

COMS BC1016

Introduction to Computational Thinking and Data Science

Lecture 8: Functions, Groups, Pivots, and Joins

BARNARD COLLEGE OF COLUMBIA UNIVERSITY

Reminders

- HW 2 is due Wednesday
 - HW 3 due next week Wednesday
 - Remember to run the last cell
- Autograder is weird about Multiple Choice and True/False questions
 - TAs will manually grade

Midterm Info

- Midterm is during class Monday, October 20
 - Exam will cover material up until Wednesday, October 8
 - Monday, October 13 is a holiday (Indigenous Peoples' Day)
 - TAs will lead a midterm review during class Wednesday, October 15
- Paper exam
 - Can create and bring your own 5x7 notecard with notes on the exam
 - Notecard will be submitted along with the exam

Lecture Outline

- Functions
- Group and Pivot Tables
- `join`

Functions

Recall: Anatomy of a Function

Name, Parameters, Body, Return Statement

Example:

```
def convert_to_figs(weight):  
    new_weight = (weight / 7).round(1)  
    return new_weight
```

The diagram illustrates the anatomy of a function using the example code. Arrows map the labels from the first block to the corresponding parts of the code: a blue arrow points from 'Name' to 'def', a purple arrow from 'Parameters' to '(weight)', an orange arrow from 'Body' to the assignment statement, and a green arrow from 'Return Statement' to the 'return' statement. A long green arrow also points from the 'Return Statement' label to the 'return' statement.

Example

What does this function do?

- What type of input do you expect it takes?
- What type of output will it give?
- What's a reasonable name for the function?

```
def f(s):  
    return s / sum(s) * 100
```

Example

What does this function do?

- What type of input do you expect it takes?
- What type of output will it give?
- What's a reasonable name for the function?

```
def percent(s):  
    return s / sum(s) * 100
```


Function Documentation

`sum?`

Signature: `sum(iterable, /, start=0)`

Docstring:

Return the sum of a 'start' value (default: 0) plus an iterable of numbers

When the iterable is empty, return the start value.

This function is intended specifically for use with numeric values and may reject non-numeric types.

Type: `builtin_function_or_method`

Function Documentation

np.where?

Call signature: np.where(*args, **kwargs)

Type: _ArrayFunctionDispatcher

String form: <built-in function where>

Docstring:

where(condition, [x, y], /)

Return elements chosen from `x` or `y` depending on `condition`.

.. note::

When only `condition` is provided, this function is a shorthand for ``np.asarray(condition).nonzero()``. Using `nonzero` directly should be preferred, as it behaves correctly for subclasses. The rest of this documentation covers only the case where all three arguments are provided.

Parameters

condition : array_like, bool

Where True, yield `x`, otherwise yield `y`.

x, y : array_like

Values from which to choose. `x`, `y` and `condition` need to be broadcastable to some shape.

Returns

out : ndarray

An array with elements from `x` where `condition` is True, and elements from `y` elsewhere.

Function Documentation

make_array?

Signature: make_array(*elements)

Docstring:

Returns an array containing all the arguments passed to this function.
A simple way to make an array with a few elements.

As with any array, all arguments should have the same type.

```
>>> make_array(0)
```

```
array([0])
```

```
>>> make_array(2, 3, 4)
```

```
array([2, 3, 4])
```

```
>>> make_array("foo", "bar")
```

```
array(['foo', 'bar'],  
      dtype='<U3')
```

```
>>> make_array()
```

```
array([], dtype=float64)
```

File: /opt/conda/lib/python3.12/site-packages/datascience/util.py

Type: function

Adding Documentation

Putting a string in the first line of a function body defines the **Docstring**

- Typically describes behavior and expectations about its arguments

```
def convert_to_figs(weight):  
    '''Divides the input by 7 (Figs weight) and  
    then rounds to the first decimal place'''  
    new_weight = (weight/7).round(1)  
    return new_weight
```

Adding Documentation

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    return new_weight
```

convert_to_figs?

Signature: convert_to_figs(weight)

Docstring:

Divides the input by 7 (Figs weight) and
then rounds to the first decimal place

File: /tmp/ipykernel_201/903026817.py

Type: function

Functions with Multiple Arguments/Parameters

Functions can take in multiple inputs

- Each argument is given a unique name and separated by commas

```
def convert_to_figs(weight, decimal_places):  
    '''Divides the input by 7 (Figs weight) and then rounds to  
    the given number of decimal places'''  
    new_weight = (weight/7).round(decimal_places)  
    return new_weight
```


Functions with Multiple Arguments/Parameters

Functions can take in multiple inputs

- Each argument is given a unique name and separated by commas
- Specifying default values for particular inputs to makes them optional

