st
SIN	50€		25€	75€	3rd
TAN	50€	40€		90€	2nd
COS		40€		40€	4th

2.2.7 API Reference

The core of the library is composed from the following modules: It contains a comprehensive list of all modules and classes within formulas.

Modules:

parser	It provides formula parser class.
builder	It provides AstBuilder class.
errors	Defines the formulas exception.
tokens	It provides tokens needed to parse the Excel formulas.
functions	It provides functions implementations to compile the Excel functions.
ranges	It provides Ranges class.
cell	It provides Cell class.
excel	It provides Excel model class.

2.2.7.1 parser

It provides formula parser class.

Classes

Parser

Parser

class Parser

Methods

__init__
ast
is_formula

__init__

Parser.**__init__**()

ast

Parser.**ast**(*expression*, *context=None*)

is_formula

Parser.**is_formula**(*value*)

__init__()

Attributes

filters
formula_check

filters

```
Parser.filters = [<class 'formulas.tokens.operand.Error'>, <class
'formulas.tokens.operand.String'>, <class 'formulas.tokens.operand.Number'>, <class
'formulas.tokens.operand.Range'>, <class 'formulas.tokens.operator.OperatorToken'>,
<class 'formulas.tokens.operator.Separator'>, <class
'formulas.tokens.function.Function'>, <class 'formulas.tokens.function.Array'>,
<class 'formulas.tokens.parenthesis.Parenthesis'>, <class
'formulas.tokens.operator.Intersect'>]
```

formula_check

```
Parser.formula_check = regex.Regex('\n
(?P<array>^\\s*{\\s*=\\s*(?P<name>\\S.*)\\s*}\\s*$)\n |\n
(?P<value>^\\s*=\\s*(?P<name>\\S.*))\n ', flags=regex.S | regex.I | regex.X |
regex.V0)
```

2.2.7.2 builder

It provides AstBuilder class.

Classes

AstBuilder

AstBuilder

class AstBuilder(*dsp=None*, *nodes=None*, *match=None*)

Methods

`__init__`
`append`
`compile`
`finish`
`get_node_id`
`pop`

__init__

AstBuilder.**__init__**(*dsp=None*, *nodes=None*, *match=None*)

append

AstBuilder.**append**(*token*)

compile

AstBuilder.**compile**(*references=None*, *context=None*, ***inputs*)

finish

AstBuilder.**finish**()

get_node_id

AstBuilder.**get_node_id**(*token*)

pop

AstBuilder.**pop**()

__init__(*dsp=None*, *nodes=None*, *match=None*)

compile_class

alias of DispatchPipe

2.2.7.3 errors

Defines the formulas exception.

Exceptions

`BaseError`
`BroadcastError`
`FormulaError`
`FoundError`
`FunctionError`
`InvalidRangeError`
`InvalidRangeName`
`ParenthesesError`
`RangeValueError`
`TokenError`

BaseError

exception BaseError(**args*)

BroadcastError

exception BroadcastError(**args*)

FormulaError

exception FormulaError(**args*)

FoundError

exception FoundError(**args, err=None, **kwargs*)

FunctionError

exception FunctionError(**args*)

InvalidRangeError

exception InvalidRangeError(**args*)

InvalidRangeName

exception InvalidRangeName

ParenthesesError

exception ParenthesesError(**args*)

RangeValueError

exception RangeValueError(**args*)

TokenError

exception TokenError(**args*)

2.2.7.4 tokens

It provides tokens needed to parse the Excel formulas.

Sub-Modules:

function	It provides Function classes.
operand	It provides Operand classes.
operator	It provides Operator classes.
parenthesis	It provides Parenthesis class.

function

It provides Function classes.

Classes

Array	
Function	

Array

`class Array(s, context=None)`

Methods

__init__	
ast	
compile	
match	
process	
set_expr	
update_input_tokens	

__init__

`Array.__init__(s, context=None)`

ast

`Array.ast(tokens, stack, builder, check_n=<function Array.<lambda>>)`

compile

Array.**compile**()

match

Array.**match**(*s*)

process

Array.**process**(*match, context=None*)

set_expr

Array.**set_expr**(**tokens*)

update_input_tokens

Array.**update_input_tokens**(**tokens*)

__init__(*s, context=None*)

Attributes

name	
node_id	

name

property Array.**name**

node_id

property Array.**node_id**

Function

class **Function**(*s*, *context=None*)

Methods

__init__
ast
compile
match
process
set_expr
update_input_tokens

__init__

Function.**__init__**(*s*, *context=None*)

ast

Function.**ast**(*tokens*, *stack*, *builder*, *check_n=<function Function.<lambda>>*)

compile

Function.**compile**()

match

Function.**match**(*s*)

process

Function.**process**(*match*, *context=None*)

set_expr

Function.**set_expr**(**tokens*)

update_input_tokens

Function.**update_input_tokens**(**tokens*)

__init__(*s*, *context=None*)

Attributes

name	
node_id	

name

property Function.**name**

node_id

property Function.**node_id**

operand

It provides Operand classes.

Functions

fast_range2parts
fast_range2parts_v1
fast_range2parts_v2
fast_range2parts_v3
fast_range2parts_v4
fast_range2parts_v5
range2parts

fast_range2parts

fast_range2parts(***kw*)

fast_range2parts_v1

fast_range2parts_v1(*r1*, *c1*, *sheet_id*)

fast_range2parts_v2

fast_range2parts_v2(*r1*, *c1*, *r2*, *c2*, *sheet_id*)

fast_range2parts_v3

fast_range2parts_v3(*r1*, *n1*, *sheet_id*)

fast_range2parts_v4

fast_range2parts_v4(*r1*, *n1*, *r2*, *n2*, *sheet_id*)

fast_range2parts_v5

fast_range2parts_v5(*ref*, *sheet_id*)

range2parts

range2parts(*outputs*, ***inputs*)

Classes

Empty
Error
Number
Operand
Range
String
XlError

Empty

class Empty

Methods

__init__
ast
compile
match
process
set_expr
update_input_tokens

__init__

Empty.**__init__**()

ast

Empty.**ast**(*tokens*, *stack*, *builder*)

compile

static Empty.**compile**()

match

Empty.**match**(*s*)

process

Empty.**process**(*match*, *context=None*)

set_expr

Empty.**set_expr**(**tokens*)

update_input_tokens

Empty.**update_input_tokens**(**tokens*)

__init__()

Attributes

name
node_id

name

property Empty.**name**

node_id

property Empty.**node_id**

Error

class Error(*s*, *context=None*)

Methods

__init__
ast
compile
match
process
set_expr
update_input_tokens

__init__

Error.**__init__**(*s*, *context=None*)

ast

Error.**ast**(*tokens*, *stack*, *builder*)

compile

Error.**compile**()

match

Error.**match**(*s*)

process

Error.**process**(*match*, *context=None*)

set_expr

Error.**set_expr**(**tokens*)

update_input_tokens

Error.**update_input_tokens**(**tokens*)

__init__(*s*, *context=None*)

Attributes

errors	
name	
node_id	

errors

Error.**errors = {'#DIV/0!': #DIV/0!, '#N/A': #N/A, '#NAME?': #NAME?, '#NULL!': #NULL!, '#NUM!': #NUM!, '#REF!': #REF!, '#VALUE!': #VALUE!}**

name

property Error.**name**

node_id

property Error.**node_id**

Number

class Number(*s*, *context=None*)

Methods

__init__	
ast	
compile	
match	
process	
set_expr	
update_input_tokens	

__init__

Number.**__init__**(*s*, *context=None*)

ast

Number.**ast**(*tokens*, *stack*, *builder*)

compile

Number.**compile**()

match

Number.**match**(*s*)

process

Number.**process**(*match*, *context=None*)

set_expr

Number.**set_expr**(**tokens*)

update_input_tokens

Number.**update_input_tokens**(**tokens*)

__init__(*s*, *context=None*)

Attributes

name	
node_id	

name

property Number.**name**

node_id

property Number.**node_id**

Operand

class Operand(*s*, *context=None*)

Methods

__init__	
ast	
match	
process	
set_expr	
update_input_tokens	

__init__

Operand.**__init__**(*s*, *context=None*)

ast

Operand.**ast**(*tokens*, *stack*, *builder*)

match

Operand.**match**(*s*)

process

Operand.**process**(*match*, *context=None*)

set_expr

Operand.**set_expr**(**tokens*)

update_input_tokens

Operand.**update_input_tokens**(**tokens*)

__init__(*s*, *context=None*)

Attributes

name
node_id

name

property Operand.**name**

node_id

property Operand.**node_id**

Range

class **Range**(*s*, *context=None*)

Methods

__init__
ast
compile
match
process
set_expr
update_input_tokens

__init__

Range.**__init__**(*s*, *context=None*)

ast

Range.**ast**(*tokens*, *stack*, *builder*)

compile

Range.**compile**()

match

Range.**match**(*s*)

process

Range.**process**(*match*, *context=None*)

set_expr

Range.**set_expr**(**tokens*)

update_input_tokens

Range.**update_input_tokens**(**tokens*)

__init__(*s*, *context=None*)

Attributes

name
node_id

name

property Range.**name**

node_id

property Range.**node_id**

String

class String(*s*, *context=None*)

Methods

__init__
ast
compile
match
process
set_expr
update_input_tokens

__init__

String.**__init__**(*s*, *context=None*)

ast

String.**ast**(*tokens*, *stack*, *builder*)

compile

String.**compile**()

match

String.**match**(*s*)

process

String.**process**(*match*, *context=None*)

set_expr

String.**set_expr**(**tokens*)

update_input_tokens

String.**update_input_tokens**(**tokens*)

__init__(*s*, *context=None*)

Attributes

name	
node_id	

name

property String.**name**

node_id

property String.**node_id**

XlError

class XlError(**args*)

Methods

__init__	
capitalize	Return a capitalized version of the string.
casefold	Return a version of the string suitable for caseless comparisons.
center	Return a centered string of length width.
count	Return the number of non-overlapping occurrences of substring sub in string S[start:end].
encode	Encode the string using the codec registered for encoding.
endswith	Return True if S ends with the specified suffix, False otherwise.
expandtabs	Return a copy where all tab characters are expanded using spaces.
find	Return the lowest index in S where substring sub is found, such that sub is contained within S[start:end].
format	Return a formatted version of S, using substitutions from args and kwargs.
format_map	Return a formatted version of S, using substitutions from mapping.
index	Return the lowest index in S where substring sub is found, such that sub is contained within S[start:end].
isalnum	Return True if the string is an alpha-numeric string, False otherwise.
isalpha	Return True if the string is an alphabetic string, False otherwise.
isascii	Return True if all characters in the string are ASCII, False otherwise.
isdecimal	Return True if the string is a decimal string, False otherwise.
isdigit	Return True if the string is a digit string, False otherwise.
isidentifier	Return True if the string is a valid Python identifier, False otherwise.
islower	Return True if the string is a lowercase string, False otherwise.
isnumeric	Return True if the string is a numeric string, False otherwise.
isprintable	Return True if the string is printable, False otherwise.
isspace	Return True if the string is a whitespace string, False otherwise.
istitle	Return True if the string is a title-cased string, False otherwise.
isupper	Return True if the string is an uppercase string, False otherwise.

continues on next page

Table 1 – continued from previous page

join	Concatenate any number of strings.
ljust	Return a left-justified string of length width.
lower	Return a copy of the string converted to lowercase.
lstrip	Return a copy of the string with leading whitespace removed.
maketrans	Return a translation table usable for str.translate().
partition	Partition the string into three parts using the given separator.
removeprefix	Return a str with the given prefix string removed if present.
removesuffix	Return a str with the given suffix string removed if present.
replace	Return a copy with all occurrences of substring old replaced by new.
rfind	Return the highest index in S where substring sub is found, such that sub is contained within S[start:end].
rindex	Return the highest index in S where substring sub is found, such that sub is contained within S[start:end].
rjust	Return a right-justified string of length width.
rpartition	Partition the string into three parts using the given separator.
rsplit	Return a list of the substrings in the string, using sep as the separator string.
rstrip	Return a copy of the string with trailing whitespace removed.
split	Return a list of the substrings in the string, using sep as the separator string.
splitlines	Return a list of the lines in the string, breaking at line boundaries.
startswith	Return True if S starts with the specified prefix, False otherwise.
strip	Return a copy of the string with leading and trailing whitespace removed.
swapcase	Convert uppercase characters to lowercase and lowercase characters to uppercase.
title	Return a version of the string where each word is titlecased.
translate	Replace each character in the string using the given translation table.
upper	Return a copy of the string converted to uppercase.
zfill	Pad a numeric string with zeros on the left, to fill a field of the given width.

__init__

`XlError.__init__(*args)`

capitalize

`XlError.capitalize()`

Return a capitalized version of the string.

More specifically, make the first character have upper case and the rest lower case.

casefold

`XlError.casefold()`

Return a version of the string suitable for caseless comparisons.

center

`XlError.center(width, fillchar=' ', /)`

Return a centered string of length width.

Padding is done using the specified fill character (default is a space).

count

`XlError.count(sub[, start[, end]]) → int`

Return the number of non-overlapping occurrences of substring sub in string S[start:end]. Optional arguments start and end are interpreted as in slice notation.

encode

`XlError.encode(encoding='utf-8', errors='strict')`

Encode the string using the codec registered for encoding.

encoding
The encoding in which to encode the string.

errors
The error handling scheme to use for encoding errors. The default is 'strict' meaning that encoding errors raise a UnicodeEncodeError. Other possible values are 'ignore', 'replace' and 'xmlcharrefreplace' as well as any other name registered with codecs.register_error that can handle UnicodeEncodeErrors.

endswith

`XlError.endswith(suffix[, start[, end]]) → bool`

Return True if S ends with the specified suffix, False otherwise. With optional start, test S beginning at that position. With optional end, stop comparing S at that position. suffix can also be a tuple of strings to try.

expandtabs

`XlError.expandtabs(tabsize=8)`

Return a copy where all tab characters are expanded using spaces.

If tabsize is not given, a tab size of 8 characters is assumed.

find

`XlError.find(sub[, start[, end]]) → int`

Return the lowest index in S where substring sub is found, such that sub is contained within S[start:end]. Optional arguments start and end are interpreted as in slice notation.

Return -1 on failure.

format

`XlError.format(*args, **kwargs) → str`

Return a formatted version of S, using substitutions from args and kwargs. The substitutions are identified by braces ('{' and '}').

format_map

`XlError.format_map(mapping) → str`

Return a formatted version of S, using substitutions from mapping. The substitutions are identified by braces ('{' and '}').

index

`XlError.index(sub[, start[, end]]) → int`

Return the lowest index in S where substring sub is found, such that sub is contained within S[start:end]. Optional arguments start and end are interpreted as in slice notation.

Raises ValueError when the substring is not found.

isalnum

`XlError.isalnum()`

Return True if the string is an alpha-numeric string, False otherwise.

A string is alpha-numeric if all characters in the string are alpha-numeric and there is at least one character in the string.

isalpha

`XlError.isalpha()`

Return True if the string is an alphabetic string, False otherwise.

A string is alphabetic if all characters in the string are alphabetic and there is at least one character in the string.

isascii

`XlError.isascii()`

Return True if all characters in the string are ASCII, False otherwise.

ASCII characters have code points in the range U+0000-U+007F. Empty string is ASCII too.

isdecimal

`XlError.isdecimal()`

Return True if the string is a decimal string, False otherwise.

A string is a decimal string if all characters in the string are decimal and there is at least one character in the string.

isdigit

`XlError.isdigit()`

Return True if the string is a digit string, False otherwise.

A string is a digit string if all characters in the string are digits and there is at least one character in the string.

isidentifier

`XlError.isidentifier()`

Return True if the string is a valid Python identifier, False otherwise.

Call keyword.iskeyword(s) to test whether string s is a reserved identifier, such as “def” or “class”.

islower

`XlError.islower()`

Return True if the string is a lowercase string, False otherwise.

A string is lowercase if all cased characters in the string are lowercase and there is at least one cased character in the string.

isnumeric

`XlError.isnumeric()`

Return True if the string is a numeric string, False otherwise.

A string is numeric if all characters in the string are numeric and there is at least one character in the string.

isprintable

`XlError.isprintable()`

Return True if the string is printable, False otherwise.

A string is printable if all of its characters are considered printable in repr() or if it is empty.

isspace

`XlError.isspace()`

Return True if the string is a whitespace string, False otherwise.

A string is whitespace if all characters in the string are whitespace and there is at least one character in the string.

istitle

`XlError.istitle()`

Return True if the string is a title-cased string, False otherwise.

In a title-cased string, upper- and title-case characters may only follow uncased characters and lowercase characters only cased ones.

isupper

`XlError.isupper()`

Return True if the string is an uppercase string, False otherwise.

A string is uppercase if all cased characters in the string are uppercase and there is at least one cased character in the string.

join

`XlError.join(iterable, /)`

Concatenate any number of strings.

The string whose method is called is inserted in between each given string. The result is returned as a new string.

Example: '.'.join(['ab', 'pq', 'rs']) -> 'ab.pq.rs'

ljust

`XlError.ljust(width, fillchar=' ', /)`

Return a left-justified string of length width.

Padding is done using the specified fill character (default is a space).

lower

`XlError.lower()`

Return a copy of the string converted to lowercase.

lstrip

`XlError.lstrip(chars=None, /)`

Return a copy of the string with leading whitespace removed.

If chars is given and not None, remove characters in chars instead.

maketrans

`static XlError.maketrans()`

Return a translation table usable for str.translate().

If there is only one argument, it must be a dictionary mapping Unicode ordinals (integers) or characters to Unicode ordinals, strings or None. Character keys will be then converted to ordinals. If there are two arguments, they must be strings of equal length, and in the resulting dictionary, each character in x will be mapped to the character at the same position in y. If there is a third argument, it must be a string, whose characters will be mapped to None in the result.

partition

`XlError.partition(sep, /)`

Partition the string into three parts using the given separator.

This will search for the separator in the string. If the separator is found, returns a 3-tuple containing the part before the separator, the separator itself, and the part after it.

If the separator is not found, returns a 3-tuple containing the original string and two empty strings.

removeprefix

`XlError.removeprefix(prefix, /)`

Return a str with the given prefix string removed if present.

If the string starts with the prefix string, return string[len(prefix):]. Otherwise, return a copy of the original string.

removesuffix

`XlError.removesuffix(suffix, /)`

Return a str with the given suffix string removed if present.

If the string ends with the suffix string and that suffix is not empty, return string[:-len(suffix)]. Otherwise, return a copy of the original string.

replace

`XlError.replace(old, new, count=-1, /)`

Return a copy with all occurrences of substring old replaced by new.

count
Maximum number of occurrences to replace. -1 (the default value) means replace all occurrences.

If the optional argument count is given, only the first count occurrences are replaced.

rfind

`XlError.rfind(sub[, start[, end]]) → int`

Return the highest index in S where substring sub is found, such that sub is contained within S[start:end]. Optional arguments start and end are interpreted as in slice notation.

Return -1 on failure.

rindex

`XlError.rindex(sub[, start[, end]]) → int`

Return the highest index in S where substring sub is found, such that sub is contained within S[start:end]. Optional arguments start and end are interpreted as in slice notation.

Raises ValueError when the substring is not found.

rjust

`XlError.rjust(width, fillchar=' ', /)`

Return a right-justified string of length width.

Padding is done using the specified fill character (default is a space).

rpartition

`XlError.rpartition(sep, /)`

Partition the string into three parts using the given separator.

This will search for the separator in the string, starting at the end. If the separator is found, returns a 3-tuple containing the part before the separator, the separator itself, and the part after it.

If the separator is not found, returns a 3-tuple containing two empty strings and the original string.

rsplit

`XlError.rsplit(sep=None, maxsplit=-1)`

Return a list of the substrings in the string, using sep as the separator string.

sep
The separator used to split the string.

When set to None (the default value), will split on any whitespace character (including n r t f and spaces) and will discard empty strings from the result.

maxsplit
Maximum number of splits (starting from the left). -1 (the default value) means no limit.

Splitting starts at the end of the string and works to the front.

rstrip

`XlError.rstrip(chars=None, /)`

Return a copy of the string with trailing whitespace removed.

If chars is given and not None, remove characters in chars instead.

split

`XlError.split(sep=None, maxsplit=-1)`

Return a list of the substrings in the string, using sep as the separator string.

sep
The separator used to split the string.

When set to None (the default value), will split on any whitespace character (including n r t f and spaces) and will discard empty strings from the result.

maxsplit
Maximum number of splits (starting from the left). -1 (the default value) means no limit.

Note, str.split() is mainly useful for data that has been intentionally delimited. With natural text that includes punctuation, consider using the regular expression module.

splitlines

`XlError.splitlines(keepends=False)`

Return a list of the lines in the string, breaking at line boundaries.

Line breaks are not included in the resulting list unless keepends is given and true.

startswith

`XlError.startswith(prefix[, start[, end]]) → bool`

Return True if S starts with the specified prefix, False otherwise. With optional start, test S beginning at that position. With optional end, stop comparing S at that position. prefix can also be a tuple of strings to try.

strip

`XlError.strip(chars=None, /)`

Return a copy of the string with leading and trailing whitespace removed.

If chars is given and not None, remove characters in chars instead.

swapcase

`XlError.swapcase()`

Convert uppercase characters to lowercase and lowercase characters to uppercase.

title

`XlError.title()`

Return a version of the string where each word is titlecased.

More specifically, words start with uppercased characters and all remaining cased characters have lower case.

translate

`XlError.translate(table, /)`

Replace each character in the string using the given translation table.

table
Translation table, which must be a mapping of Unicode ordinals to Unicode ordinals, strings, or None.

The table must implement lookup/indexing via __getitem__, for instance a dictionary or list. If this operation raises LookupError, the character is left untouched. Characters mapped to None are deleted.

upper

XlError.**upper**()

Return a copy of the string converted to uppercase.

zfill

XlError.**zfill**(*width*, /)

Pad a numeric string with zeros on the left, to fill a field of the given width.

The string is never truncated.

__init__(**args*)

operator

It provides Operator classes.

Classes

Intersect
Operator
OperatorToken
Separator

Intersect

class Intersect(*s*, *context=None*)

Methods

__init__
ast
compile
match
process
set_expr
update_input_tokens
update_name

__init__

Intersect.**__init__**(*s*, *context=None*)

ast

Intersect.**ast**(*tokens*, *stack*, *builder*)

compile

Intersect.**compile**()

match

Intersect.**match**(*s*)

process

Intersect.**process**(*match*, *context=None*)

set_expr

Intersect.**set_expr**(**tokens*)

update_input_tokens

Intersect.**update_input_tokens**(**tokens*)

update_name

Intersect.**update_name**(*tokens, stack*)

__init__(*s, context=None*)

Attributes

get_n_args
name
node_id
pred

get_n_args

property Intersect.**get_n_args**

name

property Intersect.**name**

node_id

property Intersect.**node_id**

pred

property Intersect.**pred**

Operator

class **Operator**(*s*, *context=None*)

Methods

__init__
ast
compile
match
process
set_expr
update_input_tokens
update_name

__init__

Operator.**__init__**(*s*, *context=None*)

ast

Operator.**ast**(*tokens*, *stack*, *builder*)

compile

Operator.**compile**()

match

Operator.**match**(*s*)

process

Operator.**process**(*match*, *context=None*)

set_expr

Operator.**set_expr**(**tokens*)

update_input_tokens

Operator.**update_input_tokens**(**tokens*)

update_name

Operator.**update_name**(*tokens*, *stack*)

__init__(*s*, *context=None*)

Attributes

get_n_args
name
node_id
pred

get_n_args

property Operator.**get_n_args**

name

property Operator.**name**

node_id

property Operator.**node_id**

pred

property Operator.**pred**

OperatorToken

class OperatorToken(*s*, *context=None*)

Methods

__init__
ast
compile
match
process
set_expr
update_input_tokens
update_name

__init__

OperatorToken.**__init__**(*s*, *context=None*)

ast

OperatorToken.**ast**(*tokens*, *stack*, *builder*)

compile

OperatorToken.**compile**()

match

OperatorToken.**match**(*s*)

process

OperatorToken.**process**(*match*, *context=None*)

set_expr

OperatorToken.**set_expr**(**tokens*)

update_input_tokens

OperatorToken.**update_input_tokens**(**tokens*)

update_name

OperatorToken.**update_name**(*tokens*, *stack*)

__init__(*s*, *context=None*)

Attributes

get_n_args
name
node_id
pred

get_n_args

property OperatorToken.**get_n_args**

name

property OperatorToken.**name**

node_id

property OperatorToken.**node_id**

pred

property OperatorToken.**pred**

Separator

class Separator(*s*, *context=None*)

Methods

__init__	
ast	
compile	
match	
process	
set_expr	
update_input_tokens	
update_name	

__init__

Separator.**__init__**(*s*, *context=None*)

ast

Separator.**ast**(*tokens*, *stack*, *builder*)

compile

Separator.**compile**()

match

Separator.**match**(*s*)

process

Separator.**process**(*match*, *context=None*)

set_expr

Separator.**set_expr**(**tokens*)

update_input_tokens

Separator.**update_input_tokens**(**tokens*)

update_name

Separator.**update_name**(*tokens*, *stack*)

__init__(*s*, *context=None*)

Attributes

get_n_args
name
node_id
pred

get_n_args

property Separator.**get_n_args**

name

property Separator.**name**

node_id

property Separator.**node_id**

pred

property Separator.**pred**

parenthesis

It provides Parenthesis class.

Classes

Parenthesis

Parenthesis

class Parenthesis(*s*, *context=None*)

Methods

__init__
ast
match
process
set_expr
update_input_tokens

__init__

Parenthesis.**__init__**(*s*, *context=None*)

ast

Parenthesis.**ast**(*tokens*, *stack*, *builder*)

match

Parenthesis.**match**(*s*)

process

Parenthesis.**process**(*match*, *context=None*)

set_expr

Parenthesis.**set_expr**(**tokens*)

update_input_tokens

Parenthesis.**update_input_tokens**(**tokens*)

__init__(*s*, *context=None*)

Attributes

n_args
name
node_id
opens

n_args

`Parenthesis.n_args = 0`

name

`property Parenthesis.name`

node_id

`property Parenthesis.node_id`

opens

`Parenthesis.opens = {')': '('}`

Classes

Token

Token

`class Token(s, context=None)`

Methods

__init__
ast
match
process
set_expr
update_input_tokens

__init__

Token.**__init__**(*s*, *context=None*)

ast

Token.**ast**(*tokens*, *stack*, *builder*)

match

Token.**match**(*s*)

process

Token.**process**(*match*, *context=None*)

set_expr

Token.**set_expr**(**tokens*)

update_input_tokens

Token.**update_input_tokens**(**tokens*)

__init__(*s*, *context=None*)

Attributes

name	
node_id	

name

property Token.**name**

node_id

property Token.**node_id**

2.2.7.5 functions

It provides functions implementations to compile the Excel functions.

Sub-Modules:

comp	Python equivalents of compatibility Excel functions.
date	Python equivalents of financial Excel functions.
eng	Python equivalents of engineering Excel functions.
financial	Python equivalents of financial Excel functions.
google	Python equivalents of google Excel functions.
info	Python equivalents of information Excel functions.
logic	Python equivalents of logical Excel functions.
look	Python equivalents of lookup and reference Excel functions.
math	Python equivalents of math and trigonometry Excel functions.
operators	Python equivalents of Excel operators.
stat	Python equivalents of statistical Excel functions.
text	Python equivalents of text Excel functions.

comp

Python equivalents of compatibility Excel functions.

date

Python equivalents of financial Excel functions.

Functions

xdate	
xdatedif	
xdatevalue	
xday	
xedate	
xisoweeknum	
xnow	
xsecond	
xtime	
xtimevalue	
xtoday	
xweekday	
xweeknum	
xyearfrac	

xdate

xdate(*year*, *month*, *day*)

xdatedif

xdatedif(*start_date*, *end_date*, *unit*)

xdatevalue

xdatevalue(*date_text*)

xday

xday(*serial_number*, *n=2*)

xedate

xedate(*start_date*, *months*)

xisoweeknum

xisoweeknum(*serial_number*)

xnow

xnow()

xsecond

xsecond(*serial_number*, *n=2*)

xtime

xtime(*hour*, *minute*, *second*)

xtimevalue

xtimevalue(*time_text*)

xtoday

xtoday()

xweekday

xweekday(*serial_number*, *n=1*)

xweeknum

xweeknum(*serial_number*, *n=1*)

xyearfrac

xyearfrac(*start_date*, *end_date*, *basis=0*)

eng

Python equivalents of engineering Excel functions.

Functions

hex2dec2bin2oct

hex2dec2bin2oct

hex2dec2bin2oct(*function_id*, *memo*)

financial

Python equivalents of financial Excel functions.

Functions

xcumipmt
xirr
xnper
xnpv
xppmt
xrate
xxirr
xxnpv

xcumipmt

xcumipmt(*rate*, *nper*, *pv*, *start_period*, *end_period*, *type*)

xirr

xirr(*values*, *guess=0.1*)

xnper

xnper(*rate*, *pmt*, *pv*, *fv=0*, *type=0*)

xnpv

xnpv(*rate*, *values*, *dates=None*)

xppmt

xppmt(*rate*, *per*, *nper*, *pv*, *fv=0*, *type=0*)

xrate

xrate(*nper*, *pmt*, *pv*, *fv=0*, *type=0*, *guess=0.1*)

xxirr

xxirr(*values*, *dates*, *x=0.1*)

xxnpv

xxnpv(*rate*, *values*, *dates*)

google

Python equivalents of google Excel functions.

Functions

xdummy

xdummy

xdummy(**args*)

info

Python equivalents of information Excel functions.

Functions

iserr
iserror
isna
xiseven_odd
xna

iserr

iserr(*val*)

iserror

iserror(*val*, *check=<function <lambda>>*, *array=<class 'formulas.functions.info.IsErrorArray'>*)

isna

isna(*value*)

xiseven_odd

xiseven_odd(*number*, *odd=False*)

xna

xna()

Classes

IsErrArray
IsErrorArray
IsNaArray
IsNumberArray

IsErrArray

class IsErrArray

Methods

__init__	
all	Returns True if all elements evaluate to True.
any	Returns True if any of the elements of *a* evaluate to True.
argmax	Return indices of the maximum values along the given axis.
argmin	Return indices of the minimum values along the given axis.
argpartition	Returns the indices that would partition this array.
argsort	Returns the indices that would sort this array.
astype	Copy of the array, cast to a specified type.
byteswap	Swap the bytes of the array elements
choose	Use an index array to construct a new array from a set of choices.
clip	Return an array whose values are limited to `[min, max]`.
collapse	
compress	Return selected slices of this array along given axis.
conj	Complex-conjugate all elements.

continues on next page

Table 2 – continued from previous page

`conjugate`	Return the complex conjugate, element-wise.
`copy`	Return a copy of the array.
`cumprod`	Return the cumulative product of the elements along the given axis.
`cumsum`	Return the cumulative sum of the elements along the given axis.
`diagonal`	Return specified diagonals.
`dot`	
`dump`	Dump a pickle of the array to the specified file.
`dumps`	Returns the pickle of the array as a string.
`fill`	Fill the array with a scalar value.
`flatten`	Return a copy of the array collapsed into one dimension.
`getfield`	Returns a field of the given array as a certain type.
`item`	Copy an element of an array to a standard Python scalar and return it.
`itemset`	Insert scalar into an array (scalar is cast to array's dtype, if possible)
`max`	Return the maximum along a given axis.
`mean`	Returns the average of the array elements along given axis.
`min`	Return the minimum along a given axis.
`newbyteorder`	Return the array with the same data viewed with a different byte order.
`nonzero`	Return the indices of the elements that are non-zero.
`partition`	Rearranges the elements in the array in such a way that the value of the element in kth position is in the position it would be in a sorted array.
`prod`	Return the product of the array elements over the given axis
`ptp`	Peak to peak (maximum - minimum) value along a given axis.
`put`	Set `a.flat[n] = values[n]` for all *n* in indices.
`ravel`	Return a flattened array.
`repeat`	Repeat elements of an array.
`reshape`	Returns an array containing the same data with a new shape.
`resize`	Change shape and size of array in-place.
`round`	Return *a* with each element rounded to the given number of decimals.
`searchsorted`	Find indices where elements of v should be inserted in a to maintain order.
`setfield`	Put a value into a specified place in a field defined by a data-type.
`setflags`	Set array flags WRITEABLE, ALIGNED, WRITEBACKIFCOPY, respectively.
`sort`	Sort an array in-place.
`squeeze`	Remove axes of length one from *a*.
`std`	Returns the standard deviation of the array elements along given axis.

continues on next page

Table 2 – continued from previous page

`sum`	Return the sum of the array elements over the given axis.
`swapaxes`	Return a view of the array with *axis1* and *axis2* interchanged.
`take`	Return an array formed from the elements of *a* at the given indices.
`tobytes`	Construct Python bytes containing the raw data bytes in the array.
`tofile`	Write array to a file as text or binary (default).
`tolist`	Return the array as an `a.ndim`-levels deep nested list of Python scalars.
`tostring`	A compatibility alias for *tobytes*, with exactly the same behavior.
`trace`	Return the sum along diagonals of the array.
`transpose`	Returns a view of the array with axes transposed.
`var`	Returns the variance of the array elements, along given axis.
`view`	New view of array with the same data.

__init__

`IsErrArray.__init__()`

all

`IsErrArray.all`(*axis=None*, *out=None*, *keepdims=False*, *, *where=True*)

Returns True if all elements evaluate to True.

Refer to *numpy.all* for full documentation.

See Also

numpy.all : equivalent function

any

`IsErrArray.any`(*axis=None*, *out=None*, *keepdims=False*, *, *where=True*)

Returns True if any of the elements of *a* evaluate to True.

Refer to *numpy.any* for full documentation.

See Also

numpy.any : equivalent function

argmax

`IsErrArray.`**`argmax`**`(`*axis=None*, *out=None*, *, *keepdims=False*`)`

Return indices of the maximum values along the given axis.

Refer to *numpy.argmax* for full documentation.

See Also

numpy.argmax : equivalent function

argmin

`IsErrArray.`**`argmin`**`(`*axis=None*, *out=None*, *, *keepdims=False*`)`

Return indices of the minimum values along the given axis.

Refer to *numpy.argmin* for detailed documentation.

See Also

numpy.argmin : equivalent function

argpartition

`IsErrArray.`**`argpartition`**`(`*kth*, *axis=-1*, *kind='introselect'*, *order=None*`)`

Returns the indices that would partition this array.

Refer to *numpy.argpartition* for full documentation.

New in version 1.8.0.

See Also

numpy.argpartition : equivalent function

argsort

`IsErrArray.argsort(axis=-1, kind=None, order=None)`

Returns the indices that would sort this array.

Refer to *numpy.argsort* for full documentation.

See Also

numpy.argsort : equivalent function

astype

`IsErrArray.astype(dtype, order='K', casting='unsafe', subok=True, copy=True)`

Copy of the array, cast to a specified type.

Parameters

dtype
[str or dtype] Typecode or data-type to which the array is cast.

order
[{'C', 'F', 'A', 'K'}, optional] Controls the memory layout order of the result. 'C' means C order, 'F' means Fortran order, 'A' means 'F' order if all the arrays are Fortran contiguous, 'C' order otherwise, and 'K' means as close to the order the array elements appear in memory as possible. Default is 'K'.

casting
[{'no', 'equiv', 'safe', 'same_kind', 'unsafe'}, optional] Controls what kind of data casting may occur. Defaults to 'unsafe' for backwards compatibility.

- 'no' means the data types should not be cast at all.
- 'equiv' means only byte-order changes are allowed.
- 'safe' means only casts which can preserve values are allowed.
- 'same_kind' means only safe casts or casts within a kind, like float64 to float32, are allowed.
- 'unsafe' means any data conversions may be done.

subok
[bool, optional] If True, then sub-classes will be passed-through (default), otherwise the returned array will be forced to be a base-class array.

copy
[bool, optional] By default, astype always returns a newly allocated array. If this is set to false, and the *dtype*, *order*, and *subok* requirements are satisfied, the input array is returned instead of a copy.

Returns

arr_t
[ndarray] Unless *copy* is False and the other conditions for returning the input array are satisfied (see description for *copy* input parameter), *arr_t* is a new array of the same shape as the input array, with dtype, order given by *dtype*, *order*.

Notes

Changed in version 1.17.0: Casting between a simple data type and a structured one is possible only for "unsafe" casting. Casting to multiple fields is allowed, but casting from multiple fields is not.

Changed in version 1.9.0: Casting from numeric to string types in 'safe' casting mode requires that the string dtype length is long enough to store the max integer/float value converted.

Raises

ComplexWarning
When casting from complex to float or int. To avoid this, one should use `a.real.astype(t)`.

Examples

```
>>> x = np.array([1, 2, 2.5])
>>> x
array([1. ,  2. ,  2.5])
```

```
>>> x.astype(int)
array([1, 2, 2])
```

byteswap

`IsErrArray.`**`byteswap`**(*inplace=False*)
Swap the bytes of the array elements

Toggle between low-endian and big-endian data representation by returning a byteswapped array, optionally swapped in-place. Arrays of byte-strings are not swapped. The real and imaginary parts of a complex number are swapped individually.

Parameters

inplace
[bool, optional] If `True`, swap bytes in-place, default is `False`.

Returns

out
[ndarray] The byteswapped array. If *inplace* is `True`, this is a view to self.

Examples

```
>>> A = np.array([1, 256, 8755], dtype=np.int16)
>>> list(map(hex, A))
['0x1', '0x100', '0x2233']
>>> A.byteswap(inplace=True)
array([  256,     1, 13090], dtype=int16)
>>> list(map(hex, A))
['0x100', '0x1', '0x3322']
```

Arrays of byte-strings are not swapped

```
>>> A = np.array([b'ceg', b'fac'])
>>> A.byteswap()
array([b'ceg', b'fac'], dtype='|S3')
```

`A.newbyteorder().byteswap()` produces an array with the same values
but different representation in memory

```
>>> A = np.array([1, 2, 3])
>>> A.view(np.uint8)
array([1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 3, 0, 0, 0, 0, 0,
       0, 0], dtype=uint8)
>>> A.newbyteorder().byteswap(inplace=True)
array([1, 2, 3])
>>> A.view(np.uint8)
array([0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0,
       0, 3], dtype=uint8)
```

choose

`IsErrArray.`**`choose`**(*choices*, *out=None*, *mode='raise'*)

Use an index array to construct a new array from a set of choices.

Refer to *numpy.choose* for full documentation.

See Also

numpy.choose : equivalent function

clip

`IsErrArray.clip(min=None, max=None, out=None, **kwargs)`

Return an array whose values are limited to `[min, max]`. One of max or min must be given.

Refer to *numpy.clip* for full documentation.

See Also

numpy.clip : equivalent function

collapse

`IsErrArray.collapse(shape)`

compress

`IsErrArray.compress(condition, axis=None, out=None)`

Return selected slices of this array along given axis.

Refer to *numpy.compress* for full documentation.

See Also

numpy.compress : equivalent function

conj

`IsErrArray.conj()`

Complex-conjugate all elements.

Refer to *numpy.conjugate* for full documentation.

See Also

numpy.conjugate : equivalent function

conjugate

`IsErrArray.conjugate()`

Return the complex conjugate, element-wise.

Refer to *numpy.conjugate* for full documentation.

See Also

numpy.conjugate : equivalent function

copy

`IsErrArray.copy(order='C')`

Return a copy of the array.

Parameters

order

[{'C', 'F', 'A', 'K'}, optional] Controls the memory layout of the copy. 'C' means C-order, 'F' means F-order, 'A' means 'F' if *a* is Fortran contiguous, 'C' otherwise. 'K' means match the layout of *a* as closely as possible. (Note that this function and `numpy.copy()` are very similar but have different default values for their order= arguments, and this function always passes sub-classes through.)

See also

numpy.copy : Similar function with different default behavior numpy.copyto

Notes

This function is the preferred method for creating an array copy. The function `numpy.copy()` is similar, but it defaults to using order 'K', and will not pass sub-classes through by default.

Examples

```
>>> x = np.array([[1,2,3],[4,5,6]], order='F')
```

```
>>> y = x.copy()
```

```
>>> x.fill(0)
```

```
>>> x
array([[0, 0, 0],
       [0, 0, 0]])
```

```
>>> y
array([[1, 2, 3],
       [4, 5, 6]])
```

```
>>> y.flags['C_CONTIGUOUS']
True
```

cumprod

IsErrArray.**cumprod**(*axis=None*, *dtype=None*, *out=None*)

Return the cumulative product of the elements along the given axis.

Refer to *numpy.cumprod* for full documentation.

See Also

numpy.cumprod : equivalent function

cumsum

IsErrArray.**cumsum**(*axis=None*, *dtype=None*, *out=None*)

Return the cumulative sum of the elements along the given axis.

Refer to *numpy.cumsum* for full documentation.

See Also

numpy.cumsum : equivalent function

diagonal

IsErrArray.**diagonal**(*offset=0*, *axis1=0*, *axis2=1*)

Return specified diagonals. In NumPy 1.9 the returned array is a read-only view instead of a copy as in previous NumPy versions. In a future version the read-only restriction will be removed.

Refer to `numpy.diagonal()` for full documentation.

See Also

numpy.diagonal : equivalent function

dot

IsErrArray.**dot**()

dump

IsErrArray.**dump**(*file*)

Dump a pickle of the array to the specified file. The array can be read back with pickle.load or numpy.load.

Parameters

file
[str or Path] A string naming the dump file.

Changed in version 1.17.0: *pathlib.Path* objects are now accepted.

dumps

IsErrArray.**dumps**()

Returns the pickle of the array as a string. pickle.loads will convert the string back to an array.

Parameters

None

fill

IsErrArray.**fill**(*value*)

Fill the array with a scalar value.

Parameters

value
[scalar] All elements of *a* will be assigned this value.

Examples

```
>>> a = np.array([1, 2])
>>> a.fill(0)
>>> a
array([0, 0])
>>> a = np.empty(2)
>>> a.fill(1)
>>> a
array([1.,  1.])
```

Fill expects a scalar value and always behaves the same as assigning to a single array element. The following is a rare example where this distinction is important:

```
>>> a = np.array([None, None], dtype=object)
>>> a[0] = np.array(3)
>>> a
array([array(3), None], dtype=object)
>>> a.fill(np.array(3))
>>> a
array([array(3), array(3)], dtype=object)
```

Where other forms of assignments will unpack the array being assigned:

```
>>> a[...] = np.array(3)
>>> a
array([3, 3], dtype=object)
```

flatten

`IsErrArray.flatten(order='C')`

Return a copy of the array collapsed into one dimension.

