
formulas Documentation

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<https://github.com/vincilit2000/formulas>

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

<http://formulas.readthedocs.io/>

<https://github.com/vincilit2000/formulas/wiki/>

<http://github.com/vincilit2000/formulas/releases/>

<https://donorbox.org/formulas>

excel, formulas, interpreter, compiler, dispatch

- Vincenzo Arcidiacono <vincilit2000@gmail.com>

EUPL 1.1+

CHAPTER 1

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 2

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]
```

2.1.1 What is formulas?

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

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```

2.1.3 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.

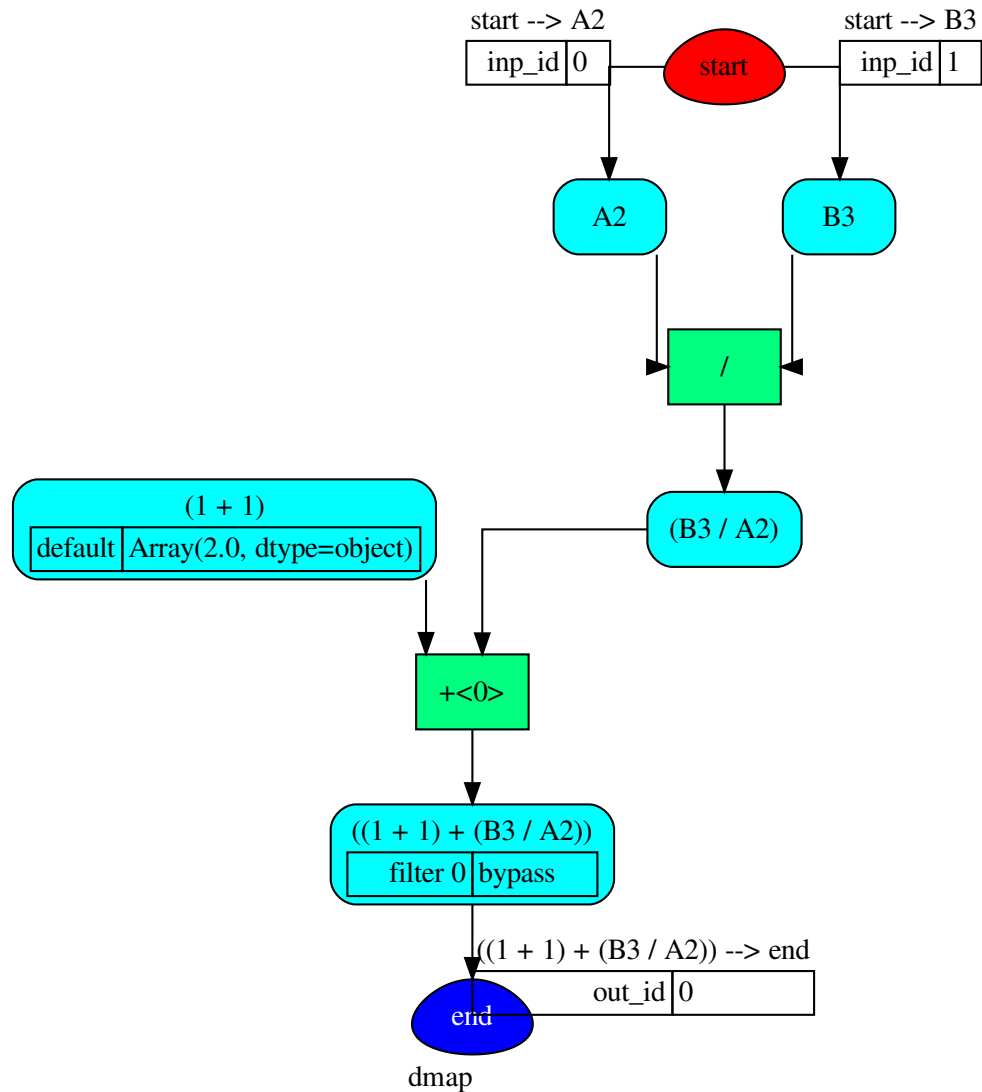
2.1.3.1 Parsing formula

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:

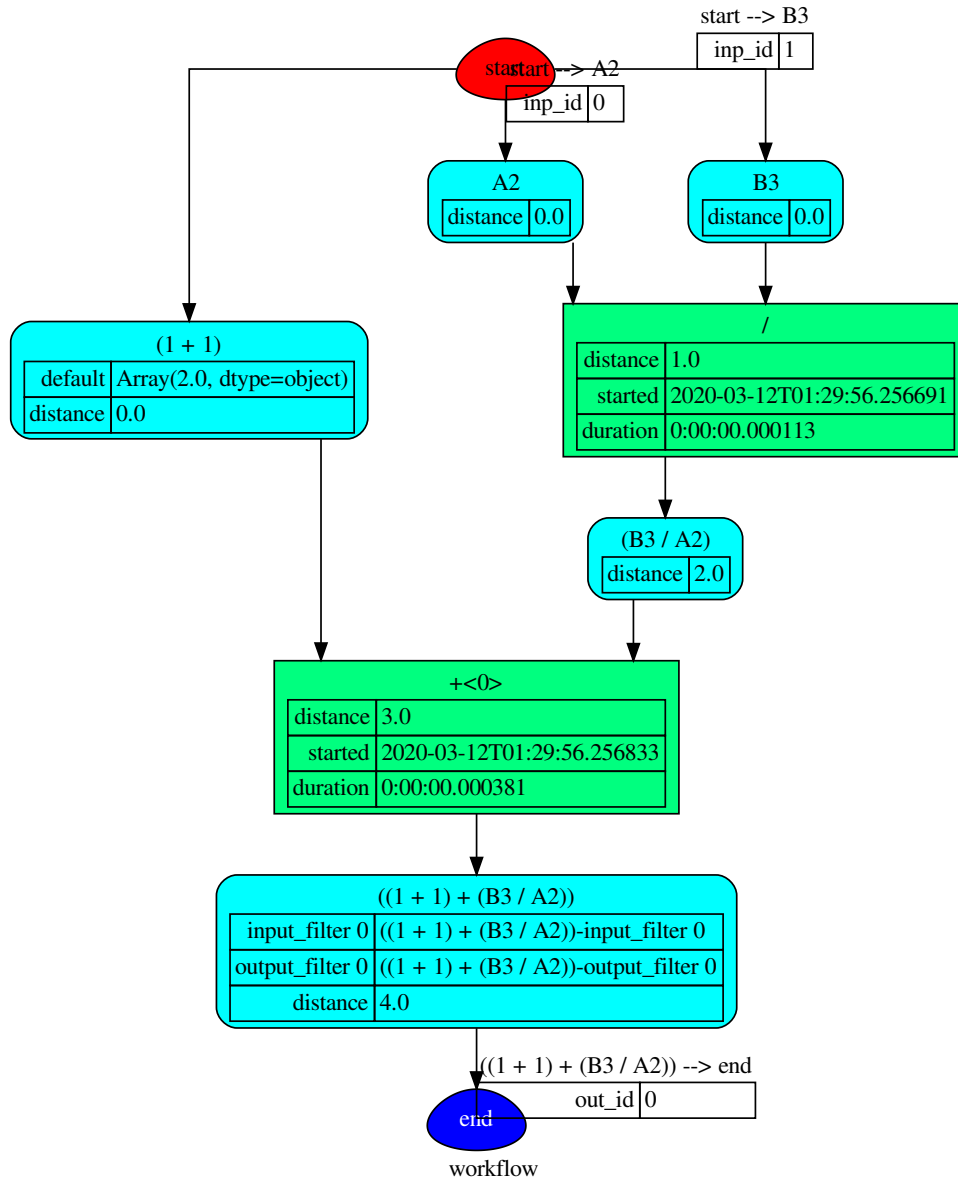
```
>>> list(func.inputs)
['A2', 'B3']
>>> func.plot(view=False) # Set view=True to plot in the default browser.
SiteMap([(=(1 + 1) + (B3 / A2)), SiteMap()]])
```



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()]])
  
```



2.1.3.2 Excel workbook

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

```

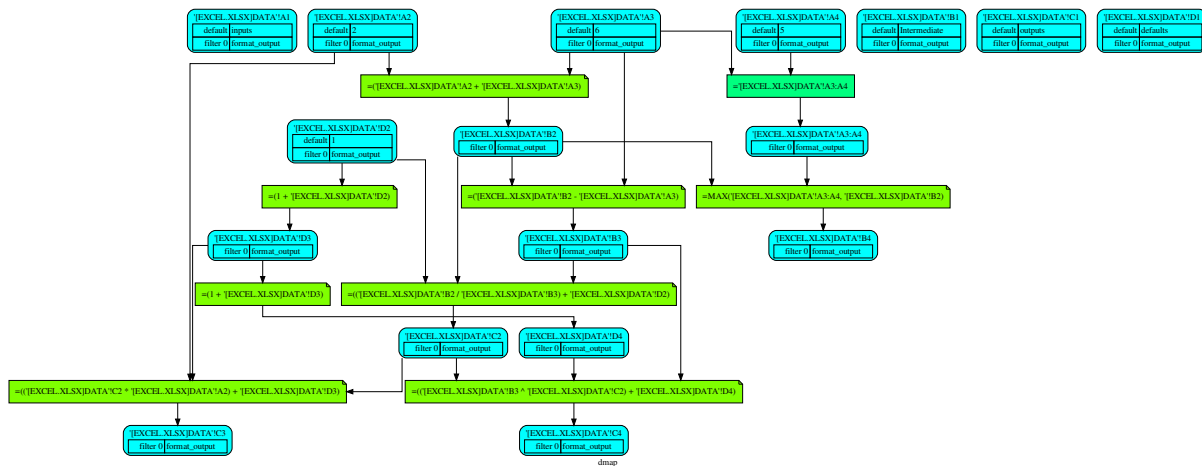
>>> import formulas
>>> fpath, dir_output = 'excel.xlsx', 'output'
>>> xl_model = formulas.ExcelModel().loads(fpath).finish()
>>> xl_model.calculate()
Solution(...)
>>> xl_model.write(dirpath=dir_output)
{'EXCEL.XLSX': {Book: <openpyxl.workbook.workbook.Workbook ...>}}

