Data visualization in python

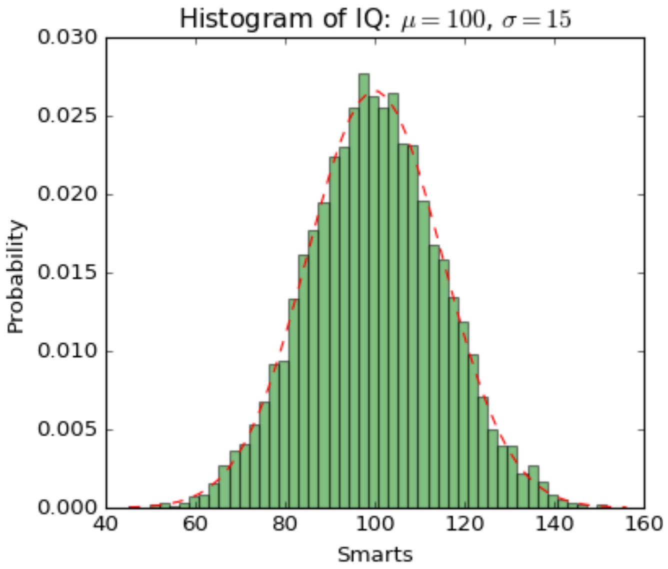
Day 2

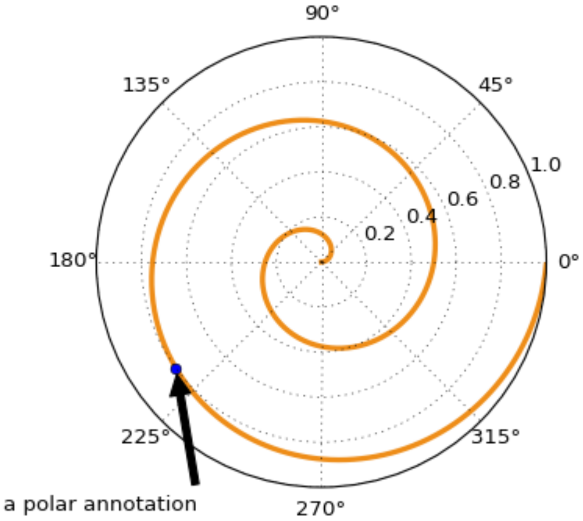
A variety of packages and philosophies

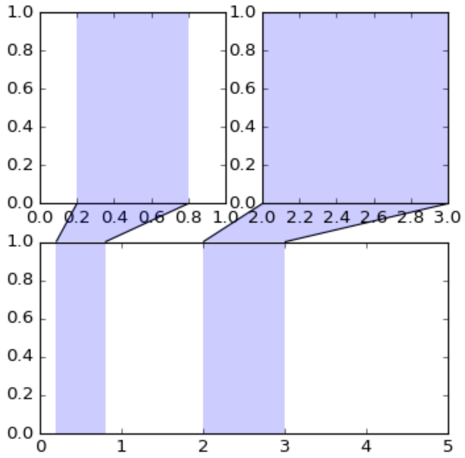
- (today) matplotlib: http://matplotlib.org/
  - Gallery: http://matplotlib.org/gallery.html
  - Frequently used commands: http://matplotlib.org/api/pyplot_summary.html
- Seaborn: http://stanford.edu/~mwaskom/software/seaborn/
- ggplot:
  - R version: http://docs.ggplot2.org/current/
  - Python port: http://ggplot.yhathq.com/
- Bokeh (live plots in your browser)
  - http://bokeh.pydata.org/en/latest/

Matplotlib

- Gallery: http://matplotlib.org/gallery.html
- Top commands: http://matplotlib.org/api/pyplot_summary.html
- Provides "pylab" API, a mimic of matlab
- Many different graph types and options, some obscure

