datascience Documentation

Release 0.8.1

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The `datascience` package was written for use in Berkeley's DS 8 course and contains useful functionality for investigating and graphically displaying data.

CHAPTER 1

Start Here: `datascience` Tutorial

This is a brief introduction to the functionality in `datascience`. For a complete reference guide, please see *Tables (datascience.tables)*.

For other useful tutorials and examples, see:

- The textbook introduction to Tables
- Example notebooks

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1.1 Getting Started

The most important functionality in the package is is the `Table` class, which is the structure used to represent columns of data. First, load the class:

```
In [1]: from datascience import Table
```

In the IPython notebook, type `Table.` followed by the TAB-key to see a list of members.

Note that for the Data Science 8 class we also import additional packages and settings for all assignments and labs. This is so that plots and other available packages mirror the ones in the textbook more closely. The exact code we use is:

```
# HIDDEN

import matplotlib
matplotlib.use('Agg')
from datascience import Table
%matplotlib inline
import matplotlib.pyplot as plt
```

```
import numpy as np
plt.style.use('fivethirtyeight')
```

In particular, the lines involving `matplotlib` allow for plotting within the IPython notebook.

1.2 Creating a Table

A Table is a sequence of labeled columns of data.

A Table can be constructed from scratch by extending an empty table with columns.

```
In [2]: t = Table().with_columns([
   ...:     'letter', ['a', 'b', 'c', 'z'],
   ...:     'count',  [  9,   3,   3,   1],
   ...:     'points', [  1,   2,   2,  10],
   ...: ])
   ...:

In [3]: print(t)
letter | count | points
a      | 9     | 1
b      | 3     | 2
c      | 3     | 2
z      | 1     | 10
```

More often, a table is read from a CSV file (or an Excel spreadsheet). Here's the content of an example file:

```
In [4]: cat sample.csv
x,y,z
1,10,100
2,11,101
3,12,102
```

And this is how we load it in as a `Table` using *`read_table()`*:

```
In [5]: Table.read_table('sample.csv')
Out[5]:
x    | y    | z
1    | 10   | 100
2    | 11   | 101
3    | 12   | 102
```

CSVs from URLs are also valid inputs to *`read_table()`*:

```
In [6]: Table.read_table('http://data8.org/textbook/notebooks/sat2014.csv')
Out[6]:
State        | Participation Rate | Critical Reading | Math | Writing | Combined
North Dakota | 2.3                | 612              | 620  | 584     | 1816
Illinois     | 4.6                | 599              | 616  | 587     | 1802
Iowa         | 3.1                | 605              | 611  | 578     | 1794
South Dakota | 2.9                | 604              | 609  | 579     | 1792
Minnesota    | 5.9                | 598              | 610  | 578     | 1786
Michigan     | 3.8                | 593              | 610  | 581     | 1784
Wisconsin    | 3.9                | 596              | 608  | 578     | 1782
Missouri     | 4.2                | 595              | 597  | 579     | 1771
Wyoming      | 3.3                | 590              | 599  | 573     | 1762
```

```
Kansas        | 5.3                     | 591                 | 596  | 566      | 1753
... (41 rows omitted)
```

It's also possible to add columns from a dictionary, but this option is discouraged because dictionaries do not preserve column order.

```
In [7]: t = Table().with_columns({
   ...:     'letter': ['a', 'b', 'c', 'z'],
   ...:     'count':  [  9,   3,   3,   1],
   ...:     'points': [  1,   2,   2,  10],
   ...: })
   ...:

In [8]: print(t)
letter | points | count
a      | 1      | 9
b      | 2      | 3
c      | 2      | 3
z      | 10     | 1
```

1.3 Accessing Values

To access values of columns in the table, use *column()*, which takes a column label or index and returns an array. Alternatively, *columns()* returns a list of columns (arrays).

```
In [9]: t
Out[9]:
letter | points | count
a      | 1      | 9
b      | 2      | 3
c      | 2      | 3
z      | 10     | 1

In [10]: t.column('letter')
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
array(['a', 'b', 'c', 'z'],
      dtype='<U1')

In [11]: t.column(1)
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
```

You can use bracket notation as a shorthand for this method:

```
In [12]: t['letter'] # This is a shorthand for t.column('letter')
Out[12]:
array(['a', 'b', 'c', 'z'],
      dtype='<U1')

In [13]: t[1]        # This is a shorthand for t.column(1)
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\Out[13]: array([ 1,  2,  2, 10])
```

To access values by row, *row()* returns a row by index. Alternatively, *rows()* returns an list-like `Rows` object that contains tuple-like `Row` objects.

```
In [14]: t.rows
Out[14]:
Rows(letter | points | count
a       | 1       | 9
b       | 2       | 3
c       | 2       | 3
z       | 10      | 1)

In [15]: t.rows[0]
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

In [16]: t.row(0)
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

In [17]: second = t.rows[1]

In [18]: second
Out[18]: Row(letter='b', points=2, count=3)

In [19]: second[0]
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\Out[19]: 'b'

In [20]: second[1]
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\Out[20]: 2
```

To get the number of rows, use *num_rows*.

```
In [21]: t.num_rows
Out[21]: 4
```

1.4 Manipulating Data

Here are some of the most common operations on data. For the rest, see the reference (*Tables (datascience.tables)*).

Adding a column with *with_column()*:

```
In [22]: t
Out[22]:
letter | points | count
a      | 1      | 9
b      | 2      | 3
c      | 2      | 3
z      | 10     | 1

In [23]: t.with_column('vowel?', ['yes', 'no', 'no', 'no'])
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
letter | points | count | vowel?
a      | 1      | 9     | yes
b      | 2      | 3     | no
c      | 2      | 3     | no
z      | 10     | 1     | no

In [24]: t # .with_column returns a new table without modifying the original
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
letter | points | count
a      | 1      | 9
b      | 2      | 3
```

```
c      | 2      | 3
z      | 10     | 1

In [25]: t.with_column('2 * count', t['count'] * 2) # A simple way to operate on columns
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
letter | points | count | 2 * count
a      | 1      | 9     | 18
b      | 2      | 3     | 6
c      | 2      | 3     | 6
z      | 10     | 1     | 2
```

Selecting columns with *select()*:

```
In [26]: t.select('letter')
Out[26]:
letter
a
b
c
z

In [27]: t.select(['letter', 'points'])
\\\\\\\\\\\\\\\\\\\\\\\\\Out[27]:
letter | points
a      | 1
b      | 2
c      | 2
z      | 10
```

Renaming columns with *relabeled()*:

```
In [28]: t
Out[28]:
letter | points | count
a      | 1      | 9
b      | 2      | 3
c      | 2      | 3
z      | 10     | 1

In [29]: t.relabeled('points', 'other name')
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
letter | other name | count
a      | 1          | 9
b      | 2          | 3
c      | 2          | 3
z      | 10         | 1

In [30]: t
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
letter | points | count
a      | 1      | 9
b      | 2      | 3
c      | 2      | 3
z      | 10     | 1

In [31]: t.relabeled(['letter', 'count', 'points'], ['x', 'y', 'z'])
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
x    | z    | y
a    | 1    | 9
```

```
b      | 2      | 3
c      | 2      | 3
z      | 10     | 1
```

Selecting out rows by index with *take()* and conditionally with *where()*:

```
In [32]: t
Out[32]:
letter | points | count
a      | 1      | 9
b      | 2      | 3
c      | 2      | 3
z      | 10     | 1

In [33]: t.take(2) # the third row
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
letter | points | count
c      | 2      | 3

In [34]: t.take[0:2] # the first and second rows
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
letter | points | count
a      | 1      | 9
b      | 2      | 3
```

```
In [35]: t.where('points', 2) # rows where points == 2
Out[35]:
letter | points | count
b      | 2      | 3
c      | 2      | 3

In [36]: t.where(t['count'] < 8) # rows where count < 8
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\Out[36]:
letter | points | count
b      | 2      | 3
c      | 2      | 3
z      | 10     | 1

In [37]: t['count'] < 8 # .where actually takes in an array of booleans
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

In [38]: t.where([False, True, True, True]) # same as the last line
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
letter | points | count
b      | 2      | 3
c      | 2      | 3
z      | 10     | 1
```

Operate on table data with *sort()*, *group()*, and *pivot()*

```
In [39]: t
Out[39]:
letter | points | count
a      | 1      | 9
b      | 2      | 3
c      | 2      | 3
z      | 10     | 1

In [40]: t.sort('count')
```

```
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
letter | points | count
z      | 10     | 1
b      | 2      | 3
c      | 2      | 3
a      | 1      | 9

In [41]: t.sort('letter', descending = True)
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
letter | points | count
z      | 10     | 1
c      | 2      | 3
b      | 2      | 3
a      | 1      | 9
```

```
# You may pass a reducing function into the collect arg
# Note the renaming of the points column because of the collect arg
In [42]: t.select(['count', 'points']).group('count', collect=sum)
Out[42]:
count | points sum
1     | 10
3     | 4
9     | 1
```

```
In [43]: other_table = Table().with_columns([
   ....:     'mar_status',  ['married', 'married', 'partner', 'partner', 'married'],
   ....:     'empl_status', ['Working as paid', 'Working as paid', 'Not working',
   ....:                     'Not working', 'Not working'],
   ....:     'count',       [1, 1, 1, 1, 1]])
   ....:

In [44]: other_table
Out[44]:
mar_status | empl_status     | count
married    | Working as paid | 1
married    | Working as paid | 1
partner    | Not working     | 1
partner    | Not working     | 1
married    | Not working     | 1

In [45]: other_table.pivot('mar_status', 'empl_status', 'count', collect=sum)
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
empl_status     | married | partner
Not working     | 1       | 2
Working as paid | 2       | 0
```

1.5 Visualizing Data

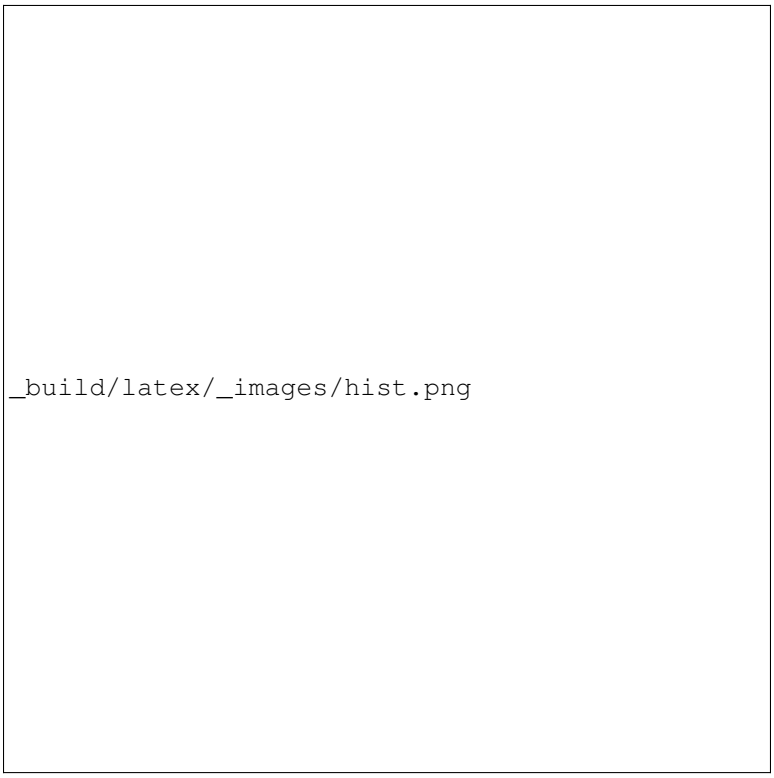
We'll start with some data drawn at random from two normal distributions:

```
In [46]: normal_data = Table().with_columns([
   ....:     'data1', np.random.normal(loc = 1, scale = 2, size = 100),
   ....:     'data2', np.random.normal(loc = 4, scale = 3, size = 100)])
   ....:

In [47]: normal_data
```