Parameters

order

[{'C', 'F', 'A', 'K'}, optional] 'C' means to flatten in row-major (C-style) order. 'F' means to flatten in column-major (Fortran- style) order. 'A' means to flatten in column-major order if *a* is Fortran *contiguous* in memory, row-major order otherwise. 'K' means to flatten *a* in the order the elements occur in memory. The default is 'C'.

Returns

y

[ndarray] A copy of the input array, flattened to one dimension.

See Also

ravel : Return a flattened array. flat : A 1-D flat iterator over the array.

Examples

```
>>> a = np.array([[1,2], [3,4]])
>>> a.flatten()
array([1, 2, 3, 4])
>>> a.flatten('F')
array([1, 3, 2, 4])
```

getfield

IsErrArray.**getfield**(*dtype*, *offset=0*)

Returns a field of the given array as a certain type.

A field is a view of the array data with a given data-type. The values in the view are determined by the given type and the offset into the current array in bytes. The offset needs to be such that the view dtype fits in the array dtype; for example an array of dtype complex128 has 16-byte elements. If taking a view with a 32-bit integer (4 bytes), the offset needs to be between 0 and 12 bytes.

Parameters

dtype
[str or dtype] The data type of the view. The dtype size of the view can not be larger than that of the array itself.

offset
[int] Number of bytes to skip before beginning the element view.

Examples

```
>>> x = np.diag([1.+1.j]*2)
>>> x[1, 1] = 2 + 4.j
>>> x
array([[1.+1.j,  0.+0.j],
       [0.+0.j,  2.+4.j]])
>>> x.getfield(np.float64)
array([[1.,  0.],
       [0.,  2.]])
```

By choosing an offset of 8 bytes we can select the complex part of the array for our view:

```
>>> x.getfield(np.float64, offset=8)
array([[1.,  0.],
       [0.,  4.]])
```

item

IsErrArray.**item**(**args*)

Copy an element of an array to a standard Python scalar and return it.

Parameters

*args : Arguments (variable number and type)

- none: in this case, the method only works for arrays with one element (*a.size == 1*), which element is copied into a standard Python scalar object and returned.
- int_type: this argument is interpreted as a flat index into the array, specifying which element to copy and return.
- tuple of int_types: functions as does a single int_type argument, except that the argument is interpreted as an nd-index into the array.

Returns

z

[Standard Python scalar object] A copy of the specified element of the array as a suitable Python scalar

Notes

When the data type of *a* is longdouble or clongdouble, item() returns a scalar array object because there is no available Python scalar that would not lose information. Void arrays return a buffer object for item(), unless fields are defined, in which case a tuple is returned.

item is very similar to a[args], except, instead of an array scalar, a standard Python scalar is returned. This can be useful for speeding up access to elements of the array and doing arithmetic on elements of the array using Python's optimized math.

Examples

```
>>> np.random.seed(123)
>>> x = np.random.randint(9, size=(3, 3))
>>> x
array([[2, 2, 6],
       [1, 3, 6],
       [1, 0, 1]])
>>> x.item(3)
1
>>> x.item(7)
0
>>> x.item((0, 1))
2
>>> x.item((2, 2))
1
```

itemset

IsErrArray.**itemset**(**args*)

Insert scalar into an array (scalar is cast to array's dtype, if possible)

There must be at least 1 argument, and define the last argument as *item*. Then, `a.itemset(*args)` is equivalent to but faster than `a[args] = item`. The item should be a scalar value and *args* must select a single item in the array *a*.

Parameters

***args**

[Arguments] If one argument: a scalar, only used in case *a* is of size 1. If two arguments: the last argument is the value to be set and must be a scalar, the first argument specifies a single array element location. It is either an int or a tuple.

Notes

Compared to indexing syntax, *itemset* provides some speed increase for placing a scalar into a particular location in an *ndarray*, if you must do this. However, generally this is discouraged: among other problems, it complicates the appearance of the code. Also, when using *itemset* (and *item*) inside a loop, be sure to assign the methods to a local variable to avoid the attribute look-up at each loop iteration.

Examples

```
>>> np.random.seed(123)
>>> x = np.random.randint(9, size=(3, 3))
>>> x
array([[2, 2, 6],
       [1, 3, 6],
       [1, 0, 1]])
>>> x.itemset(4, 0)
>>> x.itemset((2, 2), 9)
>>> x
array([[2, 2, 6],
       [1, 0, 6],
       [1, 0, 9]])
```

max

IsErrArray.**max**(*axis=None*, *out=None*, *keepdims=False*, *initial=<no value>*, *where=True*)

Return the maximum along a given axis.

Refer to *numpy.amax* for full documentation.

See Also

numpy.amax : equivalent function

mean

IsErrArray.**mean**(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, ***, *where=True*)

Returns the average of the array elements along given axis.

Refer to *numpy.mean* for full documentation.

See Also

numpy.mean : equivalent function

min

IsErrArray.**min**(*axis=None*, *out=None*, *keepdims=False*, *initial=<no value>*, *where=True*)

Return the minimum along a given axis.

Refer to *numpy.amin* for full documentation.

See Also

numpy.amin : equivalent function

newbyteorder

IsErrArray.**newbyteorder**(*new_order='S'*, */*)

Return the array with the same data viewed with a different byte order.

Equivalent to:

```
arr.view(arr.dtype.newbytorder(new_order))
```

Changes are also made in all fields and sub-arrays of the array data type.

Parameters

new_order
[string, optional] Byte order to force; a value from the byte order specifications below. *new_order* codes can be any of:

- 'S' - swap dtype from current to opposite endian
- {'<', 'little'} - little endian
- {'>', 'big'} - big endian
- {'=', 'native'} - native order, equivalent to *sys.byteorder*

- {'|', 'I'} - ignore (no change to byte order)

The default value ('S') results in swapping the current byte order.

Returns

new_arr
[array] New array object with the dtype reflecting given change to the byte order.

nonzero

`IsErrArray.nonzero()`

Return the indices of the elements that are non-zero.

Refer to *numpy.nonzero* for full documentation.

See Also

numpy.nonzero : equivalent function

partition

`IsErrArray.partition`(*kth*, *axis=-1*, *kind='introselect'*, *order=None*)

Rearranges the elements in the array in such a way that the value of the element in kth position is in the position it would be in a sorted array. All elements smaller than the kth element are moved before this element and all equal or greater are moved behind it. The ordering of the elements in the two partitions is undefined.

New in version 1.8.0.

Parameters

kth
[int or sequence of ints] Element index to partition by. The kth element value will be in its final sorted position and all smaller elements will be moved before it and all equal or greater elements behind it. The order of all elements in the partitions is undefined. If provided with a sequence of kth it will partition all elements indexed by kth of them into their sorted position at once.

Deprecated since version 1.22.0: Passing booleans as index is deprecated.

axis
[int, optional] Axis along which to sort. Default is -1, which means sort along the last axis.

kind
[{'introselect'}, optional] Selection algorithm. Default is 'introselect'.

order
[str or list of str, optional] When *a* is an array with fields defined, this argument specifies which fields to compare first, second, etc. A single field can be specified as a string, and not all fields need to be specified, but unspecified fields will still be used, in the order in which they come up in the dtype, to break ties.

See Also

numpy.partition : Return a partitioned copy of an array. argpartition : Indirect partition. sort : Full sort.

Notes

See `np.partition` for notes on the different algorithms.

Examples

```
>>> a = np.array([3, 4, 2, 1])
>>> a.partition(3)
>>> a
array([2, 1, 3, 4])
```

```
>>> a.partition((1, 3))
>>> a
array([1, 2, 3, 4])
```

prod

`IsErrArray.prod`(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, *initial=1*, *where=True*)

Return the product of the array elements over the given axis

Refer to *numpy.prod* for full documentation.

See Also

numpy.prod : equivalent function

ptp

`IsErrArray.ptp`(*axis=None*, *out=None*, *keepdims=False*)

Peak to peak (maximum - minimum) value along a given axis.

Refer to *numpy.ptp* for full documentation.

See Also

numpy.ptp : equivalent function

put

`IsErrArray.put(indices, values, mode='raise')`

Set `a.flat[n] = values[n]` for all *n* in indices.

Refer to *numpy.put* for full documentation.

See Also

numpy.put : equivalent function

ravel

`IsErrArray.ravel([order])`

Return a flattened array.

Refer to *numpy.ravel* for full documentation.

See Also

numpy.ravel : equivalent function

ndarray.flat : a flat iterator on the array.

repeat

`IsErrArray.repeat(repeats, axis=None)`

Repeat elements of an array.

Refer to *numpy.repeat* for full documentation.

See Also

numpy.repeat : equivalent function

reshape

`IsErrArray.reshape(shape, order='C')`

Returns an array containing the same data with a new shape.

Refer to *numpy.reshape* for full documentation.

See Also

numpy.reshape : equivalent function

Notes

Unlike the free function *numpy.reshape*, this method on *ndarray* allows the elements of the shape parameter to be passed in as separate arguments. For example, `a.reshape(10, 11)` is equivalent to `a.reshape((10, 11))`.

resize

`IsErrArray.`**`resize`**(*new_shape*, *refcheck=True*)

Change shape and size of array in-place.

Parameters

new_shape
[tuple of ints, or *n* ints] Shape of resized array.

refcheck
[bool, optional] If False, reference count will not be checked. Default is True.

Returns

None

Raises

ValueError
If *a* does not own its own data or references or views to it exist, and the data memory must be changed. PyPy only: will always raise if the data memory must be changed, since there is no reliable way to determine if references or views to it exist.

SystemError
If the *order* keyword argument is specified. This behaviour is a bug in NumPy.

See Also

resize : Return a new array with the specified shape.

Notes

This reallocates space for the data area if necessary.

Only contiguous arrays (data elements consecutive in memory) can be resized.

The purpose of the reference count check is to make sure you do not use this array as a buffer for another Python object and then reallocate the memory. However, reference counts can increase in other ways so if you are sure that you have not shared the memory for this array with another Python object, then you may safely set *refcheck* to False.

Examples

Shrinking an array: array is flattened (in the order that the data are stored in memory), resized, and reshaped:

```
>>> a = np.array([[0, 1], [2, 3]], order='C')
>>> a.resize((2, 1))
>>> a
array([[0],
       [1]])
```

```
>>> a = np.array([[0, 1], [2, 3]], order='F')
>>> a.resize((2, 1))
>>> a
array([[0],
       [2]])
```

Enlarging an array: as above, but missing entries are filled with zeros:

```
>>> b = np.array([[0, 1], [2, 3]])
>>> b.resize(2, 3) # new_shape parameter doesn't have to be a tuple
>>> b
array([[0, 1, 2],
       [3, 0, 0]])
```

Referencing an array prevents resizing…

```
>>> c = a
>>> a.resize((1, 1))
Traceback (most recent call last):
...
ValueError: cannot resize an array that references or is referenced ...
```

Unless *refcheck* is False:

```
>>> a.resize((1, 1), refcheck=False)
>>> a
array([[0]])
>>> c
array([[0]])
```

round

`IsErrArray.round(decimals=0, out=None)`

Return *a* with each element rounded to the given number of decimals.

Refer to *numpy.around* for full documentation.

See Also

numpy.around : equivalent function

searchsorted

`IsErrArray.searchsorted(v, side='left', sorter=None)`

Find indices where elements of v should be inserted in a to maintain order.

For full documentation, see *numpy.searchsorted*

See Also

numpy.searchsorted : equivalent function

setfield

`IsErrArray.setfield(val, dtype, offset=0)`

Put a value into a specified place in a field defined by a data-type.

Place *val* into *a*'s field defined by *dtype* and beginning *offset* bytes into the field.

Parameters

val
[object] Value to be placed in field.

dtype
[dtype object] Data-type of the field in which to place *val*.

offset
[int, optional] The number of bytes into the field at which to place *val*.

Returns

None

See Also

getfield

Examples

```
>>> x = np.eye(3)
>>> x.getfield(np.float64)
array([[1.,  0.,  0.],
       [0.,  1.,  0.],
       [0.,  0.,  1.]])
>>> x.setfield(3, np.int32)
>>> x.getfield(np.int32)
array([[3, 3, 3],
       [3, 3, 3],
       [3, 3, 3]], dtype=int32)
>>> x
array([[1.0e+000, 1.5e-323, 1.5e-323],
       [1.5e-323, 1.0e+000, 1.5e-323],
       [1.5e-323, 1.5e-323, 1.0e+000]])
>>> x.setfield(np.eye(3), np.int32)
>>> x
array([[1.,  0.,  0.],
       [0.,  1.,  0.],
       [0.,  0.,  1.]])
```

setflags

`IsErrArray.`**`setflags`**(*write=None*, *align=None*, *uic=None*)

Set array flags WRITEABLE, ALIGNED, WRITEBACKIFCOPY, respectively.

These Boolean-valued flags affect how numpy interprets the memory area used by *a* (see Notes below). The ALIGNED flag can only be set to True if the data is actually aligned according to the type. The WRITEBACKIFCOPY and flag can never be set to True. The flag WRITEABLE can only be set to True if the array owns its own memory, or the ultimate owner of the memory exposes a writeable buffer interface, or is a string. (The exception for string is made so that unpickling can be done without copying memory.)

Parameters

write
: [bool, optional] Describes whether or not *a* can be written to.

align
: [bool, optional] Describes whether or not *a* is aligned properly for its type.

uic
: [bool, optional] Describes whether or not *a* is a copy of another "base" array.

Notes

Array flags provide information about how the memory area used for the array is to be interpreted. There are 7 Boolean flags in use, only four of which can be changed by the user: WRITEBACKIFCOPY, WRITEABLE, and ALIGNED.

WRITEABLE (W) the data area can be written to;

ALIGNED (A) the data and strides are aligned appropriately for the hardware (as determined by the compiler);

WRITEBACKIFCOPY (X) this array is a copy of some other array (referenced by .base). When the C-API function PyArray_ResolveWritebackIfCopy is called, the base array will be updated with the contents of this array.

All flags can be accessed using the single (upper case) letter as well as the full name.

Examples

```
>>> y = np.array([[3, 1, 7],
...               [2, 0, 0],
...               [8, 5, 9]])
>>> y
array([[3, 1, 7],
       [2, 0, 0],
       [8, 5, 9]])
>>> y.flags
  C_CONTIGUOUS : True
  F_CONTIGUOUS : False
  OWNDATA : True
  WRITEABLE : True
  ALIGNED : True
  WRITEBACKIFCOPY : False
>>> y.setflags(write=0, align=0)
>>> y.flags
  C_CONTIGUOUS : True
  F_CONTIGUOUS : False
  OWNDATA : True
  WRITEABLE : False
  ALIGNED : False
  WRITEBACKIFCOPY : False
>>> y.setflags(uic=1)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: cannot set WRITEBACKIFCOPY flag to True
```

sort

IsErrArray.**sort**(*axis=-1*, *kind=None*, *order=None*)

Sort an array in-place. Refer to *numpy.sort* for full documentation.

Parameters

axis
[int, optional] Axis along which to sort. Default is -1, which means sort along the last axis.

kind
[{'quicksort', 'mergesort', 'heapsort', 'stable'}, optional] Sorting algorithm. The default is 'quicksort'. Note that both 'stable' and 'mergesort' use timsort under the covers and, in general, the actual implementation will vary with datatype. The 'mergesort' option is retained for backwards compatibility.

Changed in version 1.15.0: The 'stable' option was added.

order
[str or list of str, optional] When *a* is an array with fields defined, this argument specifies which fields to compare first, second, etc. A single field can be specified as a string, and not all fields need be specified, but unspecified fields will still be used, in the order in which they come up in the dtype, to break ties.

See Also

numpy.sort : Return a sorted copy of an array. numpy.argsort : Indirect sort. numpy.lexsort : Indirect stable sort on multiple keys. numpy.searchsorted : Find elements in sorted array. numpy.partition: Partial sort.

Notes

See *numpy.sort* for notes on the different sorting algorithms.

Examples

```
>>> a = np.array([[1,4], [3,1]])
>>> a.sort(axis=1)
>>> a
array([[1, 4],
       [1, 3]])
>>> a.sort(axis=0)
>>> a
array([[1, 3],
       [1, 4]])
```

Use the *order* keyword to specify a field to use when sorting a structured array:

```
>>> a = np.array([('a', 2), ('c', 1)], dtype=[('x', 'S1'), ('y', int)])
>>> a.sort(order='y')
>>> a
array([(b'c', 1), (b'a', 2)],
      dtype=[('x', 'S1'), ('y', '<i8')])
```

squeeze

IsErrArray.**squeeze**(*axis=None*)

Remove axes of length one from *a*.

Refer to *numpy.squeeze* for full documentation.

See Also

numpy.squeeze : equivalent function

std

IsErrArray.**std**(*axis=None*, *dtype=None*, *out=None*, *ddof=0*, *keepdims=False*, *, *where=True*)

Returns the standard deviation of the array elements along given axis.

Refer to *numpy.std* for full documentation.

See Also

numpy.std : equivalent function

sum

IsErrArray.**sum**(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, *initial=0*, *where=True*)

Return the sum of the array elements over the given axis.

Refer to *numpy.sum* for full documentation.

See Also

numpy.sum : equivalent function

swapaxes

`IsErrArray.swapaxes(axis1, axis2)`

Return a view of the array with *axis1* and *axis2* interchanged.

Refer to *numpy.swapaxes* for full documentation.

See Also

numpy.swapaxes : equivalent function

take

`IsErrArray.take(indices, axis=None, out=None, mode='raise')`

Return an array formed from the elements of *a* at the given indices.

Refer to *numpy.take* for full documentation.

See Also

numpy.take : equivalent function

tobytes

`IsErrArray.tobytes(order='C')`

Construct Python bytes containing the raw data bytes in the array.

Constructs Python bytes showing a copy of the raw contents of data memory. The bytes object is produced in C-order by default. This behavior is controlled by the `order` parameter.

New in version 1.9.0.

Parameters

order
[{'C', 'F', 'A'}, optional] Controls the memory layout of the bytes object. 'C' means C-order, 'F' means F-order, 'A' (short for *Any*) means 'F' if *a* is Fortran contiguous, 'C' otherwise. Default is 'C'.

Returns

s
[bytes] Python bytes exhibiting a copy of *a*'s raw data.

See also

frombuffer
Inverse of this operation, construct a 1-dimensional array from Python bytes.

Examples

```
>>> x = np.array([[0, 1], [2, 3]], dtype='<u2')
>>> x.tobytes()
b'\x00\x00\x01\x00\x02\x00\x03\x00'
>>> x.tobytes('C') == x.tobytes()
True
>>> x.tobytes('F')
b'\x00\x00\x02\x00\x01\x00\x03\x00'
```

tofile

`IsErrArray.`**`tofile`**(*fid*, *sep=''*, *format='%s'*)

Write array to a file as text or binary (default).

Data is always written in 'C' order, independent of the order of *a*. The data produced by this method can be recovered using the function fromfile().

Parameters

fid
[file or str or Path] An open file object, or a string containing a filename.

Changed in version 1.17.0: *pathlib.Path* objects are now accepted.

sep
[str] Separator between array items for text output. If "" (empty), a binary file is written, equivalent to `file.write(a.tobytes())`.

format
[str] Format string for text file output. Each entry in the array is formatted to text by first converting it to the closest Python type, and then using "format" % item.

Notes

This is a convenience function for quick storage of array data. Information on endianness and precision is lost, so this method is not a good choice for files intended to archive data or transport data between machines with different endianness. Some of these problems can be overcome by outputting the data as text files, at the expense of speed and file size.

When fid is a file object, array contents are directly written to the file, bypassing the file object's `write` method. As a result, tofile cannot be used with files objects supporting compression (e.g., GzipFile) or file-like objects that do not support `fileno()` (e.g., BytesIO).

tolist

IsErrArray.**tolist**()

Return the array as an a.ndim-levels deep nested list of Python scalars.

Return a copy of the array data as a (nested) Python list. Data items are converted to the nearest compatible builtin Python type, via the *~numpy.ndarray.item* function.

If a.ndim is 0, then since the depth of the nested list is 0, it will not be a list at all, but a simple Python scalar.

Parameters

none

Returns

y

[object, or list of object, or list of list of object, or . . .] The possibly nested list of array elements.

Notes

The array may be recreated via a = np.array(a.tolist()), although this may sometimes lose precision.

Examples

For a 1D array, a.tolist() is almost the same as list(a), except that tolist changes numpy scalars to Python scalars:

```
>>> a = np.uint32([1, 2])
>>> a_list = list(a)
>>> a_list
[1, 2]
>>> type(a_list[0])
<class 'numpy.uint32'>
>>> a_tolist = a.tolist()
>>> a_tolist
[1, 2]
>>> type(a_tolist[0])
<class 'int'>
```

Additionally, for a 2D array, tolist applies recursively:

```
>>> a = np.array([[1, 2], [3, 4]])
>>> list(a)
[array([1, 2]), array([3, 4])]
>>> a.tolist()
[[1, 2], [3, 4]]
```

The base case for this recursion is a 0D array:

```
>>> a = np.array(1)
>>> list(a)
Traceback (most recent call last):
  ...
TypeError: iteration over a 0-d array
>>> a.tolist()
1
```

tostring

`IsErrArray.tostring(order='C')`

A compatibility alias for *tobytes*, with exactly the same behavior.

Despite its name, it returns *bytes* not *str*s.

Deprecated since version 1.19.0.

trace

`IsErrArray.trace(offset=0, axis1=0, axis2=1, dtype=None, out=None)`

Return the sum along diagonals of the array.

Refer to *numpy.trace* for full documentation.

See Also

numpy.trace : equivalent function

transpose

`IsErrArray.transpose(*axes)`

Returns a view of the array with axes transposed.

Refer to *numpy.transpose* for full documentation.

Parameters

axes : None, tuple of ints, or *n* ints

- None or no argument: reverses the order of the axes.
- tuple of ints: *i* in the *j*-th place in the tuple means that the array's *i*-th axis becomes the transposed array's *j*-th axis.
- *n* ints: same as an n-tuple of the same ints (this form is intended simply as a "convenience" alternative to the tuple form).

Returns

p
[ndarray] View of the array with its axes suitably permuted.

See Also

transpose : Equivalent function. ndarray.T : Array property returning the array transposed. ndarray.reshape : Give a new shape to an array without changing its data.

Examples

```
>>> a = np.array([[1, 2], [3, 4]])
>>> a
array([[1, 2],
       [3, 4]])
>>> a.transpose()
array([[1, 3],
       [2, 4]])
>>> a.transpose((1, 0))
array([[1, 3],
       [2, 4]])
>>> a.transpose(1, 0)
array([[1, 3],
       [2, 4]])
```

```
>>> a = np.array([1, 2, 3, 4])
>>> a
array([1, 2, 3, 4])
>>> a.transpose()
array([1, 2, 3, 4])
```

var

`IsErrArray.var`(*axis=None*, *dtype=None*, *out=None*, *ddof=0*, *keepdims=False*, *, *where=True*)

Returns the variance of the array elements, along given axis.

Refer to *numpy.var* for full documentation.

See Also

numpy.var : equivalent function

view

IsErrArray.**view**(*[dtype][, type]*)

New view of array with the same data.

Note: Passing None for `dtype` is different from omitting the parameter, since the former invokes `dtype(None)` which is an alias for `dtype('float_')`.

Parameters

dtype
[data-type or ndarray sub-class, optional] Data-type descriptor of the returned view, e.g., float32 or int16. Omitting it results in the view having the same data-type as *a*. This argument can also be specified as an ndarray sub-class, which then specifies the type of the returned object (this is equivalent to setting the `type` parameter).

type
[Python type, optional] Type of the returned view, e.g., ndarray or matrix. Again, omission of the parameter results in type preservation.

Notes

`a.view()` is used two different ways:

`a.view(some_dtype)` or `a.view(dtype=some_dtype)` constructs a view of the array's memory with a different data-type. This can cause a reinterpretation of the bytes of memory.

`a.view(ndarray_subclass)` or `a.view(type=ndarray_subclass)` just returns an instance of *ndarray_subclass* that looks at the same array (same shape, dtype, etc.) This does not cause a reinterpretation of the memory.

For `a.view(some_dtype)`, if `some_dtype` has a different number of bytes per entry than the previous dtype (for example, converting a regular array to a structured array), then the last axis of `a` must be contiguous. This axis will be resized in the result.

Changed in version 1.23.0: Only the last axis needs to be contiguous. Previously, the entire array had to be C-contiguous.

Examples

```
>>> x = np.array([(1, 2)], dtype=[('a', np.int8), ('b', np.int8)])
```

Viewing array data using a different type and dtype:

```
>>> y = x.view(dtype=np.int16, type=np.matrix)
>>> y
matrix([[513]], dtype=int16)
>>> print(type(y))
<class 'numpy.matrix'>
```

Creating a view on a structured array so it can be used in calculations

```
>>> x = np.array([(1, 2),(3,4)], dtype=[('a', np.int8), ('b', np.int8)])
>>> xv = x.view(dtype=np.int8).reshape(-1,2)
>>> xv
array([[1, 2],
       [3, 4]], dtype=int8)
>>> xv.mean(0)
array([2.,  3.])
```

Making changes to the view changes the underlying array

```
>>> xv[0,1] = 20
>>> x
array([(1, 20), (3,  4)], dtype=[('a', 'i1'), ('b', 'i1')])
```

Using a view to convert an array to a recarray:

```
>>> z = x.view(np.recarray)
>>> z.a
array([1, 3], dtype=int8)
```

Views share data:

```
>>> x[0] = (9, 10)
>>> z[0]
(9, 10)
```

Views that change the dtype size (bytes per entry) should normally be avoided on arrays defined by slices, transposes, fortran-ordering, etc.:

```
>>> x = np.array([[1, 2, 3], [4, 5, 6]], dtype=np.int16)
>>> y = x[:, ::2]
>>> y
array([[1, 3],
       [4, 6]], dtype=int16)
>>> y.view(dtype=[('width', np.int16), ('length', np.int16)])
Traceback (most recent call last):
    ...
ValueError: To change to a dtype of a different size, the last axis must be␣
↪contiguous
>>> z = y.copy()
>>> z.view(dtype=[('width', np.int16), ('length', np.int16)])
array([[(1, 3)],
       [(4, 6)]], dtype=[('width', '<i2'), ('length', '<i2')])
```

However, views that change dtype are totally fine for arrays with a contiguous last axis, even if the rest of the axes are not C-contiguous:

```
>>> x = np.arange(2 * 3 * 4, dtype=np.int8).reshape(2, 3, 4)
>>> x.transpose(1, 0, 2).view(np.int16)
array([[[ 256,  770],
        [3340, 3854]],

       [[1284, 1798],
        [4368, 4882]],
```

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```
       [[2312, 2826],
        [5396, 5910]]], dtype=int16)
```

__init__()

Attributes

T	View of the transposed array.
base	Base object if memory is from some other object.
ctypes	An object to simplify the interaction of the array with the ctypes module.
data	Python buffer object pointing to the start of the array's data.
dtype	Data-type of the array's elements.
flags	Information about the memory layout of the array.
flat	A 1-D iterator over the array.
imag	The imaginary part of the array.
itemsize	Length of one array element in bytes.
nbytes	Total bytes consumed by the elements of the array.
ndim	Number of array dimensions.
real	The real part of the array.
shape	Tuple of array dimensions.
size	Number of elements in the array.
strides	Tuple of bytes to step in each dimension when traversing an array.

T

IsErrArray.**T**

View of the transposed array.

Same as `self.transpose()`.

Examples

```
>>> a = np.array([[1, 2], [3, 4]])
>>> a
array([[1, 2],
       [3, 4]])
>>> a.T
array([[1, 3],
       [2, 4]])
```

```
>>> a = np.array([1, 2, 3, 4])
>>> a
array([1, 2, 3, 4])
```

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```
>>> a.T
array([1, 2, 3, 4])
```

See Also

transpose

base

IsErrArray.**base**

Base object if memory is from some other object.

Examples

The base of an array that owns its memory is None:

```
>>> x = np.array([1,2,3,4])
>>> x.base is None
True
```

Slicing creates a view, whose memory is shared with x:

```
>>> y = x[2:]
>>> y.base is x
True
```

ctypes

IsErrArray.**ctypes**

An object to simplify the interaction of the array with the ctypes module.

This attribute creates an object that makes it easier to use arrays when calling shared libraries with the ctypes module. The returned object has, among others, data, shape, and strides attributes (see Notes below) which themselves return ctypes objects that can be used as arguments to a shared library.

Parameters

None

Returns

c
: [Python object] Possessing attributes data, shape, strides, etc.

See Also

numpy.ctypeslib

Notes

Below are the public attributes of this object which were documented in "Guide to NumPy" (we have omitted undocumented public attributes, as well as documented private attributes):

`_ctypes.data`

A pointer to the memory area of the array as a Python integer. This memory area may contain data that is not aligned, or not in correct byte-order. The memory area may not even be writeable. The array flags and data-type of this array should be respected when passing this attribute to arbitrary C-code to avoid trouble that can include Python crashing. User Beware! The value of this attribute is exactly the same as `self._array_interface_['data'][0]`.

Note that unlike `data_as`, a reference will not be kept to the array: code like `ctypes.c_void_p((a + b).ctypes.data)` will result in a pointer to a deallocated array, and should be spelt `(a + b).ctypes.data_as(ctypes.c_void_p)`

`_ctypes.shape`

(c_intp*self.ndim): A ctypes array of length self.ndim where the basetype is the C-integer corresponding to `dtype('p')` on this platform (see *~numpy.ctypeslib.c_intp*). This base-type could be *ctypes.c_int*, *ctypes.c_long*, or *ctypes.c_longlong* depending on the platform. The ctypes array contains the shape of the underlying array.

`_ctypes.strides`

(c_intp*self.ndim): A ctypes array of length self.ndim where the basetype is the same as for the shape attribute. This ctypes array contains the strides information from the underlying array. This strides information is important for showing how many bytes must be jumped to get to the next element in the array.

`_ctypes.data_as(obj)`

Return the data pointer cast to a particular c-types object. For example, calling `self._as_parameter_` is equivalent to `self.data_as(ctypes.c_void_p)`. Perhaps you want to use the data as a pointer to a ctypes array of floating-point data: `self.data_as(ctypes.POINTER(ctypes.c_double))`.

The returned pointer will keep a reference to the array.

`_ctypes.shape_as(obj)`

Return the shape tuple as an array of some other c-types type. For example: `self.shape_as(ctypes.c_short)`.

`_ctypes.strides_as(obj)`

Return the strides tuple as an array of some other c-types type. For example: `self.strides_as(ctypes.c_longlong)`.

If the ctypes module is not available, then the ctypes attribute of array objects still returns something useful, but ctypes objects are not returned and errors may be raised instead. In particular, the object will still have the `as_parameter` attribute which will return an integer equal to the data attribute.

Examples

```
>>> import ctypes
>>> x = np.array([[0, 1], [2, 3]], dtype=np.int32)
>>> x
array([[0, 1],
       [2, 3]], dtype=int32)
>>> x.ctypes.data
31962608 # may vary
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint32))
<__main__.LP_c_uint object at 0x7ff2fc1fc200> # may vary
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint32)).contents
c_uint(0)
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint64)).contents
c_ulong(4294967296)
>>> x.ctypes.shape
<numpy.core._internal.c_long_Array_2 object at 0x7ff2fc1fce60> # may vary
>>> x.ctypes.strides
<numpy.core._internal.c_long_Array_2 object at 0x7ff2fc1ff320> # may vary
```

data

`IsErrArray.data`

Python buffer object pointing to the start of the array's data.

dtype

`IsErrArray.dtype`

Data-type of the array's elements.

Warning: Setting `arr.dtype` is discouraged and may be deprecated in the future. Setting will replace the `dtype` without modifying the memory (see also *ndarray.view* and *ndarray.astype*).

Parameters

None

Returns

d : numpy dtype object

See Also

ndarray.astype : Cast the values contained in the array to a new data-type. ndarray.view : Create a view of the same data but a different data-type. numpy.dtype

Examples

```
>>> x
array([[0, 1],
       [2, 3]])
>>> x.dtype
dtype('int32')
>>> type(x.dtype)
<type 'numpy.dtype'>
```

flags

`IsErrArray.flags`

Information about the memory layout of the array.

Attributes

C_CONTIGUOUS (C)
The data is in a single, C-style contiguous segment.

F_CONTIGUOUS (F)
The data is in a single, Fortran-style contiguous segment.

OWNDATA (O)
The array owns the memory it uses or borrows it from another object.

WRITEABLE (W)
The data area can be written to. Setting this to False locks the data, making it read-only. A view (slice, etc.) inherits WRITEABLE from its base array at creation time, but a view of a writeable array may be subsequently locked while the base array remains writeable. (The opposite is not true, in that a view of a locked array may not be made writeable. However, currently, locking a base object does not lock any views that already reference it, so under that circumstance it is possible to alter the contents of a locked array via a previously created writeable view onto it.) Attempting to change a non-writeable array raises a RuntimeError exception.

ALIGNED (A)
The data and all elements are aligned appropriately for the hardware.

WRITEBACKIFCOPY (X)
This array is a copy of some other array. The C-API function PyArray_ResolveWritebackIfCopy must be called before deallocating to the base array will be updated with the contents of this array.

FNC
F_CONTIGUOUS and not C_CONTIGUOUS.

FORC
F_CONTIGUOUS or C_CONTIGUOUS (one-segment test).

BEHAVED (B)
ALIGNED and WRITEABLE.

CARRAY (CA)
BEHAVED and C_CONTIGUOUS.

FARRAY (FA)
BEHAVED and F_CONTIGUOUS and not C_CONTIGUOUS.

Notes

The *flags* object can be accessed dictionary-like (as in `a.flags['WRITEABLE']`), or by using lowercased attribute names (as in `a.flags.writeable`). Short flag names are only supported in dictionary access.

Only the WRITEBACKIFCOPY, WRITEABLE, and ALIGNED flags can be changed by the user, via direct assignment to the attribute or dictionary entry, or by calling *ndarray.setflags*.

The array flags cannot be set arbitrarily:

- WRITEBACKIFCOPY can only be set `False`.
- ALIGNED can only be set `True` if the data is truly aligned.
- WRITEABLE can only be set `True` if the array owns its own memory or the ultimate owner of the memory exposes a writeable buffer interface or is a string.

Arrays can be both C-style and Fortran-style contiguous simultaneously. This is clear for 1-dimensional arrays, but can also be true for higher dimensional arrays.

Even for contiguous arrays a stride for a given dimension `arr.strides[dim]` may be *arbitrary* if `arr.shape[dim] == 1` or the array has no elements. It does *not* generally hold that `self.strides[-1] == self.itemsize` for C-style contiguous arrays or `self.strides[0] == self.itemsize` for Fortran-style contiguous arrays is true.

flat

`IsErrArray.flat`

A 1-D iterator over the array.

This is a *numpy.flatiter* instance, which acts similarly to, but is not a subclass of, Python's built-in iterator object.

See Also

flatten : Return a copy of the array collapsed into one dimension.

flatiter

Examples

```
>>> x = np.arange(1, 7).reshape(2, 3)
>>> x
array([[1, 2, 3],
       [4, 5, 6]])
>>> x.flat[3]
4
>>> x.T
array([[1, 4],
       [2, 5],
       [3, 6]])
>>> x.T.flat[3]
5
>>> type(x.flat)
<class 'numpy.flatiter'>
```

An assignment example:

```
>>> x.flat = 3; x
array([[3, 3, 3],
       [3, 3, 3]])
>>> x.flat[[1,4]] = 1; x
array([[3, 1, 3],
       [3, 1, 3]])
```

imag

`IsErrArray.imag`

The imaginary part of the array.

Examples

```
>>> x = np.sqrt([1+0j, 0+1j])
>>> x.imag
array([ 0.        ,  0.70710678])
>>> x.imag.dtype
dtype('float64')
```

itemsize

IsErrArray.**itemsize**

Length of one array element in bytes.

Examples

```
>>> x = np.array([1,2,3], dtype=np.float64)
>>> x.itemsize
8
>>> x = np.array([1,2,3], dtype=np.complex128)
>>> x.itemsize
16
```

nbytes

IsErrArray.**nbytes**

Total bytes consumed by the elements of the array.

Notes

Does not include memory consumed by non-element attributes of the array object.

See Also

sys.getsizeof
Memory consumed by the object itself without parents in case view. This does include memory consumed by non-element attributes.

Examples

```
>>> x = np.zeros((3,5,2), dtype=np.complex128)
>>> x.nbytes
480
>>> np.prod(x.shape) * x.itemsize
480
```

ndim

IsErrArray.**ndim**

Number of array dimensions.

Examples

```
>>> x = np.array([1, 2, 3])
>>> x.ndim
1
>>> y = np.zeros((2, 3, 4))
>>> y.ndim
3
```

real

IsErrArray.**real**

The real part of the array.

Examples

```
>>> x = np.sqrt([1+0j, 0+1j])
>>> x.real
array([ 1.        ,  0.70710678])
>>> x.real.dtype
dtype('float64')
```

See Also

numpy.real : equivalent function

shape

IsErrArray.**shape**

Tuple of array dimensions.

The shape property is usually used to get the current shape of an array, but may also be used to reshape the array in-place by assigning a tuple of array dimensions to it. As with *numpy.reshape*, one of the new shape dimensions can be -1, in which case its value is inferred from the size of the array and the remaining dimensions. Reshaping an array in-place will fail if a copy is required.

> **Warning:** Setting `arr.shape` is discouraged and may be deprecated in the future. Using *ndarray.reshape* is the preferred approach.

Examples

```
>>> x = np.array([1, 2, 3, 4])
>>> x.shape
(4,)
>>> y = np.zeros((2, 3, 4))
>>> y.shape
(2, 3, 4)
>>> y.shape = (3, 8)
>>> y
array([[ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.],
       [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.],
       [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.]])
>>> y.shape = (3, 6)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: total size of new array must be unchanged
>>> np.zeros((4,2))[::2].shape = (-1,)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AttributeError: Incompatible shape for in-place modification. Use
`.reshape()` to make a copy with the desired shape.
```

See Also

numpy.shape : Equivalent getter function. numpy.reshape : Function similar to setting `shape`. ndarray.reshape : Method similar to setting `shape`.

size

`IsErrArray.size`

Number of elements in the array.

Equal to `np.prod(a.shape)`, i.e., the product of the array's dimensions.

Notes

a.size returns a standard arbitrary precision Python integer. This may not be the case with other methods of obtaining the same value (like the suggested `np.prod(a.shape)`, which returns an instance of `np.int_`), and may be relevant if the value is used further in calculations that may overflow a fixed size integer type.

Examples

```
>>> x = np.zeros((3, 5, 2), dtype=np.complex128)
>>> x.size
30
>>> np.prod(x.shape)
30
```

strides

`IsErrArray.strides`

Tuple of bytes to step in each dimension when traversing an array.

The byte offset of element `(i[0], i[1], ..., i[n])` in an array *a* is:

```
offset = sum(np.array(i) * a.strides)
```

A more detailed explanation of strides can be found in the "ndarray.rst" file in the NumPy reference guide.

> **Warning:** Setting `arr.strides` is discouraged and may be deprecated in the future. *numpy.lib.stride_tricks.as_strided* should be preferred to create a new view of the same data in a safer way.

Notes

Imagine an array of 32-bit integers (each 4 bytes):

```
x = np.array([[0, 1, 2, 3, 4],
              [5, 6, 7, 8, 9]], dtype=np.int32)
```

This array is stored in memory as 40 bytes, one after the other (known as a contiguous block of memory). The strides of an array tell us how many bytes we have to skip in memory to move to the next position along a certain axis. For example, we have to skip 4 bytes (1 value) to move to the next column, but 20 bytes (5 values) to get to the same position in the next row. As such, the strides for the array *x* will be `(20, 4)`.

See Also

numpy.lib.stride_tricks.as_strided

Examples

```
>>> y = np.reshape(np.arange(2*3*4), (2,3,4))
>>> y
array([[[ 0,  1,  2,  3],
        [ 4,  5,  6,  7],
        [ 8,  9, 10, 11]],
       [[12, 13, 14, 15],
        [16, 17, 18, 19],
        [20, 21, 22, 23]]])
>>> y.strides
(48, 16, 4)
>>> y[1,1,1]
17
>>> offset=sum(y.strides * np.array((1,1,1)))
>>> offset/y.itemsize
17
```

```
>>> x = np.reshape(np.arange(5*6*7*8), (5,6,7,8)).transpose(2,3,1,0)
>>> x.strides
(32, 4, 224, 1344)
>>> i = np.array([3,5,2,2])
>>> offset = sum(i * x.strides)
>>> x[3,5,2,2]
813
>>> offset / x.itemsize
813
```

IsErrorArray

class IsErrorArray

Methods

__init__	
all	Returns True if all elements evaluate to True.
any	Returns True if any of the elements of *a* evaluate to True.
argmax	Return indices of the maximum values along the given axis.
argmin	Return indices of the minimum values along the given axis.
argpartition	Returns the indices that would partition this array.
argsort	Returns the indices that would sort this array.
astype	Copy of the array, cast to a specified type.
byteswap	Swap the bytes of the array elements
choose	Use an index array to construct a new array from a set of choices.

continues on next page

Table 3 – continued from previous page

`clip`	Return an array whose values are limited to `[min, max]`.
`collapse`	
`compress`	Return selected slices of this array along given axis.
`conj`	Complex-conjugate all elements.
`conjugate`	Return the complex conjugate, element-wise.
`copy`	Return a copy of the array.
`cumprod`	Return the cumulative product of the elements along the given axis.
`cumsum`	Return the cumulative sum of the elements along the given axis.
`diagonal`	Return specified diagonals.
`dot`	
`dump`	Dump a pickle of the array to the specified file.
`dumps`	Returns the pickle of the array as a string.
`fill`	Fill the array with a scalar value.
`flatten`	Return a copy of the array collapsed into one dimension.
`getfield`	Returns a field of the given array as a certain type.
`item`	Copy an element of an array to a standard Python scalar and return it.
`itemset`	Insert scalar into an array (scalar is cast to array's dtype, if possible)
`max`	Return the maximum along a given axis.
`mean`	Returns the average of the array elements along given axis.
`min`	Return the minimum along a given axis.
`newbyteorder`	Return the array with the same data viewed with a different byte order.
`nonzero`	Return the indices of the elements that are non-zero.
`partition`	Rearranges the elements in the array in such a way that the value of the element in kth position is in the position it would be in a sorted array.
`prod`	Return the product of the array elements over the given axis
`ptp`	Peak to peak (maximum - minimum) value along a given axis.
`put`	Set `a.flat[n] = values[n]` for all *n* in indices.
`ravel`	Return a flattened array.
`repeat`	Repeat elements of an array.
`reshape`	Returns an array containing the same data with a new shape.
`resize`	Change shape and size of array in-place.
`round`	Return *a* with each element rounded to the given number of decimals.
`searchsorted`	Find indices where elements of v should be inserted in a to maintain order.
`setfield`	Put a value into a specified place in a field defined by a data-type.

continues on next page

Table 3 – continued from previous page

`setflags`	Set array flags WRITEABLE, ALIGNED, WRITEBACKIFCOPY, respectively.
`sort`	Sort an array in-place.
`squeeze`	Remove axes of length one from *a*.
`std`	Returns the standard deviation of the array elements along given axis.
`sum`	Return the sum of the array elements over the given axis.
`swapaxes`	Return a view of the array with *axis1* and *axis2* interchanged.
`take`	Return an array formed from the elements of *a* at the given indices.
`tobytes`	Construct Python bytes containing the raw data bytes in the array.
`tofile`	Write array to a file as text or binary (default).
`tolist`	Return the array as an `a.ndim`-levels deep nested list of Python scalars.
`tostring`	A compatibility alias for *tobytes*, with exactly the same behavior.
`trace`	Return the sum along diagonals of the array.
`transpose`	Returns a view of the array with axes transposed.
`var`	Returns the variance of the array elements, along given axis.
`view`	New view of array with the same data.