```

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]DATA'!A2": 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]DATA'!A2", <Ranges>(' [EXCEL.XLSX]DATA'!A2)=[ [3] ]),
          ("'[EXCEL.XLSX]DATA'!A3", <Ranges>(' [EXCEL.XLSX]DATA'!A3)=[ [6] ]),
          ("'[EXCEL.XLSX]DATA'!B3", <Ranges>(' [EXCEL.XLSX]DATA'!B3)=[ [1] ]),
          ("'[EXCEL.XLSX]DATA'!D2", <Ranges>(' [EXCEL.XLSX]DATA'!D2)=[ [1] ]),
          ("'[EXCEL.XLSX]DATA'!B2", <Ranges>(' [EXCEL.XLSX]DATA'!B2)=[ [9.0] ]),
          ("'[EXCEL.XLSX]DATA'!D3", <Ranges>(' [EXCEL.XLSX]DATA'!D3)=[ [2.0] ]),
          ("'[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] ]))])
```

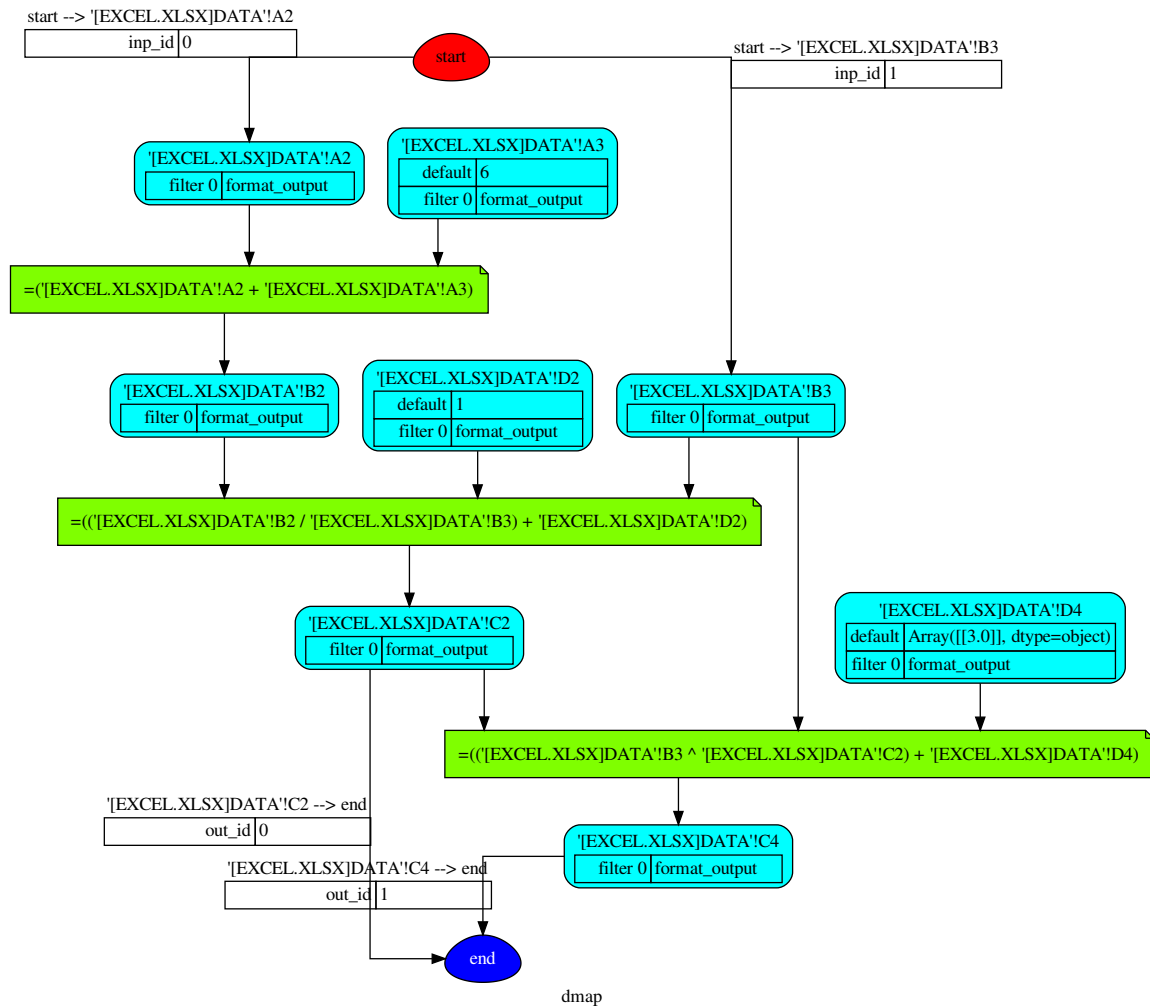
To build a single function out of an excel model with fixed inputs and outputs, you can use the `compile` method of the `ExcelModel` that returns a `DispatchPipe`. This is a function where the inputs and outputs are defined by the data node ids (i.e., cell references).

```
>>> func = xl_model.compile(
...     inputs=[
...         "'[EXCEL.XLSX]DATA'!A2", # First argument of the function.
...         "'[EXCEL.XLSX]DATA'!B3" # Second argument of the function.
...     ], # To define function inputs.
```

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```
...     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(...))])
```



2.1.3.3 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
```

2.1.4 Next moves

Things yet to do: implement the missing Excel formulas.

2.1.5 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

2.1.5.1 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`.

2.1.5.2 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.

2.1.5.3 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).

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

2.1.7 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:

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

2.1.7.1 parser

It provides formula parser class.

Classes

Parser

Parser

class Parser

Methods

ast
is_formula

ast

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

is_formula

`Parser.is_formula (value)`

`__init__()`

Initialize self. See help(type(self)) for accurate signature.

Attributes

filters
formula_check

filters

```
Parser.filters = [<class 'formulas.tokens.operand.Error'>, <class 'formulas.tokens.operand.Error'>]
```

formula_check

```
Parser.formula_check = regex.Regex('\n (?P<array>^\s*{\\s*=\\s*(?P<name>\\S.*)\\s*}\\s*
```

2.1.7.2 builder

It provides AstBuilder class.

Classes

AstBuilder

AstBuilder

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

Methods

<code>__init__</code>	Initialize self.
<code>append</code>	
<code>compile</code>	
<code>finish</code>	
<code>get_node_id</code>	
<code>pop</code>	

__init__

`AstBuilder.__init__` (*dsp=None, nodes=None, match=None*)
Initialize self. See help(type(self)) for accurate signature.

append

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

compile

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

finish

```
AstBuilder.finish()
```

get_node_id

```
AstBuilder.get_node_id(token)
```

pop

```
AstBuilder.pop()
```

```
__init__(dsp=None, nodes=None, match=None)
Initialize self. See help(type(self)) for accurate signature.
```

2.1.7.3 errors

Defines the formulas exception.

Exceptions

BaseError
BroadcastError
FormulaError
FoundError
FunctionError
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)
```

ParenthesesError

exception `ParenthesesError` (*args)

RangeValueError

exception `RangeValueError` (*args)

TokenError

exception `TokenError` (*args)

2.1.7.4 tokens

It provides tokens needed to parse the Excel formulas.

Sub-Modules:

<i>function</i>	It provides Function classes.
<i>operand</i>	It provides Operand classes.
<i>operator</i>	It provides Operator classes.
<i>parenthesis</i>	It provides Parenthesis class.

function

It provides Function classes.

Classes

<i>Array</i>
<i>Function</i>

Array

class `Array` (s, context=None)

Methods

<code>__init__</code>	Initialize self.
<code>ast</code>	
<code>compile</code>	
<code>match</code>	
<code>process</code>	
<code>set_expr</code>	
<code>update_input_tokens</code>	

`__init__`

`Array.__init__ (s, context=None)`
 Initialize self. See help(type(self)) for accurate signature.

`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)`
 Initialize self. See help(type(self)) for accurate signature.

Attributes

`name`

`node_id`

`name`

`Array.name`

`node_id`

`Array.node_id`

Function

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

Methods

<code>__init__</code>	Initialize self.
<code>ast</code>	
<code>compile</code>	
<code>match</code>	
<code>process</code>	
<code>set_expr</code>	
<code>update_input_tokens</code>	

`__init__`

Function.**__init__** (*s*, *context=None*)
 Initialize self. See help(type(self)) for accurate signature.

`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*)
 Initialize self. See help(type(self)) for accurate signature.

Attributes

`name`

`node_id`

`name`

`Function.name`

`node_id`

`Function.node_id`

operand

It provides Operand classes.

Functions

`fast_range2parts`

`fast_range2parts_v1`

`fast_range2parts_v2`

`fast_range2parts_v3`

`fast_range2parts_v4`

`range2parts`

`fast_range2parts`

`fast_range2parts (**kw)`

`fast_range2parts_v1`

`fast_range2parts_v1 (r1, c1, excel, sheet="")`

`fast_range2parts_v2`

`fast_range2parts_v2 (r1, c1, r2, c2, excel, sheet="")`

`fast_range2parts_v3`

`fast_range2parts_v3 (r1, n1, r2, n2, excel, sheet="")`

fast_range2parts_v4

fast_range2parts_v4 (*ref, excel, sheet=""*)

range2parts

range2parts (*outputs, **inputs*)

Classes

<i>Empty</i>
<i>Error</i>
<i>Number</i>
<i>Operand</i>
<i>Range</i>
<i>String</i>
<i>XLError</i>

Empty

class Empty

Methods

<code>__init__</code>	Initialize self.
<code>ast</code>	
<code>compile</code>	
<code>match</code>	
<code>process</code>	
<code>set_expr</code>	
<code>update_input_tokens</code>	

`__init__`

`Empty.__init__()`
 Initialize self. See `help(type(self))` for accurate signature.

`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__()`

Initialize self. See help(type(self)) for accurate signature.

Attributes

`name`

`node_id`

name`Empty.name`**node_id**`Empty.node_id`**Error**`class Error(s, context=None)`**Methods**

`__init__` Initialize self.