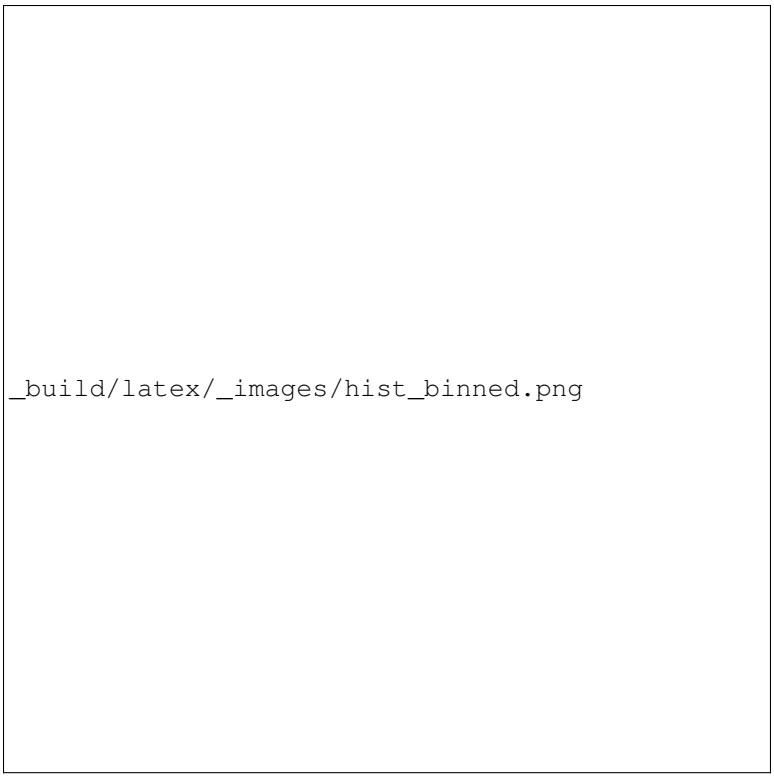
```
Out[47]:
data1     | data2
-0.535967 | -3.14428
-0.614834 | 8.86984
2.53729   | 6.92521
-3.28098  | 4.30304
2.56035   | 6.87111
-0.276579 | 2.52273
0.188342  | 7.59763
2.31034   | 0.243086
3.25435   | 0.839304
2.51925   | 6.13728
... (90 rows omitted)
```

Draw histograms with *hist()*:

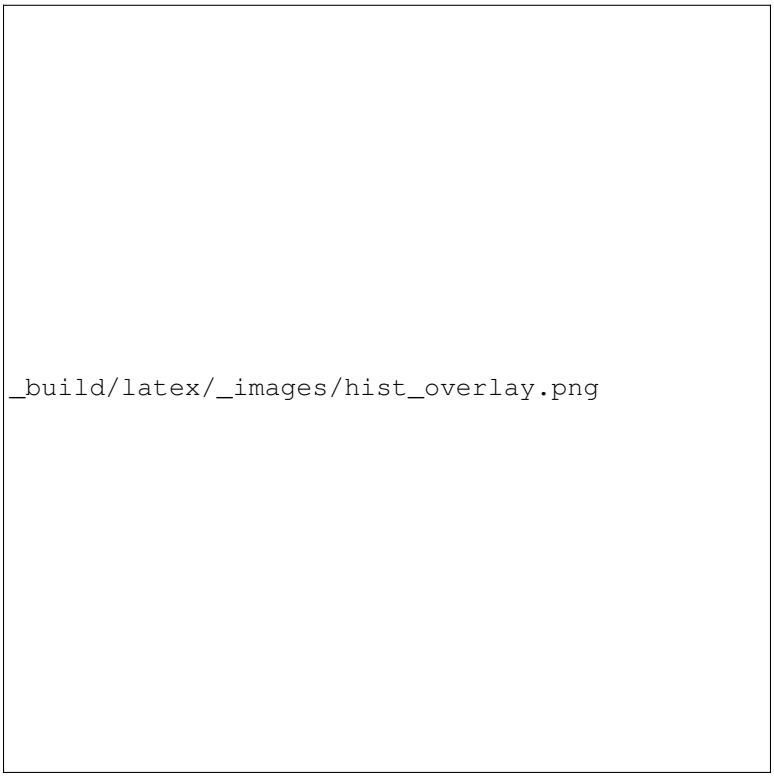
```
In [48]: normal_data.hist()
```




```
In [49]: normal_data.hist(bins = range(-5, 10))
```

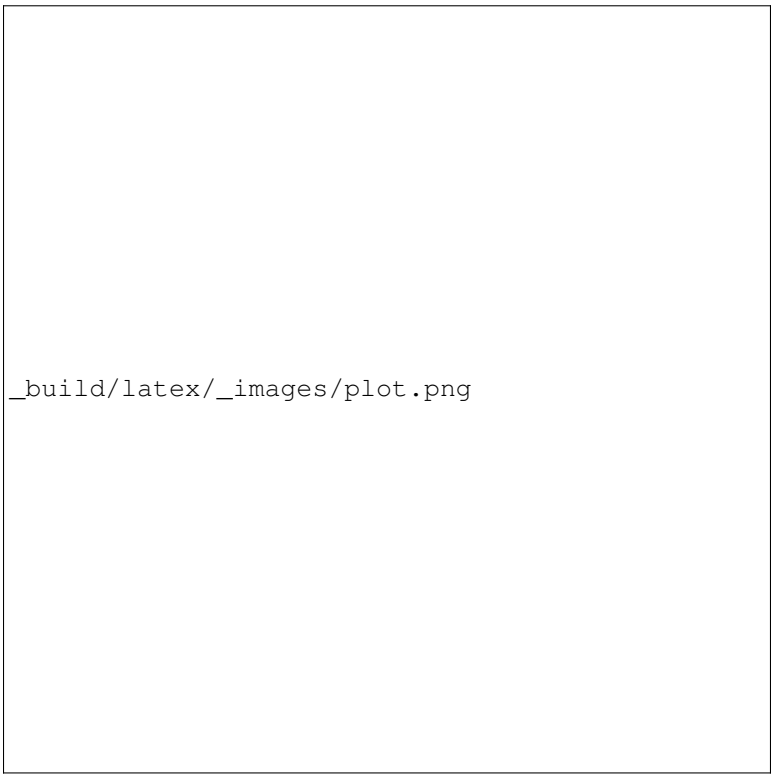



```
In [50]: normal_data.hist(bins = range(-5, 10), overlay = True)
```

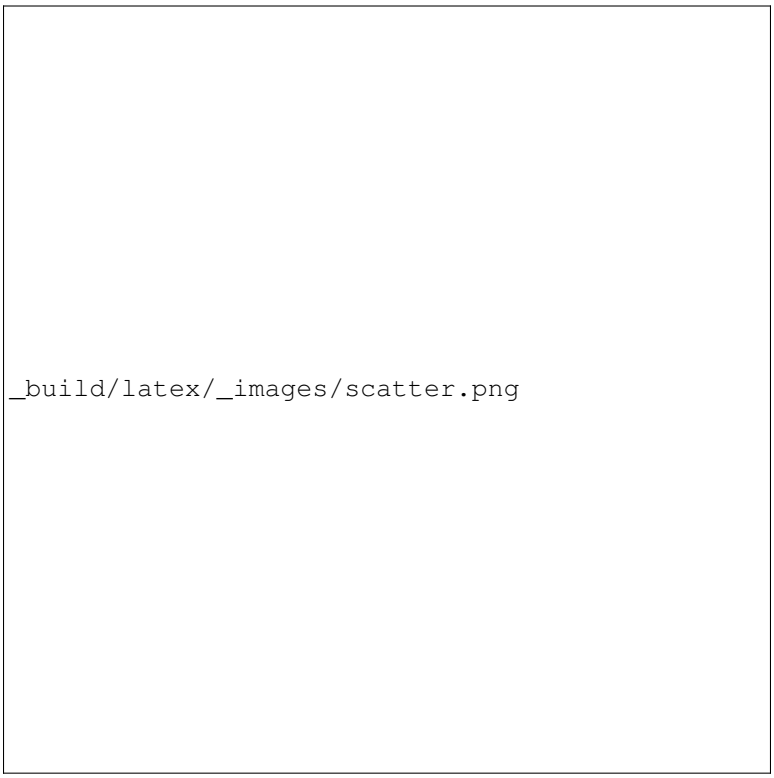


If we treat the `normal_data` table as a set of x-y points, we can *`plot()`* and *`scatter()`*:

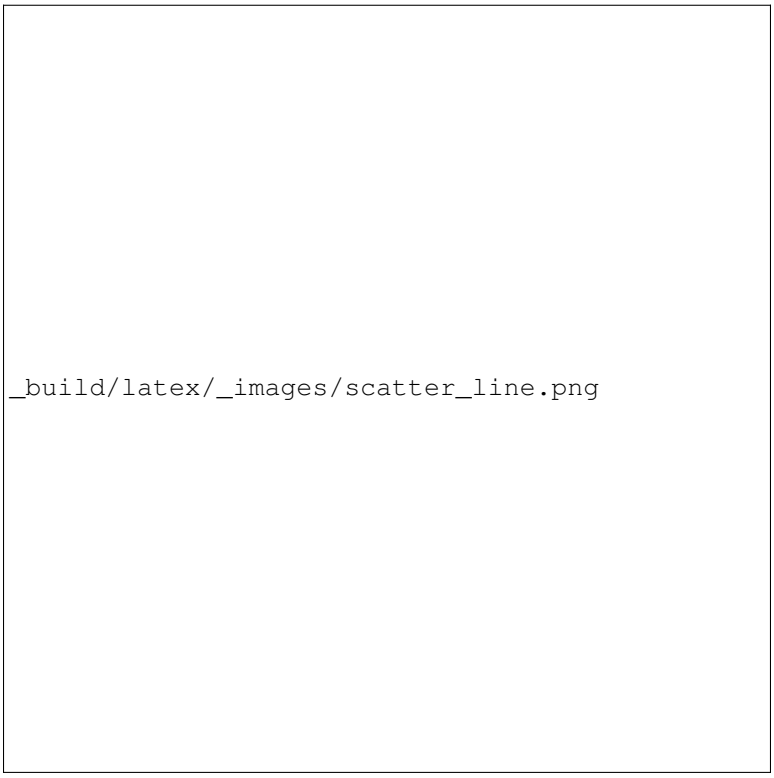
```
In [51]: normal_data.sort('data1').plot('data1') # Sort first to make plot nicer
```




```
In [52]: normal_data.scatter('data1')
```