__init__

`IsErrorArray.__init__()`

all

`IsErrorArray.all(`*axis=None*, *out=None*, *keepdims=False*, ***, *where=True*`)`

Returns True if all elements evaluate to True.

Refer to *numpy.all* for full documentation.

See Also

numpy.all : equivalent function

any

`IsErrorArray.`**`any`**`(`*axis=None*, *out=None*, *keepdims=False*, *, *where=True*`)`

Returns True if any of the elements of *a* evaluate to True.

Refer to *numpy.any* for full documentation.

See Also

numpy.any : equivalent function

argmax

`IsErrorArray.`**`argmax`**`(`*axis=None*, *out=None*, *, *keepdims=False*`)`

Return indices of the maximum values along the given axis.

Refer to *numpy.argmax* for full documentation.

See Also

numpy.argmax : equivalent function

argmin

`IsErrorArray.`**`argmin`**`(`*axis=None*, *out=None*, *, *keepdims=False*`)`

Return indices of the minimum values along the given axis.

Refer to *numpy.argmin* for detailed documentation.

See Also

numpy.argmin : equivalent function

argpartition

`IsErrorArray.`**`argpartition`**`(`*kth*, *axis=-1*, *kind='introselect'*, *order=None*`)`

Returns the indices that would partition this array.

Refer to *numpy.argpartition* for full documentation.

New in version 1.8.0.

See Also

numpy.argpartition : equivalent function

argsort

`IsErrorArray.argsort(axis=-1, kind=None, order=None)`

Returns the indices that would sort this array.

Refer to *numpy.argsort* for full documentation.

See Also

numpy.argsort : equivalent function

astype

`IsErrorArray.astype(dtype, order='K', casting='unsafe', subok=True, copy=True)`

Copy of the array, cast to a specified type.

Parameters

dtype
[str or dtype] Typecode or data-type to which the array is cast.

order
[{'C', 'F', 'A', 'K'}, optional] Controls the memory layout order of the result. 'C' means C order, 'F' means Fortran order, 'A' means 'F' order if all the arrays are Fortran contiguous, 'C' order otherwise, and 'K' means as close to the order the array elements appear in memory as possible. Default is 'K'.

casting
[{'no', 'equiv', 'safe', 'same_kind', 'unsafe'}, optional] Controls what kind of data casting may occur. Defaults to 'unsafe' for backwards compatibility.

- 'no' means the data types should not be cast at all.
- 'equiv' means only byte-order changes are allowed.
- 'safe' means only casts which can preserve values are allowed.
- 'same_kind' means only safe casts or casts within a kind, like float64 to float32, are allowed.
- 'unsafe' means any data conversions may be done.

subok
[bool, optional] If True, then sub-classes will be passed-through (default), otherwise the returned array will be forced to be a base-class array.

copy
[bool, optional] By default, astype always returns a newly allocated array. If this is set to false, and the *dtype*, *order*, and *subok* requirements are satisfied, the input array is returned instead of a copy.

Returns

arr_t
[ndarray] Unless *copy* is False and the other conditions for returning the input array are satisfied (see description for *copy* input parameter), *arr_t* is a new array of the same shape as the input array, with dtype, order given by *dtype*, *order*.

Notes

Changed in version 1.17.0: Casting between a simple data type and a structured one is possible only for "unsafe" casting. Casting to multiple fields is allowed, but casting from multiple fields is not.

Changed in version 1.9.0: Casting from numeric to string types in 'safe' casting mode requires that the string dtype length is long enough to store the max integer/float value converted.

Raises

ComplexWarning
When casting from complex to float or int. To avoid this, one should use `a.real.astype(t)`.

Examples

```
>>> x = np.array([1, 2, 2.5])
>>> x
array([1. ,  2. ,  2.5])
```

```
>>> x.astype(int)
array([1, 2, 2])
```

byteswap

`IsErrorArray.`**`byteswap`**(*inplace=False*)

Swap the bytes of the array elements

Toggle between low-endian and big-endian data representation by returning a byteswapped array, optionally swapped in-place. Arrays of byte-strings are not swapped. The real and imaginary parts of a complex number are swapped individually.

Parameters

inplace
[bool, optional] If `True`, swap bytes in-place, default is `False`.

Returns

out
: [ndarray] The byteswapped array. If *inplace* is `True`, this is a view to self.

Examples

```
>>> A = np.array([1, 256, 8755], dtype=np.int16)
>>> list(map(hex, A))
['0x1', '0x100', '0x2233']
>>> A.byteswap(inplace=True)
array([  256,     1, 13090], dtype=int16)
>>> list(map(hex, A))
['0x100', '0x1', '0x3322']
```

Arrays of byte-strings are not swapped

```
>>> A = np.array([b'ceg', b'fac'])
>>> A.byteswap()
array([b'ceg', b'fac'], dtype='|S3')
```

`A.newbyteorder().byteswap()` produces an array with the same values
: but different representation in memory

```
>>> A = np.array([1, 2, 3])
>>> A.view(np.uint8)
array([1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 3, 0, 0, 0, 0, 0,
       0, 0], dtype=uint8)
>>> A.newbyteorder().byteswap(inplace=True)
array([1, 2, 3])
>>> A.view(np.uint8)
array([0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0,
       0, 3], dtype=uint8)
```

choose

`IsErrorArray.`**`choose`**(*choices*, *out=None*, *mode='raise'*)

Use an index array to construct a new array from a set of choices.

Refer to *numpy.choose* for full documentation.

See Also

numpy.choose : equivalent function

clip

`IsErrorArray.clip(min=None, max=None, out=None, **kwargs)`

Return an array whose values are limited to `[min, max]`. One of max or min must be given.

Refer to *numpy.clip* for full documentation.

See Also

numpy.clip : equivalent function

collapse

`IsErrorArray.collapse(shape)`

compress

`IsErrorArray.compress(condition, axis=None, out=None)`

Return selected slices of this array along given axis.

Refer to *numpy.compress* for full documentation.

See Also

numpy.compress : equivalent function

conj

`IsErrorArray.conj()`

Complex-conjugate all elements.

Refer to *numpy.conjugate* for full documentation.

See Also

numpy.conjugate : equivalent function

conjugate

`IsErrorArray.conjugate()`

Return the complex conjugate, element-wise.

Refer to *numpy.conjugate* for full documentation.

See Also

numpy.conjugate : equivalent function

copy

`IsErrorArray.copy(order='C')`

Return a copy of the array.

Parameters

order
[{'C', 'F', 'A', 'K'}, optional] Controls the memory layout of the copy. 'C' means C-order, 'F' means F-order, 'A' means 'F' if *a* is Fortran contiguous, 'C' otherwise. 'K' means match the layout of *a* as closely as possible. (Note that this function and `numpy.copy()` are very similar but have different default values for their order= arguments, and this function always passes sub-classes through.)

See also

numpy.copy : Similar function with different default behavior numpy.copyto

Notes

This function is the preferred method for creating an array copy. The function `numpy.copy()` is similar, but it defaults to using order 'K', and will not pass sub-classes through by default.

Examples

```
>>> x = np.array([[1,2,3],[4,5,6]], order='F')
```

```
>>> y = x.copy()
```

```
>>> x.fill(0)
```

```
>>> x
array([[0, 0, 0],
       [0, 0, 0]])
```

```
>>> y
array([[1, 2, 3],
       [4, 5, 6]])
```

```
>>> y.flags['C_CONTIGUOUS']
True
```

cumprod

IsErrorArray.**cumprod**(*axis=None*, *dtype=None*, *out=None*)

Return the cumulative product of the elements along the given axis.

Refer to *numpy.cumprod* for full documentation.

See Also

numpy.cumprod : equivalent function

cumsum

IsErrorArray.**cumsum**(*axis=None*, *dtype=None*, *out=None*)

Return the cumulative sum of the elements along the given axis.

Refer to *numpy.cumsum* for full documentation.

See Also

numpy.cumsum : equivalent function

diagonal

IsErrorArray.**diagonal**(*offset=0*, *axis1=0*, *axis2=1*)

Return specified diagonals. In NumPy 1.9 the returned array is a read-only view instead of a copy as in previous NumPy versions. In a future version the read-only restriction will be removed.

Refer to `numpy.diagonal()` for full documentation.

See Also

numpy.diagonal : equivalent function

dot

IsErrorArray.**dot**()

dump

IsErrorArray.**dump**(*file*)

Dump a pickle of the array to the specified file. The array can be read back with pickle.load or numpy.load.

Parameters

file

[str or Path] A string naming the dump file.

Changed in version 1.17.0: *pathlib.Path* objects are now accepted.

dumps

IsErrorArray.**dumps**()

Returns the pickle of the array as a string. pickle.loads will convert the string back to an array.

Parameters

None

fill

IsErrorArray.**fill**(*value*)

Fill the array with a scalar value.

Parameters

value

[scalar] All elements of *a* will be assigned this value.

Examples

```
>>> a = np.array([1, 2])
>>> a.fill(0)
>>> a
array([0, 0])
>>> a = np.empty(2)
>>> a.fill(1)
>>> a
array([1.,  1.])
```

Fill expects a scalar value and always behaves the same as assigning to a single array element. The following is a rare example where this distinction is important:

```
>>> a = np.array([None, None], dtype=object)
>>> a[0] = np.array(3)
>>> a
array([array(3), None], dtype=object)
>>> a.fill(np.array(3))
>>> a
array([array(3), array(3)], dtype=object)
```

Where other forms of assignments will unpack the array being assigned:

```
>>> a[...] = np.array(3)
>>> a
array([3, 3], dtype=object)
```

flatten

IsErrorArray.**flatten**(*order='C'*)

Return a copy of the array collapsed into one dimension.

Parameters

order
: [{'C', 'F', 'A', 'K'}, optional] 'C' means to flatten in row-major (C-style) order. 'F' means to flatten in column-major (Fortran- style) order. 'A' means to flatten in column-major order if *a* is Fortran *contiguous* in memory, row-major order otherwise. 'K' means to flatten *a* in the order the elements occur in memory. The default is 'C'.

Returns

y
: [ndarray] A copy of the input array, flattened to one dimension.

See Also

ravel : Return a flattened array. flat : A 1-D flat iterator over the array.

Examples

```
>>> a = np.array([[1,2], [3,4]])
>>> a.flatten()
array([1, 2, 3, 4])
>>> a.flatten('F')
array([1, 3, 2, 4])
```

getfield

IsErrorArray.**getfield**(*dtype*, *offset=0*)

Returns a field of the given array as a certain type.

A field is a view of the array data with a given data-type. The values in the view are determined by the given type and the offset into the current array in bytes. The offset needs to be such that the view dtype fits in the array dtype; for example an array of dtype complex128 has 16-byte elements. If taking a view with a 32-bit integer (4 bytes), the offset needs to be between 0 and 12 bytes.

Parameters

dtype
[str or dtype] The data type of the view. The dtype size of the view can not be larger than that of the array itself.

offset
[int] Number of bytes to skip before beginning the element view.

Examples

```
>>> x = np.diag([1.+1.j]*2)
>>> x[1, 1] = 2 + 4.j
>>> x
array([[1.+1.j,  0.+0.j],
       [0.+0.j,  2.+4.j]])
>>> x.getfield(np.float64)
array([[1.,  0.],
       [0.,  2.]])
```

By choosing an offset of 8 bytes we can select the complex part of the array for our view:

```
>>> x.getfield(np.float64, offset=8)
array([[1.,  0.],
       [0.,  4.]])
```

item

IsErrorArray.**item**(**args*)

Copy an element of an array to a standard Python scalar and return it.

Parameters

*args : Arguments (variable number and type)

- none: in this case, the method only works for arrays with one element (*a.size == 1*), which element is copied into a standard Python scalar object and returned.
- int_type: this argument is interpreted as a flat index into the array, specifying which element to copy and return.
- tuple of int_types: functions as does a single int_type argument, except that the argument is interpreted as an nd-index into the array.

Returns

z

[Standard Python scalar object] A copy of the specified element of the array as a suitable Python scalar

Notes

When the data type of *a* is longdouble or clongdouble, item() returns a scalar array object because there is no available Python scalar that would not lose information. Void arrays return a buffer object for item(), unless fields are defined, in which case a tuple is returned.

item is very similar to a[args], except, instead of an array scalar, a standard Python scalar is returned. This can be useful for speeding up access to elements of the array and doing arithmetic on elements of the array using Python's optimized math.

Examples

```
>>> np.random.seed(123)
>>> x = np.random.randint(9, size=(3, 3))
>>> x
array([[2, 2, 6],
       [1, 3, 6],
       [1, 0, 1]])
>>> x.item(3)
1
>>> x.item(7)
0
>>> x.item((0, 1))
2
>>> x.item((2, 2))
1
```

itemset

IsErrorArray.**itemset**(**args*)

Insert scalar into an array (scalar is cast to array's dtype, if possible)

There must be at least 1 argument, and define the last argument as *item*. Then, `a.itemset(*args)` is equivalent to but faster than `a[args] = item`. The item should be a scalar value and *args* must select a single item in the array *a*.

Parameters

***args**

[Arguments] If one argument: a scalar, only used in case *a* is of size 1. If two arguments: the last argument is the value to be set and must be a scalar, the first argument specifies a single array element location. It is either an int or a tuple.

Notes

Compared to indexing syntax, *itemset* provides some speed increase for placing a scalar into a particular location in an *ndarray*, if you must do this. However, generally this is discouraged: among other problems, it complicates the appearance of the code. Also, when using *itemset* (and *item*) inside a loop, be sure to assign the methods to a local variable to avoid the attribute look-up at each loop iteration.

Examples

```
>>> np.random.seed(123)
>>> x = np.random.randint(9, size=(3, 3))
>>> x
array([[2, 2, 6],
       [1, 3, 6],
       [1, 0, 1]])
>>> x.itemset(4, 0)
>>> x.itemset((2, 2), 9)
>>> x
array([[2, 2, 6],
       [1, 0, 6],
       [1, 0, 9]])
```

max

IsErrorArray.**max**(*axis=None*, *out=None*, *keepdims=False*, *initial=<no value>*, *where=True*)

Return the maximum along a given axis.

Refer to *numpy.amax* for full documentation.

See Also

numpy.amax : equivalent function

mean

IsErrorArray.**mean**(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, *, *where=True*)

Returns the average of the array elements along given axis.

Refer to *numpy.mean* for full documentation.

See Also

numpy.mean : equivalent function

min

IsErrorArray.**min**(*axis=None*, *out=None*, *keepdims=False*, *initial=<no value>*, *where=True*)

Return the minimum along a given axis.

Refer to *numpy.amin* for full documentation.

See Also

numpy.amin : equivalent function

newbyteorder

IsErrorArray.**newbyteorder**(*new_order='S'*, */*)

Return the array with the same data viewed with a different byte order.

Equivalent to:

```
arr.view(arr.dtype.newbytorder(new_order))
```

Changes are also made in all fields and sub-arrays of the array data type.

Parameters

new_order

[string, optional] Byte order to force; a value from the byte order specifications below. *new_order* codes can be any of:

- 'S' - swap dtype from current to opposite endian
- {'<', 'little'} - little endian
- {'>', 'big'} - big endian
- {'=', 'native'} - native order, equivalent to *sys.byteorder*

- {‘|’, ‘I’} - ignore (no change to byte order)

The default value (‘S’) results in swapping the current byte order.

Returns

new_arr
[array] New array object with the dtype reflecting given change to the byte order.

nonzero

`IsErrorArray.nonzero()`

Return the indices of the elements that are non-zero.

Refer to *numpy.nonzero* for full documentation.

See Also

numpy.nonzero : equivalent function

partition

`IsErrorArray.partition`(*kth*, *axis=-1*, *kind='introselect'*, *order=None*)

Rearranges the elements in the array in such a way that the value of the element in kth position is in the position it would be in a sorted array. All elements smaller than the kth element are moved before this element and all equal or greater are moved behind it. The ordering of the elements in the two partitions is undefined.

New in version 1.8.0.

Parameters

kth
[int or sequence of ints] Element index to partition by. The kth element value will be in its final sorted position and all smaller elements will be moved before it and all equal or greater elements behind it. The order of all elements in the partitions is undefined. If provided with a sequence of kth it will partition all elements indexed by kth of them into their sorted position at once.

Deprecated since version 1.22.0: Passing booleans as index is deprecated.

axis
[int, optional] Axis along which to sort. Default is -1, which means sort along the last axis.

kind
[{‘introselect’}, optional] Selection algorithm. Default is ‘introselect’.

order
[str or list of str, optional] When *a* is an array with fields defined, this argument specifies which fields to compare first, second, etc. A single field can be specified as a string, and not all fields need to be specified, but unspecified fields will still be used, in the order in which they come up in the dtype, to break ties.

See Also

numpy.partition : Return a partitioned copy of an array. argpartition : Indirect partition. sort : Full sort.

Notes

See `np.partition` for notes on the different algorithms.

Examples

```
>>> a = np.array([3, 4, 2, 1])
>>> a.partition(3)
>>> a
array([2, 1, 3, 4])
```

```
>>> a.partition((1, 3))
>>> a
array([1, 2, 3, 4])
```

prod

`IsErrorArray.prod`(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, *initial=1*, *where=True*)

Return the product of the array elements over the given axis

Refer to *numpy.prod* for full documentation.

See Also

numpy.prod : equivalent function

ptp

`IsErrorArray.ptp`(*axis=None*, *out=None*, *keepdims=False*)

Peak to peak (maximum - minimum) value along a given axis.

Refer to *numpy.ptp* for full documentation.

See Also

numpy.ptp : equivalent function

put

`IsErrorArray.put(indices, values, mode='raise')`

Set `a.flat[n] = values[n]` for all *n* in indices.

Refer to *numpy.put* for full documentation.

See Also

numpy.put : equivalent function

ravel

`IsErrorArray.ravel([order])`

Return a flattened array.

Refer to *numpy.ravel* for full documentation.

See Also

numpy.ravel : equivalent function

ndarray.flat : a flat iterator on the array.

repeat

`IsErrorArray.repeat(repeats, axis=None)`

Repeat elements of an array.

Refer to *numpy.repeat* for full documentation.

See Also

numpy.repeat : equivalent function

reshape

`IsErrorArray.reshape(shape, order='C')`

Returns an array containing the same data with a new shape.

Refer to *numpy.reshape* for full documentation.

See Also

numpy.reshape : equivalent function

Notes

Unlike the free function *numpy.reshape*, this method on *ndarray* allows the elements of the shape parameter to be passed in as separate arguments. For example, `a.reshape(10, 11)` is equivalent to `a.reshape((10, 11))`.

resize

`IsErrorArray.resize`(*new_shape*, *refcheck=True*)

Change shape and size of array in-place.

Parameters

new_shape
[tuple of ints, or *n* ints] Shape of resized array.

refcheck
[bool, optional] If False, reference count will not be checked. Default is True.

Returns

None

Raises

ValueError
If *a* does not own its own data or references or views to it exist, and the data memory must be changed. PyPy only: will always raise if the data memory must be changed, since there is no reliable way to determine if references or views to it exist.

SystemError
If the *order* keyword argument is specified. This behaviour is a bug in NumPy.

See Also

resize : Return a new array with the specified shape.

Notes

This reallocates space for the data area if necessary.

Only contiguous arrays (data elements consecutive in memory) can be resized.

The purpose of the reference count check is to make sure you do not use this array as a buffer for another Python object and then reallocate the memory. However, reference counts can increase in other ways so if you are sure that you have not shared the memory for this array with another Python object, then you may safely set *refcheck* to False.

Examples

Shrinking an array: array is flattened (in the order that the data are stored in memory), resized, and reshaped:

```
>>> a = np.array([[0, 1], [2, 3]], order='C')
>>> a.resize((2, 1))
>>> a
array([[0],
       [1]])
```

```
>>> a = np.array([[0, 1], [2, 3]], order='F')
>>> a.resize((2, 1))
>>> a
array([[0],
       [2]])
```

Enlarging an array: as above, but missing entries are filled with zeros:

```
>>> b = np.array([[0, 1], [2, 3]])
>>> b.resize(2, 3) # new_shape parameter doesn't have to be a tuple
>>> b
array([[0, 1, 2],
       [3, 0, 0]])
```

Referencing an array prevents resizing…

```
>>> c = a
>>> a.resize((1, 1))
Traceback (most recent call last):
...
ValueError: cannot resize an array that references or is referenced ...
```

Unless *refcheck* is False:

```
>>> a.resize((1, 1), refcheck=False)
>>> a
array([[0]])
>>> c
array([[0]])
```

round

`IsErrorArray.round(decimals=0, out=None)`

Return *a* with each element rounded to the given number of decimals.

Refer to *numpy.around* for full documentation.

See Also

numpy.around : equivalent function

searchsorted

`IsErrorArray.searchsorted(v, side='left', sorter=None)`

Find indices where elements of v should be inserted in a to maintain order.

For full documentation, see *numpy.searchsorted*

See Also

numpy.searchsorted : equivalent function

setfield

`IsErrorArray.setfield(val, dtype, offset=0)`

Put a value into a specified place in a field defined by a data-type.

Place *val* into *a*'s field defined by *dtype* and beginning *offset* bytes into the field.

Parameters

val
[object] Value to be placed in field.

dtype
[dtype object] Data-type of the field in which to place *val*.

offset
[int, optional] The number of bytes into the field at which to place *val*.

Returns

None

See Also

getfield

Examples

```
>>> x = np.eye(3)
>>> x.getfield(np.float64)
array([[1.,  0.,  0.],
       [0.,  1.,  0.],
       [0.,  0.,  1.]])
>>> x.setfield(3, np.int32)
>>> x.getfield(np.int32)
array([[3, 3, 3],
       [3, 3, 3],
       [3, 3, 3]], dtype=int32)
>>> x
array([[1.0e+000, 1.5e-323, 1.5e-323],
       [1.5e-323, 1.0e+000, 1.5e-323],
       [1.5e-323, 1.5e-323, 1.0e+000]])
>>> x.setfield(np.eye(3), np.int32)
>>> x
array([[1.,  0.,  0.],
       [0.,  1.,  0.],
       [0.,  0.,  1.]])
```

setflags

`IsErrorArray.`**`setflags`**(*write=None*, *align=None*, *uic=None*)

Set array flags WRITEABLE, ALIGNED, WRITEBACKIFCOPY, respectively.

These Boolean-valued flags affect how numpy interprets the memory area used by *a* (see Notes below). The ALIGNED flag can only be set to True if the data is actually aligned according to the type. The WRITEBACKIFCOPY and flag can never be set to True. The flag WRITEABLE can only be set to True if the array owns its own memory, or the ultimate owner of the memory exposes a writeable buffer interface, or is a string. (The exception for string is made so that unpickling can be done without copying memory.)

Parameters

write
: [bool, optional] Describes whether or not *a* can be written to.

align
: [bool, optional] Describes whether or not *a* is aligned properly for its type.

uic
: [bool, optional] Describes whether or not *a* is a copy of another "base" array.

Notes

Array flags provide information about how the memory area used for the array is to be interpreted. There are 7 Boolean flags in use, only four of which can be changed by the user: WRITEBACKIFCOPY, WRITEABLE, and ALIGNED.

WRITEABLE (W) the data area can be written to;

ALIGNED (A) the data and strides are aligned appropriately for the hardware (as determined by the compiler);

WRITEBACKIFCOPY (X) this array is a copy of some other array (referenced by .base). When the C-API function PyArray_ResolveWritebackIfCopy is called, the base array will be updated with the contents of this array.

All flags can be accessed using the single (upper case) letter as well as the full name.

Examples

```
>>> y = np.array([[3, 1, 7],
...               [2, 0, 0],
...               [8, 5, 9]])
>>> y
array([[3, 1, 7],
       [2, 0, 0],
       [8, 5, 9]])
>>> y.flags
  C_CONTIGUOUS : True
  F_CONTIGUOUS : False
  OWNDATA : True
  WRITEABLE : True
  ALIGNED : True
  WRITEBACKIFCOPY : False
>>> y.setflags(write=0, align=0)
>>> y.flags
  C_CONTIGUOUS : True
  F_CONTIGUOUS : False
  OWNDATA : True
  WRITEABLE : False
  ALIGNED : False
  WRITEBACKIFCOPY : False
>>> y.setflags(uic=1)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: cannot set WRITEBACKIFCOPY flag to True
```

sort

IsErrorArray.**sort**(*axis=-1*, *kind=None*, *order=None*)

Sort an array in-place. Refer to *numpy.sort* for full documentation.

Parameters

axis
[int, optional] Axis along which to sort. Default is -1, which means sort along the last axis.

kind
[{'quicksort', 'mergesort', 'heapsort', 'stable'}, optional] Sorting algorithm. The default is 'quicksort'. Note that both 'stable' and 'mergesort' use timsort under the covers and, in general, the actual implementation will vary with datatype. The 'mergesort' option is retained for backwards compatibility.

Changed in version 1.15.0: The 'stable' option was added.

order
[str or list of str, optional] When *a* is an array with fields defined, this argument specifies which fields to compare first, second, etc. A single field can be specified as a string, and not all fields need be specified, but unspecified fields will still be used, in the order in which they come up in the dtype, to break ties.

See Also

numpy.sort : Return a sorted copy of an array. numpy.argsort : Indirect sort. numpy.lexsort : Indirect stable sort on multiple keys. numpy.searchsorted : Find elements in sorted array. numpy.partition: Partial sort.

Notes

See *numpy.sort* for notes on the different sorting algorithms.

Examples

```
>>> a = np.array([[1,4], [3,1]])
>>> a.sort(axis=1)
>>> a
array([[1, 4],
       [1, 3]])
>>> a.sort(axis=0)
>>> a
array([[1, 3],
       [1, 4]])
```

Use the *order* keyword to specify a field to use when sorting a structured array:

```
>>> a = np.array([('a', 2), ('c', 1)], dtype=[('x', 'S1'), ('y', int)])
>>> a.sort(order='y')
>>> a
array([(b'c', 1), (b'a', 2)],
      dtype=[('x', 'S1'), ('y', '<i8')])
```

squeeze

IsErrorArray.**squeeze**(*axis=None*)

Remove axes of length one from *a*.

Refer to *numpy.squeeze* for full documentation.

See Also

numpy.squeeze : equivalent function

std

IsErrorArray.**std**(*axis=None*, *dtype=None*, *out=None*, *ddof=0*, *keepdims=False*, *, *where=True*)

Returns the standard deviation of the array elements along given axis.

Refer to *numpy.std* for full documentation.

See Also

numpy.std : equivalent function

sum

IsErrorArray.**sum**(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, *initial=0*, *where=True*)

Return the sum of the array elements over the given axis.

Refer to *numpy.sum* for full documentation.

See Also

numpy.sum : equivalent function

swapaxes

`IsErrorArray.swapaxes(axis1, axis2)`

Return a view of the array with *axis1* and *axis2* interchanged.

Refer to *numpy.swapaxes* for full documentation.

See Also

numpy.swapaxes : equivalent function

take

`IsErrorArray.take(indices, axis=None, out=None, mode='raise')`

Return an array formed from the elements of *a* at the given indices.

Refer to *numpy.take* for full documentation.

See Also

numpy.take : equivalent function

tobytes

`IsErrorArray.tobytes(order='C')`

Construct Python bytes containing the raw data bytes in the array.

Constructs Python bytes showing a copy of the raw contents of data memory. The bytes object is produced in C-order by default. This behavior is controlled by the `order` parameter.

New in version 1.9.0.

Parameters

order
[{'C', 'F', 'A'}, optional] Controls the memory layout of the bytes object. 'C' means C-order, 'F' means F-order, 'A' (short for *Any*) means 'F' if *a* is Fortran contiguous, 'C' otherwise. Default is 'C'.

Returns

s
[bytes] Python bytes exhibiting a copy of *a*'s raw data.

See also

frombuffer
Inverse of this operation, construct a 1-dimensional array from Python bytes.

Examples

```
>>> x = np.array([[0, 1], [2, 3]], dtype='<u2')
>>> x.tobytes()
b'\x00\x00\x01\x00\x02\x00\x03\x00'
>>> x.tobytes('C') == x.tobytes()
True
>>> x.tobytes('F')
b'\x00\x00\x02\x00\x01\x00\x03\x00'
```

tofile

IsErrorArray.**tofile**(*fid*, *sep=''*, *format='%s'*)

Write array to a file as text or binary (default).

Data is always written in 'C' order, independent of the order of *a*. The data produced by this method can be recovered using the function fromfile().

Parameters

fid
[file or str or Path] An open file object, or a string containing a filename.

Changed in version 1.17.0: *pathlib.Path* objects are now accepted.

sep
[str] Separator between array items for text output. If "" (empty), a binary file is written, equivalent to `file.write(a.tobytes())`.

format
[str] Format string for text file output. Each entry in the array is formatted to text by first converting it to the closest Python type, and then using "format" % item.

Notes

This is a convenience function for quick storage of array data. Information on endianness and precision is lost, so this method is not a good choice for files intended to archive data or transport data between machines with different endianness. Some of these problems can be overcome by outputting the data as text files, at the expense of speed and file size.

When fid is a file object, array contents are directly written to the file, bypassing the file object's `write` method. As a result, tofile cannot be used with files objects supporting compression (e.g., GzipFile) or file-like objects that do not support `fileno()` (e.g., BytesIO).

tolist

`IsErrorArray.tolist()`

Return the array as an `a.ndim`-levels deep nested list of Python scalars.

Return a copy of the array data as a (nested) Python list. Data items are converted to the nearest compatible builtin Python type, via the *~numpy.ndarray.item* function.

If `a.ndim` is 0, then since the depth of the nested list is 0, it will not be a list at all, but a simple Python scalar.

Parameters

none

Returns

y

[object, or list of object, or list of list of object, or . . .] The possibly nested list of array elements.

Notes

The array may be recreated via `a = np.array(a.tolist())`, although this may sometimes lose precision.

Examples

For a 1D array, `a.tolist()` is almost the same as `list(a)`, except that `tolist` changes numpy scalars to Python scalars:

```
>>> a = np.uint32([1, 2])
>>> a_list = list(a)
>>> a_list
[1, 2]
>>> type(a_list[0])
<class 'numpy.uint32'>
>>> a_tolist = a.tolist()
>>> a_tolist
[1, 2]
>>> type(a_tolist[0])
<class 'int'>
```

Additionally, for a 2D array, `tolist` applies recursively:

```
>>> a = np.array([[1, 2], [3, 4]])
>>> list(a)
[array([1, 2]), array([3, 4])]
>>> a.tolist()
[[1, 2], [3, 4]]
```

The base case for this recursion is a 0D array:

```
>>> a = np.array(1)
>>> list(a)
Traceback (most recent call last):
  ...
TypeError: iteration over a 0-d array
>>> a.tolist()
1
```

tostring

`IsErrorArray.tostring(order='C')`

A compatibility alias for *tobytes*, with exactly the same behavior.

Despite its name, it returns *bytes* not *str*s.

Deprecated since version 1.19.0.

trace

`IsErrorArray.trace(offset=0, axis1=0, axis2=1, dtype=None, out=None)`

Return the sum along diagonals of the array.

Refer to *numpy.trace* for full documentation.

See Also

numpy.trace : equivalent function

transpose

`IsErrorArray.transpose(*axes)`

Returns a view of the array with axes transposed.

Refer to *numpy.transpose* for full documentation.

Parameters

axes : None, tuple of ints, or *n* ints

- None or no argument: reverses the order of the axes.
- tuple of ints: *i* in the *j*-th place in the tuple means that the array's *i*-th axis becomes the transposed array's *j*-th axis.
- *n* ints: same as an n-tuple of the same ints (this form is intended simply as a "convenience" alternative to the tuple form).

Returns

p
[ndarray] View of the array with its axes suitably permuted.

See Also

transpose : Equivalent function. ndarray.T : Array property returning the array transposed. ndarray.reshape : Give a new shape to an array without changing its data.

Examples

```
>>> a = np.array([[1, 2], [3, 4]])
>>> a
array([[1, 2],
       [3, 4]])
>>> a.transpose()
array([[1, 3],
       [2, 4]])
>>> a.transpose((1, 0))
array([[1, 3],
       [2, 4]])
>>> a.transpose(1, 0)
array([[1, 3],
       [2, 4]])
```

```
>>> a = np.array([1, 2, 3, 4])
>>> a
array([1, 2, 3, 4])
>>> a.transpose()
array([1, 2, 3, 4])
```

var

`IsErrorArray.`**`var`**(*axis=None*, *dtype=None*, *out=None*, *ddof=0*, *keepdims=False*, *, *where=True*)

Returns the variance of the array elements, along given axis.

Refer to *numpy.var* for full documentation.

See Also

numpy.var : equivalent function

view

IsErrorArray.**view**(*[dtype][, type]*)

New view of array with the same data.

Note: Passing None for `dtype` is different from omitting the parameter, since the former invokes `dtype(None)` which is an alias for `dtype('float_')`.

Parameters

dtype
[data-type or ndarray sub-class, optional] Data-type descriptor of the returned view, e.g., float32 or int16. Omitting it results in the view having the same data-type as *a*. This argument can also be specified as an ndarray sub-class, which then specifies the type of the returned object (this is equivalent to setting the `type` parameter).

type
[Python type, optional] Type of the returned view, e.g., ndarray or matrix. Again, omission of the parameter results in type preservation.

Notes

`a.view()` is used two different ways:

`a.view(some_dtype)` or `a.view(dtype=some_dtype)` constructs a view of the array's memory with a different data-type. This can cause a reinterpretation of the bytes of memory.

`a.view(ndarray_subclass)` or `a.view(type=ndarray_subclass)` just returns an instance of *ndarray_subclass* that looks at the same array (same shape, dtype, etc.) This does not cause a reinterpretation of the memory.

For `a.view(some_dtype)`, if `some_dtype` has a different number of bytes per entry than the previous dtype (for example, converting a regular array to a structured array), then the last axis of `a` must be contiguous. This axis will be resized in the result.

Changed in version 1.23.0: Only the last axis needs to be contiguous. Previously, the entire array had to be C-contiguous.

Examples

```
>>> x = np.array([(1, 2)], dtype=[('a', np.int8), ('b', np.int8)])
```

Viewing array data using a different type and dtype:

```
>>> y = x.view(dtype=np.int16, type=np.matrix)
>>> y
matrix([[513]], dtype=int16)
>>> print(type(y))
<class 'numpy.matrix'>
```

Creating a view on a structured array so it can be used in calculations

```
>>> x = np.array([(1, 2),(3,4)], dtype=[('a', np.int8), ('b', np.int8)])
>>> xv = x.view(dtype=np.int8).reshape(-1,2)
>>> xv
array([[1, 2],
       [3, 4]], dtype=int8)
>>> xv.mean(0)
array([2.,  3.])
```

Making changes to the view changes the underlying array

```
>>> xv[0,1] = 20
>>> x
array([(1, 20), (3,  4)], dtype=[('a', 'i1'), ('b', 'i1')])
```

Using a view to convert an array to a recarray:

```
>>> z = x.view(np.recarray)
>>> z.a
array([1, 3], dtype=int8)
```

Views share data:

```
>>> x[0] = (9, 10)
>>> z[0]
(9, 10)
```

Views that change the dtype size (bytes per entry) should normally be avoided on arrays defined by slices, transposes, fortran-ordering, etc.:

```
>>> x = np.array([[1, 2, 3], [4, 5, 6]], dtype=np.int16)
>>> y = x[:, ::2]
>>> y
array([[1, 3],
       [4, 6]], dtype=int16)
>>> y.view(dtype=[('width', np.int16), ('length', np.int16)])
Traceback (most recent call last):
    ...
ValueError: To change to a dtype of a different size, the last axis must be␣
↪contiguous
>>> z = y.copy()
>>> z.view(dtype=[('width', np.int16), ('length', np.int16)])
array([[(1, 3)],
       [(4, 6)]], dtype=[('width', '<i2'), ('length', '<i2')])
```

However, views that change dtype are totally fine for arrays with a contiguous last axis, even if the rest of the axes are not C-contiguous:

```
>>> x = np.arange(2 * 3 * 4, dtype=np.int8).reshape(2, 3, 4)
>>> x.transpose(1, 0, 2).view(np.int16)
array([[[ 256,  770],
        [3340, 3854]],

       [[1284, 1798],
        [4368, 4882]],
```

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```
       [[2312, 2826],
        [5396, 5910]]], dtype=int16)
```

__init__()

Attributes

T	View of the transposed array.
base	Base object if memory is from some other object.
ctypes	An object to simplify the interaction of the array with the ctypes module.
data	Python buffer object pointing to the start of the array's data.
dtype	Data-type of the array's elements.
flags	Information about the memory layout of the array.
flat	A 1-D iterator over the array.
imag	The imaginary part of the array.
itemsize	Length of one array element in bytes.
nbytes	Total bytes consumed by the elements of the array.
ndim	Number of array dimensions.
real	The real part of the array.
shape	Tuple of array dimensions.
size	Number of elements in the array.
strides	Tuple of bytes to step in each dimension when traversing an array.

T

IsErrorArray.**T**

View of the transposed array.

Same as `self.transpose()`.

Examples

```
>>> a = np.array([[1, 2], [3, 4]])
>>> a
array([[1, 2],
       [3, 4]])
>>> a.T
array([[1, 3],
       [2, 4]])
```

```
>>> a = np.array([1, 2, 3, 4])
>>> a
array([1, 2, 3, 4])
```

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```
>>> a.T
array([1, 2, 3, 4])
```

See Also

transpose

base

`IsErrorArray.base`

Base object if memory is from some other object.

Examples

The base of an array that owns its memory is None:

```
>>> x = np.array([1,2,3,4])
>>> x.base is None
True
```

Slicing creates a view, whose memory is shared with x:

```
>>> y = x[2:]
>>> y.base is x
True
```

ctypes

`IsErrorArray.ctypes`

An object to simplify the interaction of the array with the ctypes module.

This attribute creates an object that makes it easier to use arrays when calling shared libraries with the ctypes module. The returned object has, among others, data, shape, and strides attributes (see Notes below) which themselves return ctypes objects that can be used as arguments to a shared library.

Parameters

None

Returns

c
[Python object] Possessing attributes data, shape, strides, etc.

See Also

numpy.ctypeslib

Notes

Below are the public attributes of this object which were documented in “Guide to NumPy” (we have omitted undocumented public attributes, as well as documented private attributes):

`_ctypes.`**`data`**

A pointer to the memory area of the array as a Python integer. This memory area may contain data that is not aligned, or not in correct byte-order. The memory area may not even be writeable. The array flags and data-type of this array should be respected when passing this attribute to arbitrary C-code to avoid trouble that can include Python crashing. User Beware! The value of this attribute is exactly the same as `self._array_interface_['data'][0]`.

Note that unlike `data_as`, a reference will not be kept to the array: code like `ctypes.c_void_p((a + b).ctypes.data)` will result in a pointer to a deallocated array, and should be spelt `(a + b).ctypes.data_as(ctypes.c_void_p)`

`_ctypes.`**`shape`**

(c_intp*self.ndim): A ctypes array of length self.ndim where the basetype is the C-integer corresponding to `dtype('p')` on this platform (see *~numpy.ctypeslib.c_intp*). This base-type could be *ctypes.c_int*, *ctypes.c_long*, or *ctypes.c_longlong* depending on the platform. The ctypes array contains the shape of the underlying array.

`_ctypes.`**`strides`**

(c_intp*self.ndim): A ctypes array of length self.ndim where the basetype is the same as for the shape attribute. This ctypes array contains the strides information from the underlying array. This strides information is important for showing how many bytes must be jumped to get to the next element in the array.

`_ctypes.`**`data_as`**`(`*obj*`)`

Return the data pointer cast to a particular c-types object. For example, calling `self._as_parameter_` is equivalent to `self.data_as(ctypes.c_void_p)`. Perhaps you want to use the data as a pointer to a ctypes array of floating-point data: `self.data_as(ctypes.POINTER(ctypes.c_double))`.

The returned pointer will keep a reference to the array.

`_ctypes.`**`shape_as`**`(`*obj*`)`

Return the shape tuple as an array of some other c-types type. For example: `self.shape_as(ctypes.c_short)`.

`_ctypes.`**`strides_as`**`(`*obj*`)`

Return the strides tuple as an array of some other c-types type. For example: `self.strides_as(ctypes.c_longlong)`.

If the ctypes module is not available, then the ctypes attribute of array objects still returns something useful, but ctypes objects are not returned and errors may be raised instead. In particular, the object will still have the `as_parameter` attribute which will return an integer equal to the data attribute.

Examples

```
>>> import ctypes
>>> x = np.array([[0, 1], [2, 3]], dtype=np.int32)
>>> x
array([[0, 1],
       [2, 3]], dtype=int32)
>>> x.ctypes.data
31962608 # may vary
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint32))
<__main__.LP_c_uint object at 0x7ff2fc1fc200> # may vary
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint32)).contents
c_uint(0)
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint64)).contents
c_ulong(4294967296)
>>> x.ctypes.shape
<numpy.core._internal.c_long_Array_2 object at 0x7ff2fc1fce60> # may vary
>>> x.ctypes.strides
<numpy.core._internal.c_long_Array_2 object at 0x7ff2fc1ff320> # may vary
```

data

`IsErrorArray.`**`data`**

Python buffer object pointing to the start of the array's data.

dtype

`IsErrorArray.`**`dtype`**

Data-type of the array's elements.

> **Warning:** Setting `arr.dtype` is discouraged and may be deprecated in the future. Setting will replace the `dtype` without modifying the memory (see also *ndarray.view* and *ndarray.astype*).