`ast`

`compile`

`match`

`process`

`set_expr`

`update_input_tokens`

`__init__`

`Error.__init__(s, context=None)`
 Initialize self. See help(type(self)) for accurate signature.

`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)`
 Initialize self. See help(type(self)) for accurate signature.

Attributes

`errors`

`name`

`node_id`

`errors`

`Error.errors = {'#DIV/0!': '#DIV/0!', '#N/A': '#N/A', '#NAME?': '#NAME?', '#NULL!': '#NULL!',`

`name`

`Error.name`

node_id

`Error.node_id`

Number

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

Methods

<code>__init__</code>	Initialize self.
<code>ast</code>	
<code>compile</code>	
<code>match</code>	
<code>process</code>	
<code>set_expr</code>	
<code>update_input_tokens</code>	

`__init__`

`Number.__init__` (*s*, *context=None*)
Initialize self. See help(type(self)) for accurate signature.

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)`

Initialize self. See help(type(self)) for accurate signature.

Attributes

`name`

`node_id`

name

`Number.name`

node_id

`Number.node_id`

Operand

class `Operand (s, context=None)`

Methods

`__init__` Initialize self.

`ast`

`match`

`process`

`set_expr`

`update_input_tokens`

__init__

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

Initialize self. See help(type(self)) for accurate signature.

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*)

Initialize self. See help(type(self)) for accurate signature.

Attributes

name

node_id

name

Operand.**name**

node_id

Operand.**node_id**

Range

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

Methods

__init__ Initialize self.

ast

compile

match

process

set_expr

update_input_tokens

__init__

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

Initialize self. See help(type(self)) for accurate signature.

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*)

Initialize self. See help(type(self)) for accurate signature.

Attributes

name

node_id

name

Range.**name**

node_id

Range.**node_id**

String

class String (*s, context=None*)

Methods

<code>__init__</code>	Initialize self.
<code>ast</code>	
<code>compile</code>	
<code>match</code>	
<code>process</code>	
<code>set_expr</code>	
<code>update_input_tokens</code>	

`__init__`

`String.__init__(s, context=None)`
Initialize self. See `help(type(self))` for accurate signature.

`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)`
Initialize self. See `help(type(self))` for accurate signature.

Attributes

`name`

`node_id`

name`String.name`**node_id**`String.node_id`**XLError****class** **XLError** (*args)**Methods**

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

Continued on next page

Table 28 – continued from previous page

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

`__init__`

`XLError.__init__ (*args)`
 Initialize self. See `help(type(self))` for accurate signature.

`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 ()`
 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 ()`
 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()`

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.

Use `keyword.iskeyword()` to test for reserved identifiers such as “def” and “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()`

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()`

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()`

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()`

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.

replace

`XLError.replace()`

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()`

Return a right-justified string of length width.

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

rpartition

`XLError.rpartition()`

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()`

Return a list of the words in the string, using sep as the delimiter string.

sep The delimiter according which to split the string. None (the default value) means split according to any whitespace, and discard empty strings from the result.

maxsplit Maximum number of splits to do. -1 (the default value) means no limit.

Splits are done starting at the end of the string and working to the front.

rstrip

`XLError.rstrip()`

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()`

Return a list of the words in the string, using sep as the delimiter string.

sep The delimiter according which to split the string. None (the default value) means split according to any whitespace, and discard empty strings from the result.

maxsplit Maximum number of splits to do. -1 (the default value) means no limit.

splitlines

`XLError.splitlines()`

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()`

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

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()`

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()`

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

The string is never truncated.

`__init__ (*args)`
Initialize self. See help(type(self)) for accurate signature.

operator

It provides Operator classes.

Classes

<code>Intersect</code>
<code>Operator</code>
<code>OperatorToken</code>
<code>Separator</code>

Intersect

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

Methods

<code>__init__</code>	Initialize self.
<code>ast</code>	
<code>compile</code>	
<code>match</code>	
<code>process</code>	
<code>set_expr</code>	
<code>update_input_tokens</code>	
<code>update_name</code>	

`__init__`

`Intersect.__init__ (s, context=None)`
Initialize self. See help(type(self)) for accurate signature.

`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)`

Initialize self. See help(type(self)) for accurate signature.

Attributes

<code>get_n_args</code>
<code>name</code>
<code>node_id</code>
<code>pred</code>

get_n_args

`Intersect.get_n_args`

name

`Intersect.name`

node_id

`Intersect.node_id`

pred

`Intersect.pred`

Operator

`class Operator (s, context=None)`

Methods

<code>__init__</code>	Initialize self.
<code>ast</code>	
<code>compile</code>	
<code>match</code>	
<code>process</code>	
<code>set_expr</code>	
<code>update_input_tokens</code>	
<code>update_name</code>	

`__init__`

`Operator.__init__(s, context=None)`
 Initialize self. See help(type(self)) for accurate signature.

`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)`
 Initialize self. See help(type(self)) for accurate signature.

Attributes

<code>get_n_args</code>
<code>name</code>
<code>node_id</code>
<code>pred</code>

`get_n_args`

`Operator.get_n_args`

`name`

`Operator.name`

`node_id`

`Operator.node_id`

`pred`

`Operator.pred`

OperatorToken

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

Methods

<code>__init__</code>	Initialize self.
<code>ast</code>	
<code>compile</code>	
<code>match</code>	
<code>process</code>	
<code>set_expr</code>	
<code>update_input_tokens</code>	
<code>update_name</code>	

`__init__`

`OperatorToken.__init__` (*s*, *context=None*)
 Initialize self. See `help(type(self))` for accurate signature.

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)`
Initialize self. See help(type(self)) for accurate signature.

Attributes

<code>get_n_args</code>
<code>name</code>
<code>node_id</code>
<code>pred</code>

get_n_args

`OperatorToken.get_n_args`

name

`OperatorToken.name`

node_id

OperatorToken.**node_id**

pred

OperatorToken.**pred**

Separator

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

Methods

<code>__init__</code>	Initialize self.
<code>ast</code>	
<code>compile</code>	
<code>match</code>	
<code>process</code>	
<code>set_expr</code>	
<code>update_input_tokens</code>	
<code>update_name</code>	

`__init__`

Separator.**__init__** (*s*, *context=None*)
Initialize self. See help(type(self)) for accurate signature.

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)`

Initialize self. See help(type(self)) for accurate signature.

Attributes

`get_n_args`

`name`

`node_id`

`pred`

get_n_args

`Separator.get_n_args`

name

`Separator.name`

node_id

`Separator.node_id`

pred

`Separator.pred`

parenthesis

It provides Parenthesis class.

Classes

Parenthesis

Parenthesis

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

Methods

<code>__init__</code>	Initialize self.
<code>ast</code>	
<code>match</code>	
<code>process</code>	
<code>set_expr</code>	
<code>update_input_tokens</code>	

`__init__`

Parenthesis.__init__ (*s*, *context=None*)
 Initialize self. See help(type(self)) for accurate signature.

`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*)
 Initialize self. See help(type(self)) for accurate signature.

Attributes

n_args
name
node_id
opens

n_args

```
Parenthesis.n_args = 0
```

name

```
Parenthesis.name
```

node_id

```
Parenthesis.node_id
```

opens

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

Classes

Token

Token

```
class Token(s, context=None)
```

Methods

<code>__init__</code>	Initialize self.
<code>ast</code>	
<code>match</code>	
<code>process</code>	
<code>set_expr</code>	
<code>update_input_tokens</code>	

`__init__`

```
Token.\_\_init\_\_(s, context=None)
    Initialize self. See help(type(self)) for accurate signature.
```

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)`

Initialize self. See help(type(self)) for accurate signature.

Attributes

`name`

`node_id`

name

`Token.name`

node_id

`Token.node_id`

2.1.7.5 functions

It provides functions implementations to compile the Excel functions.

Sub-Modules:

<i>date</i>	Python equivalents of financial Excel functions.
<i>eng</i>	Python equivalents of engineering Excel functions.
<i>financial</i>	Python equivalents of financial Excel functions.

Continued on next page

Table 44 – continued from previous page

<i>info</i>	Python equivalents of information Excel functions.
<i>logic</i>	Python equivalents of logical Excel functions.
<i>look</i>	Python equivalents of lookup and reference Excel functions.
<i>math</i>	Python equivalents of math and trigonometry Excel functions.
<i>operators</i>	Python equivalents of Excel operators.
<i>stat</i>	Python equivalents of statistical Excel functions.
<i>text</i>	Python equivalents of text Excel functions.

date

Python equivalents of financial Excel functions.

Functions

<i>xdate</i>
<i>xdatevalue</i>
<i>xday</i>
<i>xnow</i>
<i>xsecond</i>
<i>xtime</i>
<i>xtimevalue</i>
<i>xtoday</i>
<i>xyearfrac</i>

xdate

xdate (*year, month, day*)

xdatevalue

xdatevalue (*date_text*)

xday

xday (*serial_number, n=2*)

xnow

xnow ()

xsecond

xsecond (*serial_number, n=2*)

xtime

xtime (*hour, minute, second*)

xtimevalue

xtimevalue (*time_text*)

xtoday

xtoday ()

xyearfrac

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

eng

Python equivalents of engineering Excel functions.

financial

Python equivalents of financial Excel functions.

Functions

xirr

xnpv

xxirr

xxnpv

xirr

xirr (*values, guess=0.1*)

xnpv

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

xxirr

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

xxnpv

xxnpv (*rate, values, dates*)

info

Python equivalents of information Excel functions.

Functions

<i>iserr</i>
<i>iserror</i>
<i>xna</i>

iserr

iserr (*val*)

iserror

iserror (*val*)

xna

xna ()

Classes

<i>IsErrArray</i>
<i>IsErrorArray</i>

IsErrArray

class IsErrArray

Methods

<code>all</code>	Returns True if all elements evaluate to True.
<code>any</code>	Returns True if any of the elements of <i>a</i> evaluate to True.
<code>argmax</code>	Return indices of the maximum values along the given axis.
<code>argmin</code>	Return indices of the minimum values along the given axis of <i>a</i> .