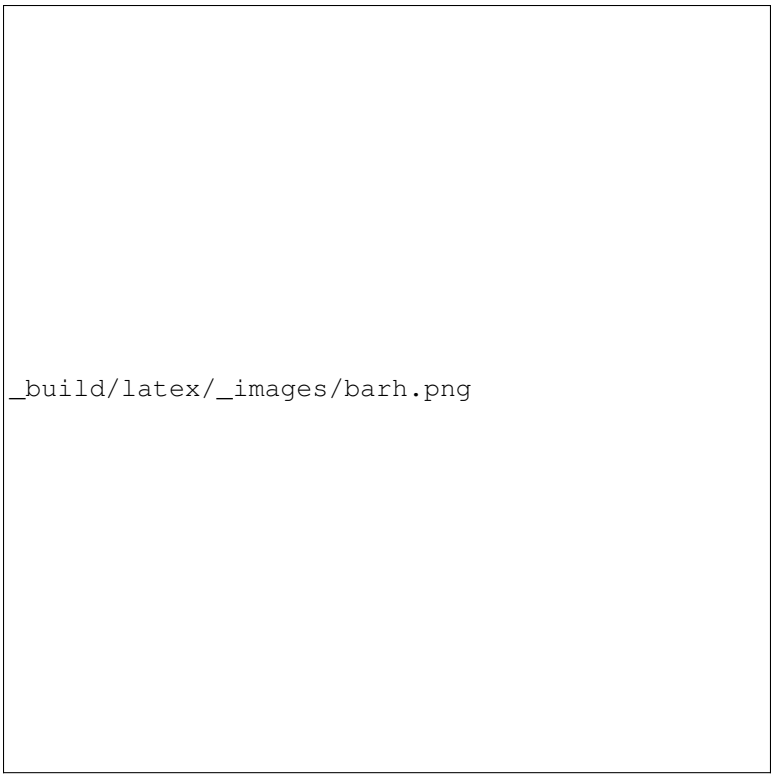


```
In [53]: normal_data.scatter('data1', fit_line = True)
```



Use *barh()* to display categorical data.

```
In [54]: t
Out[54]:
letter | points | count
a      | 1      | 9
b      | 2      | 3
c      | 2      | 3
z      | 10     | 1

In [55]: t.barh('letter')
```



1.6 Exporting

Exporting to CSV is the most common operation and can be done by first converting to a pandas dataframe with *to_df()*:

```
In [56]: normal_data
Out[56]:
data1     | data2
-0.535967 | -3.14428
-0.614834 | 8.86984
2.53729   | 6.92521
-3.28098  | 4.30304
2.56035   | 6.87111
-0.276579 | 2.52273
0.188342  | 7.59763
2.31034   | 0.243086
3.25435   | 0.839304
2.51925   | 6.13728
... (90 rows omitted)

# index = False prevents row numbers from appearing in the resulting CSV
In [57]: normal_data.to_df().to_csv('normal_data.csv', index = False)
```

1.7 An Example

We'll recreate the steps in Chapter 3 of the textbook to see if there is a significant difference in birth weights between smokers and non-smokers using a bootstrap test.

For more examples, check out the TableDemos repo.

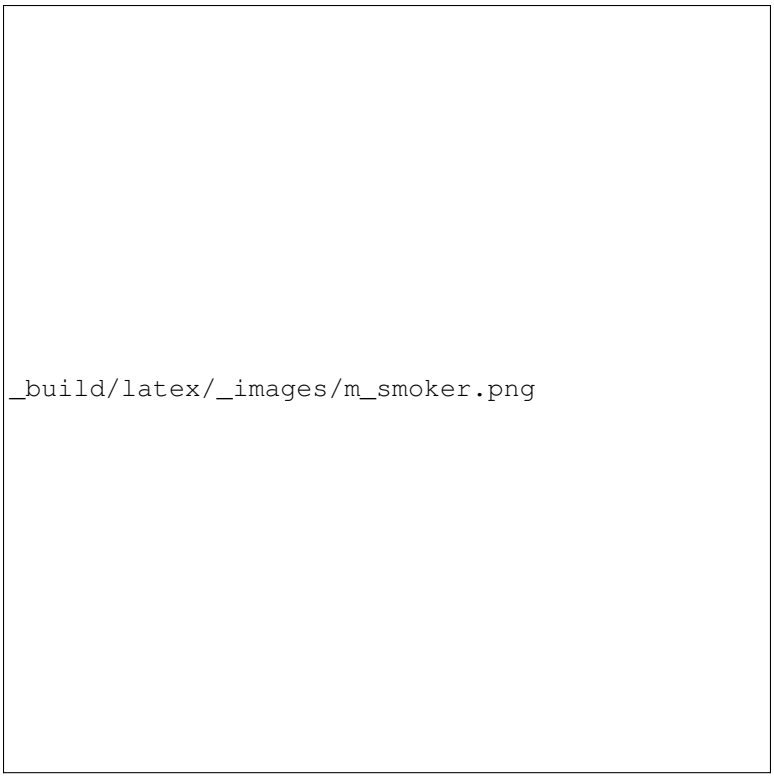
From the text:

> The table `baby` contains data on a random sample of 1,174 mothers and their newborn babies. The column `birthwt` contains the birth weight of the baby, in ounces; `gest_days` is the number of gestational days, that is, the number of days the baby was in the womb. There is also data on maternal age, maternal height, maternal pregnancy weight, and whether or not the mother was a smoker.

```
In [58]: baby = Table.read_table('https://github.com/data-8/textbook/raw/9aa0a167bc514749338cd7754f2b

In [59]: baby # Let's take a peek at the table
Out[59]:
birthwt | gest_days | mat_age | mat_ht | mat_pw | m_smoker
120     | 284       | 27      | 62     | 100    | 0
113     | 282       | 33      | 64     | 135    | 0
128     | 279       | 28      | 64     | 115    | 1
108     | 282       | 23      | 67     | 125    | 1
136     | 286       | 25      | 62     | 93     | 0
138     | 244       | 33      | 62     | 178    | 0
132     | 245       | 23      | 65     | 140    | 0
120     | 289       | 25      | 62     | 125    | 0
143     | 299       | 30      | 66     | 136    | 1
140     | 351       | 27      | 68     | 120    | 0
... (1164 rows omitted)

# Select out columns we want.
In [60]: smoker_and_wt = baby.select(['m_smoker', 'birthwt'])

In [61]: smoker_and_wt
Out[61]:
m_smoker | birthwt
0        | 120
0        | 113
1        | 128
1        | 108
0        | 136
0        | 138
0        | 132
0        | 120
1        | 143
0        | 140
... (1164 rows omitted)
```

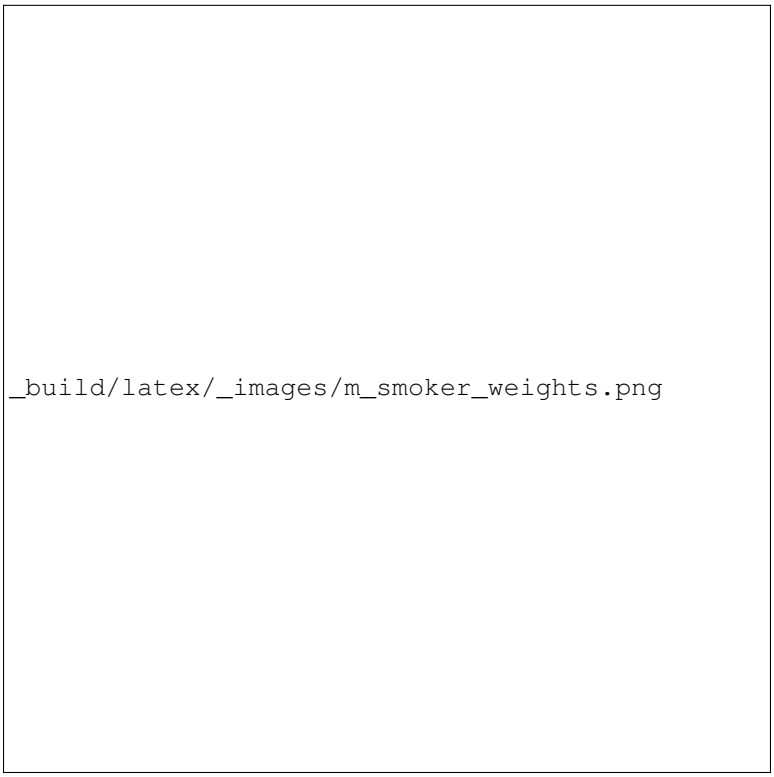
Let's compare the number of smokers to non-smokers.

```
In [62]: smoker_and_wt.select('m_smoker').hist(bins = [0, 1, 2]);
```



We can also compare the distribution of birthweights between smokers and non-smokers.

```
# Non smokers
# We do this by grabbing the rows that correspond to mothers that don't
# smoke, then plotting a histogram of just the birthweights.
In [63]: smoker_and_wt.where('m_smoker', 0).select('birthwt').hist()

# Smokers
In [64]: smoker_and_wt.where('m_smoker', 1).select('birthwt').hist()
```



What's the difference in mean birth weight of the two categories?

```
In [65]: nonsmoking_mean = smoker_and_wt.where('m_smoker', 0).column('birthwt').mean()

In [66]: smoking_mean = smoker_and_wt.where('m_smoker', 1).column('birthwt').mean()
```

```
In [67]: observed_diff = nonsmoking_mean - smoking_mean

In [68]: observed_diff
Out[68]: 9.2661425720249184
```

Let's do the bootstrap test on the two categories.

```
In [69]: num_nonsmokers = smoker_and_wt.where('m_smoker', 0).num_rows

In [70]: def bootstrap_once():
   ....:     """
   ....:     Computes one bootstrapped difference in means.
   ....:     The table.sample method lets us take random samples.
   ....:     We then split according to the number of nonsmokers in the original sample.
   ....:     """
   ....:     resample = smoker_and_wt.sample(with_replacement = True)
   ....:     bootstrap_diff = resample.column('birthwt')[:num_nonsmokers].mean() - \
   ....:         resample.column('birthwt')[num_nonsmokers:].mean()
   ....:     return bootstrap_diff
   ....:

In [71]: repetitions = 1000

In [72]: bootstrapped_diff_means = np.array(
   ....:     [ bootstrap_once() for _ in range(repetitions) ])
   ....:

In [73]: bootstrapped_diff_means[:10]
Out[73]:
array([-0.24838125, -1.99726069,  1.56550117, -1.26133736,  0.69877965,
        0.29449244,  0.63692125,  2.21016195,  0.20006399, -0.06448192])

In [74]: num_diffs_greater = (abs(bootstrapped_diff_means) > abs(observed_diff)).sum()

In [75]: p_value = num_diffs_greater / len(bootstrapped_diff_means)

In [76]: p_value
Out[76]: 0.0
```

1.8 Drawing Maps

To come.