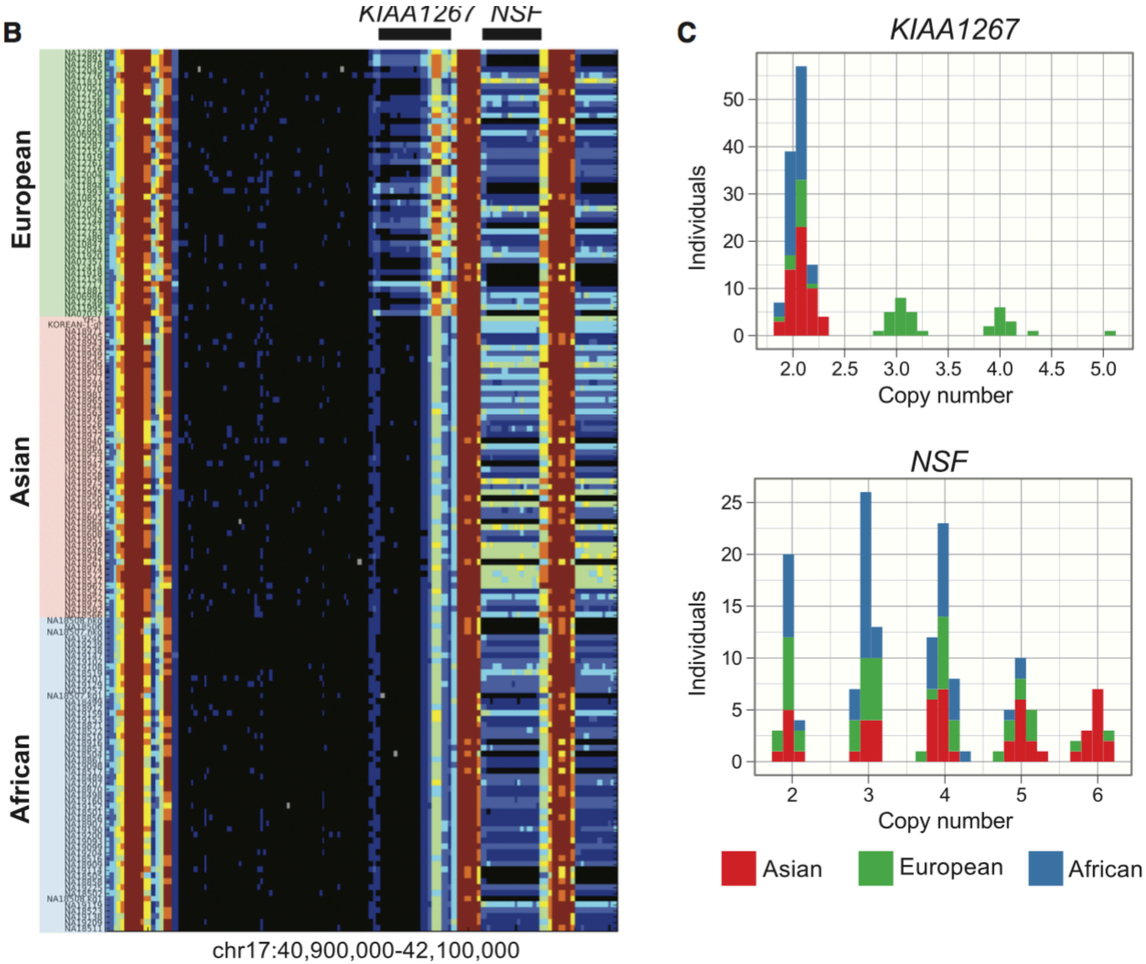






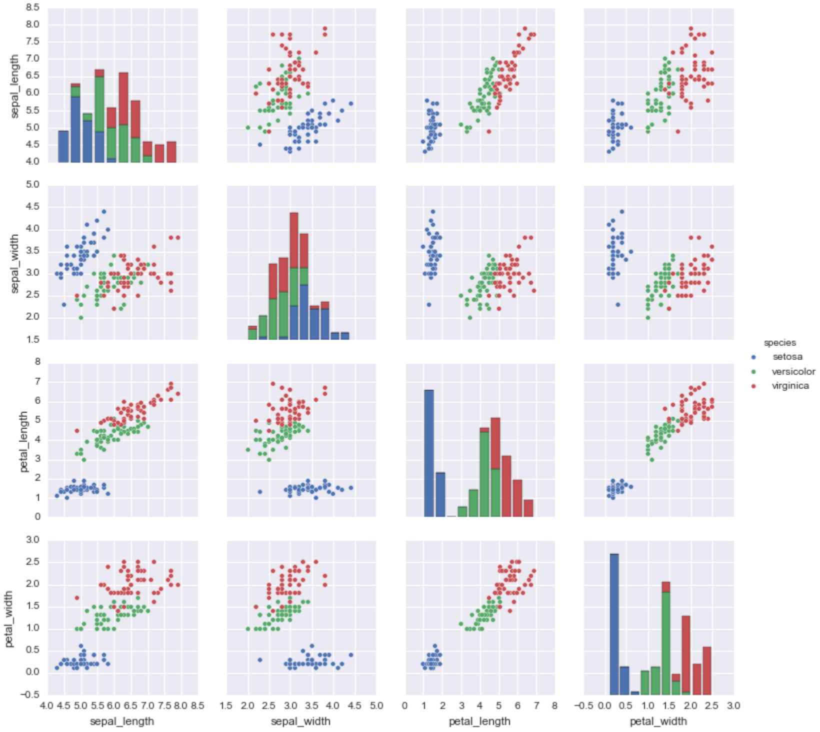
Matplotlib

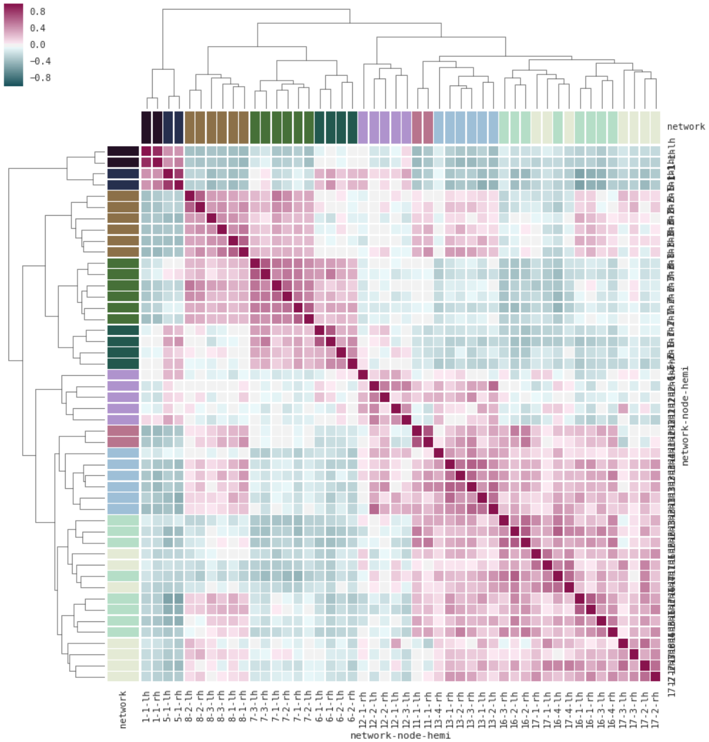
- Resulting plots represented by python objects, from entire figure down to individual points/lines.
- Large API allows any aspect to be tweaked
- Lengthy coding sometimes required to make a plot "just so"



Seaborn

- https://stanford.edu/~mwaskom/software/seaborn/
- Implements more complex plot types
  - – Joint points, clustergrams, fitted linear models
- Uses matplotlib "under the hood"





Others

- ggplot:
  - (Original) R version: http://docs.ggplot2.org/current/
  - A recent python port: http://ggplot.yhathq.com/
  - Elegant syntax for compactly specifying plots – but, they can be hard to tweak
  - We'll discuss this on the R side tomorrow, both the basics of both work similarly.