Continued on next page

Table 49 – continued from previous page

<code>argpartition</code>	Returns the indices that would partition this array.
<code>argsort</code>	Returns the indices that would sort this array.
<code>astype</code>	Copy of the array, cast to a specified type.
<code>byteswap</code>	Swap the bytes of the array elements
<code>choose</code>	Use an index array to construct a new array from a set of choices.
<code>clip</code>	Return an array whose values are limited to <code>[min, max]</code> .
<code>collapse</code>	
<code>compress</code>	Return selected slices of this array along given axis.
<code>conj</code>	Complex-conjugate all elements.
<code>conjugate</code>	Return the complex conjugate, element-wise.
<code>copy</code>	Return a copy of the array.
<code>cumprod</code>	Return the cumulative product of the elements along the given axis.
<code>cumsum</code>	Return the cumulative sum of the elements along the given axis.
<code>diagonal</code>	Return specified diagonals.
<code>dot</code>	Dot product of two arrays.
<code>dump</code>	Dump a pickle of the array to the specified file.
<code>dumps</code>	Returns the pickle of the array as a string.
<code>fill</code>	Fill the array with a scalar value.
<code>flatten</code>	Return a copy of the array collapsed into one dimension.
<code>getfield</code>	Returns a field of the given array as a certain type.
<code>item</code>	Copy an element of an array to a standard Python scalar and return it.
<code>itemset</code>	Insert scalar into an array (scalar is cast to array's dtype, if possible)
<code>max</code>	Return the maximum along a given axis.
<code>mean</code>	Returns the average of the array elements along given axis.
<code>min</code>	Return the minimum along a given axis.
<code>newbyteorder</code>	Return the array with the same data viewed with a different byte order.
<code>nonzero</code>	Return the indices of the elements that are non-zero.
<code>partition</code>	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.
<code>prod</code>	Return the product of the array elements over the given axis
<code>ptp</code>	Peak to peak (maximum - minimum) value along a given axis.
<code>put</code>	Set <code>a.flat[n] = values[n]</code> for all <code>n</code> in indices.
<code>ravel</code>	Return a flattened array.
<code>repeat</code>	Repeat elements of an array.
<code>reshape</code>	Returns an array containing the same data with a new shape.
<code>resize</code>	Change shape and size of array in-place.

Continued on next page

Table 49 – continued from previous page

<code>round</code>	Return <i>a</i> with each element rounded to the given number of decimals.
<code>searchsorted</code>	Find indices where elements of <i>v</i> should be inserted in <i>a</i> to maintain order.
<code>setfield</code>	Put a value into a specified place in a field defined by a data-type.
<code>setflags</code>	Set array flags WRITEABLE, ALIGNED, (WRITEBACKIFCOPY and UPDATEIFCOPY), respectively.
<code>sort</code>	Sort an array in-place.
<code>squeeze</code>	Remove single-dimensional entries from the shape of <i>a</i> .
<code>std</code>	Returns the standard deviation of the array elements along given axis.
<code>sum</code>	Return the sum of the array elements over the given axis.
<code>swapaxes</code>	Return a view of the array with <i>axis1</i> and <i>axis2</i> interchanged.
<code>take</code>	Return an array formed from the elements of <i>a</i> at the given indices.
<code>tobytes</code>	Construct Python bytes containing the raw data bytes in the array.
<code>tofile</code>	Write array to a file as text or binary (default).
<code>tolist</code>	Return the array as an <i>a.ndim</i> -levels deep nested list of Python scalars.
<code>tostring</code>	Construct Python bytes containing the raw data bytes in the array.
<code>trace</code>	Return the sum along diagonals of the array.
<code>transpose</code>	Returns a view of the array with axes transposed.
<code>var</code>	Returns the variance of the array elements, along given axis.
<code>view</code>	New view of array with the same data.

all

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

Returns True if all elements evaluate to True.

Refer to `numpy.all` for full documentation.

`numpy.all` : equivalent function

any

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

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

Refer to `numpy.any` for full documentation.

`numpy.any` : equivalent function

argmax

`IsErrArray.argmax (axis=None, out=None)`

Return indices of the maximum values along the given axis.

Refer to `numpy.argmax` for full documentation.

`numpy.argmax` : equivalent function

argmin

`IsErrArray.argmin (axis=None, out=None)`

Return indices of the minimum values along the given axis of *a*.

Refer to `numpy.argmin` for detailed documentation.

`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.

`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.

`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.

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.

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`.

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.

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

```
>>> 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.

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

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

```
>>> 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.

`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.

`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.

`numpy.compress` : equivalent function

conj

`IsErrArray.conj()`

Complex-conjugate all elements.

Refer to *numpy.conjugate* for full documentation.

numpy.conjugate : equivalent function

conjugate

`IsErrArray.conjugate()`

Return the complex conjugate, element-wise.

Refer to *numpy.conjugate* for full documentation.

numpy.conjugate : equivalent function

copy

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

Return a copy of the array.

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.)

numpy.copy *numpy.copyto*

```
>>> 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.

`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.

`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.

`numpy.diagonal` : equivalent function

dot

`IsErrArray.dot(b, out=None)`

Dot product of two arrays.

Refer to `numpy.dot` for full documentation.

`numpy.dot` : equivalent function

```
>>> a = np.eye(2)
>>> b = np.ones((2, 2)) * 2
>>> a.dot(b)
array([[2.,  2.],
       [2.,  2.]])
```

This array method can be conveniently chained:

```
>>> a.dot(b).dot(b)
array([[8.,  8.],
       [8.,  8.]])
```

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`.

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` or `numpy.loads` will convert the string back to an array.

None

fill

`IsErrArray.fill(value)`

Fill the array with a scalar value.

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

```

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

```

flatten

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

Return a copy of the array collapsed into one dimension.

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’.

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

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

```

>>> 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.

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.

```
>>> 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.

***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.

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

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.

```
>>> 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))
```

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```
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*.

***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.

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.

```
>>> 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.

`numpy.amax` : equivalent function

mean

`IsErrArray.mean(axis=None, dtype=None, out=None, keepdims=False)`

Returns the average of the array elements along given axis.

Refer to *numpy.mean* for full documentation.

`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.

`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.

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
- {'<', 'L'} - little endian
- {'>', 'B'} - big endian
- {'=', 'N'} - native order
- {'|', 'I'} - ignore (no change to byte order)

The default value ('S') results in swapping the current byte order. The code does a case-insensitive check on the first letter of *new_order* for the alternatives above. For example, any of 'B' or 'b' or 'biggish' are valid to specify big-endian.

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.

`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.

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.

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.

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

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

```
>>> 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.

`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.

`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.

`numpy.put` : equivalent function

ravel

`IsErrArray.ravel([order])`

Return a flattened array.

Refer to *numpy.ravel* for full documentation.

`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.

`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.

`numpy.reshape` : equivalent function

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.

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.

None

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.

`resize` : Return a new array with the specified shape.

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.

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.

`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*

`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.

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*.

None

`getfield`

```
>>> 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 and UPDATEIFCOPY), 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 (deprecated) UPDATEIFCOPY flags 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.)

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.

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, UPDATEIFCOPY, 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);

UPDATEIFCOPY (U) (deprecated), replaced by WRITEBACKIFCOPY;

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.

```
>>> 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
UPDATEIFCOPY : False
>>> y.setflags(write=0, align=0)
>>> y.flags
C_CONTIGUOUS : True
F_CONTIGUOUS : False
OWNDATA : True
WRITEABLE : False
ALIGNED : False
WRITEBACKIFCOPY : False
UPDATEIFCOPY : 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.

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.

`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.

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

```
>>> 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 single-dimensional entries from the shape of *a*.

Refer to `numpy.squeeze` for full documentation.

`numpy.squeeze` : equivalent function

std

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

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

Refer to `numpy.std` for full documentation.

`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.

`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.

`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.

`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 can be produced in either 'C' or 'Fortran', or 'Any' order (the default is 'C'-order). 'Any' order means C-order unless the `F_CONTIGUOUS` flag in the array is set, in which case it means 'Fortran' order.

New in version 1.9.0.

order [{ 'C', 'F', None }, optional] Order of the data for multidimensional arrays: C, Fortran, or the same as for the original array.

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

```

>>> 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()`.

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.

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.

none

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

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

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):
```

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```
...
TypeError: iteration over a 0-d array
>>> a.tolist()
1
```

tostring

`IsErrArray.tostring (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 can be produced in either 'C' or 'Fortran', or 'Any' order (the default is 'C'-order). 'Any' order means C-order unless the `F_CONTIGUOUS` flag in the array is set, in which case it means 'Fortran' order.

This function is a compatibility alias for `tobytes`. Despite its name it returns bytes not strings.

order [{ 'C', 'F', None }, optional] Order of the data for multidimensional arrays: C, Fortran, or the same as for the original array.

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

```
>>> 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'
```

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.

`numpy.trace` : equivalent function

transpose

`IsErrArray.transpose (*axes)`

Returns a view of the array with axes transposed.

For a 1-D array this has no effect, as a transposed vector is simply the same vector. To convert a 1-D array into a 2D column vector, an additional dimension must be added. `np.atleast2d(a).T` achieves this, as does `a[:, np.newaxis]`. For a 2-D array, this is a standard matrix transpose. For an n-D array, if axes are given, their order indicates how the axes are permuted (see Examples). If axes are not provided and `a.shape = (i[0], i[1], ..., i[n-2], i[n-1])`, then `a.transpose().shape = (i[n-1], i[n-2], ..., i[1], i[0])`.

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 a 's i -th axis becomes $a.transpose()$'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)

out [ndarray] View of a , with axes suitably permuted.

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

```
>>> 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]])
```

var

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

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

Refer to `numpy.var` for full documentation.

`numpy.var` : equivalent function

view

`IsErrArray.view` (*dtype=None, type=None*)

New view of array with the same data.

dtype [data-type or ndarray sub-class, optional] Data-type descriptor of the returned view, e.g., `float32` or `int16`. The default, `None`, 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, the default `None` results in type preservation.

`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 behavior of the view

cannot be predicted just from the superficial appearance of `a` (shown by `print(a)`). It also depends on exactly how `a` is stored in memory. Therefore if `a` is C-ordered versus fortran-ordered, versus defined as a slice or transpose, etc., the view may give different results.