CHAPTER 2

Reference

2.1 Tables (`datascience.tables`)

Summary of methods for Table. Click a method to see its documentation.

One note about reading the method signatures for this page: each method is listed with its arguments. However, optional arguments are specified in brackets. That is, a method that's documented like

`Table.foo` (first_arg, second_arg[, some_other_arg, fourth_arg])

means that the `Table.foo` method must be called with first_arg and second_arg and optionally some_other_arg and fourth_arg. That means the following are valid ways to call `Table.foo`:

```
some_table.foo(1, 2)
some_table.foo(1, 2, 'hello')
some_table.foo(1, 2, 'hello', 'world')
some_table.foo(1, 2, some_other_arg='hello')
```

But these are not valid:

```
some_table.foo(1) # Missing arg
some_table.foo(1, 2[, 'hi']) # SyntaxError
some_table.foo(1, 2[, 'hello', 'world']) # SyntaxError
```

If that syntax is confusing, you can click the method name itself to get to the details page for that method. That page will have a more straightforward syntax.

At the time of this writing, most methods only have one or two sentences of documentation, so what you see here is all that you'll get for the time being. We are actively working on documentation, prioritizing the most complicated methods (mostly visualizations).

Creation

Table.__init__([labels, _deprecated, formatter])	Create an empty table with column labels.
Table.empty([labels])	Create an empty table.
Table.from_records(records)	Create a table from a sequence of records (dicts with fixed keys).
Table.from_columns_dict(columns)	Create a table from a mapping of column labels to column values.
Table.read_table(filepath_or_buffer, *args, ...)	Read a table from a file or web address.
Table.from_df(df)	Convert a Pandas DataFrame into a Table.
Table.from_array(arr)	Convert a structured NumPy array into a Table.

2.1.1 datascience.tables.Table.__init__

Table.**__init__**(*labels=None*, *_deprecated=None*, ***, *formatter=<datascience.formats.Formatter object>*)

Create an empty table with column labels.

```
>>> tiles = Table(['letter', 'count', 'points'])
>>> tiles
letter | count | points
```

Args: `labels` (list of strings): The column labels.

formatter (Formatter): An instance of `Formatter` that formats the columns' values.

2.1.2 datascience.tables.Table.empty

classmethod Table.**empty**(*labels=None*)

Create an empty table. Column labels are optional. [Deprecated]

Args:

labels (None or list): If `None`, a table with 0 columns is created. If a list, each element is a column label in a table with 0 rows.

Returns: A new instance of `Table`.

2.1.3 datascience.tables.Table.from_records

classmethod Table.**from_records**(*records*)

Create a table from a sequence of records (dicts with fixed keys).

2.1.4 datascience.tables.Table.from_columns_dict

classmethod Table.**from_columns_dict**(*columns*)

Create a table from a mapping of column labels to column values. [Deprecated]

2.1.5 datascience.tables.Table.read_table

classmethod Table.**read_table**(*filepath_or_buffer*, **args*, ***vargs*)

Read a table from a file or web address.

filepath_or_buffer – string or file handle / StringIO; The string could be a URL. Valid URL schemes include http, ftp, s3, and file.

2.1.6 datascience.tables.Table.from_df

classmethod Table.**from_df**(*df*)

Convert a Pandas DataFrame into a Table.

2.1.7 datascience.tables.Table.from_array

classmethod `Table.`**`from_array`**(*arr*)
Convert a structured NumPy array into a Table.

Extension (does not modify original table)

Table.with_column(label, values)	Return a table with an additional or replaced column.
Table.with_columns(*labels_and_values)	Return a table with additional or replaced columns.
Table.with_row(row)	Return a table with an additional row.
Table.with_rows(rows)	Return a table with additional rows.
Table.relabeled(label, new_label)	Returns a table with label changed to new_label.

2.1.8 datascience.tables.Table.with_column

`Table.`**`with_column`**(*label*, *values*)
Return a table with an additional or replaced column.

Args:

`label` **(str): The column label. If an existing label is used,** that column will be replaced in the returned table.

`values` **(single value or sequence): If a single value, every** value in the new column is `values`.

If a sequence, the new column contains the values in `values`. `values` must be the same length as the table.

Raises:

`ValueError`: If

- `label` is not a valid column name
- `values` is a list/array and does not have the same length as the number of rows in the table.

```
>>> tiles = Table().with_columns([
...     'letter', ['c', 'd'],
...     'count',  [2, 4],
... ])
>>> tiles.with_column('points', [3, 2])
letter | count | points
c      | 2     | 3
d      | 4     | 2
>>> tiles.with_column('count', 1)
letter | count
c      | 1
d      | 1
```

2.1.9 datascience.tables.Table.with_columns

`Table.`**`with_columns`**(**labels_and_values*)
Return a table with additional or replaced columns.

Args:

`labels_and_values`: An alternating list of labels and values or a list of label-values pairs.

```
    >>> Table().with_columns([
    ...     'letter', ['c', 'd'],
    ...     'count',  [2, 4],
    ... ])
    letter | count
    c      | 2
    d      | 4
    >>> Table().with_columns(
    ...     'letter', ['c', 'd'],
    ...     'count',  [2, 4],
    ... )
    letter | count
    c      | 2
    d      | 4
    >>> Table().with_columns([
    ...     ['letter', ['c', 'd']],
    ...     ['count',  [2, 4]],
    ... ])
    letter | count
    c      | 2
    d      | 4
    >>> Table().with_columns(
    ...     ['letter', ['c', 'd']],
    ...     ['count',  [2, 4]],
    ... )
    letter | count
    c      | 2
    d      | 4
    >>> Table().with_columns([
    ...     ['letter', ['c', 'd']],
    ... ])
    letter
    c
    d
    >>> Table().with_columns(
    ...     'letter', ['c', 'd'],
    ... )
    letter
    c
    d
    >>> Table().with_columns(
    ...     ['letter', ['c', 'd']],
    ... )
    letter
    c
    d
    >>> Table().with_columns({'letter': ['c', 'd']})
    letter
    c
    d
```

2.1.10 datascience.tables.Table.with_row

`Table.`**`with_row`**(*row*)

Return a table with an additional row.

Args: `row` (sequence): A value for each column.

Raises: `ValueError`: If the row length differs from the column count.

```
>>> tiles = Table(['letter', 'count', 'points'])
>>> tiles.with_row(['c', 2, 3]).with_row(['d', 4, 2])
letter | count | points
c      | 2     | 3
d      | 4     | 2
```

2.1.11 datascience.tables.Table.with_rows

`Table.`**`with_rows`**(*rows*)

Return a table with additional rows.

Args: `rows` (sequence of sequences): Each row has a value per column.

If `rows` is a 2-d array, its shape must be (_, n) for n columns.

Raises: `ValueError`: If a row length differs from the column count.

```
>>> tiles = Table(['letter', 'count', 'points'])
>>> tiles.with_rows([['c', 2, 3], ['d', 4, 2]])
letter | count | points
c      | 2     | 3
d      | 4     | 2
```

2.1.12 datascience.tables.Table.relabeled

`Table.`**`relabeled`**(*label*, *new_label*)

Returns a table with label changed to new_label.

`label` and `new_label` may be single values or lists specifying column labels to be changed and their new corresponding labels.

Args:

`label` **(str or sequence of str): The label(s) of** columns to be changed.

`new_label` **(str or sequence of str): The new label(s) of** columns to be changed. Same number of elements as label.

```
>>> tiles = Table(['letter', 'count'])
>>> tiles = tiles.with_rows([['c', 2], ['d', 4]])
>>> tiles.relabeled('count', 'number')
letter | number
c      | 2
d      | 4
```

Accessing values

Table.num_columns	Number of columns.
Table.columns	
Table.column(index_or_label)	Return the values of a column as an array.
Table.num_rows	Number of rows.
Table.rows	Return a view of all rows.
Table.row(index)	Return a row.
Table.labels	Return a tuple of column labels.

Table 2.3 – continued from previous page

Table.column_index(column_label)	Return the index of a column.
Table.apply(fn[, column_label])	Returns an array where `fn` is applied to each set of elements by row from the specified c

2.1.13 datascience.tables.Table.num_columns

`Table.`**`num_columns`**
Number of columns.

2.1.14 datascience.tables.Table.columns

`Table.`**`columns`**

2.1.15 datascience.tables.Table.column

`Table.`**`column`**(*index_or_label*)
Return the values of a column as an array.

table.column(label) is equivalent to table[label].

```
>>> tiles = Table().with_columns([
...     'letter', ['c', 'd'],
...     'count',  [2, 4],
... ])
>>> list(tiles.column('letter'))
['c', 'd']
>>> tiles.column(1)
array([2, 4])
```

Args: label (int or str): The index or label of a column

Returns: An instance of `numpy.array`.

2.1.16 datascience.tables.Table.num_rows

`Table.`**`num_rows`**
Number of rows.

2.1.17 datascience.tables.Table.rows

`Table.`**`rows`**
Return a view of all rows.

2.1.18 datascience.tables.Table.row

`Table.`**`row`**(*index*)
Return a row.

2.1.19 datascience.tables.Table.labels

`Table.`**`labels`**
Return a tuple of column labels.

2.1.20 datascience.tables.Table.column_index

`Table.`**`column_index`**(*column_label*)
Return the index of a column.

2.1.21 datascience.tables.Table.apply

`Table.`**`apply`**(*fn*, *column_label=None*)
Returns an array where `fn` is applied to each set of elements by row from the specified columns in `column_label`. If no column_label is specified, then each row is passed to fn.

Args:

`fn` **(function): The function to be applied to elements specified** by `column_label`.

`column_label` **(single string or list of strings): Names of** columns to be passed into function `fn`. Length must match number of elements `fn` takes.

Raises:

`ValueError`: column name in `column_label` is not an existing column in the table.

Returns: A numpy array consisting of results of applying `fn` to elements specified by `column_label` in each row.

```
>>> t = Table().with_columns([
...      'letter', ['a', 'b', 'c', 'z'],
...      'count',  [9, 3, 3, 1],
...      'points', [1, 2, 2, 10]])
>>> t
letter | count | points
a      | 9     | 1
b      | 3     | 2
c      | 3     | 2
z      | 1     | 10
>>> t.apply(lambda x: x - 1, 'points')
array([0, 1, 1, 9])
>>> t.apply(lambda x, y: x * y, ['count', 'points'])
array([ 9,  6,  6, 10])
```

Whole rows are passed to the function if no columns are specified.

```
>>> t.apply(lambda row: row.item('count') * 2)
array([18,  6,  6,  2])
```

Mutation (modifies table in place)

Table.set_format(column_label_or_labels, ...)	Set the format of a column.
Table.move_to_start(column_label)	Move a column to the first in order.
Table.move_to_end(column_label)	Move a column to the last in order.
Table.append(row_or_table)	Append a row or all rows of a table.