- Bokeh
  - Live, clickable plots in your browser!
  - http://bokeh.pydata.org/en/latest/

- Plotting functionality built-in to pandas
  - http://pandas.pydata.org/pandas-docs/stable/visualization.html

Using matplotlib

- This 'magic' command tells ipython:
  - Load matplotlib (import as the alias "mpl")
  - Load the pyplot interface (as "plt"), which approximates the plotting functionality and syntax of MATLAB Put the output inline with notebook results (rather than saving to file, opening a new window, etc)

```
In[1]: %pylab inline
```

- What if we're not using ipython notebook?

```
import matplotlib as mpl
import pyplot as plt
import numpy as np
```

All the magic commands:
https://ipython.org/ipython-doc/3/interactive/magics.html

Generate some data to plot

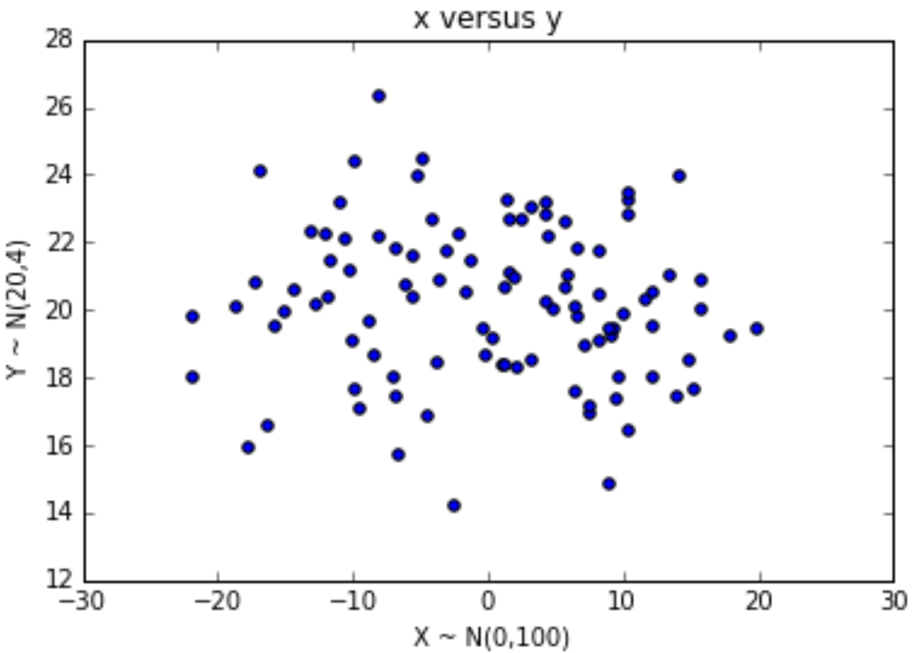
- Draw 100 samples into x from N(0, 10)
- Draw 100 samples into y from N(20, 2)
- Set z = 3 times y plus x plus N(0, 1)

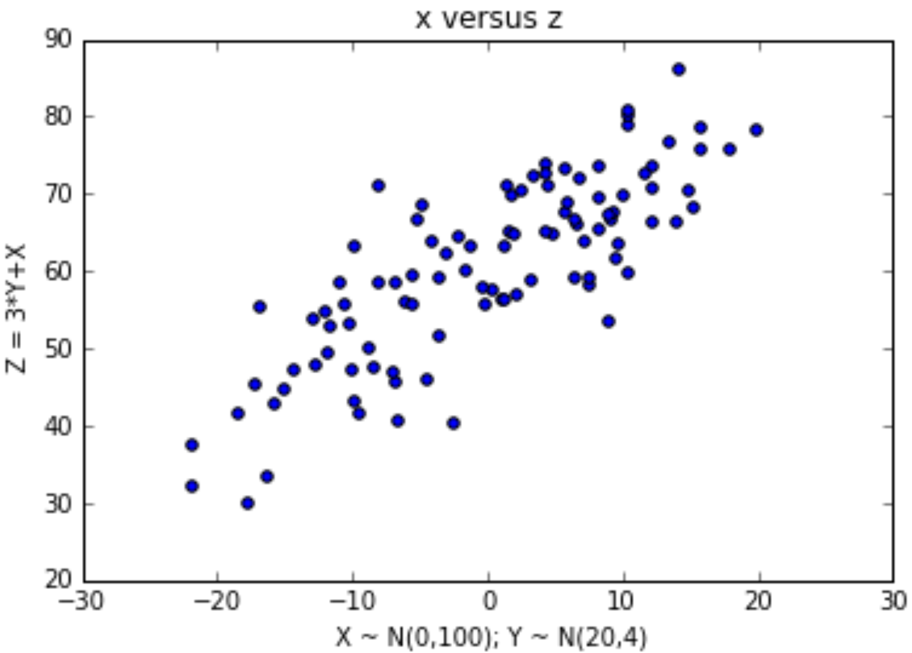
- Inspect sample mean and standard deviation using numpy functions mean, std:

```
>>> print 'x mean: ',np.mean(x)
>>> print 'x std: ',np.std(x)
x mean: 0.0820478565308
x std: 9.9856477737
```