```
>>> 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[:, 0:2]
>>> y
array([[1, 2],
       [4, 5]], 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 array must be C-
→contiguous
>>> z = y.copy()
>>> z.view(dtype=[('width', np.int16), ('length', np.int16)])
```

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```
array([[ (1, 2)],
       [ (4, 5) ]], dtype=[('width', '<i2'), ('length', '<i2')])
```

__init__()

Initialize self. See help(type(self)) for accurate signature.

Attributes

T	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

The transposed array.

Same as `self.transpose()`.

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

transpose

base

`IsErrArray.base`

Base object if memory is from some other object.

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.

`None`

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

`numpy.ctypeslib`

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. This base-type could be `ctypes.c_int`, `ctypes.c_long`, or `ctypes.c_longlong` depending on the platform. The `c_intp` type is defined accordingly in `numpy.ctypeslib`. 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.

```
>>> import ctypes
>>> x
array([[0, 1],
       [2, 3]])
>>> x.ctypes.data
30439712
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_long))
<ctypes.LP_c_long object at 0x01F01300>
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_long)).contents
c_long(0)
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_longlong)).contents
c_longlong(4294967296L)
>>> x.ctypes.shape
<numpy.core._internal.c_long_Array_2 object at 0x01FFD580>
>>> x.ctypes.shape_as(ctypes.c_long)
<numpy.core._internal.c_long_Array_2 object at 0x01FCE620>
>>> x.ctypes.strides
<numpy.core._internal.c_long_Array_2 object at 0x01FCE620>
>>> x.ctypes.strides_as(ctypes.c_longlong)
<numpy.core._internal.c_longlong_Array_2 object at 0x01F01300>
```

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.

None

`d` : numpy dtype object

numpy.dtype

```
>>> 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.

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.

UPDATEIFCOPY (U) (Deprecated, use **WRITEBACKIFCOPY**) This array is a copy of some other array. When this array is deallocated, 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**.

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

Only the **WRITEBACKIFCOPY**, **UPDATEIFCOPY**, **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:

- **UPDATEIFCOPY** can only be set `False`.
- **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.

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

`flatiter`

```
>>> 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.

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

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```
>>> x.imag.dtype
dtype('float64')
```

itemsizes

`IsErrArray.itemsizes`

Length of one array element in bytes.

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

nbytes

`IsErrArray.nbytes`

Total bytes consumed by the elements of the array.

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

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

ndim

`IsErrArray.ndim`

Number of array dimensions.

```
>>> 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.

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

`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.

```
>>> 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 a non-contiguous array
```

`numpy.reshape` : similar function `ndarray.reshape` : similar method

size

`IsErrArray.size`

Number of elements in the array.

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

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.

```
>>> 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 $(i[0], i[1], \dots, i[n])$ 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.

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 $(20, 4)$.

`numpy.lib.stride_tricks.as_strided`

```
>>> 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

<code>all</code>	Returns True if all elements evaluate to True.
<code>any</code>	Returns True if any of the elements of <i>a</i> evaluate to True.
<code>argmax</code>	Return indices of the maximum values along the given axis.
<code>argmin</code>	Return indices of the minimum values along the given axis of <i>a</i> .
<code>argpartition</code>	Returns the indices that would partition this array.
<code>argsort</code>	Returns the indices that would sort this array.
<code>astype</code>	Copy of the array, cast to a specified type.
<code>byteswap</code>	Swap the bytes of the array elements
<code>choose</code>	Use an index array to construct a new array from a set of choices.
<code>clip</code>	Return an array whose values are limited to <code>[min, max]</code> .
<code>collapse</code>	
<code>compress</code>	Return selected slices of this array along given axis.
<code>conj</code>	Complex-conjugate all elements.
<code>conjugate</code>	Return the complex conjugate, element-wise.
<code>copy</code>	Return a copy of the array.
<code>cumprod</code>	Return the cumulative product of the elements along the given axis.
<code>cumsum</code>	Return the cumulative sum of the elements along the given axis.
<code>diagonal</code>	Return specified diagonals.
<code>dot</code>	Dot product of two arrays.
<code>dump</code>	Dump a pickle of the array to the specified file.
<code>dumps</code>	Returns the pickle of the array as a string.
<code>fill</code>	Fill the array with a scalar value.
<code>flatten</code>	Return a copy of the array collapsed into one dimension.
<code>getfield</code>	Returns a field of the given array as a certain type.
<code>item</code>	Copy an element of an array to a standard Python scalar and return it.
<code>itemset</code>	Insert scalar into an array (scalar is cast to array's dtype, if possible)
<code>max</code>	Return the maximum along a given axis.
<code>mean</code>	Returns the average of the array elements along given axis.
<code>min</code>	Return the minimum along a given axis.
<code>newbyteorder</code>	Return the array with the same data viewed with a different byte order.
<code>nonzero</code>	Return the indices of the elements that are non-zero.
<code>partition</code>	Rearranges the elements in the array in such a way that the value of the element in <i>k</i> th position is in the position it would be in a sorted array.
<code>prod</code>	Return the product of the array elements over the given axis

Continued on next page

Table 51 – continued from previous page

<code>ptp</code>	Peak to peak (maximum - minimum) value along a given axis.
<code>put</code>	Set <code>a.flat[n] = values[n]</code> for all <code>n</code> in indices.
<code>ravel</code>	Return a flattened array.
<code>repeat</code>	Repeat elements of an array.
<code>reshape</code>	Returns an array containing the same data with a new shape.
<code>resize</code>	Change shape and size of array in-place.
<code>round</code>	Return <code>a</code> with each element rounded to the given number of decimals.
<code>searchsorted</code>	Find indices where elements of <code>v</code> should be inserted in <code>a</code> to maintain order.
<code>setfield</code>	Put a value into a specified place in a field defined by a data-type.
<code>setflags</code>	Set array flags WRITEABLE, ALIGNED, (WRITEBACKIFCOPY and UPDATEIFCOPY), respectively.
<code>sort</code>	Sort an array in-place.
<code>squeeze</code>	Remove single-dimensional entries from the shape of <code>a</code> .
<code>std</code>	Returns the standard deviation of the array elements along given axis.
<code>sum</code>	Return the sum of the array elements over the given axis.
<code>swapaxes</code>	Return a view of the array with <code>axis1</code> and <code>axis2</code> interchanged.
<code>take</code>	Return an array formed from the elements of <code>a</code> at the given indices.
<code>tobytes</code>	Construct Python bytes containing the raw data bytes in the array.
<code>tofile</code>	Write array to a file as text or binary (default).
<code>tolist</code>	Return the array as an <code>a.ndim</code> -levels deep nested list of Python scalars.
<code>tostring</code>	Construct Python bytes containing the raw data bytes in the array.
<code>trace</code>	Return the sum along diagonals of the array.
<code>transpose</code>	Returns a view of the array with axes transposed.
<code>var</code>	Returns the variance of the array elements, along given axis.
<code>view</code>	New view of array with the same data.

all

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

Returns True if all elements evaluate to True.

Refer to `numpy.all` for full documentation.

`numpy.all` : equivalent function

any

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

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

Refer to `numpy.any` for full documentation.

`numpy.any` : equivalent function

argmax

`IsErrorArray.argmax (axis=None, out=None)`

Return indices of the maximum values along the given axis.

Refer to `numpy.argmax` for full documentation.

`numpy.argmax` : equivalent function

argmin

`IsErrorArray.argmin (axis=None, out=None)`

Return indices of the minimum values along the given axis of *a*.

Refer to `numpy.argmin` for detailed documentation.

`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.

`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.

`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.

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.

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*.

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.

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

```
>>> 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.

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

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

```
>>> 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, 1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 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.

`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.

`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.

`numpy.compress` : equivalent function

conj

`IsErrorArray.conj ()`

Complex-conjugate all elements.

Refer to `numpy.conjugate` for full documentation.

`numpy.conjugate` : equivalent function

conjugate

`IsErrorArray.conjugate ()`

Return the complex conjugate, element-wise.

Refer to `numpy.conjugate` for full documentation.

`numpy.conjugate` : equivalent function

copy

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

Return a copy of the array.

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.)

`numpy.copy numpy.copyto`

```
>>> 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.

`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.

`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.

`numpy.diagonal` : equivalent function

dot

`IsErrorArray.dot` (*b, out=None*)

Dot product of two arrays.

Refer to `numpy.dot` for full documentation.

`numpy.dot` : equivalent function

```
>>> a = np.eye(2)
>>> b = np.ones((2, 2)) * 2
>>> a.dot(b)
array([[2.,  2.],
       [2.,  2.]])
```

This array method can be conveniently chained:

```
>>> a.dot(b).dot(b)
array([[8.,  8.],
       [8.,  8.]])
```

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`.

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` or `numpy.loads` will convert the string back to an array.

None

fill

`IsErrorArray.fill(value)`

Fill the array with a scalar value.

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

```

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

```

flatten

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

Return a copy of the array collapsed into one dimension.

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’.

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

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

```

>>> 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.

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.

```
>>> 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.

***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.

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

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.

```

>>> 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*.

***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.

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.

```

>>> 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.

`numpy.amax` : equivalent function

mean

`IsErrorArray.mean(axis=None, dtype=None, out=None, keepdims=False)`

Returns the average of the array elements along given axis.

Refer to `numpy.mean` for full documentation.

`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.

`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.

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
- {'<', 'L'} - little endian
- {'>', 'B'} - big endian
- {'=', 'N'} - native order
- {'|', 'I'} - ignore (no change to byte order)

The default value ('S') results in swapping the current byte order. The code does a case-insensitive check on the first letter of *new_order* for the alternatives above. For example, any of 'B' or 'b' or 'bigish' are valid to specify big-endian.

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.

`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.

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.

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.

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

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

```
>>> 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.

`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.