Parameters

None

Returns

d : numpy dtype object

See Also

ndarray.astype : Cast the values contained in the array to a new data-type. ndarray.view : Create a view of the same data but a different data-type. numpy.dtype

Examples

```
>>> x
array([[0, 1],
       [2, 3]])
>>> x.dtype
dtype('int32')
>>> type(x.dtype)
<type 'numpy.dtype'>
```

flags

`IsErrorArray.flags`

Information about the memory layout of the array.

Attributes

C_CONTIGUOUS (C)
The data is in a single, C-style contiguous segment.

F_CONTIGUOUS (F)
The data is in a single, Fortran-style contiguous segment.

OWNDATA (O)
The array owns the memory it uses or borrows it from another object.

WRITEABLE (W)
The data area can be written to. Setting this to False locks the data, making it read-only. A view (slice, etc.) inherits WRITEABLE from its base array at creation time, but a view of a writeable array may be subsequently locked while the base array remains writeable. (The opposite is not true, in that a view of a locked array may not be made writeable. However, currently, locking a base object does not lock any views that already reference it, so under that circumstance it is possible to alter the contents of a locked array via a previously created writeable view onto it.) Attempting to change a non-writeable array raises a RuntimeError exception.

ALIGNED (A)
The data and all elements are aligned appropriately for the hardware.

WRITEBACKIFCOPY (X)
This array is a copy of some other array. The C-API function PyArray_ResolveWritebackIfCopy must be called before deallocating to the base array will be updated with the contents of this array.

FNC
F_CONTIGUOUS and not C_CONTIGUOUS.

FORC
F_CONTIGUOUS or C_CONTIGUOUS (one-segment test).

BEHAVED (B)
ALIGNED and WRITEABLE.

CARRAY (CA)
BEHAVED and C_CONTIGUOUS.

FARRAY (FA)
BEHAVED and F_CONTIGUOUS and not C_CONTIGUOUS.

Notes

The *flags* object can be accessed dictionary-like (as in `a.flags['WRITEABLE']`), or by using lowercased attribute names (as in `a.flags.writeable`). Short flag names are only supported in dictionary access.

Only the WRITEBACKIFCOPY, WRITEABLE, and ALIGNED flags can be changed by the user, via direct assignment to the attribute or dictionary entry, or by calling *ndarray.setflags*.

The array flags cannot be set arbitrarily:

- WRITEBACKIFCOPY can only be set `False`.
- ALIGNED can only be set `True` if the data is truly aligned.
- WRITEABLE can only be set `True` if the array owns its own memory or the ultimate owner of the memory exposes a writeable buffer interface or is a string.

Arrays can be both C-style and Fortran-style contiguous simultaneously. This is clear for 1-dimensional arrays, but can also be true for higher dimensional arrays.

Even for contiguous arrays a stride for a given dimension `arr.strides[dim]` may be *arbitrary* if `arr.shape[dim] == 1` or the array has no elements. It does *not* generally hold that `self.strides[-1] == self.itemsize` for C-style contiguous arrays or `self.strides[0] == self.itemsize` for Fortran-style contiguous arrays is true.

flat

`IsErrorArray.flat`

A 1-D iterator over the array.

This is a *numpy.flatiter* instance, which acts similarly to, but is not a subclass of, Python's built-in iterator object.

See Also

flatten : Return a copy of the array collapsed into one dimension.

flatiter

Examples

```
>>> x = np.arange(1, 7).reshape(2, 3)
>>> x
array([[1, 2, 3],
       [4, 5, 6]])
>>> x.flat[3]
4
>>> x.T
array([[1, 4],
       [2, 5],
       [3, 6]])
>>> x.T.flat[3]
5
>>> type(x.flat)
<class 'numpy.flatiter'>
```

An assignment example:

```
>>> x.flat = 3; x
array([[3, 3, 3],
       [3, 3, 3]])
>>> x.flat[[1,4]] = 1; x
array([[3, 1, 3],
       [3, 1, 3]])
```

imag

`IsErrorArray.imag`

The imaginary part of the array.

Examples

```
>>> x = np.sqrt([1+0j, 0+1j])
>>> x.imag
array([ 0.        ,  0.70710678])
>>> x.imag.dtype
dtype('float64')
```

itemsize

IsErrorArray.**itemsize**

Length of one array element in bytes.

Examples

```
>>> x = np.array([1,2,3], dtype=np.float64)
>>> x.itemsize
8
>>> x = np.array([1,2,3], dtype=np.complex128)
>>> x.itemsize
16
```

nbytes

IsErrorArray.**nbytes**

Total bytes consumed by the elements of the array.

Notes

Does not include memory consumed by non-element attributes of the array object.

See Also

sys.getsizeof
Memory consumed by the object itself without parents in case view. This does include memory consumed by non-element attributes.

Examples

```
>>> x = np.zeros((3,5,2), dtype=np.complex128)
>>> x.nbytes
480
>>> np.prod(x.shape) * x.itemsize
480
```

ndim

`IsErrorArray.ndim`

Number of array dimensions.

Examples

```
>>> x = np.array([1, 2, 3])
>>> x.ndim
1
>>> y = np.zeros((2, 3, 4))
>>> y.ndim
3
```

real

`IsErrorArray.real`

The real part of the array.

Examples

```
>>> x = np.sqrt([1+0j, 0+1j])
>>> x.real
array([ 1.        ,  0.70710678])
>>> x.real.dtype
dtype('float64')
```

See Also

numpy.real : equivalent function

shape

`IsErrorArray.shape`

Tuple of array dimensions.

The shape property is usually used to get the current shape of an array, but may also be used to reshape the array in-place by assigning a tuple of array dimensions to it. As with *numpy.reshape*, one of the new shape dimensions can be -1, in which case its value is inferred from the size of the array and the remaining dimensions. Reshaping an array in-place will fail if a copy is required.

> **Warning:** Setting `arr.shape` is discouraged and may be deprecated in the future. Using *ndarray.reshape* is the preferred approach.

Examples

```
>>> x = np.array([1, 2, 3, 4])
>>> x.shape
(4,)
>>> y = np.zeros((2, 3, 4))
>>> y.shape
(2, 3, 4)
>>> y.shape = (3, 8)
>>> y
array([[ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.],
       [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.],
       [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.]])
>>> y.shape = (3, 6)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: total size of new array must be unchanged
>>> np.zeros((4,2))[::2].shape = (-1,)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AttributeError: Incompatible shape for in-place modification. Use
`.reshape()` to make a copy with the desired shape.
```

See Also

numpy.shape : Equivalent getter function. numpy.reshape : Function similar to setting `shape`. ndarray.reshape : Method similar to setting `shape`.

size

`IsErrorArray.size`

Number of elements in the array.

Equal to `np.prod(a.shape)`, i.e., the product of the array's dimensions.

Notes

a.size returns a standard arbitrary precision Python integer. This may not be the case with other methods of obtaining the same value (like the suggested `np.prod(a.shape)`, which returns an instance of `np.int_`), and may be relevant if the value is used further in calculations that may overflow a fixed size integer type.

Examples

```
>>> x = np.zeros((3, 5, 2), dtype=np.complex128)
>>> x.size
30
>>> np.prod(x.shape)
30
```

strides

`IsErrorArray.strides`

Tuple of bytes to step in each dimension when traversing an array.

The byte offset of element `(i[0], i[1], ..., i[n])` in an array *a* is:

```
offset = sum(np.array(i) * a.strides)
```

A more detailed explanation of strides can be found in the "ndarray.rst" file in the NumPy reference guide.

> **Warning:** Setting `arr.strides` is discouraged and may be deprecated in the future. *numpy.lib.stride_tricks.as_strided* should be preferred to create a new view of the same data in a safer way.

Notes

Imagine an array of 32-bit integers (each 4 bytes):

```
x = np.array([[0, 1, 2, 3, 4],
              [5, 6, 7, 8, 9]], dtype=np.int32)
```

This array is stored in memory as 40 bytes, one after the other (known as a contiguous block of memory). The strides of an array tell us how many bytes we have to skip in memory to move to the next position along a certain axis. For example, we have to skip 4 bytes (1 value) to move to the next column, but 20 bytes (5 values) to get to the same position in the next row. As such, the strides for the array *x* will be `(20, 4)`.

See Also

numpy.lib.stride_tricks.as_strided

Examples

```
>>> y = np.reshape(np.arange(2*3*4), (2,3,4))
>>> y
array([[[ 0,  1,  2,  3],
        [ 4,  5,  6,  7],
        [ 8,  9, 10, 11]],
       [[12, 13, 14, 15],
        [16, 17, 18, 19],
        [20, 21, 22, 23]]])
>>> y.strides
(48, 16, 4)
>>> y[1,1,1]
17
>>> offset=sum(y.strides * np.array((1,1,1)))
>>> offset/y.itemsize
17
```

```
>>> x = np.reshape(np.arange(5*6*7*8), (5,6,7,8)).transpose(2,3,1,0)
>>> x.strides
(32, 4, 224, 1344)
>>> i = np.array([3,5,2,2])
>>> offset = sum(i * x.strides)
>>> x[3,5,2,2]
813
>>> offset / x.itemsize
813
```

IsNaArray

class IsNaArray

Methods

__init__	
all	Returns True if all elements evaluate to True.
any	Returns True if any of the elements of *a* evaluate to True.
argmax	Return indices of the maximum values along the given axis.
argmin	Return indices of the minimum values along the given axis.
argpartition	Returns the indices that would partition this array.
argsort	Returns the indices that would sort this array.
astype	Copy of the array, cast to a specified type.
byteswap	Swap the bytes of the array elements
choose	Use an index array to construct a new array from a set of choices.

continues on next page

Table 4 – continued from previous page

`clip`	Return an array whose values are limited to `[min, max]`.
`collapse`	
`compress`	Return selected slices of this array along given axis.
`conj`	Complex-conjugate all elements.
`conjugate`	Return the complex conjugate, element-wise.
`copy`	Return a copy of the array.
`cumprod`	Return the cumulative product of the elements along the given axis.
`cumsum`	Return the cumulative sum of the elements along the given axis.
`diagonal`	Return specified diagonals.
`dot`	
`dump`	Dump a pickle of the array to the specified file.
`dumps`	Returns the pickle of the array as a string.
`fill`	Fill the array with a scalar value.
`flatten`	Return a copy of the array collapsed into one dimension.
`getfield`	Returns a field of the given array as a certain type.
`item`	Copy an element of an array to a standard Python scalar and return it.
`itemset`	Insert scalar into an array (scalar is cast to array's dtype, if possible)
`max`	Return the maximum along a given axis.
`mean`	Returns the average of the array elements along given axis.
`min`	Return the minimum along a given axis.
`newbyteorder`	Return the array with the same data viewed with a different byte order.
`nonzero`	Return the indices of the elements that are non-zero.
`partition`	Rearranges the elements in the array in such a way that the value of the element in kth position is in the position it would be in a sorted array.
`prod`	Return the product of the array elements over the given axis
`ptp`	Peak to peak (maximum - minimum) value along a given axis.
`put`	Set `a.flat[n] = values[n]` for all *n* in indices.
`ravel`	Return a flattened array.
`repeat`	Repeat elements of an array.
`reshape`	Returns an array containing the same data with a new shape.
`resize`	Change shape and size of array in-place.
`round`	Return *a* with each element rounded to the given number of decimals.
`searchsorted`	Find indices where elements of v should be inserted in a to maintain order.
`setfield`	Put a value into a specified place in a field defined by a data-type.

continues on next page

Table 4 – continued from previous page

`setflags`	Set array flags WRITEABLE, ALIGNED, WRITEBACKIFCOPY, respectively.
`sort`	Sort an array in-place.
`squeeze`	Remove axes of length one from *a*.
`std`	Returns the standard deviation of the array elements along given axis.
`sum`	Return the sum of the array elements over the given axis.
`swapaxes`	Return a view of the array with *axis1* and *axis2* interchanged.
`take`	Return an array formed from the elements of *a* at the given indices.
`tobytes`	Construct Python bytes containing the raw data bytes in the array.
`tofile`	Write array to a file as text or binary (default).
`tolist`	Return the array as an `a.ndim`-levels deep nested list of Python scalars.
`tostring`	A compatibility alias for *tobytes*, with exactly the same behavior.
`trace`	Return the sum along diagonals of the array.
`transpose`	Returns a view of the array with axes transposed.
`var`	Returns the variance of the array elements, along given axis.
`view`	New view of array with the same data.

__init__

`IsNaArray.__init__()`

all

`IsNaArray.all(`*axis=None*, *out=None*, *keepdims=False*, *, *where=True*`)`

Returns True if all elements evaluate to True.

Refer to *numpy.all* for full documentation.

See Also

numpy.all : equivalent function

any

IsNaArray.**any**(*axis=None*, *out=None*, *keepdims=False*, *, *where=True*)

Returns True if any of the elements of *a* evaluate to True.

Refer to *numpy.any* for full documentation.

See Also

numpy.any : equivalent function

argmax

IsNaArray.**argmax**(*axis=None*, *out=None*, *, *keepdims=False*)

Return indices of the maximum values along the given axis.

Refer to *numpy.argmax* for full documentation.

See Also

numpy.argmax : equivalent function

argmin

IsNaArray.**argmin**(*axis=None*, *out=None*, *, *keepdims=False*)

Return indices of the minimum values along the given axis.

Refer to *numpy.argmin* for detailed documentation.

See Also

numpy.argmin : equivalent function

argpartition

IsNaArray.**argpartition**(*kth*, *axis=-1*, *kind='introselect'*, *order=None*)

Returns the indices that would partition this array.

Refer to *numpy.argpartition* for full documentation.

New in version 1.8.0.

See Also

numpy.argpartition : equivalent function

argsort

IsNaArray.**argsort**(*axis=-1*, *kind=None*, *order=None*)

Returns the indices that would sort this array.

Refer to *numpy.argsort* for full documentation.

See Also

numpy.argsort : equivalent function

astype

IsNaArray.**astype**(*dtype*, *order='K'*, *casting='unsafe'*, *subok=True*, *copy=True*)

Copy of the array, cast to a specified type.

Parameters

dtype
[str or dtype] Typecode or data-type to which the array is cast.

order
[{'C', 'F', 'A', 'K'}, optional] Controls the memory layout order of the result. 'C' means C order, 'F' means Fortran order, 'A' means 'F' order if all the arrays are Fortran contiguous, 'C' order otherwise, and 'K' means as close to the order the array elements appear in memory as possible. Default is 'K'.

casting
[{'no', 'equiv', 'safe', 'same_kind', 'unsafe'}, optional] Controls what kind of data casting may occur. Defaults to 'unsafe' for backwards compatibility.

- 'no' means the data types should not be cast at all.
- 'equiv' means only byte-order changes are allowed.
- 'safe' means only casts which can preserve values are allowed.
- 'same_kind' means only safe casts or casts within a kind, like float64 to float32, are allowed.
- 'unsafe' means any data conversions may be done.

subok
[bool, optional] If True, then sub-classes will be passed-through (default), otherwise the returned array will be forced to be a base-class array.

copy
[bool, optional] By default, astype always returns a newly allocated array. If this is set to false, and the *dtype*, *order*, and *subok* requirements are satisfied, the input array is returned instead of a copy.

Returns

arr_t
[ndarray] Unless *copy* is False and the other conditions for returning the input array are satisfied (see description for *copy* input parameter), *arr_t* is a new array of the same shape as the input array, with dtype, order given by *dtype*, *order*.

Notes

Changed in version 1.17.0: Casting between a simple data type and a structured one is possible only for "unsafe" casting. Casting to multiple fields is allowed, but casting from multiple fields is not.

Changed in version 1.9.0: Casting from numeric to string types in 'safe' casting mode requires that the string dtype length is long enough to store the max integer/float value converted.

Raises

ComplexWarning
When casting from complex to float or int. To avoid this, one should use `a.real.astype(t)`.

Examples

```
>>> x = np.array([1, 2, 2.5])
>>> x
array([1. ,  2. ,  2.5])
```

```
>>> x.astype(int)
array([1, 2, 2])
```

byteswap

`IsNaArray.`**`byteswap`**(*inplace=False*)

Swap the bytes of the array elements

Toggle between low-endian and big-endian data representation by returning a byteswapped array, optionally swapped in-place. Arrays of byte-strings are not swapped. The real and imaginary parts of a complex number are swapped individually.

Parameters

inplace
[bool, optional] If `True`, swap bytes in-place, default is `False`.

Returns

out
[ndarray] The byteswapped array. If *inplace* is True, this is a view to self.

Examples

```
>>> A = np.array([1, 256, 8755], dtype=np.int16)
>>> list(map(hex, A))
['0x1', '0x100', '0x2233']
>>> A.byteswap(inplace=True)
array([  256,     1, 13090], dtype=int16)
>>> list(map(hex, A))
['0x100', '0x1', '0x3322']
```

Arrays of byte-strings are not swapped

```
>>> A = np.array([b'ceg', b'fac'])
>>> A.byteswap()
array([b'ceg', b'fac'], dtype='|S3')
```

A.newbyteorder().byteswap() produces an array with the same values
but different representation in memory

```
>>> A = np.array([1, 2, 3])
>>> A.view(np.uint8)
array([1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 3, 0, 0, 0, 0, 0,
       0, 0], dtype=uint8)
>>> A.newbyteorder().byteswap(inplace=True)
array([1, 2, 3])
>>> A.view(np.uint8)
array([0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0,
       0, 3], dtype=uint8)
```

choose

IsNaArray.**choose**(*choices*, *out=None*, *mode='raise'*)
Use an index array to construct a new array from a set of choices.

Refer to *numpy.choose* for full documentation.

See Also

numpy.choose : equivalent function

clip

`IsNaArray.clip`(*min=None*, *max=None*, *out=None*, ***kwargs*)

Return an array whose values are limited to `[min, max]`. One of max or min must be given.

Refer to *numpy.clip* for full documentation.

See Also

numpy.clip : equivalent function

collapse

`IsNaArray.collapse`(*shape*)

compress

`IsNaArray.compress`(*condition*, *axis=None*, *out=None*)

Return selected slices of this array along given axis.

Refer to *numpy.compress* for full documentation.

See Also

numpy.compress : equivalent function

conj

`IsNaArray.conj`()

Complex-conjugate all elements.

Refer to *numpy.conjugate* for full documentation.

See Also

numpy.conjugate : equivalent function

conjugate

IsNaArray.**conjugate**()

Return the complex conjugate, element-wise.

Refer to *numpy.conjugate* for full documentation.

See Also

numpy.conjugate : equivalent function

copy

IsNaArray.**copy**(*order='C'*)

Return a copy of the array.

Parameters

order

[{'C', 'F', 'A', 'K'}, optional] Controls the memory layout of the copy. 'C' means C-order, 'F' means F-order, 'A' means 'F' if *a* is Fortran contiguous, 'C' otherwise. 'K' means match the layout of *a* as closely as possible. (Note that this function and `numpy.copy()` are very similar but have different default values for their order= arguments, and this function always passes sub-classes through.)

See also

numpy.copy : Similar function with different default behavior numpy.copyto

Notes

This function is the preferred method for creating an array copy. The function `numpy.copy()` is similar, but it defaults to using order 'K', and will not pass sub-classes through by default.

Examples

```
>>> x = np.array([[1,2,3],[4,5,6]], order='F')
```

```
>>> y = x.copy()
```

```
>>> x.fill(0)
```

```
>>> x
array([[0, 0, 0],
       [0, 0, 0]])
```

```
>>> y
array([[1, 2, 3],
       [4, 5, 6]])
```

```
>>> y.flags['C_CONTIGUOUS']
True
```

cumprod

`IsNaArray.cumprod(axis=None, dtype=None, out=None)`

Return the cumulative product of the elements along the given axis.

Refer to *numpy.cumprod* for full documentation.

See Also

numpy.cumprod : equivalent function

cumsum

`IsNaArray.cumsum(axis=None, dtype=None, out=None)`

Return the cumulative sum of the elements along the given axis.

Refer to *numpy.cumsum* for full documentation.

See Also

numpy.cumsum : equivalent function

diagonal

`IsNaArray.diagonal(offset=0, axis1=0, axis2=1)`

Return specified diagonals. In NumPy 1.9 the returned array is a read-only view instead of a copy as in previous NumPy versions. In a future version the read-only restriction will be removed.

Refer to `numpy.diagonal()` for full documentation.

See Also

numpy.diagonal : equivalent function

dot

IsNaArray.**dot**()

dump

IsNaArray.**dump**(*file*)

Dump a pickle of the array to the specified file. The array can be read back with pickle.load or numpy.load.

Parameters

file

[str or Path] A string naming the dump file.

Changed in version 1.17.0: *pathlib.Path* objects are now accepted.

dumps

IsNaArray.**dumps**()

Returns the pickle of the array as a string. pickle.loads will convert the string back to an array.

Parameters

None

fill

IsNaArray.**fill**(*value*)

Fill the array with a scalar value.

Parameters

value

[scalar] All elements of *a* will be assigned this value.

Examples

```
>>> a = np.array([1, 2])
>>> a.fill(0)
>>> a
array([0, 0])
>>> a = np.empty(2)
>>> a.fill(1)
>>> a
array([1.,  1.])
```

Fill expects a scalar value and always behaves the same as assigning to a single array element. The following is a rare example where this distinction is important:

```
>>> a = np.array([None, None], dtype=object)
>>> a[0] = np.array(3)
>>> a
array([array(3), None], dtype=object)
>>> a.fill(np.array(3))
>>> a
array([array(3), array(3)], dtype=object)
```

Where other forms of assignments will unpack the array being assigned:

```
>>> a[...] = np.array(3)
>>> a
array([3, 3], dtype=object)
```

flatten

`IsNaArray.flatten(order='C')`

Return a copy of the array collapsed into one dimension.

Parameters

order

[{'C', 'F', 'A', 'K'}, optional] 'C' means to flatten in row-major (C-style) order. 'F' means to flatten in column-major (Fortran- style) order. 'A' means to flatten in column-major order if *a* is Fortran *contiguous* in memory, row-major order otherwise. 'K' means to flatten *a* in the order the elements occur in memory. The default is 'C'.

Returns

y

[ndarray] A copy of the input array, flattened to one dimension.

See Also

ravel : Return a flattened array. flat : A 1-D flat iterator over the array.

Examples

```
>>> a = np.array([[1,2], [3,4]])
>>> a.flatten()
array([1, 2, 3, 4])
>>> a.flatten('F')
array([1, 3, 2, 4])
```

getfield

IsNaArray.**getfield**(*dtype*, *offset=0*)

Returns a field of the given array as a certain type.

A field is a view of the array data with a given data-type. The values in the view are determined by the given type and the offset into the current array in bytes. The offset needs to be such that the view dtype fits in the array dtype; for example an array of dtype complex128 has 16-byte elements. If taking a view with a 32-bit integer (4 bytes), the offset needs to be between 0 and 12 bytes.

Parameters

dtype
[str or dtype] The data type of the view. The dtype size of the view can not be larger than that of the array itself.

offset
[int] Number of bytes to skip before beginning the element view.

Examples

```
>>> x = np.diag([1.+1.j]*2)
>>> x[1, 1] = 2 + 4.j
>>> x
array([[1.+1.j,  0.+0.j],
       [0.+0.j,  2.+4.j]])
>>> x.getfield(np.float64)
array([[1.,  0.],
       [0.,  2.]])
```

By choosing an offset of 8 bytes we can select the complex part of the array for our view:

```
>>> x.getfield(np.float64, offset=8)
array([[1.,  0.],
       [0.,  4.]])
```

item

IsNaArray.**item**(**args*)

Copy an element of an array to a standard Python scalar and return it.

Parameters

*args : Arguments (variable number and type)

- none: in this case, the method only works for arrays with one element (*a.size == 1*), which element is copied into a standard Python scalar object and returned.
- int_type: this argument is interpreted as a flat index into the array, specifying which element to copy and return.
- tuple of int_types: functions as does a single int_type argument, except that the argument is interpreted as an nd-index into the array.

Returns

z

[Standard Python scalar object] A copy of the specified element of the array as a suitable Python scalar

Notes

When the data type of *a* is longdouble or clongdouble, item() returns a scalar array object because there is no available Python scalar that would not lose information. Void arrays return a buffer object for item(), unless fields are defined, in which case a tuple is returned.

item is very similar to a[args], except, instead of an array scalar, a standard Python scalar is returned. This can be useful for speeding up access to elements of the array and doing arithmetic on elements of the array using Python's optimized math.

Examples

```
>>> np.random.seed(123)
>>> x = np.random.randint(9, size=(3, 3))
>>> x
array([[2, 2, 6],
       [1, 3, 6],
       [1, 0, 1]])
>>> x.item(3)
1
>>> x.item(7)
0
>>> x.item((0, 1))
2
>>> x.item((2, 2))
1
```

itemset

IsNaArray.**itemset**(**args*)

Insert scalar into an array (scalar is cast to array's dtype, if possible)

There must be at least 1 argument, and define the last argument as *item*. Then, `a.itemset(*args)` is equivalent to but faster than `a[args] = item`. The item should be a scalar value and *args* must select a single item in the array *a*.

Parameters

***args**

[Arguments] If one argument: a scalar, only used in case *a* is of size 1. If two arguments: the last argument is the value to be set and must be a scalar, the first argument specifies a single array element location. It is either an int or a tuple.

Notes

Compared to indexing syntax, *itemset* provides some speed increase for placing a scalar into a particular location in an *ndarray*, if you must do this. However, generally this is discouraged: among other problems, it complicates the appearance of the code. Also, when using *itemset* (and *item*) inside a loop, be sure to assign the methods to a local variable to avoid the attribute look-up at each loop iteration.

Examples

```
>>> np.random.seed(123)
>>> x = np.random.randint(9, size=(3, 3))
>>> x
array([[2, 2, 6],
       [1, 3, 6],
       [1, 0, 1]])
>>> x.itemset(4, 0)
>>> x.itemset((2, 2), 9)
>>> x
array([[2, 2, 6],
       [1, 0, 6],
       [1, 0, 9]])
```

max

IsNaArray.**max**(*axis=None*, *out=None*, *keepdims=False*, *initial=<no value>*, *where=True*)

Return the maximum along a given axis.

Refer to *numpy.amax* for full documentation.

See Also

numpy.amax : equivalent function

mean

IsNaArray.**mean**(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, *, *where=True*)

Returns the average of the array elements along given axis.

Refer to *numpy.mean* for full documentation.

See Also

numpy.mean : equivalent function

min

IsNaArray.**min**(*axis=None*, *out=None*, *keepdims=False*, *initial=<no value>*, *where=True*)

Return the minimum along a given axis.

Refer to *numpy.amin* for full documentation.

See Also

numpy.amin : equivalent function

newbyteorder

IsNaArray.**newbyteorder**(*new_order='S'*, */*)

Return the array with the same data viewed with a different byte order.

Equivalent to:

```
arr.view(arr.dtype.newbytorder(new_order))
```

Changes are also made in all fields and sub-arrays of the array data type.

Parameters

new_order

[string, optional] Byte order to force; a value from the byte order specifications below. *new_order* codes can be any of:

- 'S' - swap dtype from current to opposite endian
- {'<', 'little'} - little endian
- {'>', 'big'} - big endian
- {'=', 'native'} - native order, equivalent to *sys.byteorder*

- {'|', 'I'} - ignore (no change to byte order)

The default value ('S') results in swapping the current byte order.

Returns

new_arr
[array] New array object with the dtype reflecting given change to the byte order.

nonzero

`IsNaArray.nonzero()`

Return the indices of the elements that are non-zero.

Refer to *numpy.nonzero* for full documentation.

See Also

numpy.nonzero : equivalent function

partition

`IsNaArray.partition(kth, axis=-1, kind='introselect', order=None)`

Rearranges the elements in the array in such a way that the value of the element in kth position is in the position it would be in a sorted array. All elements smaller than the kth element are moved before this element and all equal or greater are moved behind it. The ordering of the elements in the two partitions is undefined.

New in version 1.8.0.

Parameters

kth
[int or sequence of ints] Element index to partition by. The kth element value will be in its final sorted position and all smaller elements will be moved before it and all equal or greater elements behind it. The order of all elements in the partitions is undefined. If provided with a sequence of kth it will partition all elements indexed by kth of them into their sorted position at once.

Deprecated since version 1.22.0: Passing booleans as index is deprecated.

axis
[int, optional] Axis along which to sort. Default is -1, which means sort along the last axis.

kind
[{'introselect'}, optional] Selection algorithm. Default is 'introselect'.

order
[str or list of str, optional] When *a* is an array with fields defined, this argument specifies which fields to compare first, second, etc. A single field can be specified as a string, and not all fields need to be specified, but unspecified fields will still be used, in the order in which they come up in the dtype, to break ties.

See Also

numpy.partition : Return a partitioned copy of an array. argpartition : Indirect partition. sort : Full sort.

Notes

See `np.partition` for notes on the different algorithms.

Examples

```
>>> a = np.array([3, 4, 2, 1])
>>> a.partition(3)
>>> a
array([2, 1, 3, 4])
```

```
>>> a.partition((1, 3))
>>> a
array([1, 2, 3, 4])
```

prod

`IsNaArray.`**`prod`**(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, *initial=1*, *where=True*)

Return the product of the array elements over the given axis

Refer to *numpy.prod* for full documentation.

See Also

numpy.prod : equivalent function

ptp

`IsNaArray.`**`ptp`**(*axis=None*, *out=None*, *keepdims=False*)

Peak to peak (maximum - minimum) value along a given axis.

Refer to *numpy.ptp* for full documentation.

See Also

numpy.ptp : equivalent function

put

`IsNaArray.put(indices, values, mode='raise')`

Set `a.flat[n] = values[n]` for all *n* in indices.

Refer to *numpy.put* for full documentation.

See Also

numpy.put : equivalent function

ravel

`IsNaArray.ravel([order])`

Return a flattened array.

Refer to *numpy.ravel* for full documentation.

See Also

numpy.ravel : equivalent function

ndarray.flat : a flat iterator on the array.

repeat

`IsNaArray.repeat(repeats, axis=None)`

Repeat elements of an array.

Refer to *numpy.repeat* for full documentation.

See Also

numpy.repeat : equivalent function

reshape

`IsNaArray.reshape(shape, order='C')`

Returns an array containing the same data with a new shape.

Refer to *numpy.reshape* for full documentation.

See Also

numpy.reshape : equivalent function

Notes

Unlike the free function *numpy.reshape*, this method on *ndarray* allows the elements of the shape parameter to be passed in as separate arguments. For example, `a.reshape(10, 11)` is equivalent to `a.reshape((10, 11))`.

resize

`IsNaArray.`**`resize`**(*new_shape*, *refcheck=True*)

Change shape and size of array in-place.

Parameters

new_shape
[tuple of ints, or *n* ints] Shape of resized array.

refcheck
[bool, optional] If False, reference count will not be checked. Default is True.

Returns

None

Raises

ValueError
If *a* does not own its own data or references or views to it exist, and the data memory must be changed. PyPy only: will always raise if the data memory must be changed, since there is no reliable way to determine if references or views to it exist.

SystemError
If the *order* keyword argument is specified. This behaviour is a bug in NumPy.

See Also

resize : Return a new array with the specified shape.

Notes

This reallocates space for the data area if necessary.

Only contiguous arrays (data elements consecutive in memory) can be resized.

The purpose of the reference count check is to make sure you do not use this array as a buffer for another Python object and then reallocate the memory. However, reference counts can increase in other ways so if you are sure that you have not shared the memory for this array with another Python object, then you may safely set *refcheck* to False.

Examples

Shrinking an array: array is flattened (in the order that the data are stored in memory), resized, and reshaped:

```
>>> a = np.array([[0, 1], [2, 3]], order='C')
>>> a.resize((2, 1))
>>> a
array([[0],
       [1]])
```

```
>>> a = np.array([[0, 1], [2, 3]], order='F')
>>> a.resize((2, 1))
>>> a
array([[0],
       [2]])
```

Enlarging an array: as above, but missing entries are filled with zeros:

```
>>> b = np.array([[0, 1], [2, 3]])
>>> b.resize(2, 3) # new_shape parameter doesn't have to be a tuple
>>> b
array([[0, 1, 2],
       [3, 0, 0]])
```

Referencing an array prevents resizing…

```
>>> c = a
>>> a.resize((1, 1))
Traceback (most recent call last):
...
ValueError: cannot resize an array that references or is referenced ...
```

Unless *refcheck* is False:

```
>>> a.resize((1, 1), refcheck=False)
>>> a
array([[0]])
>>> c
array([[0]])
```

round

`IsNaArray.round`(*decimals=0*, *out=None*)

Return *a* with each element rounded to the given number of decimals.

Refer to *numpy.around* for full documentation.

See Also

numpy.around : equivalent function

searchsorted

`IsNaArray.searchsorted`(*v*, *side='left'*, *sorter=None*)

Find indices where elements of v should be inserted in a to maintain order.

For full documentation, see *numpy.searchsorted*

See Also

numpy.searchsorted : equivalent function

setfield

`IsNaArray.setfield`(*val*, *dtype*, *offset=0*)

Put a value into a specified place in a field defined by a data-type.

Place *val* into *a*'s field defined by *dtype* and beginning *offset* bytes into the field.

Parameters

val
[object] Value to be placed in field.

dtype
[dtype object] Data-type of the field in which to place *val*.

offset
[int, optional] The number of bytes into the field at which to place *val*.

Returns

None

See Also

getfield

Examples

```
>>> x = np.eye(3)
>>> x.getfield(np.float64)
array([[1.,  0.,  0.],
       [0.,  1.,  0.],
       [0.,  0.,  1.]])
>>> x.setfield(3, np.int32)
>>> x.getfield(np.int32)
array([[3, 3, 3],
       [3, 3, 3],
       [3, 3, 3]], dtype=int32)
>>> x
array([[1.0e+000, 1.5e-323, 1.5e-323],
       [1.5e-323, 1.0e+000, 1.5e-323],
       [1.5e-323, 1.5e-323, 1.0e+000]])
>>> x.setfield(np.eye(3), np.int32)
>>> x
array([[1.,  0.,  0.],
       [0.,  1.,  0.],
       [0.,  0.,  1.]])
```

setflags

`IsNaArray.`**`setflags`**(*write=None*, *align=None*, *uic=None*)

Set array flags WRITEABLE, ALIGNED, WRITEBACKIFCOPY, respectively.

These Boolean-valued flags affect how numpy interprets the memory area used by *a* (see Notes below). The ALIGNED flag can only be set to True if the data is actually aligned according to the type. The WRITEBACKIFCOPY and flag can never be set to True. The flag WRITEABLE can only be set to True if the array owns its own memory, or the ultimate owner of the memory exposes a writeable buffer interface, or is a string. (The exception for string is made so that unpickling can be done without copying memory.)

Parameters

write
: [bool, optional] Describes whether or not *a* can be written to.

align
: [bool, optional] Describes whether or not *a* is aligned properly for its type.

uic
: [bool, optional] Describes whether or not *a* is a copy of another "base" array.

Notes

Array flags provide information about how the memory area used for the array is to be interpreted. There are 7 Boolean flags in use, only four of which can be changed by the user: WRITEBACKIFCOPY, WRITEABLE, and ALIGNED.

WRITEABLE (W) the data area can be written to;

ALIGNED (A) the data and strides are aligned appropriately for the hardware (as determined by the compiler);

WRITEBACKIFCOPY (X) this array is a copy of some other array (referenced by .base). When the C-API function PyArray_ResolveWritebackIfCopy is called, the base array will be updated with the contents of this array.

All flags can be accessed using the single (upper case) letter as well as the full name.

Examples

```
>>> y = np.array([[3, 1, 7],
...               [2, 0, 0],
...               [8, 5, 9]])
>>> y
array([[3, 1, 7],
       [2, 0, 0],
       [8, 5, 9]])
>>> y.flags
  C_CONTIGUOUS : True
  F_CONTIGUOUS : False
  OWNDATA : True
  WRITEABLE : True
  ALIGNED : True
  WRITEBACKIFCOPY : False
>>> y.setflags(write=0, align=0)
>>> y.flags
  C_CONTIGUOUS : True
  F_CONTIGUOUS : False
  OWNDATA : True
  WRITEABLE : False
  ALIGNED : False
  WRITEBACKIFCOPY : False
>>> y.setflags(uic=1)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: cannot set WRITEBACKIFCOPY flag to True
```

sort

IsNaArray.**sort**(*axis=-1*, *kind=None*, *order=None*)

Sort an array in-place. Refer to *numpy.sort* for full documentation.

Parameters

axis
[int, optional] Axis along which to sort. Default is -1, which means sort along the last axis.

kind
[{'quicksort', 'mergesort', 'heapsort', 'stable'}, optional] Sorting algorithm. The default is 'quicksort'. Note that both 'stable' and 'mergesort' use timsort under the covers and, in general, the actual implementation will vary with datatype. The 'mergesort' option is retained for backwards compatibility.

Changed in version 1.15.0: The 'stable' option was added.

order
[str or list of str, optional] When *a* is an array with fields defined, this argument specifies which fields to compare first, second, etc. A single field can be specified as a string, and not all fields need be specified, but unspecified fields will still be used, in the order in which they come up in the dtype, to break ties.

See Also

numpy.sort : Return a sorted copy of an array. numpy.argsort : Indirect sort. numpy.lexsort : Indirect stable sort on multiple keys. numpy.searchsorted : Find elements in sorted array. numpy.partition: Partial sort.

Notes

See *numpy.sort* for notes on the different sorting algorithms.

Examples

```
>>> a = np.array([[1,4], [3,1]])
>>> a.sort(axis=1)
>>> a
array([[1, 4],
       [1, 3]])
>>> a.sort(axis=0)
>>> a
array([[1, 3],
       [1, 4]])
```

Use the *order* keyword to specify a field to use when sorting a structured array:

```
>>> a = np.array([('a', 2), ('c', 1)], dtype=[('x', 'S1'), ('y', int)])
>>> a.sort(order='y')
>>> a
array([(b'c', 1), (b'a', 2)],
      dtype=[('x', 'S1'), ('y', '<i8')])
```

squeeze

IsNaArray.**squeeze**(*axis=None*)

Remove axes of length one from *a*.

Refer to *numpy.squeeze* for full documentation.

See Also

numpy.squeeze : equivalent function

std

IsNaArray.**std**(*axis=None*, *dtype=None*, *out=None*, *ddof=0*, *keepdims=False*, ***, *where=True*)

Returns the standard deviation of the array elements along given axis.

Refer to *numpy.std* for full documentation.

See Also

numpy.std : equivalent function

sum

IsNaArray.**sum**(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, *initial=0*, *where=True*)

Return the sum of the array elements over the given axis.

Refer to *numpy.sum* for full documentation.

See Also

numpy.sum : equivalent function

swapaxes

`IsNaArray.swapaxes(axis1, axis2)`

Return a view of the array with *axis1* and *axis2* interchanged.

Refer to *numpy.swapaxes* for full documentation.

See Also

numpy.swapaxes : equivalent function

take

`IsNaArray.take(indices, axis=None, out=None, mode='raise')`

Return an array formed from the elements of *a* at the given indices.

Refer to *numpy.take* for full documentation.

See Also

numpy.take : equivalent function

tobytes

`IsNaArray.tobytes(order='C')`

Construct Python bytes containing the raw data bytes in the array.

Constructs Python bytes showing a copy of the raw contents of data memory. The bytes object is produced in C-order by default. This behavior is controlled by the `order` parameter.

New in version 1.9.0.

Parameters

order
[{'C', 'F', 'A'}, optional] Controls the memory layout of the bytes object. 'C' means C-order, 'F' means F-order, 'A' (short for *Any*) means 'F' if *a* is Fortran contiguous, 'C' otherwise. Default is 'C'.

Returns

s
[bytes] Python bytes exhibiting a copy of *a*'s raw data.

See also

frombuffer
Inverse of this operation, construct a 1-dimensional array from Python bytes.

Examples

```
>>> x = np.array([[0, 1], [2, 3]], dtype='<u2')
>>> x.tobytes()
b'\x00\x00\x01\x00\x02\x00\x03\x00'
>>> x.tobytes('C') == x.tobytes()
True
>>> x.tobytes('F')
b'\x00\x00\x02\x00\x01\x00\x03\x00'
```

tofile

`IsNaArray.`**`tofile`**(*fid*, *sep=''*, *format='%s'*)

Write array to a file as text or binary (default).

Data is always written in 'C' order, independent of the order of *a*. The data produced by this method can be recovered using the function fromfile().

Parameters

fid
[file or str or Path] An open file object, or a string containing a filename.

Changed in version 1.17.0: *pathlib.Path* objects are now accepted.

sep
[str] Separator between array items for text output. If "" (empty), a binary file is written, equivalent to `file.write(a.tobytes())`.

format
[str] Format string for text file output. Each entry in the array is formatted to text by first converting it to the closest Python type, and then using "format" % item.

Notes

This is a convenience function for quick storage of array data. Information on endianness and precision is lost, so this method is not a good choice for files intended to archive data or transport data between machines with different endianness. Some of these problems can be overcome by outputting the data as text files, at the expense of speed and file size.

When fid is a file object, array contents are directly written to the file, bypassing the file object's `write` method. As a result, tofile cannot be used with files objects supporting compression (e.g., GzipFile) or file-like objects that do not support `fileno()` (e.g., BytesIO).

tolist

IsNaArray.**tolist**()

Return the array as an `a.ndim`-levels deep nested list of Python scalars.

Return a copy of the array data as a (nested) Python list. Data items are converted to the nearest compatible builtin Python type, via the *~numpy.ndarray.item* function.

If `a.ndim` is 0, then since the depth of the nested list is 0, it will not be a list at all, but a simple Python scalar.

Parameters

none

Returns

y

[object, or list of object, or list of list of object, or . . .] The possibly nested list of array elements.

Notes

The array may be recreated via `a = np.array(a.tolist())`, although this may sometimes lose precision.

Examples

For a 1D array, `a.tolist()` is almost the same as `list(a)`, except that `tolist` changes numpy scalars to Python scalars:

```
>>> a = np.uint32([1, 2])
>>> a_list = list(a)
>>> a_list
[1, 2]
>>> type(a_list[0])
<class 'numpy.uint32'>
>>> a_tolist = a.tolist()
>>> a_tolist
[1, 2]
>>> type(a_tolist[0])
<class 'int'>
```

Additionally, for a 2D array, `tolist` applies recursively:

```
>>> a = np.array([[1, 2], [3, 4]])
>>> list(a)
[array([1, 2]), array([3, 4])]
>>> a.tolist()
[[1, 2], [3, 4]]
```

The base case for this recursion is a 0D array:

```
>>> a = np.array(1)
>>> list(a)
Traceback (most recent call last):
  ...
TypeError: iteration over a 0-d array
>>> a.tolist()
1
```

tostring

IsNaArray.**tostring**(*order='C'*)

A compatibility alias for *tobytes*, with exactly the same behavior.

Despite its name, it returns *bytes* not *str*s.