Continued on ne

Table 2.4 – continued from previous page

Table.append_column(label, values)	Appends a column to the table or replaces a column.
Table.relabel(column_label, new_label)	Change the labels of columns specified by `column_label` to labels in `new_`

2.1.22 datascience.tables.Table.set_format

`Table.`**`set_format`**(*column_label_or_labels*, *formatter*)

Set the format of a column.

2.1.23 datascience.tables.Table.move_to_start

`Table.`**`move_to_start`**(*column_label*)

Move a column to the first in order.

2.1.24 datascience.tables.Table.move_to_end

`Table.`**`move_to_end`**(*column_label*)

Move a column to the last in order.

2.1.25 datascience.tables.Table.append

`Table.`**`append`**(*row_or_table*)

Append a row or all rows of a table. An appended table must have all columns of self.

2.1.26 datascience.tables.Table.append_column

`Table.`**`append_column`**(*label*, *values*)

Appends a column to the table or replaces a column.

`__setitem__` is aliased to this method: `table.append_column('new_col', [1, 2, 3])` is equivalent to `table['new_col'] = [1, 2, 3]`.

Args: `label` (str): The label of the new column.

`values` (single value or list/array): If a single value, every value in the new column is `values`.

If a list or array, the new column contains the values in `values`, which must be the same length as the table.

Returns: Original table with new or replaced column

Raises:

`ValueError`: If

- `label` is not a string.
- `values` is a list/array and does not have the same length as the number of rows in the table.

```
>>> table = Table().with_columns([
...     'letter', ['a', 'b', 'c', 'z'],
...     'count',  [9, 3, 3, 1],
...     'points', [1, 2, 2, 10]])
>>> table
```

```
    letter | count | points
    a      | 9     | 1
    b      | 3     | 2
    c      | 3     | 2
    z      | 1     | 10
    >>> table.append_column('new_col1', [10, 20, 30, 40])
    >>> table
    letter | count | points | new_col1
    a      | 9     | 1      | 10
    b      | 3     | 2      | 20
    c      | 3     | 2      | 30
    z      | 1     | 10     | 40
    >>> table.append_column('new_col2', 'hello')
    >>> table
    letter | count | points | new_col1 | new_col2
    a      | 9     | 1      | 10       | hello
    b      | 3     | 2      | 20       | hello
    c      | 3     | 2      | 30       | hello
    z      | 1     | 10     | 40       | hello
    >>> table.append_column(123, [1, 2, 3, 4])
    Traceback (most recent call last):
        ...
    ValueError: The column label must be a string, but a int was given
    >>> table.append_column('bad_col', [1, 2])
    Traceback (most recent call last):
        ...
    ValueError: Column length mismatch. New column does not have the same number of rows as table.
```

2.1.27 datascience.tables.Table.relabel

`Table.`**`relabel`**(*column_label*, *new_label*)

Change the labels of columns specified by `column_label` to labels in `new_label`.

Args:

`column_label` **(single str or list/array of str): The label(s) of** columns to be changed. Must be str.

`new_label` **(single str or list/array of str): The new label(s) of** columns to be changed. Must be str.

Number of elements must match number of elements in `column_label`.

Returns: Original table with modified labels

```
    >>> table = Table().with_columns([
    ...     'points', (1, 2, 3),
    ...     'id',     (12345, 123, 5123)])
    >>> table.relabel('id', 'yolo')
    points | yolo
    1      | 12345
    2      | 123
    3      | 5123
    >>> table.relabel(['points', 'yolo'], ['red', 'blue'])
    red  | blue
    1    | 12345
    2    | 123
    3    | 5123
    >>> table.relabel(['red', 'green', 'blue'], ['cyan', 'magenta', 'yellow', 'key'])
    Traceback (most recent call last):
```

```
    ...
ValueError: Invalid arguments. column_label and new_label must be of equal length.
>>> table.relabel(['red', 'blue'], ['blue', 'red'])
blue | red
1    | 12345
2    | 123
3    | 5123
```

Transformation (creates a new table)

Table.copy(*[, shallow])	Return a copy of a Table.
Table.select(*column_label_or_labels)	Returns a new `Table` with only the columns in `column_label_or_label`
Table.drop(*column_label_or_labels)	Return a Table with only columns other than selected label or labels.
Table.take()	Return a new Table of a sequence of rows taken by number.
Table.exclude()	Return a new Table without a sequence of rows excluded by number.
Table.where(column_or_label[, ...])	Return a new `Table` containing rows where `value_or_predicate` returns
Table.sort(column_or_label[, descending, ...])	Return a Table of rows sorted according to the values in a column.
Table.group(column_or_label[, collect])	Group rows by unique values in a column; count or aggregate others.
Table.groups(labels[, collect])	Group rows by multiple columns, count or aggregate others.
Table.pivot(columns, rows[, values, ...])	Generate a table with a column for rows (or a column for each row in rows list)
Table.stack(key[, labels])	Takes k original columns and returns two columns, with col.
Table.join(column_label, other[, other_label])	Generate a table with the columns of self and other, containing rows for all valu
Table.stats([ops])	Compute statistics for each column and place them in a table.
Table.percentile(p)	Returns a new table with one row containing the pth percentile for each column.
Table.sample([k, with_replacement, weights])	Returns a new table where k rows are randomly sampled from the original table.
Table.split(k)	Returns a tuple of two tables where the first table contains `k` rows randomly sam
Table.bin([select])	Group values by bin and compute counts per bin by column.

2.1.28 datascience.tables.Table.copy

`Table.`**`copy`**(*, *shallow=False*)

Return a copy of a Table.

2.1.29 datascience.tables.Table.select

`Table.`**`select`**(**column_label_or_labels*)

Returns a new `Table` with only the columns in `column_label_or_labels`.

Args: `column_label_or_labels`: Columns to select from the `Table` as either column labels (`str`) or column indices (`int`).

Returns: An new instance of `Table` containing only selected columns. The columns of the new `Table` are in the order given in `column_label_or_labels`.

Raises: `KeyError` if any of `column_label_or_labels` are not in the table.

```
>>> flowers = Table().with_columns(
...     'Number of petals', make_array(8, 34, 5),
...     'Name', make_array('lotus', 'sunflower', 'rose'),
...     'Weight', make_array(10, 5, 6)
... )
```

```
>>> flowers
Number of petals | Name      | Weight
```

```
8                | lotus      | 10
34               | sunflower | 5
5                | rose       | 6
```

```
>>> flowers.select('Number of petals', 'Weight')
Number of petals | Weight
8                | 10
34               | 5
5                | 6
```

```
>>> flowers  # original table unchanged
Number of petals | Name       | Weight
8                | lotus      | 10
34               | sunflower | 5
5                | rose       | 6
```

```
>>> flowers.select(0, 2)
Number of petals | Weight
8                | 10
34               | 5
5                | 6
```

2.1.30 datascience.tables.Table.drop

`Table.`**`drop`**`(`**column_label_or_labels*`)`

Return a Table with only columns other than selected label or labels.

Args: `column_label_or_labels` (string or list of strings): The header names or indices of the columns to be dropped. `column_label_or_labels` must be an existing header name, or a valid column index.

Returns: An instance of `Table` with given columns removed.

```
>>> t = Table().with_columns([
...     'burgers',  ['cheeseburger', 'hamburger', 'veggie burger'],
...     'prices',   [6, 5, 5],
...     'calories', [743, 651, 582]])
>>> t
burgers        | prices | calories
cheeseburger   | 6      | 743
hamburger      | 5      | 651
veggie burger | 5      | 582
>>> t.drop('prices')
burgers        | calories
cheeseburger   | 743
hamburger      | 651
veggie burger | 582
>>> t.drop(['burgers', 'calories'])
prices
6
5
5
>>> t.drop('burgers', 'calories')
prices
6
5
5
>>> t.drop([0, 2])
```

```
    prices
    6
    5
    5
    >>> t.drop(0, 2)
    prices
    6
    5
    5
    >>> t.drop(1)
    burgers       | calories
    cheeseburger  | 743
    hamburger     | 651
    veggie burger | 582
```

2.1.31 datascience.tables.Table.take

`Table.`**`take`**`()`

Return a new Table of a sequence of rows taken by number.

Args: `row_indices_or_slice` (integer or list of integers or slice): The row index, list of row indices or a slice of row indices to be selected.

Returns: A new instance of `Table`.

```
    >>> t = Table().with_columns([
    ...     'letter grade', ['A+', 'A', 'A-', 'B+', 'B', 'B-'],
    ...     'gpa', [4, 4, 3.7, 3.3, 3, 2.7]])
    >>> t
    letter grade | gpa
    A+           | 4
    A            | 4
    A-           | 3.7
    B+           | 3.3
    B            | 3
    B-           | 2.7
    >>> t.take(0)
    letter grade | gpa
    A+           | 4
    >>> t.take(5)
    letter grade | gpa
    B-           | 2.7
    >>> t.take(-1)
    letter grade | gpa
    B-           | 2.7
    >>> t.take([2, 1, 0])
    letter grade | gpa
    A-           | 3.7
    A            | 4
    A+           | 4
    >>> t.take([1, 5])
    letter grade | gpa
    A            | 4
    B-           | 2.7
    >>> t.take(range(3))
    letter grade | gpa
    A+           | 4
```

```
A             | 4
A-            | 3.7
```

Note that `take` also supports NumPy-like indexing and slicing:

```
>>> t.take[:3]
letter grade | gpa
A+           | 4
A            | 4
A-           | 3.7
```

```
>>> t.take[2, 1, 0]
letter grade | gpa
A-           | 3.7
A            | 4
A+           | 4
```

2.1.32 datascience.tables.Table.exclude

`Table.`**`exclude`**`()`

Return a new Table without a sequence of rows excluded by number.

Args:

`row_indices_or_slice` **(integer or list of integers or slice):** The row index, list of row indices or a slice of row indices to be excluded.

Returns: A new instance of `Table`.

```
>>> t = Table().with_columns([
...     'letter grade', ['A+', 'A', 'A-', 'B+', 'B', 'B-'],
...     'gpa', [4, 4, 3.7, 3.3, 3, 2.7]])
>>> t
letter grade | gpa
A+           | 4
A            | 4
A-           | 3.7
B+           | 3.3
B            | 3
B-           | 2.7
>>> t.exclude(4)
letter grade | gpa
A+           | 4
A            | 4
A-           | 3.7
B+           | 3.3
B-           | 2.7
>>> t.exclude(-1)
letter grade | gpa
A+           | 4
A            | 4
A-           | 3.7
B+           | 3.3
B            | 3
>>> t.exclude([1, 3, 4])
letter grade | gpa
A+           | 4
A-           | 3.7
```

```
B-           | 2.7
>>> t.exclude(range(3))
letter grade | gpa
B+           | 3.3
B            | 3
B-           | 2.7
```

Note that `exclude` also supports NumPy-like indexing and slicing:

```
>>> t.exclude[:3]
letter grade | gpa
B+           | 3.3
B            | 3
B-           | 2.7
```

```
>>> t.exclude[1, 3, 4]
letter grade | gpa
A+           | 4
A-           | 3.7
B-           | 2.7
```

2.1.33 datascience.tables.Table.where

`Table.`**`where`**(*column_or_label*, *value_or_predicate=None*, *other=None*)

Return a new `Table` containing rows where `value_or_predicate` returns True for values in `column_or_label`.