`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.
`numpy.put` : equivalent function

ravel

`IsErrorArray.ravel ([order])`
 Return a flattened array.
 Refer to `numpy.ravel` for full documentation.
`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.
`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.
`numpy.reshape` : equivalent function
 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.
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.
 None
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.

`resize` : Return a new array with the specified shape.

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`.

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.

`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`

`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.

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`.

None

`getfield`

```
>>> 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` and `UPDATEIFCOPY`), 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 (deprecated) `UPDATEIFCOPY` flags 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.)

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.

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, UPDATEIFCOPY, 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);

UPDATEIFCOPY (U) (deprecated), replaced by WRITEBACKIFCOPY;

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.

```
>>> 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
UPDATEIFCOPY : False
>>> y.setflags(write=0, align=0)
>>> y.flags
C_CONTIGUOUS : True
F_CONTIGUOUS : False
OWNDATA : True
WRITEABLE : False
ALIGNED : False
WRITEBACKIFCOPY : False
UPDATEIFCOPY : 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.

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.

`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.

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

```
>>> 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 single-dimensional entries from the shape of *a*.

Refer to `numpy.squeeze` for full documentation.

`numpy.squeeze` : equivalent function

std

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

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

Refer to `numpy.std` for full documentation.

`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.

`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.

`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.

`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 can be produced in either 'C' or 'Fortran', or 'Any' order (the default is 'C'-order). 'Any' order means C-order unless the `F_CONTIGUOUS` flag in the array is set, in which case it means 'Fortran' order.

New in version 1.9.0.

order [{ 'C', 'F', None }, optional] Order of the data for multidimensional arrays: C, Fortran, or the same as for the original array.

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

```
>>> 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()`.

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.

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.

none

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

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

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')`

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 can be produced in either 'C' or 'Fortran', or 'Any' order (the default is 'C'-order). 'Any' order means C-order unless the `F_CONTIGUOUS` flag in the array is set, in which case it means 'Fortran' order.

This function is a compatibility alias for `tobytes`. Despite its name it returns bytes not strings.

order [{ 'C', 'F', None }, optional] Order of the data for multidimensional arrays: C, Fortran, or the same as for the original array.

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

```
>>> 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'
```

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.

`numpy.trace` : equivalent function

transpose

`IsErrorArray.transpose(*axes)`

Returns a view of the array with axes transposed.

For a 1-D array this has no effect, as a transposed vector is simply the same vector. To convert a 1-D array into a 2D column vector, an additional dimension must be added. `np.atleast2d(a).T` achieves this, as does `a[:, np.newaxis]`. For a 2-D array, this is a standard matrix transpose. For an n-D array, if axes are given, their order indicates how the axes are permuted (see Examples). If axes are not provided and `a.shape = (i[0], i[1], ..., i[n-2], i[n-1])`, then `a.transpose().shape = (i[n-1], i[n-2], ..., i[1], i[0])`.

`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 *a*'s *i*-th axis becomes *a.transpose()*'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)

out [ndarray] View of *a*, with axes suitably permuted.

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

```
>>> 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]])
```

var

`IsErrorArray.var(axis=None, dtype=None, out=None, ddof=0, keepdims=False)`

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

Refer to `numpy.var` for full documentation.

`numpy.var` : equivalent function

view

`IsErrorArray.view(dtype=None, type=None)`

New view of array with the same data.

dtype [data-type or ndarray sub-class, optional] Data-type descriptor of the returned view, e.g., `float32` or `int16`. The default, `None`, 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, the default None results in type preservation.

`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 behavior of the view cannot be predicted just from the superficial appearance of `a` (shown by `print(a)`). It also depends on exactly how `a` is stored in memory. Therefore if `a` is C-ordered versus fortran-ordered, versus defined as a slice or transpose, etc., the view may give different results.

```
>>> 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[:, 0:2]
>>> y
array([[1, 2],
       [4, 5]], 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 array must be C-
→contiguous
>>> z = y.copy()
>>> z.view(dtype=[('width', np.int16), ('length', np.int16)])
array([[1, 2],
       [4, 5]], dtype=[('width', '<i2'), ('length', '<i2')])
```

`__init__()`

Initialize self. See help(type(self)) for accurate signature.

Attributes

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

T

`IsErrorArray.T`

The transposed array.

Same as `self.transpose()`.

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

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

transpose

base

IsErrorArray.**base**

Base object if memory is from some other object.

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.

None

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

numpy.ctypeslib

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. This base-type could be `ctypes.c_int`, `ctypes.c_long`, or `ctypes.c_longlong` depending on the platform. The `c_intp` type is defined accordingly in `numpy.ctypeslib`. 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.

```
>>> import ctypes
>>> x
array([[0, 1],
       [2, 3]])
>>> x.ctypes.data
30439712
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_long))
<ctypes.LP_c_long object at 0x01F01300>
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_long)).contents
c_long(0)
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_longlong)).contents
c_longlong(4294967296L)
>>> x.ctypes.shape
<numpy.core._internal.c_long_Array_2 object at 0x01FFD580>
>>> x.ctypes.shape_as(ctypes.c_long)
<numpy.core._internal.c_long_Array_2 object at 0x01FCE620>
>>> x.ctypes.strides
<numpy.core._internal.c_long_Array_2 object at 0x01FCE620>
>>> x.ctypes.strides_as(ctypes.c_longlong)
<numpy.core._internal.c_longlong_Array_2 object at 0x01F01300>
```

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.

None

`d` : numpy dtype object

numpy.dtype

```

>>> 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.

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.

UPDATEIFCOPY (U) (Deprecated, use **WRITEBACKIFCOPY**) This array is a copy of some other array. When this array is deallocated, 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**.

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

Only the `WRITEBACKIFCOPY`, `UPDATEIFCOPY`, `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:

- `UPDATEIFCOPY` can only be set `False`.
- `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.

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

`flatiter`

```
>>> 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.

```

>>> 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.

```

>>> 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.

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

```

>>> 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.

```

>>> 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.

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

`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.

```
>>> 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 a non-contiguous array
```

`numpy.reshape` : similar function `ndarray.reshape` : similar method

size

`IsErrorArray.size`

Number of elements in the array.

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

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.


```
>>> 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 $(i[0], i[1], \dots, i[n])$ 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.

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 $(20, 4)$.

`numpy.lib.stride_tricks.as_strided`

```
>>> 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

<code>solve_cycle</code>
<code>xand</code>
<code>xif</code>
<code>xiferror</code>
<code>xiferror_return</code>
<code>xswitch</code>

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)

xswitch

xswitch (val, *args)

look

Python equivalents of lookup and reference Excel functions.

Functions

Table 55 – continued from previous page

<i>xmround</i>
<i>xodd</i>
<i>xpower</i>
<i>xrandbetween</i>
<i>xroman</i>
<i>xround</i>
<i>xsqrtpi</i>
<i>xsum</i>
<i>xsumproduct</i>

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*)

xsumproduct

xsumproduct (**args*)

operators

Python equivalents of Excel operators.

Functions

<i>logic_input_parser</i>	
<i>logic_wrap</i>	Helps call a numpy universal function (ufunc).
<i>numeric_wrap</i>	Helps call a numpy universal function (ufunc).

logic_input_parser

logic_input_parser (*x, y*)

logic_wrap

logic_wrap (*func, *, input_parser=<function logic_input_parser>, check_error=<function get_error>, args_parser=<function <lambda>>, otype=<class 'formulas.functions.Array'>, ranges=False, return_func=<function value_return>, check_nan=True, **kw*)
 Helps call a numpy universal function (ufunc).

numeric_wrap

numeric_wrap (*func, input_parser=<function <lambda>>, check_error=<function get_error>, args_parser=<function <lambda>>, otype=<class 'formulas.functions.Array'>, ranges=False, *, return_func=<function value_return>, check_nan=True, **kw*)
 Helps call a numpy universal function (ufunc).

stat

Python equivalents of statistical Excel functions.

Functions

xaverage

xfunc

xsort

xaverage

xaverage (**args*, *func*=<function *_xaverage*>, *check*=<function *is_number*>, *convert*=None, *default*=None, *_raise*=True)

xfunc

xfunc (**args*, *func*=<built-in function *max*>, *check*=<function *is_number*>, *convert*=None, *default*=0, *_raise*=True)

xsort

xsort (*values*, *k*, *large*=True)

text

Python equivalents of text Excel functions.

Functions

xconcat

xfind

xleft

xmid

xreplace

xright

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*)

Functions

<i>flatten</i>	
<i>get_error</i>	
<i>is_not_empty</i>	
<i>is_number</i>	
<i>not_implemented</i>	
<i>parse_ranges</i>	
<i>raise_errors</i>	
<i>replace_empty</i>	
<i>value_return</i>	
<i>wrap_func</i>	
<i>wrap_ranges_func</i>	
<i>wrap_ufunc</i>	Helps call a numpy universal function (ufunc).
<i>xfilter</i>	

flatten

flatten (*v*, *check*=<function *is_number*>)

get_error

get_error (**vals*)

is_not_empty

is_not_empty (*v*)

is_number

is_number (*number*)

not_implemented

not_implemented (*args, **kwargs)

parse_ranges

parse_ranges (*args, **kw)

raise_errors

raise_errors (*args)

replace_empty

replace_empty (x, empty=0)

value_return

value_return (res, *args)

wrap_func

wrap_func (func, ranges=False)

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

all	Returns True if all elements evaluate to True.
any	Returns True if any of the elements of <i>a</i> 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 of <i>a</i> .
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 <code>[min, max]</code> .
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	Dot product of two arrays.
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.