Deprecated since version 1.19.0.

trace

IsNaArray.**trace**(*offset=0*, *axis1=0*, *axis2=1*, *dtype=None*, *out=None*)

Return the sum along diagonals of the array.

Refer to *numpy.trace* for full documentation.

See Also

numpy.trace : equivalent function

transpose

IsNaArray.**transpose**(**axes*)

Returns a view of the array with axes transposed.

Refer to *numpy.transpose* for full documentation.

Parameters

axes : None, tuple of ints, or *n* ints

- None or no argument: reverses the order of the axes.
- tuple of ints: *i* in the *j*-th place in the tuple means that the array's *i*-th axis becomes the transposed array's *j*-th axis.
- *n* ints: same as an n-tuple of the same ints (this form is intended simply as a "convenience" alternative to the tuple form).

Returns

p
[ndarray] View of the array with its axes suitably permuted.

See Also

transpose : Equivalent function. ndarray.T : Array property returning the array transposed. ndarray.reshape : Give a new shape to an array without changing its data.

Examples

```
>>> a = np.array([[1, 2], [3, 4]])
>>> a
array([[1, 2],
       [3, 4]])
>>> a.transpose()
array([[1, 3],
       [2, 4]])
>>> a.transpose((1, 0))
array([[1, 3],
       [2, 4]])
>>> a.transpose(1, 0)
array([[1, 3],
       [2, 4]])
```

```
>>> a = np.array([1, 2, 3, 4])
>>> a
array([1, 2, 3, 4])
>>> a.transpose()
array([1, 2, 3, 4])
```

var

`IsNaArray.var`(*axis=None*, *dtype=None*, *out=None*, *ddof=0*, *keepdims=False*, *, *where=True*)

Returns the variance of the array elements, along given axis.

Refer to *numpy.var* for full documentation.

See Also

numpy.var : equivalent function

view

IsNaArray.**view**(*[dtype][, type]*)

New view of array with the same data.

Note: Passing None for `dtype` is different from omitting the parameter, since the former invokes `dtype(None)` which is an alias for `dtype('float_')`.

Parameters

dtype
[data-type or ndarray sub-class, optional] Data-type descriptor of the returned view, e.g., float32 or int16. Omitting it results in the view having the same data-type as *a*. This argument can also be specified as an ndarray sub-class, which then specifies the type of the returned object (this is equivalent to setting the `type` parameter).

type
[Python type, optional] Type of the returned view, e.g., ndarray or matrix. Again, omission of the parameter results in type preservation.

Notes

`a.view()` is used two different ways:

`a.view(some_dtype)` or `a.view(dtype=some_dtype)` constructs a view of the array's memory with a different data-type. This can cause a reinterpretation of the bytes of memory.

`a.view(ndarray_subclass)` or `a.view(type=ndarray_subclass)` just returns an instance of *ndarray_subclass* that looks at the same array (same shape, dtype, etc.) This does not cause a reinterpretation of the memory.

For `a.view(some_dtype)`, if `some_dtype` has a different number of bytes per entry than the previous dtype (for example, converting a regular array to a structured array), then the last axis of `a` must be contiguous. This axis will be resized in the result.

Changed in version 1.23.0: Only the last axis needs to be contiguous. Previously, the entire array had to be C-contiguous.

Examples

```
>>> x = np.array([(1, 2)], dtype=[('a', np.int8), ('b', np.int8)])
```

Viewing array data using a different type and dtype:

```
>>> y = x.view(dtype=np.int16, type=np.matrix)
>>> y
matrix([[513]], dtype=int16)
>>> print(type(y))
<class 'numpy.matrix'>
```

Creating a view on a structured array so it can be used in calculations

```
>>> x = np.array([(1, 2),(3,4)], dtype=[('a', np.int8), ('b', np.int8)])
>>> xv = x.view(dtype=np.int8).reshape(-1,2)
>>> xv
array([[1, 2],
       [3, 4]], dtype=int8)
>>> xv.mean(0)
array([2.,  3.])
```

Making changes to the view changes the underlying array

```
>>> xv[0,1] = 20
>>> x
array([(1, 20), (3,  4)], dtype=[('a', 'i1'), ('b', 'i1')])
```

Using a view to convert an array to a recarray:

```
>>> z = x.view(np.recarray)
>>> z.a
array([1, 3], dtype=int8)
```

Views share data:

```
>>> x[0] = (9, 10)
>>> z[0]
(9, 10)
```

Views that change the dtype size (bytes per entry) should normally be avoided on arrays defined by slices, transposes, fortran-ordering, etc.:

```
>>> x = np.array([[1, 2, 3], [4, 5, 6]], dtype=np.int16)
>>> y = x[:, ::2]
>>> y
array([[1, 3],
       [4, 6]], dtype=int16)
>>> y.view(dtype=[('width', np.int16), ('length', np.int16)])
Traceback (most recent call last):
    ...
ValueError: To change to a dtype of a different size, the last axis must be␣
↪contiguous
>>> z = y.copy()
>>> z.view(dtype=[('width', np.int16), ('length', np.int16)])
array([[(1, 3)],
       [(4, 6)]], dtype=[('width', '<i2'), ('length', '<i2')])
```

However, views that change dtype are totally fine for arrays with a contiguous last axis, even if the rest of the axes are not C-contiguous:

```
>>> x = np.arange(2 * 3 * 4, dtype=np.int8).reshape(2, 3, 4)
>>> x.transpose(1, 0, 2).view(np.int16)
array([[[ 256,  770],
        [3340, 3854]],

       [[1284, 1798],
        [4368, 4882]],
```

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```
       [[2312, 2826],
        [5396, 5910]]], dtype=int16)
```

__init__()

Attributes

T	View of the transposed array.
base	Base object if memory is from some other object.
ctypes	An object to simplify the interaction of the array with the ctypes module.
data	Python buffer object pointing to the start of the array's data.
dtype	Data-type of the array's elements.
flags	Information about the memory layout of the array.
flat	A 1-D iterator over the array.
imag	The imaginary part of the array.
itemsize	Length of one array element in bytes.
nbytes	Total bytes consumed by the elements of the array.
ndim	Number of array dimensions.
real	The real part of the array.
shape	Tuple of array dimensions.
size	Number of elements in the array.
strides	Tuple of bytes to step in each dimension when traversing an array.

T

IsNaArray.**T**

View of the transposed array.

Same as `self.transpose()`.

Examples

```
>>> a = np.array([[1, 2], [3, 4]])
>>> a
array([[1, 2],
       [3, 4]])
>>> a.T
array([[1, 3],
       [2, 4]])
```

```
>>> a = np.array([1, 2, 3, 4])
>>> a
array([1, 2, 3, 4])
```

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```
>>> a.T
array([1, 2, 3, 4])
```

See Also

transpose

base

`IsNaArray.base`

Base object if memory is from some other object.

Examples

The base of an array that owns its memory is None:

```
>>> x = np.array([1,2,3,4])
>>> x.base is None
True
```

Slicing creates a view, whose memory is shared with x:

```
>>> y = x[2:]
>>> y.base is x
True
```

ctypes

`IsNaArray.ctypes`

An object to simplify the interaction of the array with the ctypes module.

This attribute creates an object that makes it easier to use arrays when calling shared libraries with the ctypes module. The returned object has, among others, data, shape, and strides attributes (see Notes below) which themselves return ctypes objects that can be used as arguments to a shared library.

Parameters

None

Returns

c
[Python object] Possessing attributes data, shape, strides, etc.

See Also

numpy.ctypeslib

Notes

Below are the public attributes of this object which were documented in "Guide to NumPy" (we have omitted undocumented public attributes, as well as documented private attributes):

`_ctypes.data`

A pointer to the memory area of the array as a Python integer. This memory area may contain data that is not aligned, or not in correct byte-order. The memory area may not even be writeable. The array flags and data-type of this array should be respected when passing this attribute to arbitrary C-code to avoid trouble that can include Python crashing. User Beware! The value of this attribute is exactly the same as `self._array_interface_['data'][0]`.

Note that unlike `data_as`, a reference will not be kept to the array: code like `ctypes.c_void_p((a + b).ctypes.data)` will result in a pointer to a deallocated array, and should be spelt `(a + b).ctypes.data_as(ctypes.c_void_p)`

`_ctypes.shape`

(c_intp*self.ndim): A ctypes array of length self.ndim where the basetype is the C-integer corresponding to `dtype('p')` on this platform (see *~numpy.ctypeslib.c_intp*). This base-type could be *ctypes.c_int*, *ctypes.c_long*, or *ctypes.c_longlong* depending on the platform. The ctypes array contains the shape of the underlying array.

`_ctypes.strides`

(c_intp*self.ndim): A ctypes array of length self.ndim where the basetype is the same as for the shape attribute. This ctypes array contains the strides information from the underlying array. This strides information is important for showing how many bytes must be jumped to get to the next element in the array.

`_ctypes.data_as`(*obj*)

Return the data pointer cast to a particular c-types object. For example, calling `self._as_parameter_` is equivalent to `self.data_as(ctypes.c_void_p)`. Perhaps you want to use the data as a pointer to a ctypes array of floating-point data: `self.data_as(ctypes.POINTER(ctypes.c_double))`.

The returned pointer will keep a reference to the array.

`_ctypes.shape_as`(*obj*)

Return the shape tuple as an array of some other c-types type. For example: `self.shape_as(ctypes.c_short)`.

`_ctypes.strides_as`(*obj*)

Return the strides tuple as an array of some other c-types type. For example: `self.strides_as(ctypes.c_longlong)`.

If the ctypes module is not available, then the ctypes attribute of array objects still returns something useful, but ctypes objects are not returned and errors may be raised instead. In particular, the object will still have the `as_parameter` attribute which will return an integer equal to the data attribute.

Examples

```
>>> import ctypes
>>> x = np.array([[0, 1], [2, 3]], dtype=np.int32)
>>> x
array([[0, 1],
       [2, 3]], dtype=int32)
>>> x.ctypes.data
31962608 # may vary
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint32))
<__main__.LP_c_uint object at 0x7ff2fc1fc200> # may vary
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint32)).contents
c_uint(0)
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint64)).contents
c_ulong(4294967296)
>>> x.ctypes.shape
<numpy.core._internal.c_long_Array_2 object at 0x7ff2fc1fce60> # may vary
>>> x.ctypes.strides
<numpy.core._internal.c_long_Array_2 object at 0x7ff2fc1ff320> # may vary
```

data

`IsNaArray.data`

Python buffer object pointing to the start of the array's data.

dtype

`IsNaArray.dtype`

Data-type of the array's elements.

Warning: Setting `arr.dtype` is discouraged and may be deprecated in the future. Setting will replace the `dtype` without modifying the memory (see also *ndarray.view* and *ndarray.astype*).

Parameters

None

Returns

d : numpy dtype object

See Also

ndarray.astype : Cast the values contained in the array to a new data-type. ndarray.view : Create a view of the same data but a different data-type. numpy.dtype

Examples

```
>>> x
array([[0, 1],
       [2, 3]])
>>> x.dtype
dtype('int32')
>>> type(x.dtype)
<type 'numpy.dtype'>
```

flags

IsNaArray.**flags**

Information about the memory layout of the array.

Attributes

C_CONTIGUOUS (C)
The data is in a single, C-style contiguous segment.

F_CONTIGUOUS (F)
The data is in a single, Fortran-style contiguous segment.

OWNDATA (O)
The array owns the memory it uses or borrows it from another object.

WRITEABLE (W)
The data area can be written to. Setting this to False locks the data, making it read-only. A view (slice, etc.) inherits WRITEABLE from its base array at creation time, but a view of a writeable array may be subsequently locked while the base array remains writeable. (The opposite is not true, in that a view of a locked array may not be made writeable. However, currently, locking a base object does not lock any views that already reference it, so under that circumstance it is possible to alter the contents of a locked array via a previously created writeable view onto it.) Attempting to change a non-writeable array raises a RuntimeError exception.

ALIGNED (A)
The data and all elements are aligned appropriately for the hardware.

WRITEBACKIFCOPY (X)
This array is a copy of some other array. The C-API function PyArray_ResolveWritebackIfCopy must be called before deallocating to the base array will be updated with the contents of this array.

FNC
F_CONTIGUOUS and not C_CONTIGUOUS.

FORC
F_CONTIGUOUS or C_CONTIGUOUS (one-segment test).

BEHAVED (B)
ALIGNED and WRITEABLE.

CARRAY (CA)
BEHAVED and C_CONTIGUOUS.

FARRAY (FA)
BEHAVED and F_CONTIGUOUS and not C_CONTIGUOUS.

Notes

The *flags* object can be accessed dictionary-like (as in `a.flags['WRITEABLE']`), or by using lowercased attribute names (as in `a.flags.writeable`). Short flag names are only supported in dictionary access.

Only the WRITEBACKIFCOPY, WRITEABLE, and ALIGNED flags can be changed by the user, via direct assignment to the attribute or dictionary entry, or by calling *ndarray.setflags*.

The array flags cannot be set arbitrarily:

- WRITEBACKIFCOPY can only be set `False`.
- ALIGNED can only be set `True` if the data is truly aligned.
- WRITEABLE can only be set `True` if the array owns its own memory or the ultimate owner of the memory exposes a writeable buffer interface or is a string.

Arrays can be both C-style and Fortran-style contiguous simultaneously. This is clear for 1-dimensional arrays, but can also be true for higher dimensional arrays.

Even for contiguous arrays a stride for a given dimension `arr.strides[dim]` may be *arbitrary* if `arr.shape[dim] == 1` or the array has no elements. It does *not* generally hold that `self.strides[-1] == self.itemsize` for C-style contiguous arrays or `self.strides[0] == self.itemsize` for Fortran-style contiguous arrays is true.

flat

`IsNaArray.flat`
A 1-D iterator over the array.

This is a *numpy.flatiter* instance, which acts similarly to, but is not a subclass of, Python's built-in iterator object.

See Also

flatten : Return a copy of the array collapsed into one dimension.

flatiter

Examples

```
>>> x = np.arange(1, 7).reshape(2, 3)
>>> x
array([[1, 2, 3],
       [4, 5, 6]])
>>> x.flat[3]
4
>>> x.T
array([[1, 4],
       [2, 5],
       [3, 6]])
>>> x.T.flat[3]
5
>>> type(x.flat)
<class 'numpy.flatiter'>
```

An assignment example:

```
>>> x.flat = 3; x
array([[3, 3, 3],
       [3, 3, 3]])
>>> x.flat[[1,4]] = 1; x
array([[3, 1, 3],
       [3, 1, 3]])
```

imag

`IsNaArray.imag`

The imaginary part of the array.

Examples

```
>>> x = np.sqrt([1+0j, 0+1j])
>>> x.imag
array([ 0.        ,  0.70710678])
>>> x.imag.dtype
dtype('float64')
```

itemsize

IsNaArray.**itemsize**

Length of one array element in bytes.

Examples

```
>>> x = np.array([1,2,3], dtype=np.float64)
>>> x.itemsize
8
>>> x = np.array([1,2,3], dtype=np.complex128)
>>> x.itemsize
16
```

nbytes

IsNaArray.**nbytes**

Total bytes consumed by the elements of the array.

Notes

Does not include memory consumed by non-element attributes of the array object.

See Also

sys.getsizeof
Memory consumed by the object itself without parents in case view. This does include memory consumed by non-element attributes.

Examples

```
>>> x = np.zeros((3,5,2), dtype=np.complex128)
>>> x.nbytes
480
>>> np.prod(x.shape) * x.itemsize
480
```

ndim

`IsNaArray.ndim`

Number of array dimensions.

Examples

```
>>> x = np.array([1, 2, 3])
>>> x.ndim
1
>>> y = np.zeros((2, 3, 4))
>>> y.ndim
3
```

real

`IsNaArray.real`

The real part of the array.

Examples

```
>>> x = np.sqrt([1+0j, 0+1j])
>>> x.real
array([ 1.        ,  0.70710678])
>>> x.real.dtype
dtype('float64')
```

See Also

numpy.real : equivalent function

shape

`IsNaArray.shape`

Tuple of array dimensions.

The shape property is usually used to get the current shape of an array, but may also be used to reshape the array in-place by assigning a tuple of array dimensions to it. As with *numpy.reshape*, one of the new shape dimensions can be -1, in which case its value is inferred from the size of the array and the remaining dimensions. Reshaping an array in-place will fail if a copy is required.

> **Warning:** Setting `arr.shape` is discouraged and may be deprecated in the future. Using *ndarray.reshape* is the preferred approach.

Examples

```
>>> x = np.array([1, 2, 3, 4])
>>> x.shape
(4,)
>>> y = np.zeros((2, 3, 4))
>>> y.shape
(2, 3, 4)
>>> y.shape = (3, 8)
>>> y
array([[ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.],
       [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.],
       [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.]])
>>> y.shape = (3, 6)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: total size of new array must be unchanged
>>> np.zeros((4,2))[::2].shape = (-1,)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AttributeError: Incompatible shape for in-place modification. Use
`.reshape()` to make a copy with the desired shape.
```

See Also

numpy.shape : Equivalent getter function. numpy.reshape : Function similar to setting `shape`. ndarray.reshape : Method similar to setting `shape`.

size

`IsNaArray.size`

Number of elements in the array.

Equal to `np.prod(a.shape)`, i.e., the product of the array's dimensions.

Notes

a.size returns a standard arbitrary precision Python integer. This may not be the case with other methods of obtaining the same value (like the suggested `np.prod(a.shape)`, which returns an instance of `np.int_`), and may be relevant if the value is used further in calculations that may overflow a fixed size integer type.

Examples

```
>>> x = np.zeros((3, 5, 2), dtype=np.complex128)
>>> x.size
30
>>> np.prod(x.shape)
30
```

strides

`IsNaArray.strides`

Tuple of bytes to step in each dimension when traversing an array.

The byte offset of element `(i[0], i[1], ..., i[n])` in an array *a* is:

```
offset = sum(np.array(i) * a.strides)
```

A more detailed explanation of strides can be found in the "ndarray.rst" file in the NumPy reference guide.

> **Warning:** Setting `arr.strides` is discouraged and may be deprecated in the future. *numpy.lib.stride_tricks.as_strided* should be preferred to create a new view of the same data in a safer way.

Notes

Imagine an array of 32-bit integers (each 4 bytes):

```
x = np.array([[0, 1, 2, 3, 4],
              [5, 6, 7, 8, 9]], dtype=np.int32)
```

This array is stored in memory as 40 bytes, one after the other (known as a contiguous block of memory). The strides of an array tell us how many bytes we have to skip in memory to move to the next position along a certain axis. For example, we have to skip 4 bytes (1 value) to move to the next column, but 20 bytes (5 values) to get to the same position in the next row. As such, the strides for the array *x* will be `(20, 4)`.

See Also

numpy.lib.stride_tricks.as_strided

Examples

```
>>> y = np.reshape(np.arange(2*3*4), (2,3,4))
>>> y
array([[[ 0,  1,  2,  3],
        [ 4,  5,  6,  7],
        [ 8,  9, 10, 11]],
       [[12, 13, 14, 15],
        [16, 17, 18, 19],
        [20, 21, 22, 23]]])
>>> y.strides
(48, 16, 4)
>>> y[1,1,1]
17
>>> offset=sum(y.strides * np.array((1,1,1)))
>>> offset/y.itemsize
17
```

```
>>> x = np.reshape(np.arange(5*6*7*8), (5,6,7,8)).transpose(2,3,1,0)
>>> x.strides
(32, 4, 224, 1344)
>>> i = np.array([3,5,2,2])
>>> offset = sum(i * x.strides)
>>> x[3,5,2,2]
813
>>> offset / x.itemsize
813
```

IsNumberArray

class IsNumberArray

Methods

__init__	
all	Returns True if all elements evaluate to True.
any	Returns True if any of the elements of *a* evaluate to True.
argmax	Return indices of the maximum values along the given axis.
argmin	Return indices of the minimum values along the given axis.
argpartition	Returns the indices that would partition this array.
argsort	Returns the indices that would sort this array.
astype	Copy of the array, cast to a specified type.
byteswap	Swap the bytes of the array elements
choose	Use an index array to construct a new array from a set of choices.

continues on next page

Table 5 – continued from previous page

`clip`	Return an array whose values are limited to `[min, max]`.
`collapse`	
`compress`	Return selected slices of this array along given axis.
`conj`	Complex-conjugate all elements.
`conjugate`	Return the complex conjugate, element-wise.
`copy`	Return a copy of the array.
`cumprod`	Return the cumulative product of the elements along the given axis.
`cumsum`	Return the cumulative sum of the elements along the given axis.
`diagonal`	Return specified diagonals.
`dot`	
`dump`	Dump a pickle of the array to the specified file.
`dumps`	Returns the pickle of the array as a string.
`fill`	Fill the array with a scalar value.
`flatten`	Return a copy of the array collapsed into one dimension.
`getfield`	Returns a field of the given array as a certain type.
`item`	Copy an element of an array to a standard Python scalar and return it.
`itemset`	Insert scalar into an array (scalar is cast to array's dtype, if possible)
`max`	Return the maximum along a given axis.
`mean`	Returns the average of the array elements along given axis.
`min`	Return the minimum along a given axis.
`newbyteorder`	Return the array with the same data viewed with a different byte order.
`nonzero`	Return the indices of the elements that are non-zero.
`partition`	Rearranges the elements in the array in such a way that the value of the element in kth position is in the position it would be in a sorted array.
`prod`	Return the product of the array elements over the given axis
`ptp`	Peak to peak (maximum - minimum) value along a given axis.
`put`	Set `a.flat[n] = values[n]` for all *n* in indices.
`ravel`	Return a flattened array.
`repeat`	Repeat elements of an array.
`reshape`	Returns an array containing the same data with a new shape.
`resize`	Change shape and size of array in-place.
`round`	Return *a* with each element rounded to the given number of decimals.
`searchsorted`	Find indices where elements of v should be inserted in a to maintain order.
`setfield`	Put a value into a specified place in a field defined by a data-type.

continues on next page

Table 5 – continued from previous page

`setflags`	Set array flags WRITEABLE, ALIGNED, WRITE-BACKIFCOPY, respectively.
`sort`	Sort an array in-place.
`squeeze`	Remove axes of length one from *a*.
`std`	Returns the standard deviation of the array elements along given axis.
`sum`	Return the sum of the array elements over the given axis.
`swapaxes`	Return a view of the array with *axis1* and *axis2* interchanged.
`take`	Return an array formed from the elements of *a* at the given indices.
`tobytes`	Construct Python bytes containing the raw data bytes in the array.
`tofile`	Write array to a file as text or binary (default).
`tolist`	Return the array as an `a.ndim`-levels deep nested list of Python scalars.
`tostring`	A compatibility alias for *tobytes*, with exactly the same behavior.
`trace`	Return the sum along diagonals of the array.
`transpose`	Returns a view of the array with axes transposed.
`var`	Returns the variance of the array elements, along given axis.
`view`	New view of array with the same data.

__init__

`IsNumberArray.__init__()`

all

`IsNumberArray.all(`*axis=None*, *out=None*, *keepdims=False*, *, *where=True*`)`

Returns True if all elements evaluate to True.

Refer to *numpy.all* for full documentation.

See Also

numpy.all : equivalent function

any

`IsNumberArray.any(axis=None, out=None, keepdims=False, *, where=True)`

Returns True if any of the elements of *a* evaluate to True.

Refer to *numpy.any* for full documentation.

See Also

numpy.any : equivalent function

argmax

`IsNumberArray.argmax(axis=None, out=None, *, keepdims=False)`

Return indices of the maximum values along the given axis.

Refer to *numpy.argmax* for full documentation.

See Also

numpy.argmax : equivalent function

argmin

`IsNumberArray.argmin(axis=None, out=None, *, keepdims=False)`

Return indices of the minimum values along the given axis.

Refer to *numpy.argmin* for detailed documentation.

See Also

numpy.argmin : equivalent function

argpartition

`IsNumberArray.argpartition(kth, axis=-1, kind='introselect', order=None)`

Returns the indices that would partition this array.

Refer to *numpy.argpartition* for full documentation.

New in version 1.8.0.

See Also

numpy.argpartition : equivalent function

argsort

`IsNumberArray.argsort(axis=-1, kind=None, order=None)`

Returns the indices that would sort this array.

Refer to *numpy.argsort* for full documentation.

See Also

numpy.argsort : equivalent function

astype

`IsNumberArray.astype(dtype, order='K', casting='unsafe', subok=True, copy=True)`

Copy of the array, cast to a specified type.

Parameters

dtype
[str or dtype] Typecode or data-type to which the array is cast.

order
[{'C', 'F', 'A', 'K'}, optional] Controls the memory layout order of the result. 'C' means C order, 'F' means Fortran order, 'A' means 'F' order if all the arrays are Fortran contiguous, 'C' order otherwise, and 'K' means as close to the order the array elements appear in memory as possible. Default is 'K'.

casting
[{'no', 'equiv', 'safe', 'same_kind', 'unsafe'}, optional] Controls what kind of data casting may occur. Defaults to 'unsafe' for backwards compatibility.

- 'no' means the data types should not be cast at all.
- 'equiv' means only byte-order changes are allowed.
- 'safe' means only casts which can preserve values are allowed.
- 'same_kind' means only safe casts or casts within a kind, like float64 to float32, are allowed.
- 'unsafe' means any data conversions may be done.

subok
[bool, optional] If True, then sub-classes will be passed-through (default), otherwise the returned array will be forced to be a base-class array.

copy
[bool, optional] By default, astype always returns a newly allocated array. If this is set to false, and the *dtype*, *order*, and *subok* requirements are satisfied, the input array is returned instead of a copy.

Returns

arr_t
[ndarray] Unless *copy* is False and the other conditions for returning the input array are satisfied (see description for *copy* input parameter), *arr_t* is a new array of the same shape as the input array, with dtype, order given by *dtype*, *order*.

Notes

Changed in version 1.17.0: Casting between a simple data type and a structured one is possible only for "unsafe" casting. Casting to multiple fields is allowed, but casting from multiple fields is not.

Changed in version 1.9.0: Casting from numeric to string types in 'safe' casting mode requires that the string dtype length is long enough to store the max integer/float value converted.

Raises

ComplexWarning
When casting from complex to float or int. To avoid this, one should use `a.real.astype(t)`.

Examples

```
>>> x = np.array([1, 2, 2.5])
>>> x
array([1. ,  2. ,  2.5])
```

```
>>> x.astype(int)
array([1, 2, 2])
```

byteswap

`IsNumberArray.`**`byteswap`**(*inplace=False*)
Swap the bytes of the array elements

Toggle between low-endian and big-endian data representation by returning a byteswapped array, optionally swapped in-place. Arrays of byte-strings are not swapped. The real and imaginary parts of a complex number are swapped individually.

Parameters

inplace
[bool, optional] If `True`, swap bytes in-place, default is `False`.

Returns

out
[ndarray] The byteswapped array. If *inplace* is `True`, this is a view to self.

Examples

```
>>> A = np.array([1, 256, 8755], dtype=np.int16)
>>> list(map(hex, A))
['0x1', '0x100', '0x2233']
>>> A.byteswap(inplace=True)
array([  256,     1, 13090], dtype=int16)
>>> list(map(hex, A))
['0x100', '0x1', '0x3322']
```

Arrays of byte-strings are not swapped

```
>>> A = np.array([b'ceg', b'fac'])
>>> A.byteswap()
array([b'ceg', b'fac'], dtype='|S3')
```

`A.newbyteorder().byteswap()` produces an array with the same values
but different representation in memory

```
>>> A = np.array([1, 2, 3])
>>> A.view(np.uint8)
array([1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 3, 0, 0, 0, 0, 0,
       0, 0], dtype=uint8)
>>> A.newbyteorder().byteswap(inplace=True)
array([1, 2, 3])
>>> A.view(np.uint8)
array([0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0,
       0, 3], dtype=uint8)
```

choose

`IsNumberArray.`**`choose`**(*choices*, *out=None*, *mode='raise'*)

Use an index array to construct a new array from a set of choices.

Refer to *numpy.choose* for full documentation.

See Also

numpy.choose : equivalent function

clip

`IsNumberArray.clip(min=None, max=None, out=None, **kwargs)`

Return an array whose values are limited to `[min, max]`. One of max or min must be given.

Refer to *numpy.clip* for full documentation.

See Also

numpy.clip : equivalent function

collapse

`IsNumberArray.collapse(shape)`

compress

`IsNumberArray.compress(condition, axis=None, out=None)`

Return selected slices of this array along given axis.

Refer to *numpy.compress* for full documentation.

See Also

numpy.compress : equivalent function

conj

`IsNumberArray.conj()`

Complex-conjugate all elements.

Refer to *numpy.conjugate* for full documentation.

See Also

numpy.conjugate : equivalent function

conjugate

`IsNumberArray.conjugate()`

Return the complex conjugate, element-wise.

Refer to *numpy.conjugate* for full documentation.

See Also

numpy.conjugate : equivalent function

copy

`IsNumberArray.copy(order='C')`

Return a copy of the array.

Parameters

order
[{'C', 'F', 'A', 'K'}, optional] Controls the memory layout of the copy. 'C' means C-order, 'F' means F-order, 'A' means 'F' if *a* is Fortran contiguous, 'C' otherwise. 'K' means match the layout of *a* as closely as possible. (Note that this function and `numpy.copy()` are very similar but have different default values for their order= arguments, and this function always passes sub-classes through.)

See also

numpy.copy : Similar function with different default behavior numpy.copyto

Notes

This function is the preferred method for creating an array copy. The function `numpy.copy()` is similar, but it defaults to using order 'K', and will not pass sub-classes through by default.

Examples

```
>>> x = np.array([[1,2,3],[4,5,6]], order='F')
```

```
>>> y = x.copy()
```

```
>>> x.fill(0)
```

```
>>> x
array([[0, 0, 0],
       [0, 0, 0]])
```

```
>>> y
array([[1, 2, 3],
       [4, 5, 6]])
```

```
>>> y.flags['C_CONTIGUOUS']
True
```

cumprod

IsNumberArray.**cumprod**(*axis=None*, *dtype=None*, *out=None*)

Return the cumulative product of the elements along the given axis.

Refer to *numpy.cumprod* for full documentation.

See Also

numpy.cumprod : equivalent function

cumsum

IsNumberArray.**cumsum**(*axis=None*, *dtype=None*, *out=None*)

Return the cumulative sum of the elements along the given axis.

Refer to *numpy.cumsum* for full documentation.

See Also

numpy.cumsum : equivalent function

diagonal

IsNumberArray.**diagonal**(*offset=0*, *axis1=0*, *axis2=1*)

Return specified diagonals. In NumPy 1.9 the returned array is a read-only view instead of a copy as in previous NumPy versions. In a future version the read-only restriction will be removed.

Refer to `numpy.diagonal()` for full documentation.

See Also

numpy.diagonal : equivalent function

dot

IsNumberArray.**dot**()

dump

IsNumberArray.**dump**(*file*)

Dump a pickle of the array to the specified file. The array can be read back with pickle.load or numpy.load.

Parameters

file

[str or Path] A string naming the dump file.

Changed in version 1.17.0: *pathlib.Path* objects are now accepted.

dumps

IsNumberArray.**dumps**()

Returns the pickle of the array as a string. pickle.loads will convert the string back to an array.

Parameters

None

fill

IsNumberArray.**fill**(*value*)

Fill the array with a scalar value.

Parameters

value

[scalar] All elements of *a* will be assigned this value.

Examples

```
>>> a = np.array([1, 2])
>>> a.fill(0)
>>> a
array([0, 0])
>>> a = np.empty(2)
>>> a.fill(1)
>>> a
array([1.,  1.])
```

Fill expects a scalar value and always behaves the same as assigning to a single array element. The following is a rare example where this distinction is important:

```
>>> a = np.array([None, None], dtype=object)
>>> a[0] = np.array(3)
>>> a
array([array(3), None], dtype=object)
>>> a.fill(np.array(3))
>>> a
array([array(3), array(3)], dtype=object)
```

Where other forms of assignments will unpack the array being assigned:

```
>>> a[...] = np.array(3)
>>> a
array([3, 3], dtype=object)
```

flatten

IsNumberArray.**flatten**(*order='C'*)

Return a copy of the array collapsed into one dimension.

Parameters

order

[{'C', 'F', 'A', 'K'}, optional] 'C' means to flatten in row-major (C-style) order. 'F' means to flatten in column-major (Fortran- style) order. 'A' means to flatten in column-major order if *a* is Fortran *contiguous* in memory, row-major order otherwise. 'K' means to flatten *a* in the order the elements occur in memory. The default is 'C'.

Returns

y

[ndarray] A copy of the input array, flattened to one dimension.

See Also

ravel : Return a flattened array. flat : A 1-D flat iterator over the array.

Examples

```
>>> a = np.array([[1,2], [3,4]])
>>> a.flatten()
array([1, 2, 3, 4])
>>> a.flatten('F')
array([1, 3, 2, 4])
```

getfield

IsNumberArray.**getfield**(*dtype*, *offset=0*)

Returns a field of the given array as a certain type.

A field is a view of the array data with a given data-type. The values in the view are determined by the given type and the offset into the current array in bytes. The offset needs to be such that the view dtype fits in the array dtype; for example an array of dtype complex128 has 16-byte elements. If taking a view with a 32-bit integer (4 bytes), the offset needs to be between 0 and 12 bytes.

Parameters

dtype
[str or dtype] The data type of the view. The dtype size of the view can not be larger than that of the array itself.

offset
[int] Number of bytes to skip before beginning the element view.

Examples

```
>>> x = np.diag([1.+1.j]*2)
>>> x[1, 1] = 2 + 4.j
>>> x
array([[1.+1.j,  0.+0.j],
       [0.+0.j,  2.+4.j]])
>>> x.getfield(np.float64)
array([[1.,  0.],
       [0.,  2.]])
```

By choosing an offset of 8 bytes we can select the complex part of the array for our view:

```
>>> x.getfield(np.float64, offset=8)
array([[1.,  0.],
       [0.,  4.]])
```

item

IsNumberArray.**item**(**args*)

Copy an element of an array to a standard Python scalar and return it.

Parameters

*args : Arguments (variable number and type)

- none: in this case, the method only works for arrays with one element (*a.size == 1*), which element is copied into a standard Python scalar object and returned.
- int_type: this argument is interpreted as a flat index into the array, specifying which element to copy and return.
- tuple of int_types: functions as does a single int_type argument, except that the argument is interpreted as an nd-index into the array.

Returns

z

[Standard Python scalar object] A copy of the specified element of the array as a suitable Python scalar

Notes

When the data type of *a* is longdouble or clongdouble, item() returns a scalar array object because there is no available Python scalar that would not lose information. Void arrays return a buffer object for item(), unless fields are defined, in which case a tuple is returned.

item is very similar to a[args], except, instead of an array scalar, a standard Python scalar is returned. This can be useful for speeding up access to elements of the array and doing arithmetic on elements of the array using Python's optimized math.

Examples

```
>>> np.random.seed(123)
>>> x = np.random.randint(9, size=(3, 3))
>>> x
array([[2, 2, 6],
       [1, 3, 6],
       [1, 0, 1]])
>>> x.item(3)
1
>>> x.item(7)
0
>>> x.item((0, 1))
2
>>> x.item((2, 2))
1
```

itemset

IsNumberArray.**itemset**(**args*)

Insert scalar into an array (scalar is cast to array's dtype, if possible)

There must be at least 1 argument, and define the last argument as *item*. Then, `a.itemset(*args)` is equivalent to but faster than `a[args] = item`. The item should be a scalar value and *args* must select a single item in the array *a*.

Parameters

***args**
[Arguments] If one argument: a scalar, only used in case *a* is of size 1. If two arguments: the last argument is the value to be set and must be a scalar, the first argument specifies a single array element location. It is either an int or a tuple.

Notes

Compared to indexing syntax, *itemset* provides some speed increase for placing a scalar into a particular location in an *ndarray*, if you must do this. However, generally this is discouraged: among other problems, it complicates the appearance of the code. Also, when using *itemset* (and *item*) inside a loop, be sure to assign the methods to a local variable to avoid the attribute look-up at each loop iteration.

Examples

```
>>> np.random.seed(123)
>>> x = np.random.randint(9, size=(3, 3))
>>> x
array([[2, 2, 6],
       [1, 3, 6],
       [1, 0, 1]])
>>> x.itemset(4, 0)
>>> x.itemset((2, 2), 9)
>>> x
array([[2, 2, 6],
       [1, 0, 6],
       [1, 0, 9]])
```

max

IsNumberArray.**max**(*axis=None*, *out=None*, *keepdims=False*, *initial=<no value>*, *where=True*)

Return the maximum along a given axis.

Refer to *numpy.amax* for full documentation.

See Also

numpy.amax : equivalent function

mean

IsNumberArray.**mean**(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, **, *where=True*)

Returns the average of the array elements along given axis.

Refer to *numpy.mean* for full documentation.

See Also

numpy.mean : equivalent function

min

IsNumberArray.**min**(*axis=None*, *out=None*, *keepdims=False*, *initial=<no value>*, *where=True*)

Return the minimum along a given axis.

Refer to *numpy.amin* for full documentation.

See Also

numpy.amin : equivalent function

newbyteorder

IsNumberArray.**newbyteorder**(*new_order='S'*, */*)

Return the array with the same data viewed with a different byte order.

Equivalent to:

```
arr.view(arr.dtype.newbytorder(new_order))
```

Changes are also made in all fields and sub-arrays of the array data type.

Parameters

new_order

[string, optional] Byte order to force; a value from the byte order specifications below. *new_order* codes can be any of:

- 'S' - swap dtype from current to opposite endian
- {'<', 'little'} - little endian
- {'>', 'big'} - big endian
- {'=', 'native'} - native order, equivalent to *sys.byteorder*

- {'|', 'I'} - ignore (no change to byte order)

The default value ('S') results in swapping the current byte order.

Returns

new_arr
[array] New array object with the dtype reflecting given change to the byte order.

nonzero

`IsNumberArray.nonzero()`

Return the indices of the elements that are non-zero.

Refer to *numpy.nonzero* for full documentation.

See Also

numpy.nonzero : equivalent function

partition

`IsNumberArray.partition(`*kth*, *axis=-1*, *kind='introselect'*, *order=None*`)`

Rearranges the elements in the array in such a way that the value of the element in kth position is in the position it would be in a sorted array. All elements smaller than the kth element are moved before this element and all equal or greater are moved behind it. The ordering of the elements in the two partitions is undefined.

New in version 1.8.0.

Parameters

kth
[int or sequence of ints] Element index to partition by. The kth element value will be in its final sorted position and all smaller elements will be moved before it and all equal or greater elements behind it. The order of all elements in the partitions is undefined. If provided with a sequence of kth it will partition all elements indexed by kth of them into their sorted position at once.

Deprecated since version 1.22.0: Passing booleans as index is deprecated.

axis
[int, optional] Axis along which to sort. Default is -1, which means sort along the last axis.

kind
[{'introselect'}, optional] Selection algorithm. Default is 'introselect'.

order
[str or list of str, optional] When *a* is an array with fields defined, this argument specifies which fields to compare first, second, etc. A single field can be specified as a string, and not all fields need to be specified, but unspecified fields will still be used, in the order in which they come up in the dtype, to break ties.

See Also

numpy.partition : Return a partitioned copy of an array. argpartition : Indirect partition. sort : Full sort.

Notes

See `np.partition` for notes on the different algorithms.

Examples

```
>>> a = np.array([3, 4, 2, 1])
>>> a.partition(3)
>>> a
array([2, 1, 3, 4])
```

```
>>> a.partition((1, 3))
>>> a
array([1, 2, 3, 4])
```

prod

`IsNumberArray.prod`(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, *initial=1*, *where=True*)

Return the product of the array elements over the given axis

Refer to *numpy.prod* for full documentation.

See Also

numpy.prod : equivalent function

ptp

`IsNumberArray.ptp`(*axis=None*, *out=None*, *keepdims=False*)

Peak to peak (maximum - minimum) value along a given axis.

Refer to *numpy.ptp* for full documentation.

See Also

numpy.ptp : equivalent function

put

`IsNumberArray.put(indices, values, mode='raise')`

Set `a.flat[n] = values[n]` for all *n* in indices.

Refer to *numpy.put* for full documentation.

See Also

numpy.put : equivalent function

ravel

`IsNumberArray.ravel([order])`

Return a flattened array.

Refer to *numpy.ravel* for full documentation.

See Also

numpy.ravel : equivalent function

ndarray.flat : a flat iterator on the array.

repeat

`IsNumberArray.repeat(repeats, axis=None)`

Repeat elements of an array.

Refer to *numpy.repeat* for full documentation.

See Also

numpy.repeat : equivalent function

reshape

`IsNumberArray.reshape(shape, order='C')`

Returns an array containing the same data with a new shape.

Refer to *numpy.reshape* for full documentation.

See Also

numpy.reshape : equivalent function

Notes

Unlike the free function *numpy.reshape*, this method on *ndarray* allows the elements of the shape parameter to be passed in as separate arguments. For example, `a.reshape(10, 11)` is equivalent to `a.reshape((10, 11))`.

resize

`IsNumberArray.`**`resize`**`(`*new_shape*, *refcheck=True*`)`

Change shape and size of array in-place.

Parameters

new_shape
[tuple of ints, or *n* ints] Shape of resized array.

refcheck
[bool, optional] If False, reference count will not be checked. Default is True.

Returns

None

Raises

ValueError
If *a* does not own its own data or references or views to it exist, and the data memory must be changed. PyPy only: will always raise if the data memory must be changed, since there is no reliable way to determine if references or views to it exist.

SystemError
If the *order* keyword argument is specified. This behaviour is a bug in NumPy.

See Also

resize : Return a new array with the specified shape.

Notes

This reallocates space for the data area if necessary.

Only contiguous arrays (data elements consecutive in memory) can be resized.

The purpose of the reference count check is to make sure you do not use this array as a buffer for another Python object and then reallocate the memory. However, reference counts can increase in other ways so if you are sure that you have not shared the memory for this array with another Python object, then you may safely set *refcheck* to False.

Examples

Shrinking an array: array is flattened (in the order that the data are stored in memory), resized, and reshaped:

```
>>> a = np.array([[0, 1], [2, 3]], order='C')
>>> a.resize((2, 1))
>>> a
array([[0],
       [1]])
```

```
>>> a = np.array([[0, 1], [2, 3]], order='F')
>>> a.resize((2, 1))
>>> a
array([[0],
       [2]])
```

Enlarging an array: as above, but missing entries are filled with zeros:

```
>>> b = np.array([[0, 1], [2, 3]])
>>> b.resize(2, 3) # new_shape parameter doesn't have to be a tuple
>>> b
array([[0, 1, 2],
       [3, 0, 0]])
```

Referencing an array prevents resizing...

```
>>> c = a
>>> a.resize((1, 1))
Traceback (most recent call last):
...
ValueError: cannot resize an array that references or is referenced ...
```

Unless *refcheck* is False:

```
>>> a.resize((1, 1), refcheck=False)
>>> a
array([[0]])
>>> c
array([[0]])
```

round

`IsNumberArray.round(decimals=0, out=None)`

Return *a* with each element rounded to the given number of decimals.

