Data Visualization

Lecture Outline

- Why Visualize
- Guidelines
- Color
- Matplotlib
- Pandas

Why Visualize?

Exploratory Data Analysis

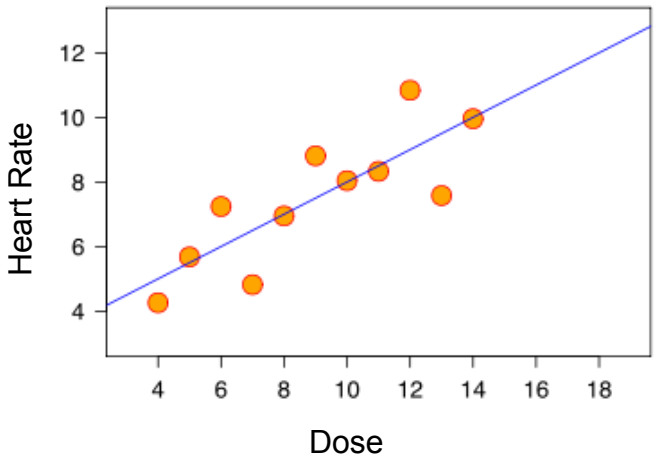
- Build a Data Frame
- Clean the Data Frame
  - Rows are individual observations, Columns are Properties
- Explore the Global Properties
- Describe Group Properties

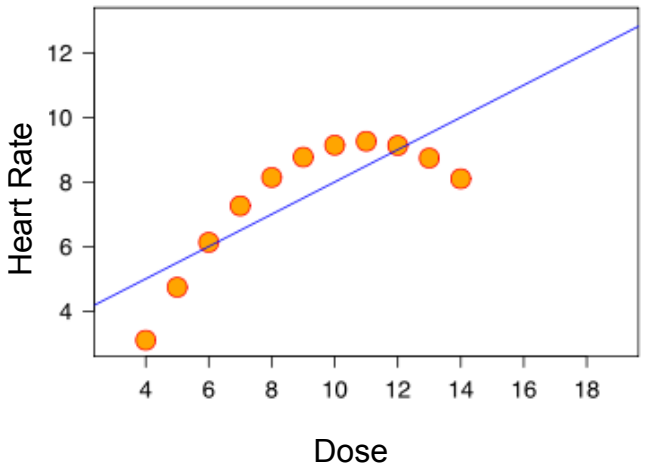
Anscombe’s Quartet

Anscombe's quartet

I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

Property	Value
Mean of x in each case	9 (exact)
Variance of x in each case	11 (exact)
Mean of y in each case	7.50 (to 2 decimal places)
Variance of y in each case	4.122 or 4.127 (to 3 decimal places)
Correlation between x and y in each case	0.816 (to 3 decimal places)
Linear regression line in each case	$y = 3.00 + 0.500x$ (to 2 and 3 decimal places, respectively)