Scatterplots

- plt.scatter
- plt.title
- plt.xlabel
- plt.ylabel





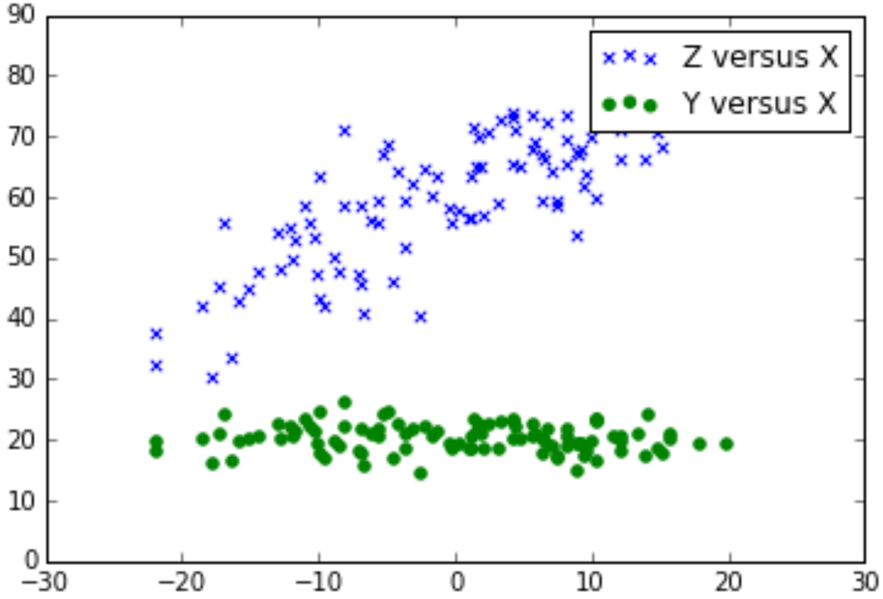
http://matplotlib.org/api/pyplot_api.html#matplotlib.pyplot.scatter

Overlay multiple series on a single plot

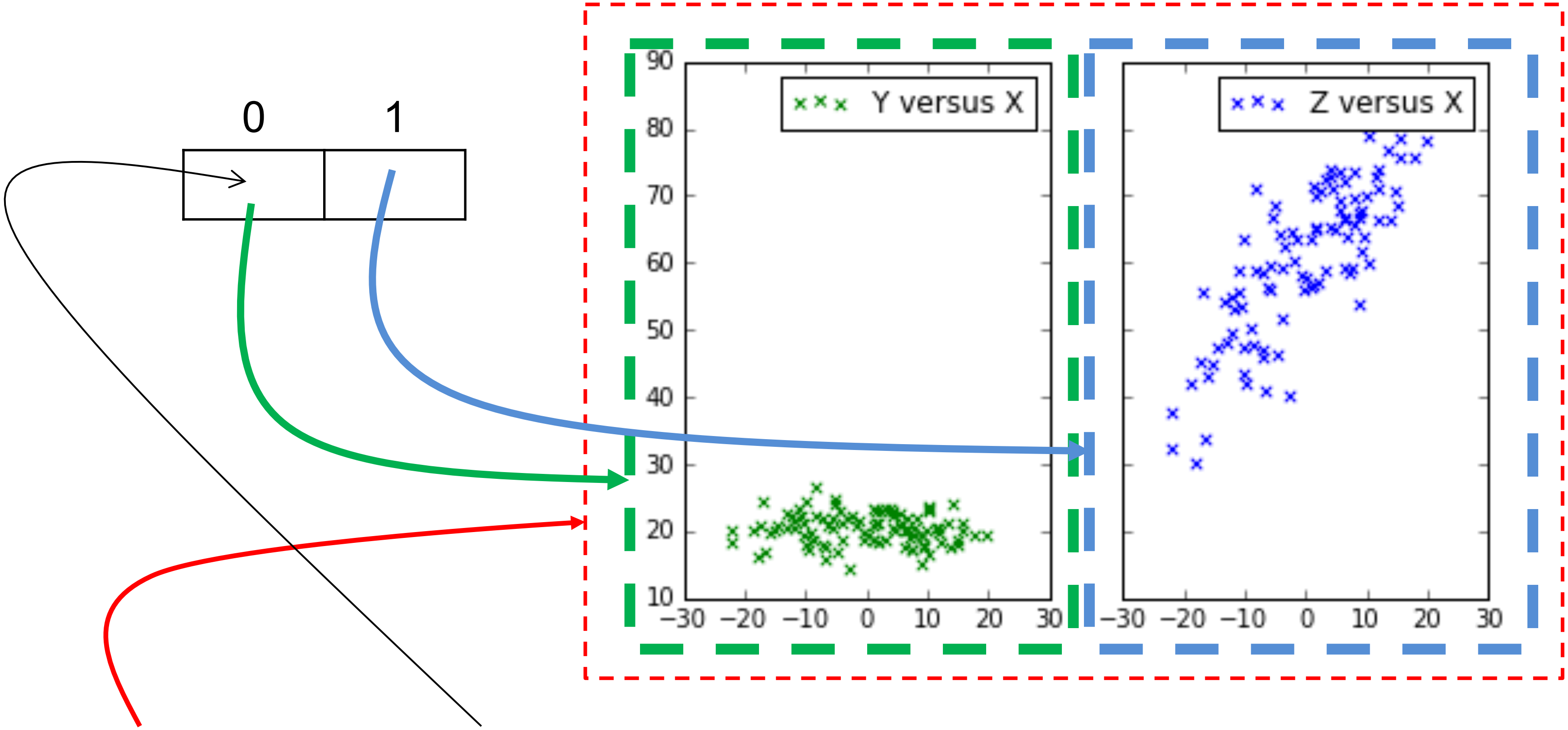
- Simply issue more than one plotting command in a row

- Just a few of the parameters you can customize:
  - marker
  - color (for other plot types, edgecolor, fillcolor)
  - **label**
  - Size