Refer to *numpy.around* for full documentation.

See Also

numpy.around : equivalent function

searchsorted

`IsNumberArray.searchsorted(v, side='left', sorter=None)`

Find indices where elements of v should be inserted in a to maintain order.

For full documentation, see *numpy.searchsorted*

See Also

numpy.searchsorted : equivalent function

setfield

`IsNumberArray.setfield(val, dtype, offset=0)`

Put a value into a specified place in a field defined by a data-type.

Place *val* into *a*'s field defined by *dtype* and beginning *offset* bytes into the field.

Parameters

val
[object] Value to be placed in field.

dtype
[dtype object] Data-type of the field in which to place *val*.

offset
[int, optional] The number of bytes into the field at which to place *val*.

Returns

None

See Also

getfield

Examples

```
>>> x = np.eye(3)
>>> x.getfield(np.float64)
array([[1.,  0.,  0.],
       [0.,  1.,  0.],
       [0.,  0.,  1.]])
>>> x.setfield(3, np.int32)
>>> x.getfield(np.int32)
array([[3, 3, 3],
       [3, 3, 3],
       [3, 3, 3]], dtype=int32)
>>> x
array([[1.0e+000, 1.5e-323, 1.5e-323],
       [1.5e-323, 1.0e+000, 1.5e-323],
       [1.5e-323, 1.5e-323, 1.0e+000]])
>>> x.setfield(np.eye(3), np.int32)
>>> x
array([[1.,  0.,  0.],
       [0.,  1.,  0.],
       [0.,  0.,  1.]])
```

setflags

`IsNumberArray.`**`setflags`**(*write=None*, *align=None*, *uic=None*)

Set array flags WRITEABLE, ALIGNED, WRITEBACKIFCOPY, respectively.

These Boolean-valued flags affect how numpy interprets the memory area used by *a* (see Notes below). The ALIGNED flag can only be set to True if the data is actually aligned according to the type. The WRITEBACKIFCOPY and flag can never be set to True. The flag WRITEABLE can only be set to True if the array owns its own memory, or the ultimate owner of the memory exposes a writeable buffer interface, or is a string. (The exception for string is made so that unpickling can be done without copying memory.)

Parameters

write
[bool, optional] Describes whether or not *a* can be written to.

align
[bool, optional] Describes whether or not *a* is aligned properly for its type.

uic
[bool, optional] Describes whether or not *a* is a copy of another "base" array.

Notes

Array flags provide information about how the memory area used for the array is to be interpreted. There are 7 Boolean flags in use, only four of which can be changed by the user: WRITEBACKIFCOPY, WRITEABLE, and ALIGNED.

WRITEABLE (W) the data area can be written to;

ALIGNED (A) the data and strides are aligned appropriately for the hardware (as determined by the compiler);

WRITEBACKIFCOPY (X) this array is a copy of some other array (referenced by .base). When the C-API function PyArray_ResolveWritebackIfCopy is called, the base array will be updated with the contents of this array.

All flags can be accessed using the single (upper case) letter as well as the full name.

Examples

```
>>> y = np.array([[3, 1, 7],
...               [2, 0, 0],
...               [8, 5, 9]])
>>> y
array([[3, 1, 7],
       [2, 0, 0],
       [8, 5, 9]])
>>> y.flags
  C_CONTIGUOUS : True
  F_CONTIGUOUS : False
  OWNDATA : True
  WRITEABLE : True
  ALIGNED : True
  WRITEBACKIFCOPY : False
>>> y.setflags(write=0, align=0)
>>> y.flags
  C_CONTIGUOUS : True
  F_CONTIGUOUS : False
  OWNDATA : True
  WRITEABLE : False
  ALIGNED : False
  WRITEBACKIFCOPY : False
>>> y.setflags(uic=1)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: cannot set WRITEBACKIFCOPY flag to True
```

sort

IsNumberArray.**sort**(*axis=-1*, *kind=None*, *order=None*)

Sort an array in-place. Refer to *numpy.sort* for full documentation.

Parameters

axis
[int, optional] Axis along which to sort. Default is -1, which means sort along the last axis.

kind
[{'quicksort', 'mergesort', 'heapsort', 'stable'}, optional] Sorting algorithm. The default is 'quicksort'. Note that both 'stable' and 'mergesort' use timsort under the covers and, in general, the actual implementation will vary with datatype. The 'mergesort' option is retained for backwards compatibility.

Changed in version 1.15.0: The 'stable' option was added.

order
[str or list of str, optional] When *a* is an array with fields defined, this argument specifies which fields to compare first, second, etc. A single field can be specified as a string, and not all fields need be specified, but unspecified fields will still be used, in the order in which they come up in the dtype, to break ties.

See Also

numpy.sort : Return a sorted copy of an array. numpy.argsort : Indirect sort. numpy.lexsort : Indirect stable sort on multiple keys. numpy.searchsorted : Find elements in sorted array. numpy.partition: Partial sort.

Notes

See *numpy.sort* for notes on the different sorting algorithms.

Examples

```
>>> a = np.array([[1,4], [3,1]])
>>> a.sort(axis=1)
>>> a
array([[1, 4],
       [1, 3]])
>>> a.sort(axis=0)
>>> a
array([[1, 3],
       [1, 4]])
```

Use the *order* keyword to specify a field to use when sorting a structured array:

```
>>> a = np.array([('a', 2), ('c', 1)], dtype=[('x', 'S1'), ('y', int)])
>>> a.sort(order='y')
>>> a
array([(b'c', 1), (b'a', 2)],
      dtype=[('x', 'S1'), ('y', '<i8')])
```

squeeze

IsNumberArray.**squeeze**(*axis=None*)

Remove axes of length one from *a*.

Refer to *numpy.squeeze* for full documentation.

See Also

numpy.squeeze : equivalent function

std

IsNumberArray.**std**(*axis=None*, *dtype=None*, *out=None*, *ddof=0*, *keepdims=False*, *, *where=True*)

Returns the standard deviation of the array elements along given axis.

Refer to *numpy.std* for full documentation.

See Also

numpy.std : equivalent function

sum

IsNumberArray.**sum**(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, *initial=0*, *where=True*)

Return the sum of the array elements over the given axis.

Refer to *numpy.sum* for full documentation.

See Also

numpy.sum : equivalent function

swapaxes

`IsNumberArray.swapaxes(axis1, axis2)`

Return a view of the array with *axis1* and *axis2* interchanged.

Refer to *numpy.swapaxes* for full documentation.

See Also

numpy.swapaxes : equivalent function

take

`IsNumberArray.take(indices, axis=None, out=None, mode='raise')`

Return an array formed from the elements of *a* at the given indices.

Refer to *numpy.take* for full documentation.

See Also

numpy.take : equivalent function

tobytes

`IsNumberArray.tobytes(order='C')`

Construct Python bytes containing the raw data bytes in the array.

Constructs Python bytes showing a copy of the raw contents of data memory. The bytes object is produced in C-order by default. This behavior is controlled by the `order` parameter.

New in version 1.9.0.

Parameters

order
[{'C', 'F', 'A'}, optional] Controls the memory layout of the bytes object. 'C' means C-order, 'F' means F-order, 'A' (short for *Any*) means 'F' if *a* is Fortran contiguous, 'C' otherwise. Default is 'C'.

Returns

s
[bytes] Python bytes exhibiting a copy of *a*'s raw data.

See also

frombuffer
Inverse of this operation, construct a 1-dimensional array from Python bytes.

Examples

```
>>> x = np.array([[0, 1], [2, 3]], dtype='<u2')
>>> x.tobytes()
b'\x00\x00\x01\x00\x02\x00\x03\x00'
>>> x.tobytes('C') == x.tobytes()
True
>>> x.tobytes('F')
b'\x00\x00\x02\x00\x01\x00\x03\x00'
```

tofile

`IsNumberArray.tofile(`*fid*, *sep=''*, *format='%s'*`)`

Write array to a file as text or binary (default).

Data is always written in 'C' order, independent of the order of *a*. The data produced by this method can be recovered using the function fromfile().

Parameters

fid
[file or str or Path] An open file object, or a string containing a filename.

Changed in version 1.17.0: *pathlib.Path* objects are now accepted.

sep
[str] Separator between array items for text output. If "" (empty), a binary file is written, equivalent to `file.write(a.tobytes())`.

format
[str] Format string for text file output. Each entry in the array is formatted to text by first converting it to the closest Python type, and then using "format" % item.

Notes

This is a convenience function for quick storage of array data. Information on endianness and precision is lost, so this method is not a good choice for files intended to archive data or transport data between machines with different endianness. Some of these problems can be overcome by outputting the data as text files, at the expense of speed and file size.

When fid is a file object, array contents are directly written to the file, bypassing the file object's `write` method. As a result, tofile cannot be used with files objects supporting compression (e.g., GzipFile) or file-like objects that do not support `fileno()` (e.g., BytesIO).

tolist

IsNumberArray.**tolist**()

Return the array as an `a.ndim`-levels deep nested list of Python scalars.

Return a copy of the array data as a (nested) Python list. Data items are converted to the nearest compatible builtin Python type, via the *~numpy.ndarray.item* function.

If `a.ndim` is 0, then since the depth of the nested list is 0, it will not be a list at all, but a simple Python scalar.

Parameters

none

Returns

y

[object, or list of object, or list of list of object, or ...] The possibly nested list of array elements.

Notes

The array may be recreated via `a = np.array(a.tolist())`, although this may sometimes lose precision.

Examples

For a 1D array, `a.tolist()` is almost the same as `list(a)`, except that `tolist` changes numpy scalars to Python scalars:

```
>>> a = np.uint32([1, 2])
>>> a_list = list(a)
>>> a_list
[1, 2]
>>> type(a_list[0])
<class 'numpy.uint32'>
>>> a_tolist = a.tolist()
>>> a_tolist
[1, 2]
>>> type(a_tolist[0])
<class 'int'>
```

Additionally, for a 2D array, `tolist` applies recursively:

```
>>> a = np.array([[1, 2], [3, 4]])
>>> list(a)
[array([1, 2]), array([3, 4])]
>>> a.tolist()
[[1, 2], [3, 4]]
```

The base case for this recursion is a 0D array:

```
>>> a = np.array(1)
>>> list(a)
Traceback (most recent call last):
  ...
TypeError: iteration over a 0-d array
>>> a.tolist()
1
```

tostring

IsNumberArray.**tostring**(*order='C'*)

A compatibility alias for *tobytes*, with exactly the same behavior.

Despite its name, it returns *bytes* not *str*s.

Deprecated since version 1.19.0.

trace

IsNumberArray.**trace**(*offset=0*, *axis1=0*, *axis2=1*, *dtype=None*, *out=None*)

Return the sum along diagonals of the array.

Refer to *numpy.trace* for full documentation.

See Also

numpy.trace : equivalent function

transpose

IsNumberArray.**transpose**(**axes*)

Returns a view of the array with axes transposed.

Refer to *numpy.transpose* for full documentation.

Parameters

axes : None, tuple of ints, or *n* ints

- None or no argument: reverses the order of the axes.
- tuple of ints: *i* in the *j*-th place in the tuple means that the array's *i*-th axis becomes the transposed array's *j*-th axis.
- *n* ints: same as an n-tuple of the same ints (this form is intended simply as a "convenience" alternative to the tuple form).

Returns

p
[ndarray] View of the array with its axes suitably permuted.

See Also

transpose : Equivalent function. ndarray.T : Array property returning the array transposed. ndarray.reshape : Give a new shape to an array without changing its data.

Examples

```
>>> a = np.array([[1, 2], [3, 4]])
>>> a
array([[1, 2],
       [3, 4]])
>>> a.transpose()
array([[1, 3],
       [2, 4]])
>>> a.transpose((1, 0))
array([[1, 3],
       [2, 4]])
>>> a.transpose(1, 0)
array([[1, 3],
       [2, 4]])
```

```
>>> a = np.array([1, 2, 3, 4])
>>> a
array([1, 2, 3, 4])
>>> a.transpose()
array([1, 2, 3, 4])
```

var

`IsNumberArray.`**`var`**(*axis=None*, *dtype=None*, *out=None*, *ddof=0*, *keepdims=False*, *, *where=True*)

Returns the variance of the array elements, along given axis.

Refer to *numpy.var* for full documentation.

See Also

numpy.var : equivalent function

view

IsNumberArray.**view**(*[dtype][, type]*)

New view of array with the same data.

Note: Passing None for `dtype` is different from omitting the parameter, since the former invokes `dtype(None)` which is an alias for `dtype('float_')`.

Parameters

dtype
[data-type or ndarray sub-class, optional] Data-type descriptor of the returned view, e.g., float32 or int16. Omitting it results in the view having the same data-type as *a*. This argument can also be specified as an ndarray sub-class, which then specifies the type of the returned object (this is equivalent to setting the `type` parameter).

type
[Python type, optional] Type of the returned view, e.g., ndarray or matrix. Again, omission of the parameter results in type preservation.

Notes

`a.view()` is used two different ways:

`a.view(some_dtype)` or `a.view(dtype=some_dtype)` constructs a view of the array's memory with a different data-type. This can cause a reinterpretation of the bytes of memory.

`a.view(ndarray_subclass)` or `a.view(type=ndarray_subclass)` just returns an instance of *ndarray_subclass* that looks at the same array (same shape, dtype, etc.) This does not cause a reinterpretation of the memory.

For `a.view(some_dtype)`, if `some_dtype` has a different number of bytes per entry than the previous dtype (for example, converting a regular array to a structured array), then the last axis of `a` must be contiguous. This axis will be resized in the result.

Changed in version 1.23.0: Only the last axis needs to be contiguous. Previously, the entire array had to be C-contiguous.

Examples

```
>>> x = np.array([(1, 2)], dtype=[('a', np.int8), ('b', np.int8)])
```

Viewing array data using a different type and dtype:

```
>>> y = x.view(dtype=np.int16, type=np.matrix)
>>> y
matrix([[513]], dtype=int16)
>>> print(type(y))
<class 'numpy.matrix'>
```

Creating a view on a structured array so it can be used in calculations

```
>>> x = np.array([(1, 2),(3,4)], dtype=[('a', np.int8), ('b', np.int8)])
>>> xv = x.view(dtype=np.int8).reshape(-1,2)
>>> xv
array([[1, 2],
       [3, 4]], dtype=int8)
>>> xv.mean(0)
array([2.,  3.])
```

Making changes to the view changes the underlying array

```
>>> xv[0,1] = 20
>>> x
array([(1, 20), (3,  4)], dtype=[('a', 'i1'), ('b', 'i1')])
```

Using a view to convert an array to a recarray:

```
>>> z = x.view(np.recarray)
>>> z.a
array([1, 3], dtype=int8)
```

Views share data:

```
>>> x[0] = (9, 10)
>>> z[0]
(9, 10)
```

Views that change the dtype size (bytes per entry) should normally be avoided on arrays defined by slices, transposes, fortran-ordering, etc.:

```
>>> x = np.array([[1, 2, 3], [4, 5, 6]], dtype=np.int16)
>>> y = x[:, ::2]
>>> y
array([[1, 3],
       [4, 6]], dtype=int16)
>>> y.view(dtype=[('width', np.int16), ('length', np.int16)])
Traceback (most recent call last):
    ...
ValueError: To change to a dtype of a different size, the last axis must be␣
↪contiguous
>>> z = y.copy()
>>> z.view(dtype=[('width', np.int16), ('length', np.int16)])
array([[(1, 3)],
       [(4, 6)]], dtype=[('width', '<i2'), ('length', '<i2')])
```

However, views that change dtype are totally fine for arrays with a contiguous last axis, even if the rest of the axes are not C-contiguous:

```
>>> x = np.arange(2 * 3 * 4, dtype=np.int8).reshape(2, 3, 4)
>>> x.transpose(1, 0, 2).view(np.int16)
array([[[ 256,  770],
        [3340, 3854]],

       [[1284, 1798],
        [4368, 4882]],
```

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```
       [[2312, 2826],
        [5396, 5910]]], dtype=int16)
```

__init__()

Attributes

T	View of the transposed array.
base	Base object if memory is from some other object.
ctypes	An object to simplify the interaction of the array with the ctypes module.
data	Python buffer object pointing to the start of the array's data.
dtype	Data-type of the array's elements.
flags	Information about the memory layout of the array.
flat	A 1-D iterator over the array.
imag	The imaginary part of the array.
itemsize	Length of one array element in bytes.
nbytes	Total bytes consumed by the elements of the array.
ndim	Number of array dimensions.
real	The real part of the array.
shape	Tuple of array dimensions.
size	Number of elements in the array.
strides	Tuple of bytes to step in each dimension when traversing an array.

T

IsNumberArray.**T**

View of the transposed array.

Same as `self.transpose()`.

Examples

```
>>> a = np.array([[1, 2], [3, 4]])
>>> a
array([[1, 2],
       [3, 4]])
>>> a.T
array([[1, 3],
       [2, 4]])
```

```
>>> a = np.array([1, 2, 3, 4])
>>> a
array([1, 2, 3, 4])
```

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```
>>> a.T
array([1, 2, 3, 4])
```

See Also

transpose

base

`IsNumberArray.base`

Base object if memory is from some other object.

Examples

The base of an array that owns its memory is None:

```
>>> x = np.array([1,2,3,4])
>>> x.base is None
True
```

Slicing creates a view, whose memory is shared with x:

```
>>> y = x[2:]
>>> y.base is x
True
```

ctypes

`IsNumberArray.ctypes`

An object to simplify the interaction of the array with the ctypes module.

This attribute creates an object that makes it easier to use arrays when calling shared libraries with the ctypes module. The returned object has, among others, data, shape, and strides attributes (see Notes below) which themselves return ctypes objects that can be used as arguments to a shared library.

Parameters

None

Returns

c
[Python object] Possessing attributes data, shape, strides, etc.

See Also

numpy.ctypeslib

Notes

Below are the public attributes of this object which were documented in "Guide to NumPy" (we have omitted undocumented public attributes, as well as documented private attributes):

`_ctypes.data`

A pointer to the memory area of the array as a Python integer. This memory area may contain data that is not aligned, or not in correct byte-order. The memory area may not even be writeable. The array flags and data-type of this array should be respected when passing this attribute to arbitrary C-code to avoid trouble that can include Python crashing. User Beware! The value of this attribute is exactly the same as `self._array_interface_['data'][0]`.

Note that unlike `data_as`, a reference will not be kept to the array: code like `ctypes.c_void_p((a + b).ctypes.data)` will result in a pointer to a deallocated array, and should be spelt `(a + b).ctypes.data_as(ctypes.c_void_p)`

`_ctypes.shape`

(c_intp*self.ndim): A ctypes array of length self.ndim where the basetype is the C-integer corresponding to `dtype('p')` on this platform (see *~numpy.ctypeslib.c_intp*). This base-type could be *ctypes.c_int*, *ctypes.c_long*, or *ctypes.c_longlong* depending on the platform. The ctypes array contains the shape of the underlying array.

`_ctypes.strides`

(c_intp*self.ndim): A ctypes array of length self.ndim where the basetype is the same as for the shape attribute. This ctypes array contains the strides information from the underlying array. This strides information is important for showing how many bytes must be jumped to get to the next element in the array.

`_ctypes.data_as(`*obj*`)`

Return the data pointer cast to a particular c-types object. For example, calling `self._as_parameter_` is equivalent to `self.data_as(ctypes.c_void_p)`. Perhaps you want to use the data as a pointer to a ctypes array of floating-point data: `self.data_as(ctypes.POINTER(ctypes.c_double))`.

The returned pointer will keep a reference to the array.

`_ctypes.shape_as(`*obj*`)`

Return the shape tuple as an array of some other c-types type. For example: `self.shape_as(ctypes.c_short)`.

`_ctypes.strides_as(`*obj*`)`

Return the strides tuple as an array of some other c-types type. For example: `self.strides_as(ctypes.c_longlong)`.

If the ctypes module is not available, then the ctypes attribute of array objects still returns something useful, but ctypes objects are not returned and errors may be raised instead. In particular, the object will still have the `as_parameter` attribute which will return an integer equal to the data attribute.

Examples

```
>>> import ctypes
>>> x = np.array([[0, 1], [2, 3]], dtype=np.int32)
>>> x
array([[0, 1],
       [2, 3]], dtype=int32)
>>> x.ctypes.data
31962608 # may vary
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint32))
<__main__.LP_c_uint object at 0x7ff2fc1fc200> # may vary
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint32)).contents
c_uint(0)
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint64)).contents
c_ulong(4294967296)
>>> x.ctypes.shape
<numpy.core._internal.c_long_Array_2 object at 0x7ff2fc1fce60> # may vary
>>> x.ctypes.strides
<numpy.core._internal.c_long_Array_2 object at 0x7ff2fc1ff320> # may vary
```

data

`IsNumberArray.data`

Python buffer object pointing to the start of the array's data.

dtype

`IsNumberArray.dtype`

Data-type of the array's elements.

Warning: Setting `arr.dtype` is discouraged and may be deprecated in the future. Setting will replace the `dtype` without modifying the memory (see also *ndarray.view* and *ndarray.astype*).

Parameters

None

Returns

d : numpy dtype object

See Also

ndarray.astype : Cast the values contained in the array to a new data-type. ndarray.view : Create a view of the same data but a different data-type. numpy.dtype

Examples

```
>>> x
array([[0, 1],
       [2, 3]])
>>> x.dtype
dtype('int32')
>>> type(x.dtype)
<type 'numpy.dtype'>
```

flags

`IsNumberArray.flags`

Information about the memory layout of the array.

Attributes

C_CONTIGUOUS (C)
The data is in a single, C-style contiguous segment.

F_CONTIGUOUS (F)
The data is in a single, Fortran-style contiguous segment.

OWNDATA (O)
The array owns the memory it uses or borrows it from another object.

WRITEABLE (W)
The data area can be written to. Setting this to False locks the data, making it read-only. A view (slice, etc.) inherits WRITEABLE from its base array at creation time, but a view of a writeable array may be subsequently locked while the base array remains writeable. (The opposite is not true, in that a view of a locked array may not be made writeable. However, currently, locking a base object does not lock any views that already reference it, so under that circumstance it is possible to alter the contents of a locked array via a previously created writeable view onto it.) Attempting to change a non-writeable array raises a RuntimeError exception.

ALIGNED (A)
The data and all elements are aligned appropriately for the hardware.

WRITEBACKIFCOPY (X)
This array is a copy of some other array. The C-API function PyArray_ResolveWritebackIfCopy must be called before deallocating to the base array will be updated with the contents of this array.

FNC
F_CONTIGUOUS and not C_CONTIGUOUS.

FORC
F_CONTIGUOUS or C_CONTIGUOUS (one-segment test).

BEHAVED (B)
ALIGNED and WRITEABLE.

CARRAY (CA)
BEHAVED and C_CONTIGUOUS.

FARRAY (FA)
BEHAVED and F_CONTIGUOUS and not C_CONTIGUOUS.

Notes

The *flags* object can be accessed dictionary-like (as in `a.flags['WRITEABLE']`), or by using lowercased attribute names (as in `a.flags.writeable`). Short flag names are only supported in dictionary access.

Only the WRITEBACKIFCOPY, WRITEABLE, and ALIGNED flags can be changed by the user, via direct assignment to the attribute or dictionary entry, or by calling *ndarray.setflags*.

The array flags cannot be set arbitrarily:

- WRITEBACKIFCOPY can only be set `False`.
- ALIGNED can only be set `True` if the data is truly aligned.
- WRITEABLE can only be set `True` if the array owns its own memory or the ultimate owner of the memory exposes a writeable buffer interface or is a string.

Arrays can be both C-style and Fortran-style contiguous simultaneously. This is clear for 1-dimensional arrays, but can also be true for higher dimensional arrays.

Even for contiguous arrays a stride for a given dimension `arr.strides[dim]` may be *arbitrary* if `arr.shape[dim] == 1` or the array has no elements. It does *not* generally hold that `self.strides[-1] == self.itemsize` for C-style contiguous arrays or `self.strides[0] == self.itemsize` for Fortran-style contiguous arrays is true.

flat

`IsNumberArray.flat`

A 1-D iterator over the array.

This is a *numpy.flatiter* instance, which acts similarly to, but is not a subclass of, Python's built-in iterator object.

See Also

flatten : Return a copy of the array collapsed into one dimension.

flatiter

Examples

```
>>> x = np.arange(1, 7).reshape(2, 3)
>>> x
array([[1, 2, 3],
       [4, 5, 6]])
>>> x.flat[3]
4
>>> x.T
array([[1, 4],
       [2, 5],
       [3, 6]])
>>> x.T.flat[3]
5
>>> type(x.flat)
<class 'numpy.flatiter'>
```

An assignment example:

```
>>> x.flat = 3; x
array([[3, 3, 3],
       [3, 3, 3]])
>>> x.flat[[1,4]] = 1; x
array([[3, 1, 3],
       [3, 1, 3]])
```

imag

`IsNumberArray.`**`imag`**

The imaginary part of the array.

Examples

```
>>> x = np.sqrt([1+0j, 0+1j])
>>> x.imag
array([ 0.        ,  0.70710678])
>>> x.imag.dtype
dtype('float64')
```

itemsize

IsNumberArray.**itemsize**

Length of one array element in bytes.

Examples

```
>>> x = np.array([1,2,3], dtype=np.float64)
>>> x.itemsize
8
>>> x = np.array([1,2,3], dtype=np.complex128)
>>> x.itemsize
16
```

nbytes

IsNumberArray.**nbytes**

Total bytes consumed by the elements of the array.

Notes

Does not include memory consumed by non-element attributes of the array object.

See Also

sys.getsizeof
Memory consumed by the object itself without parents in case view. This does include memory consumed by non-element attributes.

Examples

```
>>> x = np.zeros((3,5,2), dtype=np.complex128)
>>> x.nbytes
480
>>> np.prod(x.shape) * x.itemsize
480
```

ndim

`IsNumberArray.ndim`

Number of array dimensions.

Examples

```
>>> x = np.array([1, 2, 3])
>>> x.ndim
1
>>> y = np.zeros((2, 3, 4))
>>> y.ndim
3
```

real

`IsNumberArray.real`

The real part of the array.

Examples

```
>>> x = np.sqrt([1+0j, 0+1j])
>>> x.real
array([ 1.        ,  0.70710678])
>>> x.real.dtype
dtype('float64')
```

See Also

numpy.real : equivalent function

shape

`IsNumberArray.shape`

Tuple of array dimensions.

The shape property is usually used to get the current shape of an array, but may also be used to reshape the array in-place by assigning a tuple of array dimensions to it. As with *numpy.reshape*, one of the new shape dimensions can be -1, in which case its value is inferred from the size of the array and the remaining dimensions. Reshaping an array in-place will fail if a copy is required.

Warning: Setting `arr.shape` is discouraged and may be deprecated in the future. Using *ndarray.reshape* is the preferred approach.

Examples

```
>>> x = np.array([1, 2, 3, 4])
>>> x.shape
(4,)
>>> y = np.zeros((2, 3, 4))
>>> y.shape
(2, 3, 4)
>>> y.shape = (3, 8)
>>> y
array([[ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.],
       [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.],
       [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.]])
>>> y.shape = (3, 6)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: total size of new array must be unchanged
>>> np.zeros((4,2))[::2].shape = (-1,)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AttributeError: Incompatible shape for in-place modification. Use
`.reshape()` to make a copy with the desired shape.
```

See Also

numpy.shape : Equivalent getter function. numpy.reshape : Function similar to setting `shape`. ndarray.reshape : Method similar to setting `shape`.

size

`IsNumberArray.`**`size`**

Number of elements in the array.

Equal to `np.prod(a.shape)`, i.e., the product of the array's dimensions.

Notes

a.size returns a standard arbitrary precision Python integer. This may not be the case with other methods of obtaining the same value (like the suggested `np.prod(a.shape)`, which returns an instance of `np.int_`), and may be relevant if the value is used further in calculations that may overflow a fixed size integer type.

Examples

```
>>> x = np.zeros((3, 5, 2), dtype=np.complex128)
>>> x.size
30
>>> np.prod(x.shape)
30
```

strides

IsNumberArray.**strides**

Tuple of bytes to step in each dimension when traversing an array.

The byte offset of element `(i[0], i[1], ..., i[n])` in an array *a* is:

```
offset = sum(np.array(i) * a.strides)
```

A more detailed explanation of strides can be found in the "ndarray.rst" file in the NumPy reference guide.

> **Warning:** Setting `arr.strides` is discouraged and may be deprecated in the future. *numpy.lib.stride_tricks.as_strided* should be preferred to create a new view of the same data in a safer way.

Notes

Imagine an array of 32-bit integers (each 4 bytes):

```
x = np.array([[0, 1, 2, 3, 4],
              [5, 6, 7, 8, 9]], dtype=np.int32)
```

This array is stored in memory as 40 bytes, one after the other (known as a contiguous block of memory). The strides of an array tell us how many bytes we have to skip in memory to move to the next position along a certain axis. For example, we have to skip 4 bytes (1 value) to move to the next column, but 20 bytes (5 values) to get to the same position in the next row. As such, the strides for the array *x* will be `(20, 4)`.

See Also

numpy.lib.stride_tricks.as_strided

Examples

```
>>> y = np.reshape(np.arange(2*3*4), (2,3,4))
>>> y
array([[[ 0,  1,  2,  3],
        [ 4,  5,  6,  7],
        [ 8,  9, 10, 11]],
       [[12, 13, 14, 15],
        [16, 17, 18, 19],
        [20, 21, 22, 23]]])
>>> y.strides
(48, 16, 4)
>>> y[1,1,1]
17
>>> offset=sum(y.strides * np.array((1,1,1)))
>>> offset/y.itemsize
17
```

```
>>> x = np.reshape(np.arange(5*6*7*8), (5,6,7,8)).transpose(2,3,1,0)
>>> x.strides
(32, 4, 224, 1344)
>>> i = np.array([3,5,2,2])
>>> offset = sum(i * x.strides)
>>> x[3,5,2,2]
813
>>> offset / x.itemsize
813
```

logic

Python equivalents of logical Excel functions.

Functions

solve_cycle
xand
xif
xiferror
xiferror_return
xifna
xifs
xswitch

solve_cycle

solve_cycle(**args*)

xand

xand(*logical*, **logicals*, *func=<built-in method reduce of numpy.ufunc object>*)

xif

xif(*condition*, *x=True*, *y=False*)

xiferror

xiferror(*val*, *val_if_error*)

xiferror_return

xiferror_return(*res*, *val*, *val_if_error*)

xifna

xifna(*val*, *val_if_error*)

xifs

xifs(**cond_vals*)

xswitch

xswitch(*val*, **args*)

look

Python equivalents of lookup and reference Excel functions.

Functions

xaddress	
xcolumn	
xindex	
xlookup	
xmatch	
xrow	
xsingle	

xaddress

xaddress(*row_num*, *column_num*, *abs_num=1*, *a1=True*, *sheet_text=None*)

xcolumn

xcolumn(*cell=None*, *ref=None*)

xindex

xindex(*array*, *row_num*, *col_num=None*, *area_num=1*)

xlookup

xlookup(*lookup_val*, *lookup_vec*, *result_vec=None*, *match_type=1*)

xmatch

xmatch(*lookup_value*, *lookup_array*, *match_type=1*)

xrow

xrow(*cell=None*, *ref=None*)

xsingle

xsingle(*cell*, *rng*)

math

Python equivalents of math and trigonometry Excel functions.

Functions

round_up
xarabic
xarctan2
xceiling
xceiling_math
xcot
xdecimal
xeven
xfact
xfactdouble
xgcd
xlcm
xmod
xmround
xodd
xpower
xrandbetween
xroman
xround
xsrqtpi
xsum
xsumproduct
xtrunc

round_up

round_up(*x*)

xarabic

xarabic(*text*)

xarctan2

xarctan2(*x*, *y*)

xceiling

xceiling(*num*, *sig*, *ceil=<built-in function ceil>*, *dfl=0*)

xceiling_math

xceiling_math(*num*, *sig=None*, *mode=0*, *ceil=<built-in function ceil>*)

xcot

xcot(*x*, *func=<ufunc 'tan'>*)

xdecimal

xdecimal(*text*, *radix*)

xeven

xeven(*x*)

xfact

xfact(*number*, *fact=<built-in function factorial>*, *limit=0*)

xfactdouble

xfactdouble(*number*)

xgcd

xgcd(**args*)

xlcm

xlcm(**args*)

xmod

xmod(*x*, *y*)

xmround

xmround(**args*)

xodd

xodd(*x*)

xpower

xpower(*number*, *power*)

xrandbetween

xrandbetween(*bottom*, *top*)

xroman

xroman(*num*, *form=0*)

xround

xround(*x*, *d*, *func=<function round_up>*)

xsrqtpi

xsrqtpi(*number*)

xsum

xsum(**args*, *func=<function sum>*)

xsumproduct

xsumproduct(**args*)

xtrunc

xtrunc(*x*, *d=0*, *func=<built-in function trunc>*)

operators

Python equivalents of Excel operators.

Functions

logic_input_parser

logic_input_parser

logic_input_parser(*x*, *y*)

stat

Python equivalents of statistical Excel functions.

Functions

xcorrel	
xforecast	
xfunc	
xslope	
xsort	
xstdev	

xcorrel

xcorrel(*arr1*, *arr2*)

xforecast

xforecast(*x*, *a=None*, *b=None*)

xfunc

xfunc(**args*, *func=<built-in function max>*, *check=<function is_number>*, *convert=None*, *default=0*, *_raise=True*)

xslope

xslope(*yp*, *xp*)

xsort

xsort(*values*, *k*, *large=True*)

xstdev

xstdev(*args*, *ddof=1*, *func=<function std>*)

text

Python equivalents of text Excel functions.

Functions

xconcat
xfind
xleft
xmid
xreplace
xright
xsearch
xtext
xvalue

xconcat

xconcat(*text*, **args*)

xfind

xfind(*find_text*, *within_text*, *start_num=1*)

xleft

xleft(*from_str*, *num_chars*)

xmid

xmid(*from_str*, *start_num*, *num_chars*)

xreplace

xreplace(*old_text*, *start_num*, *num_chars*, *new_text*)

xright

xright(*from_str*, *num_chars*)

xsearch

xsearch(*find_text*, *within_text*, *start_num=1*)

xtext

xtext(*value*, *format_code*)

xvalue

xvalue(*value*)

Functions

args2list	
args2vals	
clean_values	
convert2float	
convert_nan	
convert_noshp	
flatten	
get_error	
get_functions	
is_not_empty	
is_number	
not_implemented	
parse_ranges	
raise_errors	
replace_empty	
text2num	
to_number	
value_return	
wrap_func	
wrap_impure_func	
wrap_ranges_func	
wrap_ufunc	Helps call a numpy universal function (ufunc).
xfilter	

args2list

`args2list`(*max_shape*, *shapes*, **args*)

args2vals

`args2vals`(*args*)

clean_values

`clean_values`(*values*)

convert2float

`convert2float`(**a*)

convert_nan

`convert_nan`(*value*, *default=#NUM!*)

convert_noshp

`convert_noshp`(*value*)

flatten

`flatten`(*v*, *check=<function is_number>*, *drop_empty=False*)

get_error

`get_error`(**vals*)

get_functions

`get_functions`()

is_not_empty

is_not_empty(*v*)

is_number

is_number(*number*, *xl_return=True*, *bool_return=False*)

not_implemented

not_implemented(**args*, ***kwargs*)

parse_ranges

parse_ranges(**args*, ***kw*)

raise_errors

raise_errors(**args*)

replace_empty

replace_empty(*x*, *empty=0*)

text2num

text2num(**args*, ***kwargs*)

to_number

to_number(**args*, ***kwargs*)

value_return

value_return(*res*, **args*)

wrap_func

wrap_func(*func*, *ranges=False*)

wrap_impure_func

wrap_impure_func(*func*)

wrap_ranges_func

wrap_ranges_func(*func*, *n_out=1*)

wrap_ufunc

wrap_ufunc(*func*, *input_parser=<function <lambda>>*, *check_error=<function get_error>*, *args_parser=<function <lambda>>*, *otype=<class 'formulas.functions.Array'>*, *ranges=False*, *return_func=<function <lambda>>*, *check_nan=True*, ***kw*)

Helps call a numpy universal function (ufunc).

xfilter

xfilter(*accumulator*, *test_range*, *condition*, *operating_range=None*)

Classes

Array

Array

class Array

Methods

__init__	
all	Returns True if all elements evaluate to True.
any	Returns True if any of the elements of *a* evaluate to True.
argmax	Return indices of the maximum values along the given axis.

continues on next page

Table 6 – continued from previous page

`argmin`	Return indices of the minimum values along the given axis.
`argpartition`	Returns the indices that would partition this array.
`argsort`	Returns the indices that would sort this array.
`astype`	Copy of the array, cast to a specified type.
`byteswap`	Swap the bytes of the array elements
`choose`	Use an index array to construct a new array from a set of choices.
`clip`	Return an array whose values are limited to `[min, max]`.
`collapse`	
`compress`	Return selected slices of this array along given axis.
`conj`	Complex-conjugate all elements.
`conjugate`	Return the complex conjugate, element-wise.
`copy`	Return a copy of the array.
`cumprod`	Return the cumulative product of the elements along the given axis.
`cumsum`	Return the cumulative sum of the elements along the given axis.
`diagonal`	Return specified diagonals.
`dot`	
`dump`	Dump a pickle of the array to the specified file.
`dumps`	Returns the pickle of the array as a string.
`fill`	Fill the array with a scalar value.
`flatten`	Return a copy of the array collapsed into one dimension.
`getfield`	Returns a field of the given array as a certain type.
`item`	Copy an element of an array to a standard Python scalar and return it.
`itemset`	Insert scalar into an array (scalar is cast to array's dtype, if possible)
`max`	Return the maximum along a given axis.
`mean`	Returns the average of the array elements along given axis.
`min`	Return the minimum along a given axis.
`newbyteorder`	Return the array with the same data viewed with a different byte order.
`nonzero`	Return the indices of the elements that are non-zero.
`partition`	Rearranges the elements in the array in such a way that the value of the element in kth position is in the position it would be in a sorted array.
`prod`	Return the product of the array elements over the given axis
`ptp`	Peak to peak (maximum - minimum) value along a given axis.
`put`	Set `a.flat[n] = values[n]` for all *n* in indices.
`ravel`	Return a flattened array.
`repeat`	Repeat elements of an array.
`reshape`	Returns an array containing the same data with a new shape.

continues on next page

Table 6 – continued from previous page

`resize`	Change shape and size of array in-place.
`round`	Return *a* with each element rounded to the given number of decimals.
`searchsorted`	Find indices where elements of v should be inserted in a to maintain order.
`setfield`	Put a value into a specified place in a field defined by a data-type.
`setflags`	Set array flags WRITEABLE, ALIGNED, WRITE-BACKIFCOPY, respectively.
`sort`	Sort an array in-place.
`squeeze`	Remove axes of length one from *a*.
`std`	Returns the standard deviation of the array elements along given axis.
`sum`	Return the sum of the array elements over the given axis.
`swapaxes`	Return a view of the array with *axis1* and *axis2* interchanged.
`take`	Return an array formed from the elements of *a* at the given indices.
`tobytes`	Construct Python bytes containing the raw data bytes in the array.
`tofile`	Write array to a file as text or binary (default).
`tolist`	Return the array as an `a.ndim`-levels deep nested list of Python scalars.
`tostring`	A compatibility alias for *tobytes*, with exactly the same behavior.
`trace`	Return the sum along diagonals of the array.
`transpose`	Returns a view of the array with axes transposed.
`var`	Returns the variance of the array elements, along given axis.
`view`	New view of array with the same data.

__init__

`Array.__init__()`

all

`Array.all`(*axis=None*, *out=None*, *keepdims=False*, *, *where=True*)

Returns True if all elements evaluate to True.

Refer to *numpy.all* for full documentation.

See Also

numpy.all : equivalent function

any

`Array.any`(*axis=None*, *out=None*, *keepdims=False*, *, *where=True*)

Returns True if any of the elements of *a* evaluate to True.

Refer to *numpy.any* for full documentation.

See Also

numpy.any : equivalent function

argmax

`Array.argmax`(*axis=None*, *out=None*, *, *keepdims=False*)

Return indices of the maximum values along the given axis.

Refer to *numpy.argmax* for full documentation.

See Also

numpy.argmax : equivalent function

argmin

`Array.argmin`(*axis=None*, *out=None*, *, *keepdims=False*)

Return indices of the minimum values along the given axis.

Refer to *numpy.argmin* for detailed documentation.

See Also

numpy.argmin : equivalent function

argpartition

`Array.argpartition(kth, axis=-1, kind='introselect', order=None)`

Returns the indices that would partition this array.

Refer to *numpy.argpartition* for full documentation.

New in version 1.8.0.

See Also

numpy.argpartition : equivalent function

argsort

`Array.argsort(axis=-1, kind=None, order=None)`

Returns the indices that would sort this array.

Refer to *numpy.argsort* for full documentation.

See Also

numpy.argsort : equivalent function

astype

`Array.astype(dtype, order='K', casting='unsafe', subok=True, copy=True)`

Copy of the array, cast to a specified type.

Parameters

dtype
[str or dtype] Typecode or data-type to which the array is cast.

order
[{'C', 'F', 'A', 'K'}, optional] Controls the memory layout order of the result. 'C' means C order, 'F' means Fortran order, 'A' means 'F' order if all the arrays are Fortran contiguous, 'C' order otherwise, and 'K' means as close to the order the array elements appear in memory as possible. Default is 'K'.

casting
[{'no', 'equiv', 'safe', 'same_kind', 'unsafe'}, optional] Controls what kind of data casting may occur. Defaults to 'unsafe' for backwards compatibility.

- 'no' means the data types should not be cast at all.
- 'equiv' means only byte-order changes are allowed.

- 'safe' means only casts which can preserve values are allowed.
- 'same_kind' means only safe casts or casts within a kind, like float64 to float32, are allowed.
- 'unsafe' means any data conversions may be done.

subok
[bool, optional] If True, then sub-classes will be passed-through (default), otherwise the returned array will be forced to be a base-class array.

copy
[bool, optional] By default, astype always returns a newly allocated array. If this is set to false, and the *dtype*, *order*, and *subok* requirements are satisfied, the input array is returned instead of a copy.

Returns

arr_t
[ndarray] Unless *copy* is False and the other conditions for returning the input array are satisfied (see description for *copy* input parameter), *arr_t* is a new array of the same shape as the input array, with dtype, order given by *dtype*, *order*.