Continued on next page

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<code>partition</code>	Rearranges the elements in the array in such a way that the value of the element in <i>k</i> th position is in the position it would be in a sorted array.
<code>prod</code>	Return the product of the array elements over the given axis
<code>ptp</code>	Peak to peak (maximum - minimum) value along a given axis.
<code>put</code>	Set <code>a.flat[n] = values[n]</code> for all <i>n</i> in indices.
<code>ravel</code>	Return a flattened array.
<code>repeat</code>	Repeat elements of an array.
<code>reshape</code>	Returns an array containing the same data with a new shape.
<code>resize</code>	Change shape and size of array in-place.
<code>round</code>	Return <i>a</i> with each element rounded to the given number of decimals.
<code>searchsorted</code>	Find indices where elements of <i>v</i> should be inserted in <i>a</i> to maintain order.
<code>setfield</code>	Put a value into a specified place in a field defined by a data-type.
<code>setflags</code>	Set array flags WRITEABLE, ALIGNED, (WRITEBACKIFCOPY and UPDATEIFCOPY), respectively.
<code>sort</code>	Sort an array in-place.
<code>squeeze</code>	Remove single-dimensional entries from the shape of <i>a</i> .
<code>std</code>	Returns the standard deviation of the array elements along given axis.
<code>sum</code>	Return the sum of the array elements over the given axis.
<code>swapaxes</code>	Return a view of the array with <i>axis1</i> and <i>axis2</i> interchanged.
<code>take</code>	Return an array formed from the elements of <i>a</i> at the given indices.
<code>tobytes</code>	Construct Python bytes containing the raw data bytes in the array.
<code>tofile</code>	Write array to a file as text or binary (default).
<code>tolist</code>	Return the array as an <code>a.ndim</code> -levels deep nested list of Python scalars.
<code>tostring</code>	Construct Python bytes containing the raw data bytes in the array.
<code>trace</code>	Return the sum along diagonals of the array.
<code>transpose</code>	Returns a view of the array with axes transposed.
<code>var</code>	Returns the variance of the array elements, along given axis.
<code>view</code>	New view of array with the same data.

all

`Array.all` (*axis=None, out=None, keepdims=False*)
Returns True if all elements evaluate to True.

Refer to *numpy.all* for full documentation.

numpy.all : equivalent function

any

Array.any (*axis=None, out=None, keepdims=False*)

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

Refer to *numpy.any* for full documentation.

numpy.any : equivalent function

argmax

Array.argmax (*axis=None, out=None*)

Return indices of the maximum values along the given axis.

Refer to *numpy.argmax* for full documentation.

numpy.argmax : equivalent function

argmin

Array.argmin (*axis=None, out=None*)

Return indices of the minimum values along the given axis of *a*.

Refer to *numpy.argmin* for detailed documentation.

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.

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.

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.

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.

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*.

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.

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

```
>>> 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.

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

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

```
>>> 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, 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.

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.

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.
`numpy.compress` : equivalent function

conj

`Array.conj ()`
 Complex-conjugate all elements.
 Refer to `numpy.conjugate` for full documentation.
`numpy.conjugate` : equivalent function

conjugate

`Array.conjugate ()`
 Return the complex conjugate, element-wise.
 Refer to `numpy.conjugate` for full documentation.
`numpy.conjugate` : equivalent function

copy

`Array.copy (order='C')`
 Return a copy of the array.
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.)
`numpy.copy` `numpy.copyto`

```
>>> 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.

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.

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.

numpy.diagonal : equivalent function

dot

Array.**dot** (*b, out=None*)

Dot product of two arrays.

Refer to *numpy.dot* for full documentation.

numpy.dot : equivalent function

```
>>> a = np.eye(2)
>>> b = np.ones((2, 2)) * 2
>>> a.dot(b)
array([[2.,  2.],
       [2.,  2.]])
```

This array method can be conveniently chained:

```
>>> a.dot(b).dot(b)
array([[8.,  8.],
       [8.,  8.]])
```


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`.

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` or `numpy.loads` will convert the string back to an array.

None

fill

`Array.fill(value)`

Fill the array with a scalar value.

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

```

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

```

flatten

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

Return a copy of the array collapsed into one dimension.

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’.

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

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

```

>>> 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.

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.

```
>>> 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.

***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.

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

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.

```

>>> 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

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*.

***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.

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.

```

>>> 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.

`numpy.amax` : equivalent function

mean

`Array.mean (axis=None, dtype=None, out=None, keepdims=False)`

Returns the average of the array elements along given axis.

Refer to `numpy.mean` for full documentation.

`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.

`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.

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
- {'<', 'L'} - little endian
- {'>', 'B'} - big endian
- {'=', 'N'} - native order
- {'|', 'I'} - ignore (no change to byte order)

The default value ('S') results in swapping the current byte order. The code does a case-insensitive check on the first letter of *new_order* for the alternatives above. For example, any of 'B' or 'b' or 'bigish' are valid to specify big-endian.

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.

`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.

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.

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.

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

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

```
>>> 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.

`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.

`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.
`numpy.put` : equivalent function

ravel

`Array.ravel ([order])`
 Return a flattened array.
 Refer to `numpy.ravel` for full documentation.
`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.
`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.
`numpy.reshape` : equivalent function
 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.
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.
 None
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.

resize : Return a new array with the specified shape.

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.

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.

`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`

`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.

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*.

None

`getfield`

```
>>> 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 and UPDATEIFCOPY), 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 (deprecated) UPDATEIFCOPY flags 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.)

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.

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, UPDATEIFCOPY, 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);

UPDATEIFCOPY (U) (deprecated), replaced by WRITEBACKIFCOPY;

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.

```
>>> 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
UPDATEIFCOPY : False
>>> y.setflags(write=0, align=0)
>>> y.flags
C_CONTIGUOUS : True
F_CONTIGUOUS : False
OWNDATA : True
WRITEABLE : False
ALIGNED : False
WRITEBACKIFCOPY : False
UPDATEIFCOPY : 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.

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.

`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.

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

```
>>> 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 single-dimensional entries from the shape of *a*.

Refer to `numpy.squeeze` for full documentation.

`numpy.squeeze` : equivalent function

std

`Array.std` (*axis=None, dtype=None, out=None, ddof=0, keepdims=False*)

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

Refer to `numpy.std` for full documentation.

`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.

`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.

`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.

`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 can be produced in either 'C' or 'Fortran', or 'Any' order (the default is 'C'-order). 'Any' order means C-order unless the `F_CONTIGUOUS` flag in the array is set, in which case it means 'Fortran' order.

New in version 1.9.0.

order [{ 'C', 'F', None }, optional] Order of the data for multidimensional arrays: C, Fortran, or the same as for the original array.

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

```

>>> 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()`.

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.

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.

none

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

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

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

Array.**tostring** (*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 can be produced in either 'C' or 'Fortran', or 'Any' order (the default is 'C'-order). 'Any' order means C-order unless the `F_CONTIGUOUS` flag in the array is set, in which case it means 'Fortran' order.

This function is a compatibility alias for `tobytes`. Despite its name it returns bytes not strings.

order [{ 'C', 'F', None }, optional] Order of the data for multidimensional arrays: C, Fortran, or the same as for the original array.

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

```
>>> 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'
```

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.

`numpy.trace` : equivalent function

transpose

Array.**transpose** (*axes)

Returns a view of the array with axes transposed.

For a 1-D array this has no effect, as a transposed vector is simply the same vector. To convert a 1-D array into a 2D column vector, an additional dimension must be added. `np.atleast2d(a).T` achieves this, as does `a[:, np.newaxis]`. For a 2-D array, this is a standard matrix transpose. For an n-D array, if axes are given, their order indicates how the axes are permuted (see Examples). If axes are not provided and `a.shape = (i[0], i[1], ..., i[n-2], i[n-1])`, then `a.transpose().shape = (i[n-1], i[n-2], ..., i[1], i[0])`.

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 *a*'s *i*-th axis becomes *a.transpose()*'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)

out [ndarray] View of *a*, with axes suitably permuted.

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

```
>>> 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]])
```

var

Array.**var** (axis=None, dtype=None, out=None, ddof=0, keepdims=False)

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

Refer to `numpy.var` for full documentation.

numpy.var : equivalent function

view

Array.**view** (dtype=None, type=None)

New view of array with the same data.

dtype [data-type or ndarray sub-class, optional] Data-type descriptor of the returned view, e.g., float32 or int16. The default, None, 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, the default None results in type preservation.

`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 behavior of the view cannot be predicted just from the superficial appearance of `a` (shown by `print(a)`). It also depends on exactly how `a` is stored in memory. Therefore if `a` is C-ordered versus fortran-ordered, versus defined as a slice or transpose, etc., the view may give different results.

```
>>> 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[:, 0:2]
>>> y
array([[1, 2],
       [4, 5]], 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 array must be C-
→contiguous
>>> z = y.copy()
>>> z.view(dtype=[('width', np.int16), ('length', np.int16)])
array([[1, 2],
       [4, 5]], dtype=[('width', '<i2'), ('length', '<i2')])
```

`__init__()`

Initialize self. See help(type(self)) for accurate signature.

Attributes

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

T

`Array.T`

The transposed array.

Same as `self.transpose()`.

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

(continues on next page)

(continued from previous page)

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

transpose

base

Array.base

Base object if memory is from some other object.

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.

None

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

numpy.ctypeslib

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. This base-type could be `ctypes.c_int`, `ctypes.c_long`, or `ctypes.c_longlong` depending on the platform. The `c_intp` type is defined accordingly in `numpy.ctypeslib`. 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.

```
>>> import ctypes
>>> x
array([[0, 1],
       [2, 3]])
>>> x.ctypes.data
30439712
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_long))
<ctypes.LP_c_long object at 0x01F01300>
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_long)).contents
c_long(0)
>>> x.ctypes.data_as(ctypes.POINTER(ctypes.c_longlong)).contents
c_longlong(4294967296L)
>>> x.ctypes.shape
<numpy.core._internal.c_long_Array_2 object at 0x01FFD580>
>>> x.ctypes.shape_as(ctypes.c_long)
<numpy.core._internal.c_long_Array_2 object at 0x01FCE620>
>>> x.ctypes.strides
<numpy.core._internal.c_long_Array_2 object at 0x01FCE620>
>>> x.ctypes.strides_as(ctypes.c_longlong)
<numpy.core._internal.c_longlong_Array_2 object at 0x01F01300>
```

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.

None

d : numpy dtype object

numpy.dtype

```

>>> 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.

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.

UPDATEIFCOPY (U) (Deprecated, use WRITEBACKIFCOPY) This array is a copy of some other array. When this array is deallocated, 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.

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

Only the `WRITEBACKIFCOPY`, `UPDATEIFCOPY`, `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:

- `UPDATEIFCOPY` can only be set `False`.
- `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.

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

`flatiter`

```
>>> 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.

```

>>> 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.