- plt.legend() adds a legend



Adjacent plots

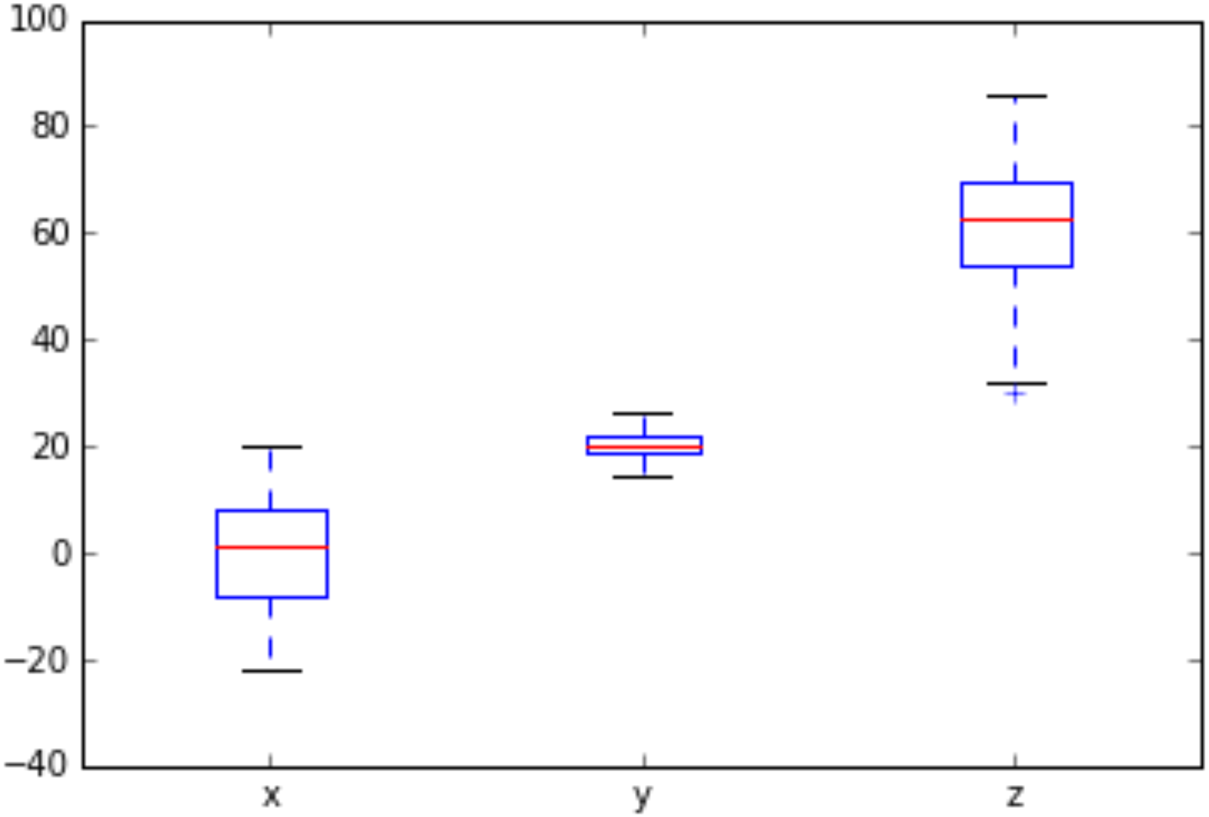


```
>>> my_figure, my_axes = plt.subplots(
                        1, 2,
                        sharey=True, sharex=True )
>>> my_axes[0].scatter( … )
# ...
```

http://matplotlib.org/api/pyplot_api.html#matplotlib.pyplot.subplots

Boxplots

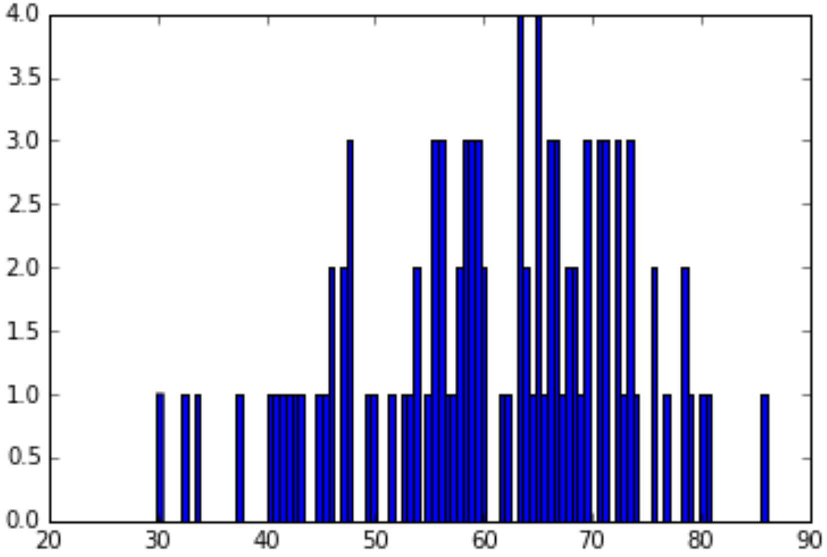
- plt.boxplot(...)