Args: `column_or_label`: A column of the `Table` either as a label (`str`) or an index (`int`). Can also be an array of booleans; only the rows where the array value is `True` are kept.

`value_or_predicate`: If a function, it is applied to every value in `column_or_label`. Only the rows where `value_or_predicate` returns True are kept. If a single value, only the rows where the values in `column_or_label` are equal to `value_or_predicate` are kept.

`other`: Optional additional column label for `value_or_predicate` to make pairwise comparisons. See the examples below for usage. When `other` is supplied, `value_or_predicate` must be a callable function.

Returns: If `value_or_predicate` is a function, returns a new `Table` containing only the rows where `value_or_predicate(val)` is True for the `val``s in ``column_or_label`.

If `value_or_predicate` is a value, returns a new `Table` containing only the rows where the values in `column_or_label` are equal to `value_or_predicate`.

If `column_or_label` is an array of booleans, returns a new `Table` containing only the rows where `column_or_label` is `True`.

```
>>> marbles = Table().with_columns(
...     "Color", make_array("Red", "Green", "Blue", "Red", "Green", "Green"),
...     "Shape", make_array("Round", "Rectangular", "Rectangular", "Round", "Rectangular", "Round
...     "Amount", make_array(4, 6, 12, 7, 9, 2),
...     "Price", make_array(1.30, 1.20, 2.00, 1.75, 0, 3.00))
```

```
>>> marbles
Color | Shape       | Amount | Price
Red   | Round       | 4      | 1.3
Green | Rectangular | 6      | 1.2
Blue  | Rectangular | 12     | 2
```

```
Red   | Round       | 7      | 1.75
Green | Rectangular | 9      | 0
Green | Round       | 2      | 3
```

Use a value to select matching rows

```
>>> marbles.where("Price", 1.3)
Color | Shape | Amount | Price
Red   | Round | 4      | 1.3
```

In general, a higher order predicate function such as the functions in `datascience.predicates.are` can be used.

```
>>> from datascience.predicates import are
>>> # equivalent to previous example
>>> marbles.where("Price", are.equal_to(1.3))
Color | Shape | Amount | Price
Red   | Round | 4      | 1.3
```

```
>>> marbles.where("Price", are.above(1.5))
Color | Shape       | Amount | Price
Blue  | Rectangular | 12     | 2
Red   | Round       | 7      | 1.75
Green | Round       | 2      | 3
```

Use the optional argument `other` to apply predicates to compare columns.

```
>>> marbles.where("Price", are.above, "Amount")
Color | Shape | Amount | Price
Green | Round | 2      | 3
```

```
>>> marbles.where("Price", are.equal_to, "Amount") # empty table
Color | Shape | Amount | Price
```

2.1.34 datascience.tables.Table.sort

`Table.`**`sort`**(*column_or_label*, *descending=False*, *distinct=False*)

Return a Table of rows sorted according to the values in a column.

Args: `column_or_label`: the column whose values are used for sorting.

`descending`: if True, sorting will be in descending, rather than ascending order.

`distinct`: if True, repeated values in `column_or_label` will be omitted.

Returns: An instance of `Table` containing rows sorted based on the values in `column_or_label`.

```
>>> marbles = Table().with_columns([
...     "Color", ["Red", "Green", "Blue", "Red", "Green", "Green"],
...     "Shape", ["Round", "Rectangular", "Rectangular", "Round", "Rectangular", "Round"],
...     "Amount", [4, 6, 12, 7, 9, 2],
...     "Price", [1.30, 1.30, 2.00, 1.75, 1.40, 1.00]])
>>> marbles
Color | Shape       | Amount | Price
Red   | Round       | 4      | 1.3
Green | Rectangular | 6      | 1.3
Blue  | Rectangular | 12     | 2
Red   | Round       | 7      | 1.75
```

```
    Green | Rectangular | 9      | 1.4
    Green | Round       | 2      | 1
    >>> marbles.sort("Amount")
    Color | Shape       | Amount | Price
    Green | Round       | 2      | 1
    Red   | Round       | 4      | 1.3
    Green | Rectangular | 6      | 1.3
    Red   | Round       | 7      | 1.75
    Green | Rectangular | 9      | 1.4
    Blue  | Rectangular | 12     | 2
    >>> marbles.sort("Amount", descending = True)
    Color | Shape       | Amount | Price
    Blue  | Rectangular | 12     | 2
    Green | Rectangular | 9      | 1.4
    Red   | Round       | 7      | 1.75
    Green | Rectangular | 6      | 1.3
    Red   | Round       | 4      | 1.3
    Green | Round       | 2      | 1
    >>> marbles.sort(3) # the Price column
    Color | Shape       | Amount | Price
    Green | Round       | 2      | 1
    Red   | Round       | 4      | 1.3
    Green | Rectangular | 6      | 1.3
    Green | Rectangular | 9      | 1.4
    Red   | Round       | 7      | 1.75
    Blue  | Rectangular | 12     | 2
    >>> marbles.sort(3, distinct = True)
    Color | Shape       | Amount | Price
    Green | Round       | 2      | 1
    Red   | Round       | 4      | 1.3
    Green | Rectangular | 9      | 1.4
    Red   | Round       | 7      | 1.75
    Blue  | Rectangular | 12     | 2
```

2.1.35 datascience.tables.Table.group

`Table.`**`group`**(*column_or_label*, *collect=None*)

Group rows by unique values in a column; count or aggregate others.

Args: `column_or_label`: values to group (column label or index, or array)

`collect`: a function applied to values in other columns for each group

Returns: A Table with each row corresponding to a unique value in `column_or_label`, where the first column contains the unique values from `column_or_label`, and the second contains counts for each of the unique values. If `collect` is provided, a Table is returned with all original columns, each containing values calculated by first grouping rows according to `column_or_label`, then applying `collect` to each set of grouped values in the other columns.

Note: The grouped column will appear first in the result table. If `collect` does not accept arguments with one of the column types, that column will be empty in the resulting table.

```
    >>> marbles = Table().with_columns([
    ...     "Color", ["Red", "Green", "Blue", "Red", "Green", "Green"],
    ...     "Shape", ["Round", "Rectangular", "Rectangular", "Round", "Rectangular", "Round"],
    ...     "Amount", [4, 6, 12, 7, 9, 2],
    ...     "Price", [1.30, 1.30, 2.00, 1.75, 1.40, 1.00]])
    >>> marbles
```

```
    Color | Shape       | Amount | Price
    Red   | Round       | 4      | 1.3
    Green | Rectangular | 6      | 1.3
    Blue  | Rectangular | 12     | 2
    Red   | Round       | 7      | 1.75
    Green | Rectangular | 9      | 1.4
    Green | Round       | 2      | 1
    >>> marbles.group("Color") # just gives counts
    Color | count
    Blue  | 1
    Green | 3
    Red   | 2
    >>> marbles.group("Color", max) # takes the max of each grouping, in each column
    Color | Shape max   | Amount max | Price max
    Blue  | Rectangular | 12         | 2
    Green | Round       | 9          | 1.4
    Red   | Round       | 7          | 1.75
    >>> marbles.group("Shape", sum) # sum doesn't make sense for strings
    Shape       | Color sum | Amount sum | Price sum
    Rectangular |           | 27         | 4.7
    Round       |           | 13         | 4.05
```

2.1.36 datascience.tables.Table.groups

`Table.`**`groups`**(*labels*, *collect=None*)

Group rows by multiple columns, count or aggregate others.

Args: `labels`: list of column names (or indices) to group on

`collect`: a function applied to values in other columns for each group

Returns: A Table with each row corresponding to a unique combination of values in the columns specified in `labels`, where the first columns are those specified in `labels`, followed by a column of counts for each of the unique values. If `collect` is provided, a Table is returned with all original columns, each containing values calculated by first grouping rows according to to values in the `labels` column, then applying `collect` to each set of grouped values in the other columns.

Note: The grouped columns will appear first in the result table. If `collect` does not accept arguments with one of the column types, that column will be empty in the resulting table.

```
    >>> marbles = Table().with_columns([
    ...     "Color", ["Red", "Green", "Blue", "Red", "Green", "Green"],
    ...     "Shape", ["Round", "Rectangular", "Rectangular", "Round", "Rectangular", "Round"],
    ...     "Amount", [4, 6, 12, 7, 9, 2],
    ...     "Price", [1.30, 1.30, 2.00, 1.75, 1.40, 1.00]])
    >>> marbles
    Color | Shape       | Amount | Price
    Red   | Round       | 4      | 1.3
    Green | Rectangular | 6      | 1.3
    Blue  | Rectangular | 12     | 2
    Red   | Round       | 7      | 1.75
    Green | Rectangular | 9      | 1.4
    Green | Round       | 2      | 1
    >>> marbles.groups(["Color", "Shape"])
    Color | Shape       | count
    Blue  | Rectangular | 1
    Green | Rectangular | 2
    Green | Round       | 1
```

```
    Red   | Round       | 2
    >>> marbles.groups(["Color", "Shape"], sum)
    Color | Shape       | Amount sum | Price sum
    Blue  | Rectangular | 12         | 2
    Green | Rectangular | 15         | 2.7
    Green | Round       | 2          | 1
    Red   | Round       | 11         | 3.05
```

2.1.37 datascience.tables.Table.pivot

`Table.`**`pivot`**(*columns*, *rows*, *values=None*, *collect=None*, *zero=None*)

Generate a table with a column for rows (or a column for each row in rows list) and a column for each unique value in columns. Each row counts/aggregates the values that match both row and column.

columns – column label in self rows – column label or a list of column labels values – column label in self (or None to produce counts) collect – aggregation function over values zero – zero value for non-existent row-column combinations

2.1.38 datascience.tables.Table.stack

`Table.`**`stack`**(*key*, *labels=None*)

Takes k original columns and returns two columns, with col. 1 of all column names and col. 2 of all associated data.

2.1.39 datascience.tables.Table.join

`Table.`**`join`**(*column_label*, *other*, *other_label=None*)

Generate a table with the columns of self and other, containing rows for all values of a column that appear in both tables. If a join value appears more than once in self, each row will be used, but in the other table, only the first of each will be used.

If the result is empty, return None.

2.1.40 datascience.tables.Table.stats

`Table.`**`stats`**(*ops=(<built-in function min>, <built-in function max>, <function median at 0x7f0167541268>, <built-in function sum>)*)

Compute statistics for each column and place them in a table.