```
def convert_to_figs(weight, decimal_places=1):  
    '''Divides the input by 7 (Figs weight) and then rounds to  
    the given number of decimal places'''  
    new_weight = (weight/7).round(decimal_places)  
    return new_weight
```

Groups and Pivot Tables

Groups and Pivots

Two ways of **summarizing** table data by categorical variables

Recall: Prof Lee's Cat Census

Professor Lee is in a cat picture group chat. She has collected data on the cats shared in this chat:

Name	Age	Weight	Coloring	Sex	Owner
Ruby	14	8	tuxedo	F	Alice
Gertrude	15	12	tuxedo	F	Alice
Hamby	8	16	tabby	M	Bob
Fig	3	7	tabby	F	Bob
Corina	6	10	tortie	F	Carol
Frito	2	8.5	tabby	M	Carol

Grouping by a Single Column

The `group` method aggregates all rows with the same value in column `c`

- `tbl.group(c)`
- `tbl.group(c, func)`

`group` can optionally apply `func` to grouped values, for example:

- `len`: count of grouped values (default)
- `list`: list of all grouped values
- `sum`: total of all grouped values

```
cat_tbl.group('Owner')
```

Owner	count
Alice	2
Bob	2
Carol	2

```
cat_tbl.group('Owner', np.average)
```

Owner	Name average	Age average	Weight average	Coloring average	Sex average
Alice		14.5	10		
Bob		5.5	11.5		
Carol		4	9.25		

Grouping by Multiple Columns

The `group` method can also aggregate all rows that *share the combination of values* from multiple columns

```
cat_tbl.group(['Owner', 'Sex'])
```

Owner	Sex	count
Alice	F	2
Bob	F	1
Bob	M	1
Carol	F	1
Carol	M	1

```
cat_tbl.group(['Sex', 'Coloring'], sum)
```

Sex	Coloring	Name sum	Age sum	Weight sum	Owner sum
F	tabby		3	7	
F	tortie		6	10	
F	tuxedo		29	20	
M	tabby		10	24.5	

Pivot Tables

Cross-classifies according to *two* categorical variables

- Produces a grid of all possible combinations of the two categorical variables
- Grid entries are either counts or aggregated values

Create a pivot table where entries are counts:

```
tbl.pivot(col_var, row_var)
```

Create a pivot table where entries are aggregated according function
collect on values in column values

```
tbl.pivot(col_var, row_var, values, collect)
```

Pivot Tables

```
tbl.pivot(col_var, row_var)
```

- `col_var`: Variable that forms column labels of grid
- `row_var`: Variable that forms row labels of grid

```
cat_tbl.pivot('Owner', 'Sex')
```

Sex	Alice	Bob	Carol
F	2	1	1
M	0	1	1

Pivot Tables

```
tbl.pivot(col_var, row_var, values, collect)
```

- values: Table column to aggregate
- collect: Function to aggregate with

Either include **both** values and collect or **neither**

```
cat_tbl.pivot('Owner', 'Sex', 'Age', np.average)
```

Sex	Alice	Bob	Carol
F	14.5	3	6
M	0	8	2

Group vs Pivot

Group

- One combo of grouping variables **per row**
- **Any number** of grouping variables
- Aggregate values of **all other columns** in the table
- Missing combos are **absent**

```
cat_tbl.group(['Sex', 'Coloring'], np.average)
```

Sex	Coloring	Name average	Age average	Weight average	Owner average
F	tabby		3	7	
F	tortie		6	10	
F	tuxedo		14.5	10	
M	tabby		5	12.25	

Pivot

- One combo of grouping variables **per entry**
- **Two** grouping variables: columns and rows
- Aggregate values of **values column**
- Missing combos = **0 (or empty string)**

```
cat_tbl.pivot('Sex', 'Coloring', 'Weight', np.average)
```

Coloring	F	M
tabby	7	12.25
tortie	10	0
tuxedo	10	0

Joining Two Tables

Sometimes data about the same individuals are in different tables

- `join` combines the two datasets together
- Entries that do not appear in both tables are not included in the new table

To combine entries from `table1` and `table2` based on columns `c1` and `c2`

- `table1.join(c1, table2, c2)`

join Example

bubble_tea

cafe	drinks	prices
Gong Cha	Matcha Tea Latte	5.75
Tea Magic	Oolong Milk Tea	8
Hey Tea	Coconut Mango Boom	6.49
Moge Tee	Taro Milk Tea	7.45

discounts

% off	location
10	Gong Cha
25	Hey Tea
5	Moge Tee

join Example

bubble_tea

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discounts

% off	location
10	Gong Cha
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```
bubble_tea.join('cafe', discounts, 'location')
```

Match rows in
this table...

...using values in
this column ...

...with rows in this
second table...

...using values in
this column.

join Example

bubble_t teas

cafe	drinks	prices
Gong Cha	Matcha Tea Latte	5.75
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discounts

% off	location
10	Gong Cha
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```
bubble_t teas.join('cafe', discounts, 'location')
```

Match rows in this table...

...using values in this column ...

...with rows in this second table...

...using values in this column.

output:

cafe	drinks	prices	% off
Gong Cha	Matcha Tea Latte	5.75	10
Hey Tea	Coconut Mango Boom	6.49	25
Moge Tee	Taro Milk Tea	7.45	5

join Example

`bubble_t teas`

cafe	drinks	prices
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Tea Magic	Oolong Milk Tea	8
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`discounts`

% off	location
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```
bubble_t teas.join('cafe', discounts, 'location')
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Match rows in this table...

...using values in this column ...

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output:

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Next Class

- Conditionals and Iteration (if/else, for loops)