Notes

Changed in version 1.17.0: Casting between a simple data type and a structured one is possible only for "unsafe" casting. Casting to multiple fields is allowed, but casting from multiple fields is not.

Changed in version 1.9.0: Casting from numeric to string types in 'safe' casting mode requires that the string dtype length is long enough to store the max integer/float value converted.

Raises

ComplexWarning
When casting from complex to float or int. To avoid this, one should use `a.real.astype(t)`.

Examples

```
>>> x = np.array([1, 2, 2.5])
>>> x
array([1. ,  2. ,  2.5])
```

```
>>> x.astype(int)
array([1, 2, 2])
```

byteswap

`Array.byteswap(inplace=False)`

Swap the bytes of the array elements

Toggle between low-endian and big-endian data representation by returning a byteswapped array, optionally swapped in-place. Arrays of byte-strings are not swapped. The real and imaginary parts of a complex number are swapped individually.

Parameters

inplace
[bool, optional] If `True`, swap bytes in-place, default is `False`.

Returns

out
[ndarray] The byteswapped array. If *inplace* is `True`, this is a view to self.

Examples

```
>>> A = np.array([1, 256, 8755], dtype=np.int16)
>>> list(map(hex, A))
['0x1', '0x100', '0x2233']
>>> A.byteswap(inplace=True)
array([  256,     1, 13090], dtype=int16)
>>> list(map(hex, A))
['0x100', '0x1', '0x3322']
```

Arrays of byte-strings are not swapped

```
>>> A = np.array([b'ceg', b'fac'])
>>> A.byteswap()
array([b'ceg', b'fac'], dtype='|S3')
```

`A.newbyteorder().byteswap()` produces an array with the same values
but different representation in memory

```
>>> A = np.array([1, 2, 3])
>>> A.view(np.uint8)
array([1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 3, 0, 0, 0, 0, 0,
       0, 0], dtype=uint8)
>>> A.newbyteorder().byteswap(inplace=True)
array([1, 2, 3])
>>> A.view(np.uint8)
array([0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0,
       0, 3], dtype=uint8)
```

choose

`Array.choose(choices, out=None, mode='raise')`

Use an index array to construct a new array from a set of choices.

Refer to *numpy.choose* for full documentation.

See Also

numpy.choose : equivalent function

clip

`Array.clip(min=None, max=None, out=None, **kwargs)`

Return an array whose values are limited to `[min, max]`. One of max or min must be given.

Refer to *numpy.clip* for full documentation.

See Also

numpy.clip : equivalent function

collapse

`Array.collapse(shape)`

compress

`Array.compress(condition, axis=None, out=None)`

Return selected slices of this array along given axis.

Refer to *numpy.compress* for full documentation.

See Also

numpy.compress : equivalent function

conj

`Array.conj()`

Complex-conjugate all elements.

Refer to *numpy.conjugate* for full documentation.

See Also

numpy.conjugate : equivalent function

conjugate

`Array.conjugate()`

Return the complex conjugate, element-wise.

Refer to *numpy.conjugate* for full documentation.

See Also

numpy.conjugate : equivalent function

copy

`Array.copy(order='C')`

Return a copy of the array.

Parameters

order
[{'C', 'F', 'A', 'K'}, optional] Controls the memory layout of the copy. 'C' means C-order, 'F' means F-order, 'A' means 'F' if *a* is Fortran contiguous, 'C' otherwise. 'K' means match the layout of *a* as closely as possible. (Note that this function and `numpy.copy()` are very similar but have different default values for their order= arguments, and this function always passes sub-classes through.)

See also

numpy.copy : Similar function with different default behavior numpy.copyto

Notes

This function is the preferred method for creating an array copy. The function `numpy.copy()` is similar, but it defaults to using order 'K', and will not pass sub-classes through by default.

Examples

```
>>> x = np.array([[1,2,3],[4,5,6]], order='F')
```

```
>>> y = x.copy()
```

```
>>> x.fill(0)
```

```
>>> x
array([[0, 0, 0],
       [0, 0, 0]])
```

```
>>> y
array([[1, 2, 3],
       [4, 5, 6]])
```

```
>>> y.flags['C_CONTIGUOUS']
True
```

cumprod

`Array.cumprod`(*axis=None*, *dtype=None*, *out=None*)

Return the cumulative product of the elements along the given axis.

Refer to *numpy.cumprod* for full documentation.

See Also

numpy.cumprod : equivalent function

cumsum

`Array.cumsum`(*axis=None*, *dtype=None*, *out=None*)

Return the cumulative sum of the elements along the given axis.

Refer to *numpy.cumsum* for full documentation.

See Also

numpy.cumsum : equivalent function

diagonal

`Array.diagonal`(*offset=0*, *axis1=0*, *axis2=1*)

Return specified diagonals. In NumPy 1.9 the returned array is a read-only view instead of a copy as in previous NumPy versions. In a future version the read-only restriction will be removed.

Refer to `numpy.diagonal()` for full documentation.

See Also

numpy.diagonal : equivalent function

dot

`Array.dot()`

dump

`Array.dump(file)`

Dump a pickle of the array to the specified file. The array can be read back with pickle.load or numpy.load.

Parameters

file
[str or Path] A string naming the dump file.

Changed in version 1.17.0: *pathlib.Path* objects are now accepted.

dumps

`Array.dumps()`

Returns the pickle of the array as a string. pickle.loads will convert the string back to an array.

Parameters

None

fill

`Array.fill(value)`

Fill the array with a scalar value.

Parameters

value
[scalar] All elements of *a* will be assigned this value.

Examples

```
>>> a = np.array([1, 2])
>>> a.fill(0)
>>> a
array([0, 0])
>>> a = np.empty(2)
>>> a.fill(1)
>>> a
array([1.,  1.])
```

Fill expects a scalar value and always behaves the same as assigning to a single array element. The following is a rare example where this distinction is important:

```
>>> a = np.array([None, None], dtype=object)
>>> a[0] = np.array(3)
>>> a
array([array(3), None], dtype=object)
>>> a.fill(np.array(3))
>>> a
array([array(3), array(3)], dtype=object)
```

Where other forms of assignments will unpack the array being assigned:

```
>>> a[...] = np.array(3)
>>> a
array([3, 3], dtype=object)
```

flatten

`Array.flatten`(*order='C'*)

Return a copy of the array collapsed into one dimension.

Parameters

order

[{'C', 'F', 'A', 'K'}, optional] 'C' means to flatten in row-major (C-style) order. 'F' means to flatten in column-major (Fortran- style) order. 'A' means to flatten in column-major order if *a* is Fortran *contiguous* in memory, row-major order otherwise. 'K' means to flatten *a* in the order the elements occur in memory. The default is 'C'.

Returns

y
[ndarray] A copy of the input array, flattened to one dimension.

See Also

ravel : Return a flattened array. flat : A 1-D flat iterator over the array.

Examples

```
>>> a = np.array([[1,2], [3,4]])
>>> a.flatten()
array([1, 2, 3, 4])
>>> a.flatten('F')
array([1, 3, 2, 4])
```

getfield

`Array.getfield`(*dtype*, *offset=0*)

Returns a field of the given array as a certain type.

A field is a view of the array data with a given data-type. The values in the view are determined by the given type and the offset into the current array in bytes. The offset needs to be such that the view dtype fits in the array dtype; for example an array of dtype complex128 has 16-byte elements. If taking a view with a 32-bit integer (4 bytes), the offset needs to be between 0 and 12 bytes.

Parameters

dtype
[str or dtype] The data type of the view. The dtype size of the view can not be larger than that of the array itself.

offset
[int] Number of bytes to skip before beginning the element view.

Examples

```
>>> x = np.diag([1.+1.j]*2)
>>> x[1, 1] = 2 + 4.j
>>> x
array([[1.+1.j,  0.+0.j],
       [0.+0.j,  2.+4.j]])
>>> x.getfield(np.float64)
array([[1.,  0.],
       [0.,  2.]])
```

By choosing an offset of 8 bytes we can select the complex part of the array for our view:

```
>>> x.getfield(np.float64, offset=8)
array([[1.,  0.],
       [0.,  4.]])
```

item

`Array.item(*args)`

Copy an element of an array to a standard Python scalar and return it.

Parameters

*args : Arguments (variable number and type)

- none: in this case, the method only works for arrays with one element (*a.size == 1*), which element is copied into a standard Python scalar object and returned.
- int_type: this argument is interpreted as a flat index into the array, specifying which element to copy and return.
- tuple of int_types: functions as does a single int_type argument, except that the argument is interpreted as an nd-index into the array.

Returns

z

[Standard Python scalar object] A copy of the specified element of the array as a suitable Python scalar

Notes

When the data type of *a* is longdouble or clongdouble, item() returns a scalar array object because there is no available Python scalar that would not lose information. Void arrays return a buffer object for item(), unless fields are defined, in which case a tuple is returned.

item is very similar to a[args], except, instead of an array scalar, a standard Python scalar is returned. This can be useful for speeding up access to elements of the array and doing arithmetic on elements of the array using Python's optimized math.

Examples

```
>>> np.random.seed(123)
>>> x = np.random.randint(9, size=(3, 3))
>>> x
array([[2, 2, 6],
       [1, 3, 6],
       [1, 0, 1]])
>>> x.item(3)
1
>>> x.item(7)
```

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```
0
>>> x.item((0, 1))
2
>>> x.item((2, 2))
1
```

itemset

Array.**itemset**(**args*)

Insert scalar into an array (scalar is cast to array's dtype, if possible)

There must be at least 1 argument, and define the last argument as *item*. Then, `a.itemset(*args)` is equivalent to but faster than `a[args] = item`. The item should be a scalar value and *args* must select a single item in the array *a*.

Parameters

***args**
[Arguments] If one argument: a scalar, only used in case *a* is of size 1. If two arguments: the last argument is the value to be set and must be a scalar, the first argument specifies a single array element location. It is either an int or a tuple.

Notes

Compared to indexing syntax, *itemset* provides some speed increase for placing a scalar into a particular location in an *ndarray*, if you must do this. However, generally this is discouraged: among other problems, it complicates the appearance of the code. Also, when using *itemset* (and *item*) inside a loop, be sure to assign the methods to a local variable to avoid the attribute look-up at each loop iteration.

Examples

```
>>> np.random.seed(123)
>>> x = np.random.randint(9, size=(3, 3))
>>> x
array([[2, 2, 6],
       [1, 3, 6],
       [1, 0, 1]])
>>> x.itemset(4, 0)
>>> x.itemset((2, 2), 9)
>>> x
array([[2, 2, 6],
       [1, 0, 6],
       [1, 0, 9]])
```

max

Array.**max**(*axis=None*, *out=None*, *keepdims=False*, *initial=<no value>*, *where=True*)

Return the maximum along a given axis.

Refer to *numpy.amax* for full documentation.

See Also

numpy.amax : equivalent function

mean

Array.**mean**(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, ***, *where=True*)

Returns the average of the array elements along given axis.

Refer to *numpy.mean* for full documentation.

See Also

numpy.mean : equivalent function

min

Array.**min**(*axis=None*, *out=None*, *keepdims=False*, *initial=<no value>*, *where=True*)

Return the minimum along a given axis.

Refer to *numpy.amin* for full documentation.

See Also

numpy.amin : equivalent function

newbyteorder

Array.**newbyteorder**(*new_order='S'*, */*)

Return the array with the same data viewed with a different byte order.

Equivalent to:

```
arr.view(arr.dtype.newbytorder(new_order))
```

Changes are also made in all fields and sub-arrays of the array data type.

Parameters

new_order
[string, optional] Byte order to force; a value from the byte order specifications below. *new_order* codes can be any of:

- ‘S’ - swap dtype from current to opposite endian
- {‘<’, ‘little’} - little endian
- {‘>’, ‘big’} - big endian
- {‘=’, ‘native’} - native order, equivalent to *sys.byteorder*
- {‘|’, ‘I’} - ignore (no change to byte order)

The default value (‘S’) results in swapping the current byte order.

Returns

new_arr
[array] New array object with the dtype reflecting given change to the byte order.

nonzero

`Array.nonzero()`

Return the indices of the elements that are non-zero.

Refer to *numpy.nonzero* for full documentation.

See Also

numpy.nonzero : equivalent function

partition

`Array.partition(kth, axis=-1, kind='introselect', order=None)`

Rearranges the elements in the array in such a way that the value of the element in kth position is in the position it would be in a sorted array. All elements smaller than the kth element are moved before this element and all equal or greater are moved behind it. The ordering of the elements in the two partitions is undefined.

New in version 1.8.0.

Parameters

kth
[int or sequence of ints] Element index to partition by. The kth element value will be in its final sorted position and all smaller elements will be moved before it and all equal or greater elements behind it. The order of all elements in the partitions is undefined. If provided with a sequence of kth it will partition all elements indexed by kth of them into their sorted position at once.

Deprecated since version 1.22.0: Passing booleans as index is deprecated.

axis
[int, optional] Axis along which to sort. Default is -1, which means sort along the last axis.

kind
[{'introselect'}, optional] Selection algorithm. Default is 'introselect'.

order
[str or list of str, optional] When *a* is an array with fields defined, this argument specifies which fields to compare first, second, etc. A single field can be specified as a string, and not all fields need to be specified, but unspecified fields will still be used, in the order in which they come up in the dtype, to break ties.

See Also

numpy.partition : Return a partitioned copy of an array. argpartition : Indirect partition. sort : Full sort.

Notes

See `np.partition` for notes on the different algorithms.

Examples

```
>>> a = np.array([3, 4, 2, 1])
>>> a.partition(3)
>>> a
array([2, 1, 3, 4])
```

```
>>> a.partition((1, 3))
>>> a
array([1, 2, 3, 4])
```

prod

`Array.prod`(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, *initial=1*, *where=True*)

Return the product of the array elements over the given axis

Refer to *numpy.prod* for full documentation.

See Also

numpy.prod : equivalent function

ptp

`Array.ptp(axis=None, out=None, keepdims=False)`

Peak to peak (maximum - minimum) value along a given axis.

Refer to *numpy.ptp* for full documentation.

See Also

numpy.ptp : equivalent function

put

`Array.put(indices, values, mode='raise')`

Set `a.flat[n] = values[n]` for all *n* in indices.

Refer to *numpy.put* for full documentation.

See Also

numpy.put : equivalent function

ravel

`Array.ravel([order])`

Return a flattened array.

Refer to *numpy.ravel* for full documentation.

See Also

numpy.ravel : equivalent function

ndarray.flat : a flat iterator on the array.

repeat

`Array.repeat(repeats, axis=None)`

Repeat elements of an array.

Refer to *numpy.repeat* for full documentation.

See Also

numpy.repeat : equivalent function

reshape

`Array.reshape(shape, order='C')`

Returns an array containing the same data with a new shape.

Refer to *numpy.reshape* for full documentation.

See Also

numpy.reshape : equivalent function

Notes

Unlike the free function *numpy.reshape*, this method on *ndarray* allows the elements of the shape parameter to be passed in as separate arguments. For example, `a.reshape(10, 11)` is equivalent to `a.reshape((10, 11))`.

resize

`Array.resize(new_shape, refcheck=True)`

Change shape and size of array in-place.

Parameters

new_shape
[tuple of ints, or *n* ints] Shape of resized array.

refcheck
[bool, optional] If False, reference count will not be checked. Default is True.

Returns

None

Raises

ValueError
: If *a* does not own its own data or references or views to it exist, and the data memory must be changed. PyPy only: will always raise if the data memory must be changed, since there is no reliable way to determine if references or views to it exist.

SystemError
: If the *order* keyword argument is specified. This behaviour is a bug in NumPy.

See Also

resize : Return a new array with the specified shape.

Notes

This reallocates space for the data area if necessary.

Only contiguous arrays (data elements consecutive in memory) can be resized.

The purpose of the reference count check is to make sure you do not use this array as a buffer for another Python object and then reallocate the memory. However, reference counts can increase in other ways so if you are sure that you have not shared the memory for this array with another Python object, then you may safely set *refcheck* to False.

Examples

Shrinking an array: array is flattened (in the order that the data are stored in memory), resized, and reshaped:

```
>>> a = np.array([[0, 1], [2, 3]], order='C')
>>> a.resize((2, 1))
>>> a
array([[0],
       [1]])
```

```
>>> a = np.array([[0, 1], [2, 3]], order='F')
>>> a.resize((2, 1))
>>> a
array([[0],
       [2]])
```

Enlarging an array: as above, but missing entries are filled with zeros:

```
>>> b = np.array([[0, 1], [2, 3]])
>>> b.resize(2, 3) # new_shape parameter doesn't have to be a tuple
>>> b
array([[0, 1, 2],
       [3, 0, 0]])
```

Referencing an array prevents resizing…

```
>>> c = a
>>> a.resize((1, 1))
Traceback (most recent call last):
...
ValueError: cannot resize an array that references or is referenced ...
```

Unless *refcheck* is False:

```
>>> a.resize((1, 1), refcheck=False)
>>> a
array([[0]])
>>> c
array([[0]])
```

round

`Array.round`(*decimals=0*, *out=None*)

Return *a* with each element rounded to the given number of decimals.

Refer to *numpy.around* for full documentation.

See Also

numpy.around : equivalent function

searchsorted

`Array.searchsorted`(*v*, *side='left'*, *sorter=None*)

Find indices where elements of v should be inserted in a to maintain order.

For full documentation, see *numpy.searchsorted*

See Also

numpy.searchsorted : equivalent function

setfield

`Array.setfield(val, dtype, offset=0)`

Put a value into a specified place in a field defined by a data-type.

Place *val* into *a*'s field defined by *dtype* and beginning *offset* bytes into the field.

Parameters

val
[object] Value to be placed in field.

dtype
[dtype object] Data-type of the field in which to place *val*.

offset
[int, optional] The number of bytes into the field at which to place *val*.

Returns

None

See Also

getfield

Examples

```
>>> x = np.eye(3)
>>> x.getfield(np.float64)
array([[1.,  0.,  0.],
       [0.,  1.,  0.],
       [0.,  0.,  1.]])
>>> x.setfield(3, np.int32)
>>> x.getfield(np.int32)
array([[3, 3, 3],
       [3, 3, 3],
       [3, 3, 3]], dtype=int32)
>>> x
array([[1.0e+000, 1.5e-323, 1.5e-323],
       [1.5e-323, 1.0e+000, 1.5e-323],
       [1.5e-323, 1.5e-323, 1.0e+000]])
>>> x.setfield(np.eye(3), np.int32)
>>> x
array([[1.,  0.,  0.],
       [0.,  1.,  0.],
       [0.,  0.,  1.]])
```

setflags

`Array.setflags(write=None, align=None, uic=None)`

Set array flags WRITEABLE, ALIGNED, WRITEBACKIFCOPY, respectively.

These Boolean-valued flags affect how numpy interprets the memory area used by *a* (see Notes below). The ALIGNED flag can only be set to True if the data is actually aligned according to the type. The WRITEBACKIFCOPY and flag can never be set to True. The flag WRITEABLE can only be set to True if the array owns its own memory, or the ultimate owner of the memory exposes a writeable buffer interface, or is a string. (The exception for string is made so that unpickling can be done without copying memory.)

Parameters

write

[bool, optional] Describes whether or not *a* can be written to.

align

[bool, optional] Describes whether or not *a* is aligned properly for its type.

uic

[bool, optional] Describes whether or not *a* is a copy of another "base" array.

Notes

Array flags provide information about how the memory area used for the array is to be interpreted. There are 7 Boolean flags in use, only four of which can be changed by the user: WRITEBACKIFCOPY, WRITEABLE, and ALIGNED.

WRITEABLE (W) the data area can be written to;

ALIGNED (A) the data and strides are aligned appropriately for the hardware (as determined by the compiler);

WRITEBACKIFCOPY (X) this array is a copy of some other array (referenced by .base). When the C-API function PyArray_ResolveWritebackIfCopy is called, the base array will be updated with the contents of this array.

All flags can be accessed using the single (upper case) letter as well as the full name.

Examples

```
>>> y = np.array([[3, 1, 7],
...               [2, 0, 0],
...               [8, 5, 9]])
>>> y
array([[3, 1, 7],
       [2, 0, 0],
       [8, 5, 9]])
>>> y.flags
  C_CONTIGUOUS : True
  F_CONTIGUOUS : False
  OWNDATA : True
  WRITEABLE : True
```

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```
  ALIGNED : True
  WRITEBACKIFCOPY : False
>>> y.setflags(write=0, align=0)
>>> y.flags
  C_CONTIGUOUS : True
  F_CONTIGUOUS : False
  OWNDATA : True
  WRITEABLE : False
  ALIGNED : False
  WRITEBACKIFCOPY : False
>>> y.setflags(uic=1)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: cannot set WRITEBACKIFCOPY flag to True
```

sort

`Array.sort`(*axis=-1*, *kind=None*, *order=None*)

Sort an array in-place. Refer to *numpy.sort* for full documentation.

Parameters

axis
[int, optional] Axis along which to sort. Default is -1, which means sort along the last axis.

kind
[{'quicksort', 'mergesort', 'heapsort', 'stable'}, optional] Sorting algorithm. The default is 'quicksort'. Note that both 'stable' and 'mergesort' use timsort under the covers and, in general, the actual implementation will vary with datatype. The 'mergesort' option is retained for backwards compatibility.

Changed in version 1.15.0: The 'stable' option was added.

order
[str or list of str, optional] When *a* is an array with fields defined, this argument specifies which fields to compare first, second, etc. A single field can be specified as a string, and not all fields need be specified, but unspecified fields will still be used, in the order in which they come up in the dtype, to break ties.

See Also

numpy.sort : Return a sorted copy of an array. numpy.argsort : Indirect sort. numpy.lexsort : Indirect stable sort on multiple keys. numpy.searchsorted : Find elements in sorted array. numpy.partition: Partial sort.

Notes

See *numpy.sort* for notes on the different sorting algorithms.

Examples

```
>>> a = np.array([[1,4], [3,1]])
>>> a.sort(axis=1)
>>> a
array([[1, 4],
       [1, 3]])
>>> a.sort(axis=0)
>>> a
array([[1, 3],
       [1, 4]])
```

Use the *order* keyword to specify a field to use when sorting a structured array:

```
>>> a = np.array([('a', 2), ('c', 1)], dtype=[('x', 'S1'), ('y', int)])
>>> a.sort(order='y')
>>> a
array([(b'c', 1), (b'a', 2)],
      dtype=[('x', 'S1'), ('y', '<i8')])
```

squeeze

`Array.squeeze`(*axis=None*)

Remove axes of length one from *a*.

Refer to *numpy.squeeze* for full documentation.

See Also

numpy.squeeze : equivalent function

std

`Array.std`(*axis=None*, *dtype=None*, *out=None*, *ddof=0*, *keepdims=False*, *, *where=True*)

Returns the standard deviation of the array elements along given axis.

Refer to *numpy.std* for full documentation.

See Also

numpy.std : equivalent function

sum

`Array.sum`(*axis=None*, *dtype=None*, *out=None*, *keepdims=False*, *initial=0*, *where=True*)

Return the sum of the array elements over the given axis.

Refer to *numpy.sum* for full documentation.

See Also

numpy.sum : equivalent function

swapaxes

`Array.swapaxes`(*axis1*, *axis2*)

Return a view of the array with *axis1* and *axis2* interchanged.

Refer to *numpy.swapaxes* for full documentation.

See Also

numpy.swapaxes : equivalent function

take

`Array.take`(*indices*, *axis=None*, *out=None*, *mode='raise'*)

Return an array formed from the elements of *a* at the given indices.

Refer to *numpy.take* for full documentation.

See Also

numpy.take : equivalent function

tobytes

`Array.tobytes`(*order='C'*)

Construct Python bytes containing the raw data bytes in the array.

Constructs Python bytes showing a copy of the raw contents of data memory. The bytes object is produced in C-order by default. This behavior is controlled by the `order` parameter.

New in version 1.9.0.

Parameters

order
[{'C', 'F', 'A'}, optional] Controls the memory layout of the bytes object. 'C' means C-order, 'F' means F-order, 'A' (short for *Any*) means 'F' if *a* is Fortran contiguous, 'C' otherwise. Default is 'C'.

Returns

s
[bytes] Python bytes exhibiting a copy of *a*'s raw data.

See also

frombuffer
Inverse of this operation, construct a 1-dimensional array from Python bytes.

Examples

```
>>> x = np.array([[0, 1], [2, 3]], dtype='<u2')
>>> x.tobytes()
b'\x00\x00\x01\x00\x02\x00\x03\x00'
>>> x.tobytes('C') == x.tobytes()
True
>>> x.tobytes('F')
b'\x00\x00\x02\x00\x01\x00\x03\x00'
```

tofile

`Array.tofile`(*fid*, *sep=''*, *format='%s'*)

Write array to a file as text or binary (default).

Data is always written in 'C' order, independent of the order of *a*. The data produced by this method can be recovered using the function fromfile().

Parameters

fid
[file or str or Path] An open file object, or a string containing a filename.

Changed in version 1.17.0: *pathlib.Path* objects are now accepted.

sep
[str] Separator between array items for text output. If "" (empty), a binary file is written, equivalent to `file.write(a.tobytes())`.

format
[str] Format string for text file output. Each entry in the array is formatted to text by first converting it to the closest Python type, and then using "format" % item.

Notes

This is a convenience function for quick storage of array data. Information on endianness and precision is lost, so this method is not a good choice for files intended to archive data or transport data between machines with different endianness. Some of these problems can be overcome by outputting the data as text files, at the expense of speed and file size.

When fid is a file object, array contents are directly written to the file, bypassing the file object's `write` method. As a result, tofile cannot be used with files objects supporting compression (e.g., GzipFile) or file-like objects that do not support `fileno()` (e.g., BytesIO).

tolist

`Array.tolist()`

Return the array as an `a.ndim`-levels deep nested list of Python scalars.

Return a copy of the array data as a (nested) Python list. Data items are converted to the nearest compatible builtin Python type, via the *~numpy.ndarray.item* function.

If `a.ndim` is 0, then since the depth of the nested list is 0, it will not be a list at all, but a simple Python scalar.

Parameters

none

Returns

y

[object, or list of object, or list of list of object, or …] The possibly nested list of array elements.

Notes

The array may be recreated via `a = np.array(a.tolist())`, although this may sometimes lose precision.

Examples

For a 1D array, `a.tolist()` is almost the same as `list(a)`, except that `tolist` changes numpy scalars to Python scalars:

```
>>> a = np.uint32([1, 2])
>>> a_list = list(a)
>>> a_list
[1, 2]
>>> type(a_list[0])
<class 'numpy.uint32'>
>>> a_tolist = a.tolist()
>>> a_tolist
```

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```
[1, 2]
>>> type(a_tolist[0])
<class 'int'>
```

Additionally, for a 2D array, `tolist` applies recursively:

```
>>> a = np.array([[1, 2], [3, 4]])
>>> list(a)
[array([1, 2]), array([3, 4])]
>>> a.tolist()
[[1, 2], [3, 4]]
```

The base case for this recursion is a 0D array:

```
>>> a = np.array(1)
>>> list(a)
Traceback (most recent call last):
  ...
TypeError: iteration over a 0-d array
>>> a.tolist()
1
```

tostring

`Array.tostring`(*order='C'*)

A compatibility alias for *tobytes*, with exactly the same behavior.

Despite its name, it returns *bytes* not *str*s.

Deprecated since version 1.19.0.

trace

`Array.trace`(*offset=0*, *axis1=0*, *axis2=1*, *dtype=None*, *out=None*)

Return the sum along diagonals of the array.

Refer to *numpy.trace* for full documentation.

See Also

numpy.trace : equivalent function

transpose

`Array.transpose(*axes)`

Returns a view of the array with axes transposed.

Refer to *numpy.transpose* for full documentation.

Parameters

axes : None, tuple of ints, or *n* ints

- None or no argument: reverses the order of the axes.
- tuple of ints: *i* in the *j*-th place in the tuple means that the array's *i*-th axis becomes the transposed array's *j*-th axis.
- *n* ints: same as an n-tuple of the same ints (this form is intended simply as a "convenience" alternative to the tuple form).

Returns

p

[ndarray] View of the array with its axes suitably permuted.

See Also

transpose : Equivalent function. ndarray.T : Array property returning the array transposed. ndarray.reshape : Give a new shape to an array without changing its data.

Examples

```
>>> a = np.array([[1, 2], [3, 4]])
>>> a
array([[1, 2],
       [3, 4]])
>>> a.transpose()
array([[1, 3],
       [2, 4]])
>>> a.transpose((1, 0))
array([[1, 3],
       [2, 4]])
>>> a.transpose(1, 0)
array([[1, 3],
       [2, 4]])
```

```
>>> a = np.array([1, 2, 3, 4])
>>> a
array([1, 2, 3, 4])
>>> a.transpose()
array([1, 2, 3, 4])
```

var

`Array.var(axis=None, dtype=None, out=None, ddof=0, keepdims=False, *, where=True)`

Returns the variance of the array elements, along given axis.

Refer to *numpy.var* for full documentation.

See Also

numpy.var : equivalent function

view

`Array.view([dtype][, type])`

New view of array with the same data.

Note: Passing None for `dtype` is different from omitting the parameter, since the former invokes `dtype(None)` which is an alias for `dtype('float_')`.

Parameters

dtype

[data-type or ndarray sub-class, optional] Data-type descriptor of the returned view, e.g., float32 or int16. Omitting it results in the view having the same data-type as *a*. This argument can also be specified as an ndarray sub-class, which then specifies the type of the returned object (this is equivalent to setting the `type` parameter).

type

[Python type, optional] Type of the returned view, e.g., ndarray or matrix. Again, omission of the parameter results in type preservation.

Notes

`a.view()` is used two different ways:

`a.view(some_dtype)` or `a.view(dtype=some_dtype)` constructs a view of the array's memory with a different data-type. This can cause a reinterpretation of the bytes of memory.

`a.view(ndarray_subclass)` or `a.view(type=ndarray_subclass)` just returns an instance of *ndarray_subclass* that looks at the same array (same shape, dtype, etc.) This does not cause a reinterpretation of the memory.

For `a.view(some_dtype)`, if `some_dtype` has a different number of bytes per entry than the previous dtype (for example, converting a regular array to a structured array), then the last axis of `a` must be contiguous. This axis will be resized in the result.

Changed in version 1.23.0: Only the last axis needs to be contiguous. Previously, the entire array had to be C-contiguous.

Examples

```
>>> x = np.array([(1, 2)], dtype=[('a', np.int8), ('b', np.int8)])
```

Viewing array data using a different type and dtype:

```
>>> y = x.view(dtype=np.int16, type=np.matrix)
>>> y
matrix([[513]], dtype=int16)
>>> print(type(y))
<class 'numpy.matrix'>
```

Creating a view on a structured array so it can be used in calculations

```
>>> x = np.array([(1, 2),(3,4)], dtype=[('a', np.int8), ('b', np.int8)])
>>> xv = x.view(dtype=np.int8).reshape(-1,2)
>>> xv
array([[1, 2],
       [3, 4]], dtype=int8)
>>> xv.mean(0)
array([2.,  3.])
```

Making changes to the view changes the underlying array

```
>>> xv[0,1] = 20
>>> x
array([(1, 20), (3,  4)], dtype=[('a', 'i1'), ('b', 'i1')])
```

Using a view to convert an array to a recarray:

```
>>> z = x.view(np.recarray)
>>> z.a
array([1, 3], dtype=int8)
```

Views share data:

```
>>> x[0] = (9, 10)
>>> z[0]
(9, 10)
```

Views that change the dtype size (bytes per entry) should normally be avoided on arrays defined by slices, transposes, fortran-ordering, etc.:

```
>>> x = np.array([[1, 2, 3], [4, 5, 6]], dtype=np.int16)
>>> y = x[:, ::2]
>>> y
array([[1, 3],
       [4, 6]], dtype=int16)
>>> y.view(dtype=[('width', np.int16), ('length', np.int16)])
Traceback (most recent call last):
    ...
ValueError: To change to a dtype of a different size, the last axis must be␣
↪contiguous
>>> z = y.copy()
```

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```
>>> z.view(dtype=[('width', np.int16), ('length', np.int16)])
array([[(1, 3)],
       [(4, 6)]], dtype=[('width', '<i2'), ('length', '<i2')])
```

However, views that change dtype are totally fine for arrays with a contiguous last axis, even if the rest of the axes are not C-contiguous:

```
>>> x = np.arange(2 * 3 * 4, dtype=np.int8).reshape(2, 3, 4)
>>> x.transpose(1, 0, 2).view(np.int16)
array([[[ 256,  770],
        [3340, 3854]],

       [[1284, 1798],
        [4368, 4882]],

       [[2312, 2826],
        [5396, 5910]]], dtype=int16)
```

__init__()

Attributes

`T`	View of the transposed array.
`base`	Base object if memory is from some other object.
`ctypes`	An object to simplify the interaction of the array with the ctypes module.
`data`	Python buffer object pointing to the start of the array's data.
`dtype`	Data-type of the array's elements.
`flags`	Information about the memory layout of the array.
`flat`	A 1-D iterator over the array.
`imag`	The imaginary part of the array.
`itemsize`	Length of one array element in bytes.
`nbytes`	Total bytes consumed by the elements of the array.
`ndim`	Number of array dimensions.
`real`	The real part of the array.
`shape`	Tuple of array dimensions.
`size`	Number of elements in the array.
`strides`	Tuple of bytes to step in each dimension when traversing an array.

T

`Array.T`

View of the transposed array.

Same as `self.transpose()`.

Examples

```
>>> a = np.array([[1, 2], [3, 4]])
>>> a
array([[1, 2],
       [3, 4]])
>>> a.T
array([[1, 3],
       [2, 4]])
```

```
>>> a = np.array([1, 2, 3, 4])
>>> a
array([1, 2, 3, 4])
>>> a.T
array([1, 2, 3, 4])
```

See Also

transpose

base

`Array.base`

Base object if memory is from some other object.

Examples

The base of an array that owns its memory is None:

```
>>> x = np.array([1,2,3,4])
>>> x.base is None
True
```

Slicing creates a view, whose memory is shared with x:

```
>>> y = x[2:]
>>> y.base is x
True
```

ctypes

`Array.ctypes`

An object to simplify the interaction of the array with the ctypes module.

This attribute creates an object that makes it easier to use arrays when calling shared libraries with the ctypes module. The returned object has, among others, data, shape, and strides attributes (see Notes below) which themselves return ctypes objects that can be used as arguments to a shared library.

Parameters

None

Returns

c

[Python object] Possessing attributes data, shape, strides, etc.

See Also

numpy.ctypeslib

Notes

Below are the public attributes of this object which were documented in "Guide to NumPy" (we have omitted undocumented public attributes, as well as documented private attributes):

`_ctypes.data`

A pointer to the memory area of the array as a Python integer. This memory area may contain data that is not aligned, or not in correct byte-order. The memory area may not even be writeable. The array flags and data-type of this array should be respected when passing this attribute to arbitrary C-code to avoid trouble that can include Python crashing. User Beware! The value of this attribute is exactly the same as `self._array_interface_['data'][0]`.

Note that unlike `data_as`, a reference will not be kept to the array: code like `ctypes.c_void_p((a + b).ctypes.data)` will result in a pointer to a deallocated array, and should be spelt `(a + b).ctypes.data_as(ctypes.c_void_p)`

`_ctypes.shape`

(c_intp*self.ndim): A ctypes array of length self.ndim where the basetype is the C-integer corresponding to `dtype('p')` on this platform (see *~numpy.ctypeslib.c_intp*). This base-type could be *ctypes.c_int*, *ctypes.c_long*, or *ctypes.c_longlong* depending on the platform. The ctypes array contains the shape of the underlying array.

`_ctypes.strides`

(c_intp*self.ndim): A ctypes array of length self.ndim where the basetype is the same as for the shape attribute. This ctypes array contains the strides information from the underlying array. This strides information is important for showing how many bytes must be jumped to get to the next element in the array.

_ctypes.**data_as**(*obj*)

Return the data pointer cast to a particular c-types object. For example, calling `self._as_parameter_` is equivalent to `self.data_as(ctypes.c_void_p)`. Perhaps you want to use the data as a pointer to a ctypes array of floating-point data: `self.data_as(ctypes.POINTER(ctypes.c_double))`.

The returned pointer will keep a reference to the array.

_ctypes.**shape_as**(*obj*)

Return the shape tuple as an array of some other c-types type. For example: `self.shape_as(ctypes.c_short)`.

_ctypes.**strides_as**(*obj*)

Return the strides tuple as an array of some other c-types type. For example: `self.strides_as(ctypes.c_longlong)`.

If the ctypes module is not available, then the ctypes attribute of array objects still returns something useful, but ctypes objects are not returned and errors may be raised instead. In particular, the object will still have the `as_parameter` attribute which will return an integer equal to the data attribute.

Examples

```
>>> import ctypes
>>> x = np.array([[0, 1], [2, 3]], dtype=np.int32)
>>> x
array([[0, 1],
       [2, 3]], dtype=int32)
>>> x.ctypes.data
31962608 # may vary
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint32))
<__main__.LP_c_uint object at 0x7ff2fc1fc200> # may vary
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint32)).contents
c_uint(0)
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_uint64)).contents
c_ulong(4294967296)
>>> x.ctypes.shape
<numpy.core._internal.c_long_Array_2 object at 0x7ff2fc1fce60> # may vary
>>> x.ctypes.strides
<numpy.core._internal.c_long_Array_2 object at 0x7ff2fc1ff320> # may vary
```

data

Array.**data**

Python buffer object pointing to the start of the array's data.

dtype

`Array.dtype`

Data-type of the array's elements.

> **Warning:** Setting `arr.dtype` is discouraged and may be deprecated in the future. Setting will replace the `dtype` without modifying the memory (see also *ndarray.view* and *ndarray.astype*).

Parameters

None

Returns

d : numpy dtype object

See Also

ndarray.astype : Cast the values contained in the array to a new data-type. ndarray.view : Create a view of the same data but a different data-type. numpy.dtype

Examples

```
>>> x
array([[0, 1],
       [2, 3]])
>>> x.dtype
dtype('int32')
>>> type(x.dtype)
<type 'numpy.dtype'>
```

flags

`Array.flags`

Information about the memory layout of the array.

Attributes

C_CONTIGUOUS (C)
The data is in a single, C-style contiguous segment.

F_CONTIGUOUS (F)
The data is in a single, Fortran-style contiguous segment.

OWNDATA (O)
The array owns the memory it uses or borrows it from another object.

WRITEABLE (W)
The data area can be written to. Setting this to False locks the data, making it read-only. A view (slice, etc.) inherits WRITEABLE from its base array at creation time, but a view of a writeable array may be subsequently locked while the base array remains writeable. (The opposite is not true, in that a view of a locked array may not be made writeable. However, currently, locking a base object does not lock any views that already reference it, so under that circumstance it is possible to alter the contents of a locked array via a previously created writeable view onto it.) Attempting to change a non-writeable array raises a RuntimeError exception.

ALIGNED (A)
The data and all elements are aligned appropriately for the hardware.

WRITEBACKIFCOPY (X)
This array is a copy of some other array. The C-API function PyArray_ResolveWritebackIfCopy must be called before deallocating to the base array will be updated with the contents of this array.

FNC
F_CONTIGUOUS and not C_CONTIGUOUS.

FORC
F_CONTIGUOUS or C_CONTIGUOUS (one-segment test).

BEHAVED (B)
ALIGNED and WRITEABLE.

CARRAY (CA)
BEHAVED and C_CONTIGUOUS.

FARRAY (FA)
BEHAVED and F_CONTIGUOUS and not C_CONTIGUOUS.

Notes

The *flags* object can be accessed dictionary-like (as in `a.flags['WRITEABLE']`), or by using lowercased attribute names (as in `a.flags.writeable`). Short flag names are only supported in dictionary access.

Only the WRITEBACKIFCOPY, WRITEABLE, and ALIGNED flags can be changed by the user, via direct assignment to the attribute or dictionary entry, or by calling *ndarray.setflags*.

The array flags cannot be set arbitrarily:

- WRITEBACKIFCOPY can only be set `False`.
- ALIGNED can only be set `True` if the data is truly aligned.
- WRITEABLE can only be set `True` if the array owns its own memory or the ultimate owner of the memory exposes a writeable buffer interface or is a string.

Arrays can be both C-style and Fortran-style contiguous simultaneously. This is clear for 1-dimensional arrays, but can also be true for higher dimensional arrays.

Even for contiguous arrays a stride for a given dimension `arr.strides[dim]` may be *arbitrary* if `arr.shape[dim] == 1` or the array has no elements. It does *not* generally hold that `self.strides[-1] == self.itemsize` for C-style contiguous arrays or `self.strides[0] == self.itemsize` for Fortran-style contiguous arrays is true.

flat

`Array.flat`

A 1-D iterator over the array.

This is a *numpy.flatiter* instance, which acts similarly to, but is not a subclass of, Python's built-in iterator object.

See Also

flatten : Return a copy of the array collapsed into one dimension.

flatiter

Examples

```
>>> x = np.arange(1, 7).reshape(2, 3)
>>> x
array([[1, 2, 3],
       [4, 5, 6]])
>>> x.flat[3]
4
>>> x.T
array([[1, 4],
       [2, 5],
       [3, 6]])
>>> x.T.flat[3]
5
>>> type(x.flat)
<class 'numpy.flatiter'>
```

An assignment example:

```
>>> x.flat = 3; x
array([[3, 3, 3],
       [3, 3, 3]])
>>> x.flat[[1,4]] = 1; x
array([[3, 1, 3],
       [3, 1, 3]])
```

imag

`Array.imag`

The imaginary part of the array.

Examples

```
>>> x = np.sqrt([1+0j, 0+1j])
>>> x.imag
array([ 0.        ,  0.70710678])
>>> x.imag.dtype
dtype('float64')
```

itemsize

`Array.itemsize`

Length of one array element in bytes.

Examples

```
>>> x = np.array([1,2,3], dtype=np.float64)
>>> x.itemsize
8
>>> x = np.array([1,2,3], dtype=np.complex128)
>>> x.itemsize
16
```

nbytes

`Array.nbytes`

Total bytes consumed by the elements of the array.

Notes

Does not include memory consumed by non-element attributes of the array object.

See Also

sys.getsizeof
Memory consumed by the object itself without parents in case view. This does include memory consumed by non-element attributes.

Examples

```
>>> x = np.zeros((3,5,2), dtype=np.complex128)
>>> x.nbytes
480
>>> np.prod(x.shape) * x.itemsize
480
```

ndim

`Array.ndim`

Number of array dimensions.

Examples

```
>>> x = np.array([1, 2, 3])
>>> x.ndim
1
>>> y = np.zeros((2, 3, 4))
>>> y.ndim
3
```

real

`Array.real`

The real part of the array.