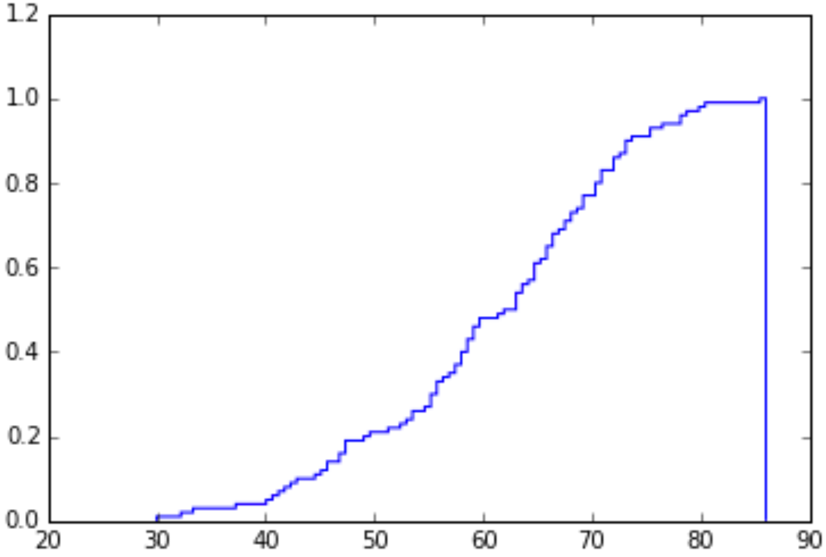


http://matplotlib.org/api/pyplot_api.html#matplotlib.pyplot.boxplot

Histograms

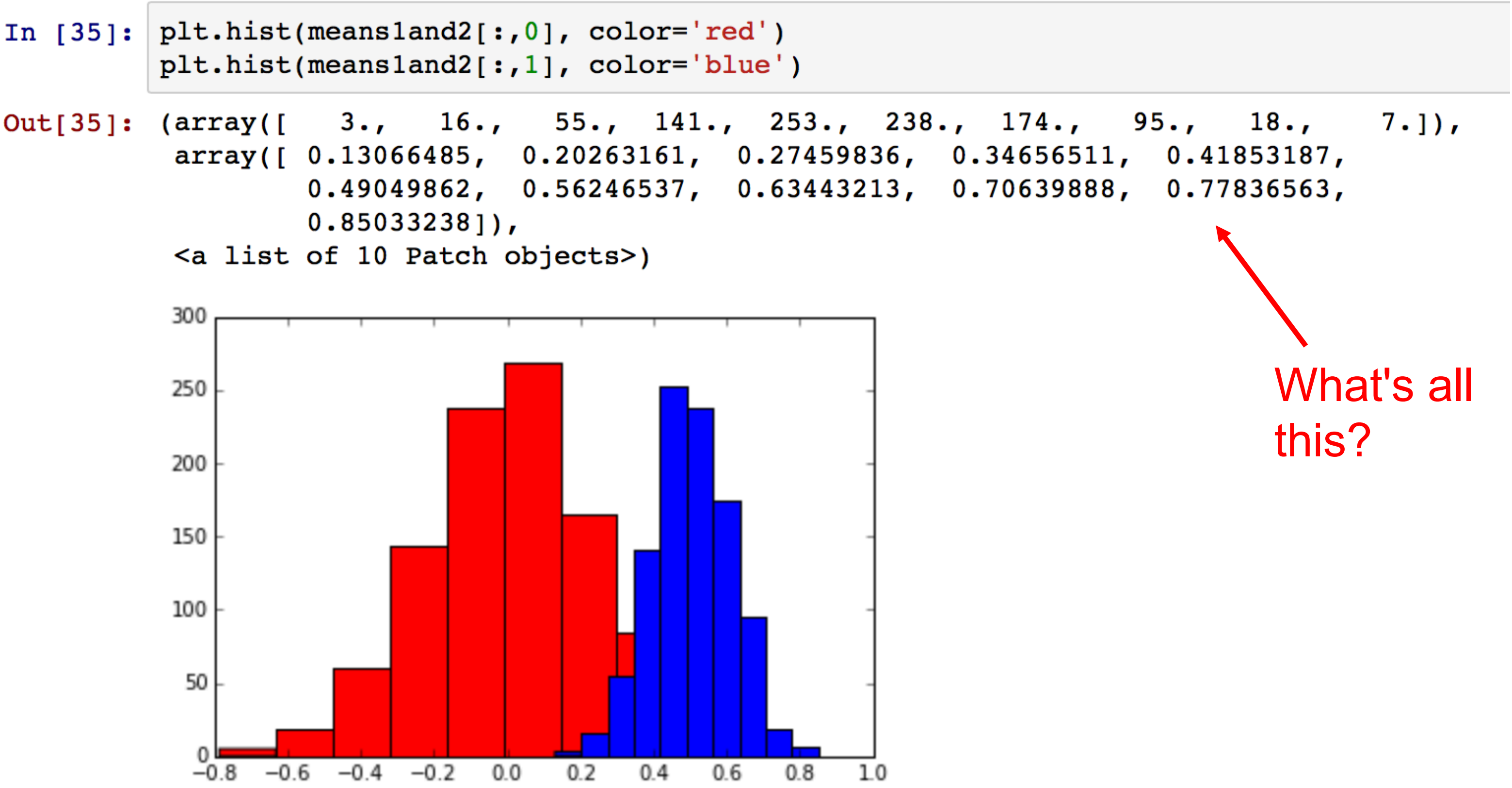
- plt.hist(…)





http://matplotlib.org/api/pyplot_api.html#matplotlib.pyplot.hist

Why are these binned differently?