2.1.41 datascience.tables.Table.percentile

`Table.`**`percentile`**(*p*)

Returns a new table with one row containing the pth percentile for each column.

Assumes that each column only contains one type of value.

Returns a new table with one row and the same column labels. The row contains the pth percentile of the original column, where the pth percentile of a column is the smallest value that at at least as large as the p% of numbers in the column.

```
>>> table = Table().with_columns([
...     'count',  [9, 3, 3, 1],
...     'points', [1, 2, 2, 10]])
>>> table
count | points
9     | 1
3     | 2
3     | 2
1     | 10
>>> table.percentile(80)
count | points
9     | 10
```

2.1.42 datascience.tables.Table.sample

`Table.`**`sample`**(*k=None*, *with_replacement=True*, *weights=None*)

Returns a new table where k rows are randomly sampled from the original table.

Kwargs:

k (int or None): If None (default), all the rows in the table are sampled. If an integer, k rows from the original table are sampled.

with_replacement (bool): If True (default), samples the rows with replacement. If False, samples the rows without replacement.

weights (list/array or None): If None (default), samples the rows using a uniform random distribution. If a list/array is passed in, it must be the same length as the number of rows in the table and the values must sum to 1. The rows will then be sampled according the the probability distribution in `weights`.

Returns: A new instance of `Table`.

```
>>> jobs = Table().with_columns([
...     'job',  ['a', 'b', 'c', 'd'],
...     'wage', [10, 20, 15, 8]])
>>> jobs
job  | wage
a    | 10
b    | 20
c    | 15
d    | 8
>>> jobs.sample()
job  | wage
b    | 20
b    | 20
a    | 10
d    | 8
>>> jobs.sample(with_replacement=True)
job  | wage
d    | 8
b    | 20
c    | 15
a    | 10
>>> jobs.sample(k = 2)
job  | wage
b    | 20
c    | 15
>>> jobs.sample(k = 2, with_replacement = True,
```

```
...      weights = [0.5, 0.5, 0, 0])
job  | wage
a    | 10
a    | 10
```

2.1.43 datascience.tables.Table.split

`Table.`**`split`**`(`*`k`*`)`

Returns a tuple of two tables where the first table contains `k` rows randomly sampled and the second contains the remaining rows.

Args:

`k` (int): The number of rows randomly sampled into the first table. `k` must be between 1 and `num_rows - 1`.

Raises: `ValueError`: `k` is not between 1 and `num_rows - 1`.

Returns: A tuple containing two instances of `Table`.

```
>>> jobs = Table().with_columns([
...     'job',  ['a', 'b', 'c', 'd'],
...     'wage', [10, 20, 15, 8]])
>>> jobs
job  | wage
a    | 10
b    | 20
c    | 15
d    | 8
>>> sample, rest = jobs.split(3)
>>> sample
job  | wage
c    | 15
a    | 10
b    | 20
>>> rest
job  | wage
d    | 8
```

2.1.44 datascience.tables.Table.bin

`Table.`**`bin`**`(`*`select=None`*`, `*`**vargs`*`)`

Group values by bin and compute counts per bin by column.

By default, bins are chosen to contain all values in all columns. The following named arguments from numpy.histogram can be applied to specialize bin widths:

If the original table has n columns, the resulting binned table has n+1 columns, where column 0 contains the lower bound of each bin.

Args:

`select` (columns): Columns to be binned. If None, all columns are binned.

`bins` (int or sequence of scalars): If bins is an int, it defines the number of equal-width bins in the given range (10, by default). If bins is a sequence, it defines the bin edges, including the rightmost edge, allowing for non-uniform bin widths.

range ((float, float)): The lower and upper range of the bins. If not provided, range contains all values in the table. Values outside the range are ignored.

density (bool): If False, the result will contain the number of samples in each bin. If True, the result is the value of the probability density function at the bin, normalized such that the integral over the range is 1. Note that the sum of the histogram values will not be equal to 1 unless bins of unity width are chosen; it is not a probability mass function.

Exporting / Displaying

Table.show([max_rows])	Display the table.
Table.as_text([max_rows, sep])	Format table as text.
Table.as_html([max_rows])	Format table as HTML.
Table.index_by(column_or_label)	Return a dict keyed by values in a column that contains lists of rows corresponding to each
Table.to_array()	Convert the table to a structured NumPy array.
Table.to_df()	Convert the table to a Pandas DataFrame.
Table.to_csv(filename)	Creates a CSV file with the provided filename.

2.1.45 datascience.tables.Table.show

Table.**show**(*max_rows=0*)
Display the table.

2.1.46 datascience.tables.Table.as_text

Table.**as_text**(*max_rows=0*, *sep=' | '*)
Format table as text.

2.1.47 datascience.tables.Table.as_html

Table.**as_html**(*max_rows=0*)
Format table as HTML.

2.1.48 datascience.tables.Table.index_by

Table.**index_by**(*column_or_label*)
Return a dict keyed by values in a column that contains lists of rows corresponding to each value.

2.1.49 datascience.tables.Table.to_array

Table.**to_array**()
Convert the table to a structured NumPy array.

2.1.50 datascience.tables.Table.to_df

Table.**to_df**()
Convert the table to a Pandas DataFrame.

2.1.51 datascience.tables.Table.to_csv

`Table.`**`to_csv`**(*filename*)

Creates a CSV file with the provided filename.

The CSV is created in such a way that if we run `table.to_csv('my_table.csv')` we can recreate the same table with `Table.read_table('my_table.csv')`.

Args: `filename` (str): The filename of the output CSV file.

Returns: None, outputs a file with name `filename`.

```
>>> jobs = Table().with_columns([
...     'job',  ['a', 'b', 'c', 'd'],
...     'wage', [10, 20, 15, 8]])
>>> jobs
job  | wage
a    | 10
b    | 20
c    | 15
d    | 8
>>> jobs.to_csv('my_table.csv')
<outputs a file called my_table.csv in the current directory>
```

Visualizations

Table.plot([column_for_xticks, select, overlay])	Plot line charts for the table.
Table.bar([column_for_categories, select, ...])	Plot bar charts for the table.
Table.barh([column_for_categories, select, ...])	Plot horizontal bar charts for the table.
Table.pivot_hist(pivot_column_label, ...[, ...])	Draw histograms of each category in a column.
Table.hist([select, overlay, bins, counts, unit])	Plots one histogram for each column in the table.
Table.scatter(column_for_x[, select, ...])	Creates scatterplots, optionally adding a line of best fit.
Table.boxplot(**vargs)	Plots a boxplot for the table.

2.1.52 datascience.tables.Table.plot

`Table.`**`plot`**(*column_for_xticks=None*, *select=None*, *overlay=True*, ***vargs*)

Plot line charts for the table.

Each plot is labeled using the values in *column_for_xticks* and one plot is produced for every other column (or for the columns designated by *select*).

Every selected column except for *column_for_xticks* must be numerical.

Args: column_for_xticks (str/array): A column containing x-axis labels

Kwargs:

overlay (bool): create a chart with one color per data column; if False, each will be displayed separately.

vargs: Additional arguments that get passed into *plt.plot*. See http://matplotlib.org/api/pyplot_api.html#matplotlib.pyplo for additional arguments that can be passed into vargs.

2.1.53 datascience.tables.Table.bar

`Table.`**`bar`**(*column_for_categories=None*, *select=None*, *overlay=True*, ***vargs*)

Plot bar charts for the table.

Each plot is labeled using the values in *column_for_categories* and one plot is produced for every other column (or for the columns designated by *select*).

Every selected except column for *column_for_categories* must be numerical.

Args: column_for_categories (str): A column containing x-axis categories

Kwargs:

overlay (bool): create a chart with one color per data column; if False, each will be displayed separately.

vargs: Additional arguments that get passed into *plt.bar*. See http://matplotlib.org/api/pyplot_api.html#matplotlib.pyplot for additional arguments that can be passed into vargs.

2.1.54 datascience.tables.Table.barh

`Table.`**`barh`**(*column_for_categories=None*, *select=None*, *overlay=True*, ***vargs*)

Plot horizontal bar charts for the table.

Each plot is labeled using the values in *column_for_categories* and one plot is produced for every other column (or for the columns designated by *select*).

Every selected except column for *column_for_categories* must be numerical.

Args: column_for_categories (str): A column containing y-axis categories

Kwargs:

overlay (bool): create a chart with one color per data column; if False, each will be displayed separately.

vargs: Additional arguments that get passed into *plt.barh*. See http://matplotlib.org/api/pyplot_api.html#matplotlib.pyplot for additional arguments that can be passed into vargs.

```
>>> t = Table().with_columns([
...     'Furniture', ['chairs', 'tables', 'desks'],
...     'Count', [6, 1, 2],
...     'Price', [10, 20, 30]
...     ])
>>> t
Furniture | Count | Price
chairs    | 6     | 10
tables    | 1     | 20
desks     | 2     | 30
>>> furniture_table.barh('Furniture')
<bar graph with furniture as categories and bars for count and price>
>>> furniture_table.barh('Furniture', 'Price')
<bar graph with furniture as categories and bars for price>
>>> furniture_table.barh('Furniture', [1, 2])
<bar graph with furniture as categories and bars for count and price>
```

2.1.55 datascience.tables.Table.pivot_hist

`Table.`**`pivot_hist`**(*pivot_column_label*, *value_column_label*, *overlay=True*, ***vargs*)

Draw histograms of each category in a column.

2.1.56 datascience.tables.Table.hist

`Table.`**`hist`**(*select=None*, *overlay=True*, *bins=None*, *counts=None*, *unit=None*, ***vargs*)

Plots one histogram for each column in the table.

Every column must be numerical.

Kwargs:

overlay (bool): If True, plots 1 chart with all the histograms overlaid on top of each other (instead of the default behavior of one histogram for each column in the table). Also adds a legend that matches each bar color to its column.

bins (column name or list): Lower bound for each bin in the histogram. If None, bins will be chosen automatically.

counts (column name or column): A column of counted values. All other columns are treated as counts of these values. If None, each value in each row is assigned a count of 1.

vargs: Additional arguments that get passed into :func:plt.hist. See http://matplotlib.org/api/pyplot_api.html#matplotlib for additional arguments that can be passed into vargs. These include: *range*, *normed*, *cumulative*, and *orientation*, to name a few.

```
>>> t = Table().with_columns([
...      'count',  [9, 3, 3, 1],
...      'points', [1, 2, 2, 10]])
>>> t
count | points
9     | 1
3     | 2
3     | 2
1     | 10
>>> t.hist()
<histogram of values in count>
<histogram of values in points>
```

```
>>> t = Table().with_columns([
...      'value',      [101, 102, 103],
...      'proportion', [0.25, 0.5, 0.25]])
>>> t.hist(counts='value')
<histogram of values in prop weighted by corresponding values in value>
```

2.1.57 datascience.tables.Table.scatter

`Table.`**`scatter`**(*column_for_x*, *select=None*, *overlay=True*, *fit_line=False*, *colors=None*, *labels=None*, ***vargs*)

Creates scatterplots, optionally adding a line of best fit.