Examples

```
>>> x = np.sqrt([1+0j, 0+1j])
>>> x.real
array([ 1.        ,  0.70710678])
>>> x.real.dtype
dtype('float64')
```

See Also

numpy.real : equivalent function

shape

`Array.shape`

Tuple of array dimensions.

The shape property is usually used to get the current shape of an array, but may also be used to reshape the array in-place by assigning a tuple of array dimensions to it. As with *numpy.reshape*, one of the new shape dimensions can be -1, in which case its value is inferred from the size of the array and the remaining dimensions. Reshaping an array in-place will fail if a copy is required.

> **Warning:** Setting `arr.shape` is discouraged and may be deprecated in the future. Using *ndarray.reshape* is the preferred approach.

Examples

```
>>> x = np.array([1, 2, 3, 4])
>>> x.shape
(4,)
>>> y = np.zeros((2, 3, 4))
>>> y.shape
(2, 3, 4)
>>> y.shape = (3, 8)
>>> y
array([[ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.],
       [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.],
       [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.]])
>>> y.shape = (3, 6)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: total size of new array must be unchanged
>>> np.zeros((4,2))[::2].shape = (-1,)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AttributeError: Incompatible shape for in-place modification. Use
`.reshape()` to make a copy with the desired shape.
```

See Also

numpy.shape : Equivalent getter function. numpy.reshape : Function similar to setting `shape`. ndarray.reshape : Method similar to setting `shape`.

size

`Array.size`

Number of elements in the array.

Equal to `np.prod(a.shape)`, i.e., the product of the array's dimensions.

Notes

a.size returns a standard arbitrary precision Python integer. This may not be the case with other methods of obtaining the same value (like the suggested `np.prod(a.shape)`, which returns an instance of `np.int_`), and may be relevant if the value is used further in calculations that may overflow a fixed size integer type.

Examples

```
>>> x = np.zeros((3, 5, 2), dtype=np.complex128)
>>> x.size
30
>>> np.prod(x.shape)
30
```

strides

`Array.strides`

Tuple of bytes to step in each dimension when traversing an array.

The byte offset of element `(i[0], i[1], ..., i[n])` in an array *a* is:

```
offset = sum(np.array(i) * a.strides)
```

A more detailed explanation of strides can be found in the "ndarray.rst" file in the NumPy reference guide.

> **Warning:** Setting `arr.strides` is discouraged and may be deprecated in the future. *numpy.lib.stride_tricks.as_strided* should be preferred to create a new view of the same data in a safer way.

Notes

Imagine an array of 32-bit integers (each 4 bytes):

```
x = np.array([[0, 1, 2, 3, 4],
              [5, 6, 7, 8, 9]], dtype=np.int32)
```

This array is stored in memory as 40 bytes, one after the other (known as a contiguous block of memory). The strides of an array tell us how many bytes we have to skip in memory to move to the next position along a certain axis. For example, we have to skip 4 bytes (1 value) to move to the next column, but 20 bytes (5 values) to get to the same position in the next row. As such, the strides for the array *x* will be `(20, 4)`.

See Also

numpy.lib.stride_tricks.as_strided

Examples

```
>>> y = np.reshape(np.arange(2*3*4), (2,3,4))
>>> y
array([[[ 0,  1,  2,  3],
        [ 4,  5,  6,  7],
        [ 8,  9, 10, 11]],
       [[12, 13, 14, 15],
        [16, 17, 18, 19],
        [20, 21, 22, 23]]])
>>> y.strides
(48, 16, 4)
>>> y[1,1,1]
17
>>> offset=sum(y.strides * np.array((1,1,1)))
>>> offset/y.itemsize
17
```

```
>>> x = np.reshape(np.arange(5*6*7*8), (5,6,7,8)).transpose(2,3,1,0)
>>> x.strides
(32, 4, 224, 1344)
>>> i = np.array([3,5,2,2])
>>> offset = sum(i * x.strides)
>>> x[3,5,2,2]
813
>>> offset / x.itemsize
813
```

reshape(*shape*, *order='C'*)

Returns an array containing the same data with a new shape.

Refer to *numpy.reshape* for full documentation.

See Also

numpy.reshape : equivalent function

Notes

Unlike the free function *numpy.reshape*, this method on *ndarray* allows the elements of the shape parameter to be passed in as separate arguments. For example, `a.reshape(10, 11)` is equivalent to `a.reshape((10, 11))`.

2.2.7.6 ranges

It provides Ranges class.

Classes

Ranges

Ranges

class Ranges(*ranges=()*, *values=None*)

Methods

__init__
format_range
get_range
intersect
push
pushes
set_value
simplify

__init__

Ranges.**__init__**(*ranges=()*, *values=None*)

format_range

static Ranges.**format_range**(**args*, ***kwargs*)

get_range

static Ranges.**get_range**(*ref*, *context*)

intersect

Ranges.**intersect**(*other*)

push

Ranges.**push**(*ref*, *value=empty*, *context=None*)

pushes

Ranges.**pushes**(*refs*, *values=()*, *context=None*)

set_value

Ranges.**set_value**(*rng*, *value=empty*)

simplify

Ranges.**simplify**()

__init__(*ranges=()*, *values=None*)

Attributes

ranges
values
is_set
value

ranges

Ranges.**ranges**

values

Ranges.**values**

is_set

property Ranges.**is_set**

value

property Ranges.**value**

2.2.7.7 cell

It provides Cell class.

Functions

format_output	
wrap_cell_func	

format_output

format_output(*rng*, *value*)

wrap_cell_func

wrap_cell_func(*func*, *parse_args=<function <lambda>>*, *parse_kwargs=<function <lambda>>*)

Classes

Cell
CellWrapper
RangesAssembler
Ref

Cell

class Cell(*reference*, *value*, *context=None*, *check_formula=True*, *replace_missing_ref=True*)

Methods

__init__
add
compile
update_inputs

__init__

Cell.**__init__**(*reference*, *value*, *context=None*, *check_formula=True*, *replace_missing_ref=True*)

add

Cell.**add**(*dsp*, *context=None*)

compile

Cell.**compile**(*references=None*, *context=None*)

update_inputs

`Cell.`**`update_inputs`**(*references=None*)

`__init__`(*reference*, *value*, *context=None*, *check_formula=True*, *replace_missing_ref=True*)

Attributes

parser

parser

`Cell.`**`parser = <formulas.parser.Parser object>`**

CellWrapper

`class CellWrapper`(*func*, *parse_args*, *parse_kwargs*)

Methods

`__init__`	
check_cycles	

__init__

`CellWrapper.`**`__init__`**(*func*, *parse_args*, *parse_kwargs*)

check_cycles

`CellWrapper.`**`check_cycles`**(*cycle*)

`__init__`(*func*, *parse_args*, *parse_kwargs*)

RangesAssembler

`class RangesAssembler`(*ref*, *context=None*, *compact=1*)

Methods

__init__
add
push

__init__

`RangesAssembler.__init__`(*ref*, *context=None*, *compact=1*)

add

`RangesAssembler.add`(*dsp*)

push

`RangesAssembler.push`(*indices*, *output=None*)

`__init__`(*ref*, *context=None*, *compact=1*)

Attributes

output

output

`property RangesAssembler.output`

Ref

class **Ref**(*reference*, *value*, *context=None*, *check_formula=True*)

Methods

__init__
add
compile
update_inputs

__init__

Ref.**__init__**(*reference*, *value*, *context=None*, *check_formula=True*)

add

Ref.**add**(*dsp*, *context=None*)

compile

Ref.**compile**(*references=None*, *context=None*)

update_inputs

Ref.**update_inputs**(*references=None*)

__init__(*reference*, *value*, *context=None*, *check_formula=True*)

Attributes

parser

parser

```
Ref.parser = <formulas.parser.Parser object>
```

2.2.7.8 excel

It provides Excel model class.

Sub-Modules:

cycle	A dependency-free version of networkx's implementation of *simple_cycles*.
xlreader	It provides a custom Excel Reader class.

cycle

A dependency-free version of networkx's implementation of *simple_cycles*.

Functions

simple_cycles

simple_cycles

simple_cycles(*graph*, *copy=True*)

xlreader

It provides a custom Excel Reader class.

Functions

load_workbook

load_workbook

load_workbook(*filename*, ***kw*)

Classes

XlReader

XlReader

class **XlReader**(**args*, *raw_date=True*, ***kwargs*)

Methods

__init__
read
read_chartsheet
read_custom
read_manifest
read_properties
read_strings
read_theme
read_workbook
read_worksheets

__init__

XlReader.**__init__**(**args*, *raw_date=True*, ***kwargs*)

read

XlReader.**read**()

read_chartsheet

XlReader.**read_chartsheet**(*sheet*, *rel*)

read_custom

XlReader.**read_custom**()

read_manifest

XlReader.**read_manifest**()

read_properties

XlReader.**read_properties**()

read_strings

XlReader.**read_strings**()

read_theme

XlReader.**read_theme**()

read_workbook

XlReader.**read_workbook**()

read_worksheets

XlReader.**read_worksheets**()

__init__(**args*, *raw_date=True*, ***kwargs*)

Classes

ExcelModel
XlCircular

ExcelModel

class ExcelModel

Methods

__init__
add_book
add_cell
add_references
add_sheet
assemble
calculate
compare
compile
compile_cell
complete
external_links
finish
formula_ranges
formula_references
from_dict
from_ranges
inverse_references
load
loads
push
pushes
solve_circular
to_dict
write

__init__

ExcelModel.**__init__**()

add_book

ExcelModel.**add_book**(*book=None*, *context=None*, *data_only=False*)

add_cell

ExcelModel.**add_cell**(*cell*, *context*, *formula_ranges*)

add_references

ExcelModel.**add_references**(*book*, *context=None*)

add_sheet

ExcelModel.**add_sheet**(*worksheet*, *context*)

assemble

ExcelModel.**assemble**(*compact=1*)

calculate

ExcelModel.**calculate**(**args*, ***kwargs*)

compare

ExcelModel.**compare**(**fpaths*, *solution=None*, *tolerance=1e-06*, ***kwargs*)

compile

ExcelModel.**compile**(*inputs*, *outputs*)

compile_cell

ExcelModel.**compile_cell**(*cell*, *context*, *references*, *formula_references*)

complete

ExcelModel.**complete**(*stack=None*)

external_links

ExcelModel.**external_links**(*ctx*)

finish

ExcelModel.**finish**(*complete=True*, *circular=False*, *assemble=True*)

formula_ranges

ExcelModel.**formula_ranges**(*ctx*)

formula_references

ExcelModel.**formula_references**(*ctx*)

from_dict

ExcelModel.**from_dict**(*adict*, *context=None*, *assemble=True*, *ref=True*)

from_ranges

ExcelModel.**from_ranges**(**ranges*)

inverse_references

ExcelModel.**inverse_references**()

load

ExcelModel.**load**(*filename*)

loads

ExcelModel.**loads**(**file_names*)

push

ExcelModel.**push**(*worksheet*, *context*)

pushes

ExcelModel.**pushes**(**worksheets*, *context=None*)

solve_circular

ExcelModel.**solve_circular**()

to_dict

ExcelModel.**to_dict**()

write

ExcelModel.**write**(*books=None*, *solution=None*, *dirpath=None*)

__init__()

Attributes

references

references

property ExcelModel.**references**

compile_class

alias of DispatchPipe

XlCircular

class XlCircular(**args*)

Methods

__init__	
capitalize	Return a capitalized version of the string.
casefold	Return a version of the string suitable for caseless comparisons.
center	Return a centered string of length width.
count	Return the number of non-overlapping occurrences of substring sub in string S[start:end].
encode	Encode the string using the codec registered for encoding.
endswith	Return True if S ends with the specified suffix, False otherwise.
expandtabs	Return a copy where all tab characters are expanded using spaces.
find	Return the lowest index in S where substring sub is found, such that sub is contained within S[start:end].
format	Return a formatted version of S, using substitutions from args and kwargs.
format_map	Return a formatted version of S, using substitutions from mapping.
index	Return the lowest index in S where substring sub is found, such that sub is contained within S[start:end].
isalnum	Return True if the string is an alpha-numeric string, False otherwise.
isalpha	Return True if the string is an alphabetic string, False otherwise.
isascii	Return True if all characters in the string are ASCII, False otherwise.
isdecimal	Return True if the string is a decimal string, False otherwise.
isdigit	Return True if the string is a digit string, False otherwise.
isidentifier	Return True if the string is a valid Python identifier, False otherwise.
islower	Return True if the string is a lowercase string, False otherwise.

continues on next page

Table 7 – continued from previous page

`isnumeric`	Return True if the string is a numeric string, False otherwise.
`isprintable`	Return True if the string is printable, False otherwise.
`isspace`	Return True if the string is a whitespace string, False otherwise.
`istitle`	Return True if the string is a title-cased string, False otherwise.
`isupper`	Return True if the string is an uppercase string, False otherwise.
`join`	Concatenate any number of strings.
`ljust`	Return a left-justified string of length width.
`lower`	Return a copy of the string converted to lowercase.
`lstrip`	Return a copy of the string with leading whitespace removed.
`maketrans`	Return a translation table usable for str.translate().
`partition`	Partition the string into three parts using the given separator.
`removeprefix`	Return a str with the given prefix string removed if present.
`removesuffix`	Return a str with the given suffix string removed if present.
`replace`	Return a copy with all occurrences of substring old replaced by new.
`rfind`	Return the highest index in S where substring sub is found, such that sub is contained within S[start:end].
`rindex`	Return the highest index in S where substring sub is found, such that sub is contained within S[start:end].
`rjust`	Return a right-justified string of length width.
`rpartition`	Partition the string into three parts using the given separator.
`rsplit`	Return a list of the substrings in the string, using sep as the separator string.
`rstrip`	Return a copy of the string with trailing whitespace removed.
`split`	Return a list of the substrings in the string, using sep as the separator string.
`splitlines`	Return a list of the lines in the string, breaking at line boundaries.
`startswith`	Return True if S starts with the specified prefix, False otherwise.
`strip`	Return a copy of the string with leading and trailing whitespace removed.
`swapcase`	Convert uppercase characters to lowercase and lowercase characters to uppercase.
`title`	Return a version of the string where each word is titlecased.
`translate`	Replace each character in the string using the given translation table.
`upper`	Return a copy of the string converted to uppercase.
`zfill`	Pad a numeric string with zeros on the left, to fill a field of the given width.

__init__

XlCircular.**__init__**(**args*)

capitalize

XlCircular.**capitalize**()

Return a capitalized version of the string.

More specifically, make the first character have upper case and the rest lower case.

casefold

XlCircular.**casefold**()

Return a version of the string suitable for caseless comparisons.

center

XlCircular.**center**(*width*, *fillchar=' '*, */*)

Return a centered string of length width.

Padding is done using the specified fill character (default is a space).

count

XlCircular.**count**(*sub*[, *start*[, *end*]]) → int

Return the number of non-overlapping occurrences of substring sub in string S[start:end]. Optional arguments start and end are interpreted as in slice notation.

encode

XlCircular.**encode**(*encoding='utf-8'*, *errors='strict'*)

Encode the string using the codec registered for encoding.

encoding
The encoding in which to encode the string.

errors
The error handling scheme to use for encoding errors. The default is 'strict' meaning that encoding errors raise a UnicodeEncodeError. Other possible values are 'ignore', 'replace' and 'xmlcharrefreplace' as well as any other name registered with codecs.register_error that can handle UnicodeEncodeErrors.

endswith

XlCircular.**endswith**(*suffix*[, *start*[, *end*]]) → bool

Return True if S ends with the specified suffix, False otherwise. With optional start, test S beginning at that position. With optional end, stop comparing S at that position. suffix can also be a tuple of strings to try.

expandtabs

XlCircular.**expandtabs**(*tabsize=8*)

Return a copy where all tab characters are expanded using spaces.

If tabsize is not given, a tab size of 8 characters is assumed.

find

XlCircular.**find**(*sub*[, *start*[, *end*]]) → int

Return the lowest index in S where substring sub is found, such that sub is contained within S[start:end]. Optional arguments start and end are interpreted as in slice notation.

Return -1 on failure.

format

XlCircular.**format**(**args*, ***kwargs*) → str

Return a formatted version of S, using substitutions from args and kwargs. The substitutions are identified by braces ('{' and '}').

format_map

XlCircular.**format_map**(*mapping*) → str

Return a formatted version of S, using substitutions from mapping. The substitutions are identified by braces ('{' and '}').

index

XlCircular.**index**(*sub*[, *start*[, *end*]]) → int

Return the lowest index in S where substring sub is found, such that sub is contained within S[start:end]. Optional arguments start and end are interpreted as in slice notation.

Raises ValueError when the substring is not found.

isalnum

`XlCircular.isalnum()`

Return True if the string is an alpha-numeric string, False otherwise.

A string is alpha-numeric if all characters in the string are alpha-numeric and there is at least one character in the string.

isalpha

`XlCircular.isalpha()`

Return True if the string is an alphabetic string, False otherwise.

A string is alphabetic if all characters in the string are alphabetic and there is at least one character in the string.

isascii

`XlCircular.isascii()`

Return True if all characters in the string are ASCII, False otherwise.

ASCII characters have code points in the range U+0000-U+007F. Empty string is ASCII too.

isdecimal

`XlCircular.isdecimal()`

Return True if the string is a decimal string, False otherwise.

A string is a decimal string if all characters in the string are decimal and there is at least one character in the string.

isdigit

`XlCircular.isdigit()`

Return True if the string is a digit string, False otherwise.

A string is a digit string if all characters in the string are digits and there is at least one character in the string.

isidentifier

`XlCircular.isidentifier()`

Return True if the string is a valid Python identifier, False otherwise.

Call keyword.iskeyword(s) to test whether string s is a reserved identifier, such as “def” or “class”.

islower

`XlCircular.islower()`

Return True if the string is a lowercase string, False otherwise.

A string is lowercase if all cased characters in the string are lowercase and there is at least one cased character in the string.

isnumeric

`XlCircular.isnumeric()`

Return True if the string is a numeric string, False otherwise.

A string is numeric if all characters in the string are numeric and there is at least one character in the string.

isprintable

`XlCircular.isprintable()`

Return True if the string is printable, False otherwise.

A string is printable if all of its characters are considered printable in repr() or if it is empty.

isspace

`XlCircular.isspace()`

Return True if the string is a whitespace string, False otherwise.

A string is whitespace if all characters in the string are whitespace and there is at least one character in the string.

istitle

`XlCircular.istitle()`

Return True if the string is a title-cased string, False otherwise.

In a title-cased string, upper- and title-case characters may only follow uncased characters and lowercase characters only cased ones.

isupper

`XlCircular.isupper()`

Return True if the string is an uppercase string, False otherwise.

A string is uppercase if all cased characters in the string are uppercase and there is at least one cased character in the string.

join

`XlCircular.join(iterable, /)`

Concatenate any number of strings.

The string whose method is called is inserted in between each given string. The result is returned as a new string.

Example: '.'.join(['ab', 'pq', 'rs']) -> 'ab.pq.rs'

ljust

`XlCircular.ljust(width, fillchar=' ', /)`

Return a left-justified string of length width.

Padding is done using the specified fill character (default is a space).

lower

`XlCircular.lower()`

Return a copy of the string converted to lowercase.

lstrip

`XlCircular.lstrip(chars=None, /)`

Return a copy of the string with leading whitespace removed.

If chars is given and not None, remove characters in chars instead.

maketrans

`static XlCircular.maketrans()`

Return a translation table usable for str.translate().

If there is only one argument, it must be a dictionary mapping Unicode ordinals (integers) or characters to Unicode ordinals, strings or None. Character keys will be then converted to ordinals. If there are two arguments, they must be strings of equal length, and in the resulting dictionary, each character in x will be mapped to the character at the same position in y. If there is a third argument, it must be a string, whose characters will be mapped to None in the result.

partition

`XlCircular.partition(sep, /)`

Partition the string into three parts using the given separator.

This will search for the separator in the string. If the separator is found, returns a 3-tuple containing the part before the separator, the separator itself, and the part after it.

If the separator is not found, returns a 3-tuple containing the original string and two empty strings.

removeprefix

`XlCircular.removeprefix(prefix, /)`

Return a str with the given prefix string removed if present.

If the string starts with the prefix string, return string[len(prefix):]. Otherwise, return a copy of the original string.

removesuffix

`XlCircular.removesuffix(suffix, /)`

Return a str with the given suffix string removed if present.

If the string ends with the suffix string and that suffix is not empty, return string[:-len(suffix)]. Otherwise, return a copy of the original string.

replace

`XlCircular.replace(old, new, count=-1, /)`

Return a copy with all occurrences of substring old replaced by new.

count
Maximum number of occurrences to replace. -1 (the default value) means replace all occurrences.

If the optional argument count is given, only the first count occurrences are replaced.

rfind

`XlCircular.rfind(sub[, start[, end]]) → int`

Return the highest index in S where substring sub is found, such that sub is contained within S[start:end]. Optional arguments start and end are interpreted as in slice notation.

Return -1 on failure.

rindex

`XlCircular.rindex(sub[, start[, end]]) → int`

Return the highest index in S where substring sub is found, such that sub is contained within S[start:end]. Optional arguments start and end are interpreted as in slice notation.

Raises ValueError when the substring is not found.

rjust

`XlCircular.rjust(width, fillchar=' ', /)`

Return a right-justified string of length width.

Padding is done using the specified fill character (default is a space).

rpartition

`XlCircular.rpartition(sep, /)`

Partition the string into three parts using the given separator.

This will search for the separator in the string, starting at the end. If the separator is found, returns a 3-tuple containing the part before the separator, the separator itself, and the part after it.

If the separator is not found, returns a 3-tuple containing two empty strings and the original string.

rsplit

`XlCircular.rsplit(sep=None, maxsplit=-1)`

Return a list of the substrings in the string, using sep as the separator string.

sep
The separator used to split the string.

When set to None (the default value), will split on any whitespace character (including n r t f and spaces) and will discard empty strings from the result.

maxsplit
Maximum number of splits (starting from the left). -1 (the default value) means no limit.

Splitting starts at the end of the string and works to the front.

rstrip

`XlCircular.rstrip(chars=None, /)`

Return a copy of the string with trailing whitespace removed.

If chars is given and not None, remove characters in chars instead.

split

`XlCircular.split(sep=None, maxsplit=-1)`

Return a list of the substrings in the string, using sep as the separator string.

sep
The separator used to split the string.

When set to None (the default value), will split on any whitespace character (including n r t f and spaces) and will discard empty strings from the result.

maxsplit
Maximum number of splits (starting from the left). -1 (the default value) means no limit.

Note, str.split() is mainly useful for data that has been intentionally delimited. With natural text that includes punctuation, consider using the regular expression module.

splitlines

`XlCircular.splitlines(keepends=False)`

Return a list of the lines in the string, breaking at line boundaries.

Line breaks are not included in the resulting list unless keepends is given and true.

startswith

`XlCircular.startswith(prefix[, start[, end]]) → bool`

Return True if S starts with the specified prefix, False otherwise. With optional start, test S beginning at that position. With optional end, stop comparing S at that position. prefix can also be a tuple of strings to try.

strip

`XlCircular.strip(chars=None, /)`

Return a copy of the string with leading and trailing whitespace removed.

If chars is given and not None, remove characters in chars instead.

swapcase

`XlCircular.swapcase()`

Convert uppercase characters to lowercase and lowercase characters to uppercase.

title

`XlCircular.title()`

Return a version of the string where each word is titlecased.

More specifically, words start with uppercased characters and all remaining cased characters have lower case.

translate

`XlCircular.translate(table, /)`

Replace each character in the string using the given translation table.

table
Translation table, which must be a mapping of Unicode ordinals to Unicode ordinals, strings, or None.

The table must implement lookup/indexing via __getitem__, for instance a dictionary or list. If this operation raises LookupError, the character is left untouched. Characters mapped to None are deleted.

upper

`XlCircular.upper()`

Return a copy of the string converted to uppercase.

zfill

`XlCircular.zfill(width, /)`

Pad a numeric string with zeros on the left, to fill a field of the given width.

The string is never truncated.

`__init__(*args)`

2.2.8 Changelog

2.2.8.1 v1.2.6 (2023-11-15)

Feat

- (builder) #104: Allow custom reference definition.
- (test): Update test cases.
- (operand) #106: Accept number like *.3* to be parsed.
- (text) #113: Add *TEXT* function without fraction formatting.
- (logic): Update logic functions according to new excel logic.
- (text) #113: Add *VALUE* function.
- (math) #121: Improve performances of *SUMPRODUCT*, *PRODUCT*, *SUM*, and *SUMIF*.
- (setup): Update requirements.
- (core): Change development status.
- (core): Add support for python 3.10 and 3.11.
- (functions) #121: Improve handling of EMPTY values.
- (excel): Avoid using *flatten* function in basic routines.
- (doc): Add Read the Docs configuration file.
- (excel): Add tolerance when comparing two excels.
- (excel): Add compare method to verify if formulas is able to replicate excel values.

Fix

- (doc): Remove broken badge.
- (excel) #100: Correct reading rounding from excel.
- (math) #100: Correct *TRUNC* defaults.
- (tokens) #113: Correct *sheet_id* definition.
- (functions): Correct dill pickling error.
- (excel): Correct reference parsing when loading from JSON.
- (functions): Use an alternative method of vectorize when more than 32 arguments are provided.
- (look): Correct *MATCH*, *LOOKUP*,`HLOOKUP`, and *VLOOKUP* behaviour when empty values are given.
- (date): Correct *DATEDIF* behaviour when unit is lowercase.
- (test): Use regex for unstable tests due to changes in last digits.
- (doc): Correct documentation bug due to new *sphinx*.
- (excel) #114: Update reading code according to *openpyxl>=3.1*.

2.2.8.2 v1.2.6 (2022-12-13)

Fix

- (setup): Update *schedula* requirement.

2.2.8.3 v1.2.5 (2022-11-07)

Fix

- (parser): Correct missing raise.
- (excel): Skip hidden named ranges.

2.2.8.4 v1.2.4 (2022-07-02)

Feat

- (core): Improve speed performance.
- (cell): Improve speed *RangesAssembler* definition.

Fix

- (cell): Correct range assembler defaults when no *sheet_id* is defined.
- (math) #99: Convert args into np.arrays in func *xsumproduct*.
- (look): Correct lookup parser for float and strings.

2.2.8.5 v1.2.3 (2022-05-10)

Feat

- (test): Add more error logs.
- (test): Improve code coverage.
- (builder): Add *compile_class* attribute to *AstBuilder*.
- (info): Add *ISODD*, *ISEVEN*, *ISBLANK*, *ISTEXT*, *ISNONTEXT*, and *ISLOGICAL* functions.

Fix

- (excel): Correct file path excel definition.
- (logic): Correct *SWITCH* error handling.
- (actions): Rename workflow name.
- (readme): Correct badge link for dependencies status.
- (excel): Correct *basedir* reference to load files.
- (date): Correct *YEARFRAC* and *DATEDIF* formulation.
- (cell): Enable R1C1 notation for absolute and relative references.
- (cell): Correct RangeAssembler value assignment.

2.2.8.6 v1.2.2 (2022-01-22)

Fix

- (excel): Correct function compilation from excel.

2.2.8.7 v1.2.1 (2022-01-21)

Feat

- (functions): Improve performances caching results.
- (excel): Make replacing missing ref optional in *from_dict* method.
- (excel) #73, #75: Improve performances to parse full ranges.

Fix

- (excel): Correct compile function when inputs are computed with a default function.

2.2.8.8 v1.2.0 (2021-12-23)

Feat

- (binder): Refresh environment binder for 2021.
- (look) #87: Add *ADDRESS* function.
- (test): Update test cases.
- (financial) #74, #87: Add *FV*, *PV*, *IPMT*, *PMT*, *PPMT*, *RATE*, *CUMIPMT*, and *NPER* functions.
- (info, logic): Add *ISNA* and *IFNA* functions.
- (date) #87: Add *WEEKDAY*, *WEEKNUM*, *ISOWEEKNUM*, and *DATEDIF* functions.
- (stat, math) #87: Add *SLOPE* and *PRODUCT* functions.
- (stats) #87: Add *CORREL* and *MEDIAN* functions.
- (bin): Add *bin* folder.
- (actions): Add test cases.
- (stats) #80: Add *FORECAST* and *FORECAST.LINEAR* functions.
- (excel) #82: Add inverse of simple references.

Fix

- (stat): Correct *LARGE* and *SMALL* error handling.
- (actions): Skip *Setup Graphviz* when not needed.
- (actions): Correct coverall setting.
- (actions): Remove unstable test case.
- (actions): Disable fail fast.
- (date, stat): Correct collapsed return value.
- (function) #78, #79, #91: Correct import error.

2.2.8.9 v1.1.1 (2021-10-13)

Feat

- (excel): Improve performances of *complete* method.
- (setup): Add add python 3.9 in setup.py.
- (functions): Add *SEARCH*, *ISNUMBER*, and *EDATE* functions.
- (travis): Update python version for coveralls.

Fix

- (doc): Correct missing documentation link.
- (doc): Correct typo.
- (operator) #70: Correct % operator preceded by space.

2.2.8.10 v1.1.0 (2021-02-16)

Feat

- (look) #57: Add *SINGLE* function.
- (function) #51: Add google Excel functions.
- (logic) #55, #57: Add IFS function.
- (excel) #65: Add documentation and rename method to load models from ranges.
- (excel) #65: Add method to load sub-models from range.
- (doc): Update Copyright.
- (excel): Improve performances.
- (excel) #64: Read model from outputs.
- (core): Update range definition with path file.
- (excel) #64: Add warning for missing reference.
- (excel) #64: Add warning message when book loading fails.
- (readme) #44: Add example to export and import the model to JSON format.
- (readme) #53: Add instructions to install the development version.
- (excel) #44: Add feature to export and import the model to JSON- able dict.
- (stat, comp) #43: Add *STDEV*, *STDEV.S*, *STDEV.P*, *STDEVA*, *STDEVPA*, *VAR*, *VAR.S*, *VAR.P*, *VARA*, and *VARPA* functions.

Fix

- (financial): Correct requirements for *irr* function.
- (excel) #48: Correct reference pointing to different workbooks.
- (function) #67: Correct compilation of impure functions (e.g., *rand*, *now*, etc.).
- (look) #66: Correct *check* function did not return value.
- (test): Remove *temp* dir.
- (excel): Correct external link reading.
- (operator) #63: Correct operator parser when starts with spaces.
- (text) #61: Convert float as int when stringify if it is an integer.
- (math) #59: Convert string to number in math operations.
- (functions): Correct *_xfilter* operating range type.

- (parser) #61: Skip *n* in formula expression.
- (operator) #58: Correct operator parser for composed operators.
- (excel): Correct invalid range definition and missing sheet or files.
- (operand) #52: Correct range parser.
- (operand) #50: Correct sheet name parser with space.
- (tokens): Correct closure parenthesis parser.
- (excel): Skip function compilation for string cells.
- (tokens): Correct error parsing when sheet name is defined.

2.2.8.11 v1.0.0 (2020-03-12)

Feat

- (core): Add *CODE_OF_CONDUCT.md*.
- (function) #39: Transform *NotImplementedError* into *#NAME?*.
- (text) #39: Add *CONCAT* and *CONCATENATE* functions.
- (logic) #38: Add TRUE/FALSE functions.
- (excel) #42: Save missing nodes.
- (excel) #42: Update logic for *RangesAssembler*.
- (excel): Improve performance of *finish* method.
- (core): Update build script.
- (core): Add support for python 3.8 and drop python 3.5 and drop *appveyor*.
- (core): Improve memory performance.
- (refact): Update copyright.
- (operand): Add *fast_range2parts_v4* for named ranges.

Fix

- (math) #37: Match excel default rounding algorithm of round half up.
- (cell): Correct reference in *push* method.
- (readme): Correct doctest.
- (token): Correct separator parser.
- (excel) #35: Update logic to parse named ranges.
- (operand): Associate *excel_id==0* to current excel.
- (array): Ensure correct deepcopy of *Array* attributes.
- (operand) #39: Correct range parser for named ranges.
- (operand) #41: Correct named ranges parser.

2.2.8.12 v0.4.0 (2019-08-31)

Feat

- (doc): Add binder.
- (setup): Add env *ENABLE_SETUP_LONG_DESCRIPTION*.
- (core): Add useful constants.
- (excel): Add option to write all calculate books inside a folder.
- (stat) #21: Add *COUNTBLANK*, *LARGE*, *SMALL* functions.
- (date) #35: Add *NPV*, *XNPV*, *IRR*, *XIRR* functions.
- (stat) #21: Add *AVERAGEIF*, *COUNT*, *COUNTA*, *COUNTIF* functions.
- (math) #21: Add *SUMIF* function.
- (date) #21, #35, #36: Add *date* functions *DATE*, *DATEVALUE*, *DAY*, *MONTH*, *YEAR*, *TODAY*, *TIME*, *TIMEVALUE*, *SECOND*, *MINUTE*, *HOUR*, *NOW*, *YEARFRAC*.
- (info) #21: Add *NA* function.
- (date) #21, #35, #36: Add *date* functions *DATE*, *DATEVALUE*, *DAY*, *MONTH*, *YEAR*, *TODAY*, *TIME*, *TIMEVALUE*, *SECOND*, *MINUTE*, *HOUR*, *NOW*, *YEARFRAC*.
- (stat) #35: Add *MINA*, *AVERAGEA*, *MAXA* functions.

Fix

- (setup): Update tests requirements.
- (setup): Correct setup dependency (*beautifulsoup4*).
- (stat): Correct round indices.
- (setup) #34: Build universal wheels.
- (test): Correct import error.
- (date) #35: Correct behaviour of *LOOKUP* function when dealing with errors.
- (excel) #35: Improve cycle detection.
- (excel,date) #21, #35: Add custom Excel Reader to parse raw datetime.
- (excel) #35: Correct when definedName is relative *#REF!*.

2.2.8.13 v0.3.0 (2019-04-24)

Feat

- (logic) #27: Add *OR*, *XOR*, *AND*, *NOT* functions.
- (look) #27: Add *INDEX* function.
- (look) #24: Improve performances of *look* functions.
- (functions) #26: Add *SWITCH*.
- (functions) #30: Add *GCD* and *LCM*.

- (chore): Improve performances avoiding *combine_dicts*.
- (chore): Improve performances checking intersection.

Fix

- (tokens): Correct string nodes ids format adding ".
- (ranges): Correct behaviour union of ranges.
- (import): Enable PyCharm autocomplete.
- (import): Save imports.
- (test): Add repo path to system path.
- (parser): Parse empty args for functions.
- (functions) #30: Correct implementation of *GCD* and *LCM*.
- (ranges) #24: Enable full column and row reference.
- (excel): Correct bugs due to new *openpyxl*.

2.2.8.14 v0.2.0 (2018-12-11)

Feat

- (doc) #23: Enhance *ExcelModel* documentation.

Fix

- (core): Add python 3.7 and drop python 3.4.
- (excel): Make *ExcelModel* dillable and pickable.
- (builder): Avoid FormulaError exception during formulas compilation.
- (excel): Correct bug when compiling excel with circular references.

2.2.8.15 v0.1.4 (2018-10-19)

Fix

- (tokens) #20: Improve Number regex.

2.2.8.16 v0.1.3 (2018-10-09)

Feat

- (excel) #16: Solve circular references.
- (setup): Add donate url.

Fix

- (functions) #18: Enable *check_error* in *IF* function just for the first argument.
- (functions) #18: Disable *input_parser* in *IF* function to return any type of values.
- (rtd): Define *fpath* from *prj_dir* for rtd.
- (rtd): Add missing requirements *openpyxl* for rtd.
- (setup): Patch to use *sphinxcontrib.restbuilder* in setup *long_description*.

Other

- Update documentation.
- Replace *excel* with *Excel*.
- Create PULL_REQUEST_TEMPLATE.md.
- Update issue templates.
- Update copyright.
- (doc): Update author mail.

2.2.8.17 v0.1.2 (2018-09-12)

Feat

- (functions) #14: Add *ROW* and *COLUMN*.
- (cell): Pass cell reference when compiling cell + new function struct with dict to add inputs like CELL.

Fix

- (ranges): Replace system max size with excel max row and col.
- (tokens): Correct number regex.

2.2.8.18 v0.1.1 (2018-09-11)

Feat

- (contrib): Add contribution instructions.
- (setup): Add additional project_urls.
- (setup): Update *Development Status* to *4 - Beta*.

Fix

- (init) #15: Replace *FUNCTIONS* and *OPERATORS* objs with *get_functions*, *SUBMODULES*.
- (doc): Correct link docs_status.

2.2.8.19 v0.1.0 (2018-07-20)

Feat

- (readme) #6, #7: Add examples.
- (doc): Add changelog.
- (test): Add info of executed test of *test_excel_model*.
- (functions) #11: Add *HEX2OCT*, *HEX2BIN*, *HEX2DEC*, *OCT2HEX*, *OCT2BIN*, *OCT2DEC*, *BIN2HEX*, *BIN2OCT*, *BIN2DEC*, *DEC2HEX*, *DEC2OCT*, and *DEC2BIN* functions.
- (setup) #13: Add extras_require to setup file.

Fix

- (excel): Use DispatchPipe to compile a sub model of excel workbook.
- (range) #11: Correct range regex to avoid parsing of function like ranges (e.g., HEX2DEC).

2.2.8.20 v0.0.10 (2018-06-05)

Feat

- (look): Simplify *_get_type_id* function.

Fix

- (functions): Correct ImportError for FUNCTIONS.
- (operations): Correct behaviour of the basic operations.

2.2.8.21 v0.0.9 (2018-05-28)

Feat

- (excel): Improve performances pre-calculating the range format.
- (core): Improve performances using *DispatchPipe* instead *SubDispatchPipe* when compiling formulas.
- (function): Improve performances setting *errstate* outside vectorization.
- (core): Improve performances of range2parts function (overall 50% faster).

Fix

- (ranges): Minimize conversion str to int and vice versa.
- (functions) #10: Avoid returning shapeless array.

2.2.8.22 v0.0.8 (2018-05-23)

Feat

- (functions): Add *MATCH*, *LOOKUP*, *HLOOKUP*, *VLOOKUP* functions.
- (excel): Add method to compile *ExcelModel*.
- (travis): Run coveralls in python 3.6.
- (functions): Add *FIND*,`LEFT`,`LEN`,`LOWER`,`MID`,`REPLACE`,`RIGHT`,`TRIM`, and`UPPER` functions.
- (functions): Add *IRR* function.
- (formulas): Custom reshape to Array class.
- (functions): Add *ISO.CEILING*, *SQRTPI*, *TRUNC* functions.
- (functions): Add *ROUND*, *ROUNDDOWN*, *ROUNDUP*, *SEC*, *SECH*, *SIGN* functions.
- (functions): Add *DECIMAL*, *EVEN*, *MROUND*, *ODD*, *RAND*, *RANDBETWEEN* functions.
- (functions): Add *FACT* and *FACTDOUBLE* functions.
- (functions): Add *ARABIC* and *ROMAN* functions.
- (functions): Parametrize function *wrap_ufunc*.
- (functions): Split function *raise_errors* adding *get_error* function.
- (ranges): Add custom default and error value for defining ranges Arrays.
- (functions): Add *LOG10* function + fix *LOG*.
- (functions): Add *CSC* and *CSCH* functions.
- (functions): Add *COT* and *COTH* functions.
- (functions): Add *FLOOR*, *FLOOR.MATH*, and *FLOOR.PRECISE* functions.
- (test): Improve log message of test cell.

Fix

- (rtd): Update installation file for read the docs.
- (functions): Remove unused functions.
- (formulas): Avoid too broad exception.
- (functions.math): Drop scipy dependency for calculate factorial2.
- (functions.logic): Correct error behaviour of *if* and *iferror* functions + add BroadcastError.
- (functions.info): Correct behaviour of *iserr* function.
- (functions): Correct error behaviour of average function.
- (functions): Correct *iserror* and *iserr* returning a custom Array.
- (functions): Now *xceiling* function returns np.nan instead Error.errors['#NUM!'].
- (functions): Correct *is_number* function, now returns False when number is a bool.
- (test): Ensure same order of workbook comparisons.
- (functions): Correct behaviour of *min max* and *int* function.
- (ranges): Ensure to have a value with correct shape.
- (parser): Change order of parsing to avoid TRUE and FALSE parsed as ranges or errors as strings.
- (function):Remove unused kwargs n_out.
- (parser): Parse error string as formulas.
- (readme): Remove *downloads_count* because it is no longer available.

Other

- Refact: Update Copyright + minor pep.
- Excel returns 1-indexed string positions???
- Added common string functions.
- Merge pull request #9 from ecatkins/irr.
- Implemented IRR function using numpy.

2.2.8.23 v0.0.7 (2017-07-20)

Feat

- (appveyor): Add python 3.6.
- (functions) #4: Add *sumproduct* function.

Fix

- (install): Force update setuptools>=36.0.1.
- (functions): Correct *iserror iserr* functions.
- (ranges): Replace '#N/A' with '' as empty value when assemble values.
- (functions) #4: Remove check in ufunc when inputs have different size.
- (functions) #4: Correct *power*, *arctan2*, and *mod* error results.
- (functions) #4: Simplify ufunc code.
- (test) #4: Check that all results are in the output.
- (functions) #4: Correct *atan2* argument order.
- (range) #5: Avoid parsing function name as range when it is followed by *(*.
- (operator) #3: Replace *strip* with *replace*.
- (operator) #3: Correct valid operators like ^- or *+.

Other

- Made the ufunc wrapper work with multi input functions, e.g., power, mod, and atan2.
- Created a workbook comparison method in TestExcelModel.
- Added MIN and MAX to the test.xlsx.
- Cleaned up the ufunc wrapper and added min and max to the functions list.
- Relaxed equality in TestExcelModel and made some small fixes to functions.py.
- Added a wrapper for numpy ufuncs, mapped some Excel functions to ufuncs and provided tests.

2.2.8.24 v0.0.6 (2017-05-31)

Fix

- (plot): Update schedula to 0.1.12.
- (range): Sheet name without commas has this [^Wd][w.] format.

2.2.8.25 v0.0.5 (2017-05-04)

Fix

- (doc): Update schedula to 0.1.11.

2.2.8.26 v0.0.4 (2017-02-10)

Fix

- (regex): Remove deprecation warnings.

2.2.8.27 v0.0.3 (2017-02-09)

Fix

- (appveyor): Setup of lxml.
- (excel): Remove deprecation warning openpyxl.
- (requirements): Update schedula requirement 0.1.9.

2.2.8.28 v0.0.2 (2017-02-08)

Fix

- (setup): setup fails due to long description.
- (excel): Remove deprecation warning *remove_sheet* –> *remove*.

CHAPTER

THREE

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PYTHON MODULE INDEX

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