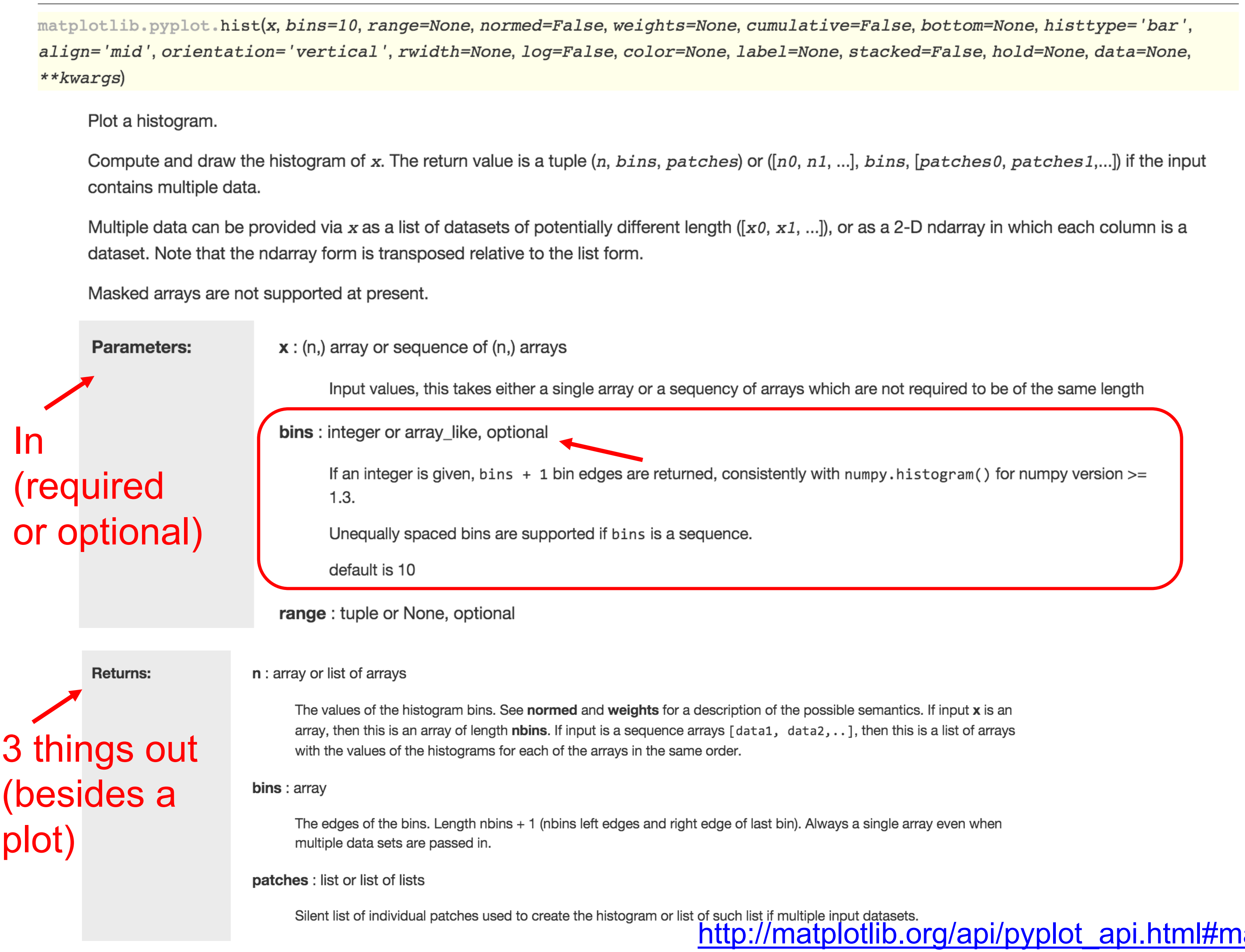
```
In [35]: plt.hist(means1and2[:,0], color='red')
         plt.hist(means1and2[:,1], color='blue')

Out[35]: (array([   3.,    16.,    55.,   141.,   253.,   238.,   174.,    95.,    18.,     7.]),
          array([ 0.13066485,  0.20263161,  0.27459836,  0.34656511,  0.41853187,
                  0.49049862,  0.56246537,  0.63443213,  0.70639888,  0.77836563,
                  0.85033238]),
          <a list of 10 Patch objects>)
```

What's all this?

http://matplotlib.org/api/pyplot_api.html#matplotlib.pyplot.hist

Check the manual...



`matplotlib.pyplot.hist(x, bins=10, range=None, normed=False, weights=None, cumulative=False, bottom=None, histtype='bar', align='mid', orientation='vertical', rwidth=None, log=False, color=None, label=None, stacked=False, hold=None, data=None, **kwargs)`

Plot a histogram.

Compute and draw the histogram of *x*. The return value is a tuple (*n*, *bins*, *patches*) or ([*n0*, *n1*, ...], *bins*, [*patches0*, *patches1*,...]) if the input contains multiple data.

Multiple data can be provided via *x* as a list of datasets of potentially different length ([*x0*, *x1*, ...]), or as a 2-D ndarray in which each column is a dataset. Note that the ndarray form is transposed relative to the list form.

Masked arrays are not supported at present.

Parameters:

x : (n,) array or sequence of (n,) arrays

Input values, this takes either a single array or a sequency of arrays which are not required to be of the same length

bins : integer or array_like, optional

If an integer is given, `bins + 1` bin edges are returned, consistently with `numpy.histogram()` for numpy version >= 1.3.

Unequally spaced bins are supported if `bins` is a sequence.

default is 10

range : tuple or None, optional

In (required or optional)

Returns:

n : array or list of arrays

The values of the histogram bins. See **normed** and **weights** for a description of the possible semantics. If input **x** is an array, then this is an array of length **nbins**. If input is a sequence arrays `[data1, data2,..]`, then this is a list of arrays with the values of the histograms for each of the arrays in the same order.

bins : array

The edges of the bins. Length nbins + 1 (nbins left edges and right edge of last bin). Always a single array even when multiple data sets are passed in.

patches : list or list of lists

Silent list of individual patches used to create the histogram or list of such list if multiple input datasets.

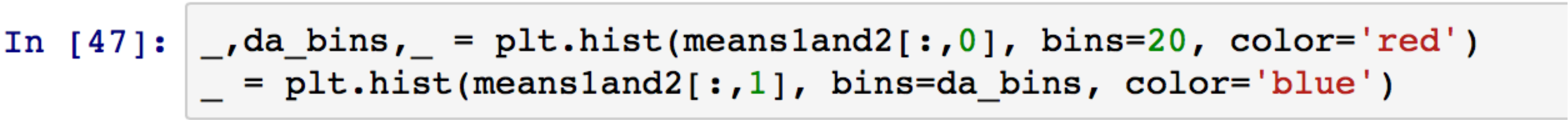
3 things out (besides a plot)