Each plot uses the values in *column_for_x* for horizontal positions. One plot is produced for every other column as y (or for the columns designated by *select*).

Every selected except column for *column_for_categories* must be numerical.

Args:

`column_for_x` **(str): The name to use for the x-axis values of the** scatter plots.

Kwargs:

`overlay` **(bool): create a chart with one color per data column;** if False, each will be displayed separately.

`fit_line` (bool): draw a line of best fit for each set of points

vargs: Additional arguments that get passed into *plt.scatter*. See http://matplotlib.org/api/pyplot_api.html#matplotlib.p for additional arguments that can be passed into vargs. These include: *marker* and *norm*, to name a couple.

`colors`: A column of colors (labels or numeric values)

`labels`: A column of text labels to annotate dots

```
>>> table = Table().with_columns([
...     'x', [9, 3, 3, 1],
...     'y', [1, 2, 2, 10],
...     'z', [3, 4, 5, 6]])
>>> table
x    | y    | z
9    | 1    | 3
3    | 2    | 4
3    | 2    | 5
1    | 10   | 6
>>> table.scatter('x')
<scatterplot of values in y and z on x>
```

```
>>> table.scatter('x', overlay=False)
<scatterplot of values in y on x>
<scatterplot of values in z on x>
```

```
>>> table.scatter('x', fit_line=True)
<scatterplot of values in y and z on x with lines of best fit>
```

2.1.58 datascience.tables.Table.boxplot

`Table.`**`boxplot`**`(**vargs)`

Plots a boxplot for the table.

Every column must be numerical.

Kwargs:

vargs: Additional arguments that get passed into *plt.boxplot*. See http://matplotlib.org/api/pyplot_api.html#matplotlib.py for additional arguments that can be passed into vargs. These include *vert* and *showmeans*.

Returns: None

Raises: ValueError: The Table contains columns with non-numerical values.

```
>>> table = Table().with_columns([
...     'test1', [92.5, 88, 72, 71, 99, 100, 95, 83, 94, 93],
...     'test2', [89, 84, 74, 66, 92, 99, 88, 81, 95, 94]])
>>> table
test1 | test2
92.5  | 89
88    | 84
72    | 74
71    | 66
99    | 92
100   | 99
95    | 88
83    | 81
94    | 95
```

```
93    | 94
>>> table.boxplot()
<boxplot of test1 and boxplot of test2 side-by-side on the same figure>
```

2.2 Maps (datascience.maps)

Draw maps using folium.

class datascience.maps.**Map**(*features=()*, *ids=()*, *width=960*, *height=500*, ***kwargs*)
A map from IDs to features. Keyword args are forwarded to folium.

color(*values*, *ids=()*, *key_on='feature.id'*, *palette='YlOrBr'*, ***kwargs*)
Color map features by binning values.

values – a sequence of values or a table of keys and values ids – an ID for each value; if none are provided, indices are used key_on – attribute of each feature to match to ids palette – one of the following color brewer palettes:

'BuGn', 'BuPu', 'GnBu', 'OrRd', 'PuBu', 'PuBuGn', 'PuRd', 'RdPu', 'YlGn', 'YlGnBu', 'YlOrBr', and 'YlOrRd'.

Defaults from Folium:

threshold_scale: list, default None Data range for D3 threshold scale. Defaults to the following range of quantiles: [0, 0.5, 0.75, 0.85, 0.9], rounded to the nearest order-of-magnitude integer. Ex: 270 rounds to 200, 5600 to 6000.

fill_opacity: float, default 0.6 Area fill opacity, range 0-1.

line_color: string, default 'black' GeoJSON geopath line color.

line_weight: int, default 1 GeoJSON geopath line weight.

line_opacity: float, default 1 GeoJSON geopath line opacity, range 0-1.

legend_name: string, default None Title for data legend. If not passed, defaults to columns[1].

copy()
Copies the current Map into a new one and returns it.

features

format(***kwargs*)
Apply formatting.

geojson()
Render features as a FeatureCollection.

overlay(*feature*, *color='Blue'*, *opacity=0.6*)
Overlays `feature` on the map. Returns a new Map.

Args:

feature: a Table of map features, a list of map features, a Map, a Region, or a circle marker map table. The features will be overlayed on the Map with specified `color`.

`color` (`str`): Color of feature. Defaults to 'Blue'

opacity (float): Opacity of overlain feature. Defaults to 0.6.

Returns: A new `Map` with the overlain `feature`.

classmethod read_geojson(*path_or_json_or_string*)
Read a geoJSON string, object, or file. Return a dict of features keyed by ID.

class datascience.maps.**Marker**(*lat*, *lon*, *popup=''*, *color='blue'*, ***kwargs*)
A marker displayed with Folium's simple_marker method.

popup – text that pops up when marker is clicked color – fill color

Defaults from Folium:

marker_icon: string, default 'info-sign' icon from (http://getbootstrap.com/components/) you want on the marker

clustered_marker: boolean, default False boolean of whether or not you want the marker clustered with other markers

icon_angle: int, default 0 angle of icon

popup_width: int, default 300 width of popup

copy()
Return a deep copy

format(***kwargs*)
Apply formatting.

geojson(*feature_id*)
GeoJSON representation of the marker as a point.

lat_lons

classmethod map(*latitudes*, *longitudes*, *labels=None*, *colors=None*, *radii=None*, ***kwargs*)
Return markers from columns of coordinates, labels, & colors.

The radii column is not applicable to markers, but sets circle radius.

classmethod map_table(*table*, ***kwargs*)
Return markers from the colums of a table.

class datascience.maps.**Circle**(*lat*, *lon*, *popup=''*, *color='blue'*, *radius=10*, ***kwargs*)
A marker displayed with Folium's circle_marker method.

popup – text that pops up when marker is clicked color – fill color radius – pixel radius of the circle

Defaults from Folium:

fill_opacity: float, default 0.6 Circle fill opacity

For example, to draw three circles:

t = Table().with_columns([

'lat', [37.8, 38, 37.9], 'lon', [-122, -122.1, -121.9], 'label', ['one', 'two', 'three'], 'color', ['red', 'green', 'blue'], 'radius', [3000, 4000, 5000],

])

Circle.map_table(t)

class datascience.maps.**Region**(*geojson*, ***kwargs*)
A GeoJSON feature displayed with Folium's geo_json method.

copy()
Return a deep copy

format(***kwargs*)
Apply formatting.

geojson (*feature_id*)
Return GeoJSON with ID substituted.

lat_lons
A flat list of (lat, lon) pairs.

polygons
Return a list of polygons describing the region.

- Each polygon is a list of linear rings, where the first describes the exterior and the rest describe interior holes.
- Each linear ring is a list of positions where the last is a repeat of the first.
- Each position is a (lat, lon) pair.

properties

type
The GEOJSON type of the regions: Polygon or MultiPolygon.

2.3 Formats (datascience.formats)

String formatting for table entries.

class datascience.formats.**Formatter**(*min_width=None*, *max_width=None*, *etc=None*)
String formatter that truncates long values.

static convert(*value*)
Identity conversion (override to convert values).

converts_values
Whether this Formatter also converts values.

etc = '...'

format_column(*label*, *column*)
Return a formatting function that pads & truncates values.

static format_value(*value*)
Pretty-print an arbitrary value.

max_width = 60

min_width = 4

class datascience.formats.**NumberFormatter**(*decimals=2*, *decimal_point='.'*, *separator=','*)
Format numbers that may have delimiters.

convert(*value*)
Convert string 93,000.00 to float 93000.0.

converts_values = True

format_value(*value*)

class datascience.formats.**CurrencyFormatter**(*symbol='$'*, **args*, ***vargs*)
Format currency and convert to float.

convert(*value*)
Convert value to float. If value is a string, ensure that the first character is the same as symbol ie. the value is in the currency this formatter is representing.

converts_values = True

format_value(*value*)
Format currency.

class datascience.formats.**DateFormatter**(*format='%Y-%m-%d %H:%M:%S.%f'*, **args*, ***vargs*)
Format date & time and convert to UNIX timestamp.

convert(*value*)
Convert 2015-08-03 to a Unix timestamp int.

converts_values = True

format_value(*value*)
Format timestamp as a string.

class datascience.formats.**PercentFormatter**(*decimals=2*, **args*, ***vargs*)
Format a number as a percentage.

converts_values = False

format_value(*value*)
Format number as percentage.

2.4 Utility Functions (datascience.util)

Utility functions

datascience.util.**make_array**(**elements*)
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)
```

datascience.util.**percentile**(*p*, *arr=None*)
Returns the pth percentile of the input array (the value that is at least as great as p% of the values in the array).

If arr is not provided, percentile returns itself curried with p

```
>>> percentile(74.9, [1, 3, 5, 9])
5
>>> percentile(75, [1, 3, 5, 9])
5
>>> percentile(75.1, [1, 3, 5, 9])
9
>>> f = percentile(75)
>>> f([1, 3, 5, 9])
5
```

datascience.util.**plot_cdf_area**(*rbound=None*, *lbound=None*, *mean=0*, *sd=1*)
Plots a normal curve with specified parameters and area below curve shaded between `lbound` and `rbound`.

Args: `rbound` (numeric): right boundary of shaded region

`lbound` (numeric): left boundary of shaded region; by default is negative infinity

`mean` (numeric): mean/expectation of normal distribution

`sd` (numeric): standard deviation of normal distribution

datascience.util.**plot_normal_cdf**(*rbound=None*, *lbound=None*, *mean=0*, *sd=1*)
Plots a normal curve with specified parameters and area below curve shaded between `lbound` and `rbound`.

Args: `rbound` (numeric): right boundary of shaded region

`lbound` (numeric): left boundary of shaded region; by default is negative infinity

`mean` (numeric): mean/expectation of normal distribution

`sd` (numeric): standard deviation of normal distribution

datascience.util.**table_apply**(*table*, *func*, *subset=None*)
Applies a function to each column and returns a Table.

Uses pandas *apply* under the hood, then converts back to a Table

Args:

table [instance of Table] The table to apply your function to

func [function] Any function that will work with DataFrame.apply

subset [list | None] A list of columns to apply the function to. If None, function will be applied to all columns in table

tab [instance of Table] A table with the given function applied. It will either be the shape == shape(table), or shape (1, table.shape[1])

datascience.util.**minimize**(*f*, *start=None*, *smooth=False*, *log=None*, *array=False*, ***vargs*)
Minimize a function f of one or more arguments.

Args: f: A function that takes numbers and returns a number

start: A starting value or list of starting values

smooth: Whether to assume that f is smooth and use first-order info

log: Logging function called on the result of optimization (e.g. print)

vargs: Other named arguments passed to scipy.optimize.minimize

Returns either:

1. the minimizing argument of a one-argument function
2. an array of minimizing arguments of a multi-argument function

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