```

>>> 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.

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

```

>>> 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.

```

>>> 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.

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

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.

```
>>> 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 a non-contiguous array
```

numpy.reshape : similar function ndarray.reshape : similar method

size

Array.**size**

Number of elements in the array.

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

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.

```
>>> 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 $(i[0], i[1], \dots, i[n])$ 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.

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 $(20, 4)$.

numpy.lib.stride_tricks.as_strided

```
>>> 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.

numpy.reshape : equivalent function

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))*.

2.1.7.6 ranges

It provides Ranges class.

Classes

Ranges

Ranges

class **Ranges** (*ranges*=(), *values*=None)

Methods

<code>__init__</code>	Initialize self.
<code>format_range</code>	
<code>get_range</code>	
<code>intersect</code>	
<code>push</code>	
<code>pushes</code>	
<code>set_value</code>	
<code>simplify</code>	

`__init__`

Ranges.__init__ (*ranges*=(), *values*=None)

Initialize self. See *help(type(self))* for accurate signature.

format_range

static **Ranges.format_range** (**args*, ***kwargs*)

get_range

static **Ranges.get_range** (*format_range*, *ref*, *context*=None)

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*)

Initialize self. See help(type(self)) for accurate signature.

Attributes

<code>input_fields</code>
<code>is_set</code>
<code>ranges</code>
<code>value</code>
<code>values</code>

input_fields

`Ranges.input_fields` = ('excel', 'sheet', 'n1', 'n2', 'r1', 'r2')

is_set

`Ranges.is_set`

ranges

`Ranges.ranges`

value

Ranges.**value**

values

Ranges.**values**

2.1.7.7 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)

Methods

__init__

Initialize self.

add

compile

update_inputs

`__init__`

`Cell.__init__(reference, value, context=None)`
Initialize self. See help(type(self)) for accurate signature.

`add`

`Cell.add(dsp, context=None)`

`compile`

`Cell.compile(references=None)`

`update_inputs`

`Cell.update_inputs(references=None)`
`__init__(reference, value, context=None)`
Initialize self. See help(type(self)) for accurate signature.

CellWrapper

`class CellWrapper(func, parse_args, parse_kwargs)`

Methods

<code>__init__</code>	Initialize self.
<code>check_cycles</code>	

`__init__`

`CellWrapper.__init__(func, parse_args, parse_kwargs)`
Initialize self. See help(type(self)) for accurate signature.

`check_cycles`

`CellWrapper.check_cycles(cycle)`
`__init__(func, parse_args, parse_kwargs)`
Initialize self. See help(type(self)) for accurate signature.

RangesAssembler

`class RangesAssembler(ref, context=None)`

Methods

<code>__init__</code>	Initialize self.
<code>add</code>	
<code>push</code>	

`__init__`

`RangesAssembler.__init__(ref, context=None)`
Initialize self. See `help(type(self))` for accurate signature.

`add`

`RangesAssembler.add(dsp)`

`push`

`RangesAssembler.push(cell)`
`__init__(ref, context=None)`
Initialize self. See `help(type(self))` for accurate signature.

Attributes

<code>output</code>

`output`

`RangesAssembler.output`

Ref

class `Ref` (*reference, value, context=None*)

Methods

<code>__init__</code>	Initialize self.
<code>add</code>	
<code>compile</code>	
<code>update_inputs</code>	

`__init__`

`Ref.__init__(reference, value, context=None)`
Initialize self. See `help(type(self))` for accurate signature.

add

`Ref.add(dsp, context=None)`

compile

`Ref.compile(references=None)`

update_inputs

`Ref.update_inputs(references=None)`

`__init__(reference, value, context=None)`

Initialize self. See help(type(self)) for accurate signature.

2.1.7.8 excel

It provides Excel model class.

Sub-Modules:

<code>cycle</code>	A dependency-free version of networkx's implementation of <i>simple_cycles</i> .
<code>xlreader</code>	It provides a custom Excel Reader class.

cycle

A dependency-free version of networkx's implementation of *simple_cycles*.

Functions

<code>simple_cycles</code>

simple_cycles

`simple_cycles(graph, copy=True)`

xlreader

It provides a custom Excel Reader class.

Functions

<code>load_workbook</code>

load_workbook

load_workbook (*filename*, ****kw**)

Classes

XlReader

XlReader

class XlReader (**args*, *raw_date=True*, ****kwargs**)

Methods

<code>__init__</code>	Initialize self.
<code>read</code>	
<code>read_chartsheet</code>	
<code>read_manifest</code>	
<code>read_properties</code>	
<code>read_strings</code>	
<code>read_theme</code>	
<code>read_workbook</code>	
<code>read_worksheets</code>	

`__init__`

`XlReader.__init__` (**args*, *raw_date=True*, ****kwargs**)
 Initialize self. See `help(type(self))` for accurate signature.

`read`

`XlReader.read` ()

`read_chartsheet`

`XlReader.read_chartsheet` (*sheet*, *rel*)

`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)`
Initialize self. See help(type(self)) for accurate signature.

Classes

ExcelModel

XlCircular

ExcelModel

class ExcelModel

Methods

<code>__init__</code>	Initialize self.
<code>add_book</code>	
<code>add_cell</code>	
<code>add_references</code>	
<code>add_sheet</code>	
<code>calculate</code>	
<code>compile</code>	
<code>complete</code>	
<code>external_links</code>	
<code>finish</code>	
<code>formula_ranges</code>	
<code>formula_references</code>	
<code>load</code>	
<code>loads</code>	
<code>push</code>	
<code>pushes</code>	

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<code>solve_circular</code>
<code>write</code>
<code>__init__</code>
<p><code>ExcelModel.__init__()</code></p> <p>Initialize self. See <code>help(type(self))</code> for accurate signature.</p>
<code>add_book</code>
<p><code>ExcelModel.add_book(book=None, context=None, data_only=False)</code></p>
<code>add_cell</code>
<p><code>ExcelModel.add_cell(cell, context, references=None, formula_references=None, formula_ranges=None, external_links=None)</code></p>
<code>add_references</code>
<p><code>ExcelModel.add_references(book, context=None)</code></p>
<code>add_sheet</code>
<p><code>ExcelModel.add_sheet(worksheet, context)</code></p>
<code>calculate</code>
<p><code>ExcelModel.calculate(*args, **kwargs)</code></p>
<code>compile</code>
<p><code>ExcelModel.compile(inputs, outputs)</code></p>
<code>complete</code>
<p><code>ExcelModel.complete()</code></p>
<code>external_links</code>
<p><code>ExcelModel.external_links(ctx)</code></p>
<code>finish</code>
<p><code>ExcelModel.finish(complete=True, circular=False)</code></p>

formula_ranges

ExcelModel.**formula_ranges** (*ctx*)

formula_references

ExcelModel.**formula_references** (*ctx*)

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** ()

write

ExcelModel.**write** (*books=None, solution=None, dirpath=None*)

__init__ ()

Initialize self. See help(type(self)) for accurate signature.

Attributes

references

references

ExcelModel.**references**

compile_class

alias of `schedula.utils.dsp.DispatchPipe`

XICircular**class** **XlCircular** (*args)**Methods**

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

Continued on next page

Table 81 – continued from previous page

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

`__init__``XlCircular.__init__(*args)`Initialize self. See `help(type(self))` for accurate signature.**`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()`

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()`

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()`

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.

Use `keyword.iskeyword()` to test for reserved identifiers such as “def” and “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()`

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()`

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()`

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()`

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.

replace

`XlCircular.replace()`

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()`

Return a right-justified string of length `width`.

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

rpartition

`XlCircular.rpartition()`

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()`

Return a list of the words in the string, using sep as the delimiter string.

sep The delimiter according which to split the string. None (the default value) means split according to any whitespace, and discard empty strings from the result.

maxsplit Maximum number of splits to do. -1 (the default value) means no limit.

Splits are done starting at the end of the string and working to the front.

rstrip

`XlCircular.rstrip()`

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()`

Return a list of the words in the string, using sep as the delimiter string.

sep The delimiter according which to split the string. None (the default value) means split according to any whitespace, and discard empty strings from the result.

maxsplit Maximum number of splits to do. -1 (the default value) means no limit.

splitlines

`XlCircular.splitlines()`

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()`

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

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()`

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()`

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

The string is never truncated.

`__init__(*args)`

Initialize self. See `help(type(self))` for accurate signature.

2.1.8 Changelog

2.1.8.1 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.

2.1.8.2 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!*.

2.1.8.3 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*.

2.1.8.4 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.

2.1.8.5 v0.1.4 (2018-10-19)

Fix

- (tokens) #20: Improve Number regex.

2.1.8.6 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.

2.1.8.7 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.

2.1.8.8 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.

2.1.8.9 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*).

2.1.8.10 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.

2.1.8.11 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.

2.1.8.12 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.

2.1.8.13 v0.0.7 (2017-07-20)

Feat

- (appveyor): Add python 3.6.
- (functions) [#4](#): Add *sumproduct* function.

Fix

- (install): Force update setuptools \geq 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.

2.1.8.14 v0.0.6 (2017-05-31)

Fix

- (plot): Update schedula to 0.1.12.
- (range): Sheet name without commas has this `[^Wd][w.]` format.

2.1.8.15 v0.0.5 (2017-05-04)

Fix

- (doc): Update schedula to 0.1.11.

2.1.8.16 v0.0.4 (2017-02-10)

Fix

- (regex): Remove deprecation warnings.

2.1.8.17 v0.0.3 (2017-02-09)

Fix

- (appveyor): Setup of lxml.
- (excel): Remove deprecation warning `openpyxl`.
- (requirements): Update schedula requirement 0.1.9.

2.1.8.18 v0.0.2 (2017-02-08)

Fix

- (setup): setup fails due to long description.
- (excel): Remove deprecation warning `remove_sheet` → `remove`.

CHAPTER 3

Indices and tables

- `genindex`
- `modindex`
- `search`

f

- `formulas`, 12
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