http://matplotlib.org/api/pyplot_api.html#matplotlib.pyplot.hist

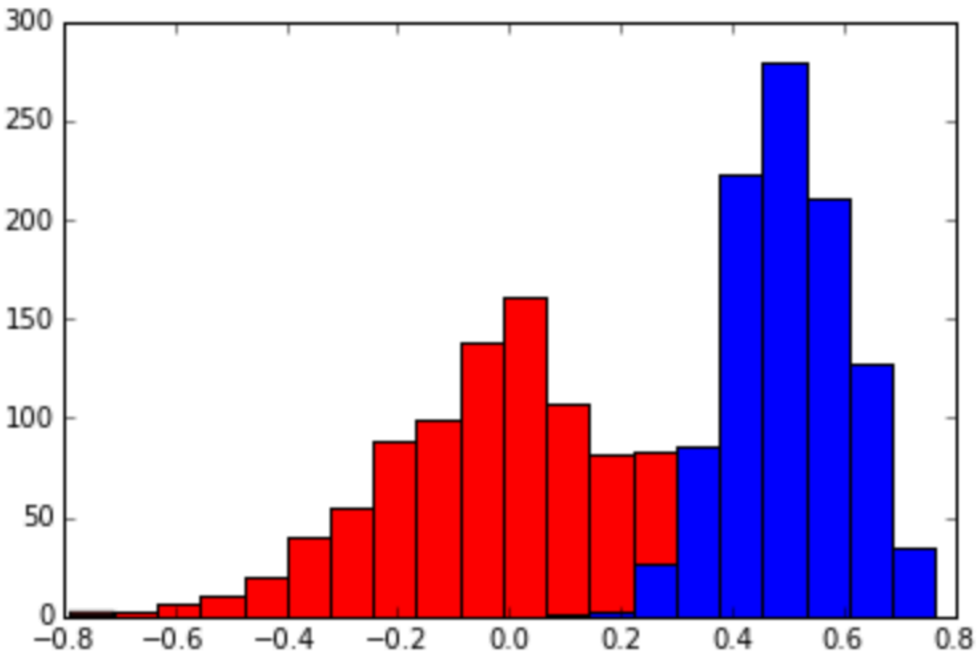
Get bin boundaries from 1st hist, use in 2nd

`_ = something(…)` here,

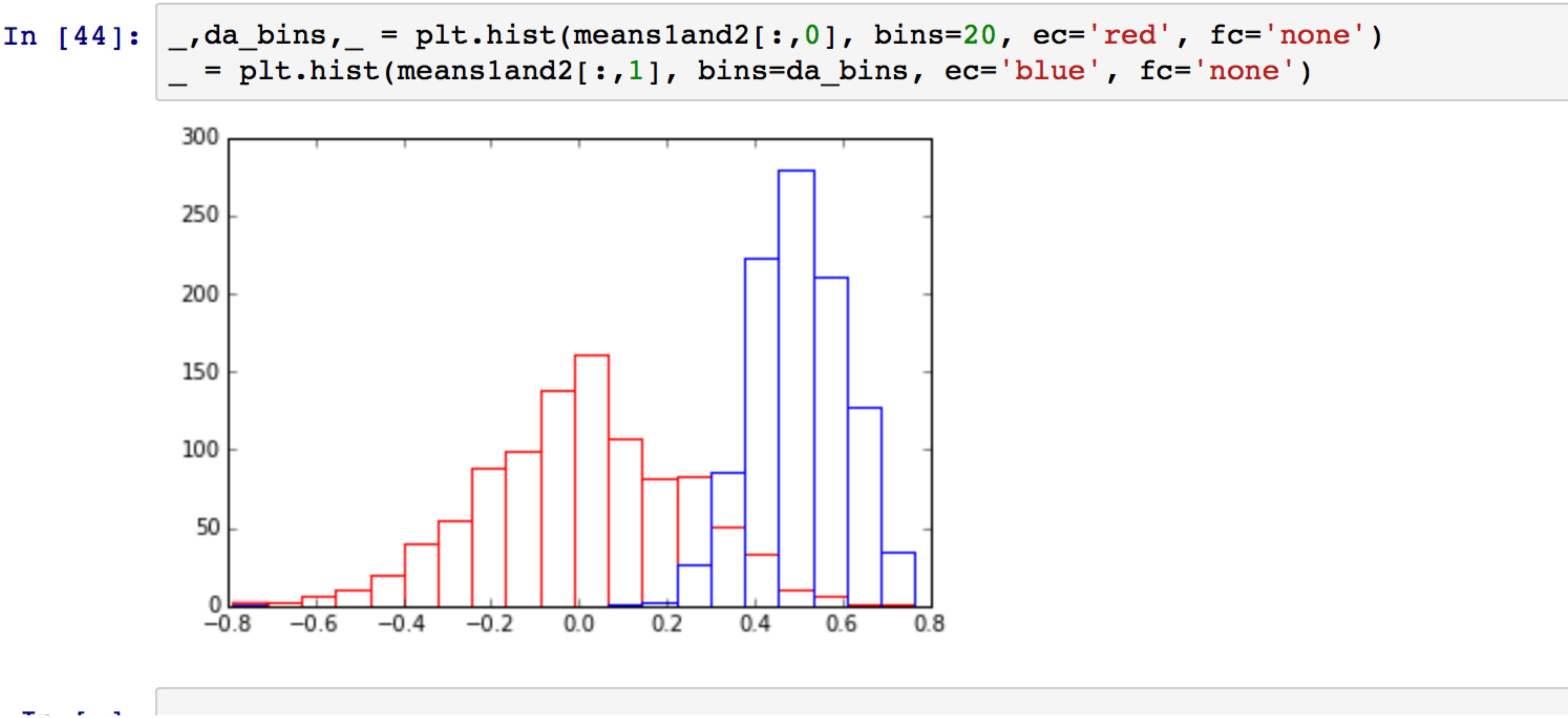
means call function something (or interpret some expression), get the result, and then discard (don't put in a variable)



```
In [47]: _,da_bins,_ = plt.hist(means1and2[:,0], bins=20, color='red')
         _ = plt.hist(means1and2[:,1], bins=da_bins, color='blue')
```



No fill color – can see through overlapping bins



```
In [44]: _,da_bins,_ = plt.hist(means1and2[:,0], bins=20, ec='red', fc='none')
         _ = plt.hist(means1and2[:,1], bins=da_bins, ec='blue', fc='none')
```