Heart Rate
Dose
4
6
8
10
12
14
16
18


Heart Rate
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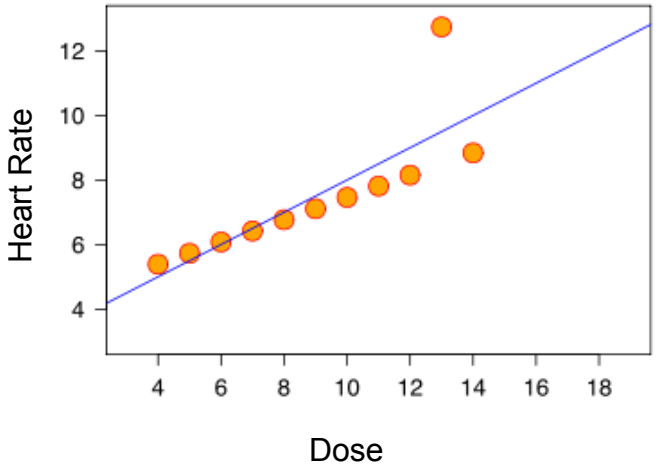
Heart Rate
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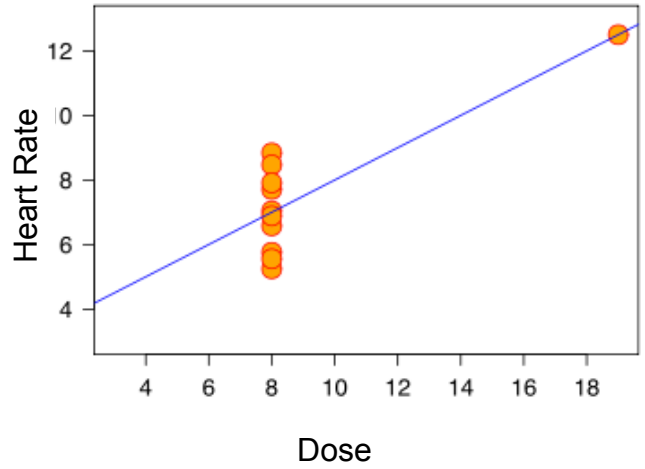
Heart Rate
Dose
4
6
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10
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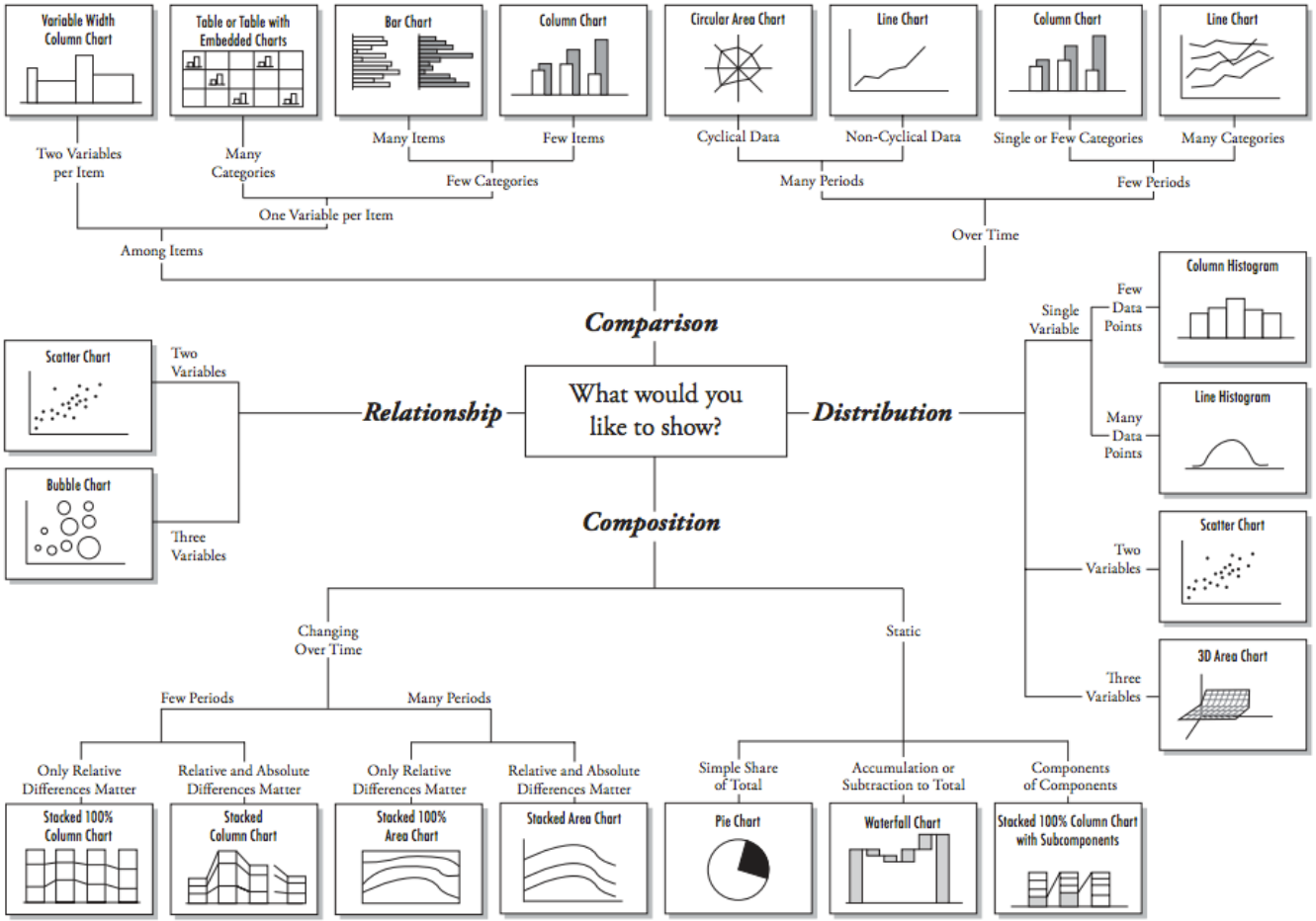
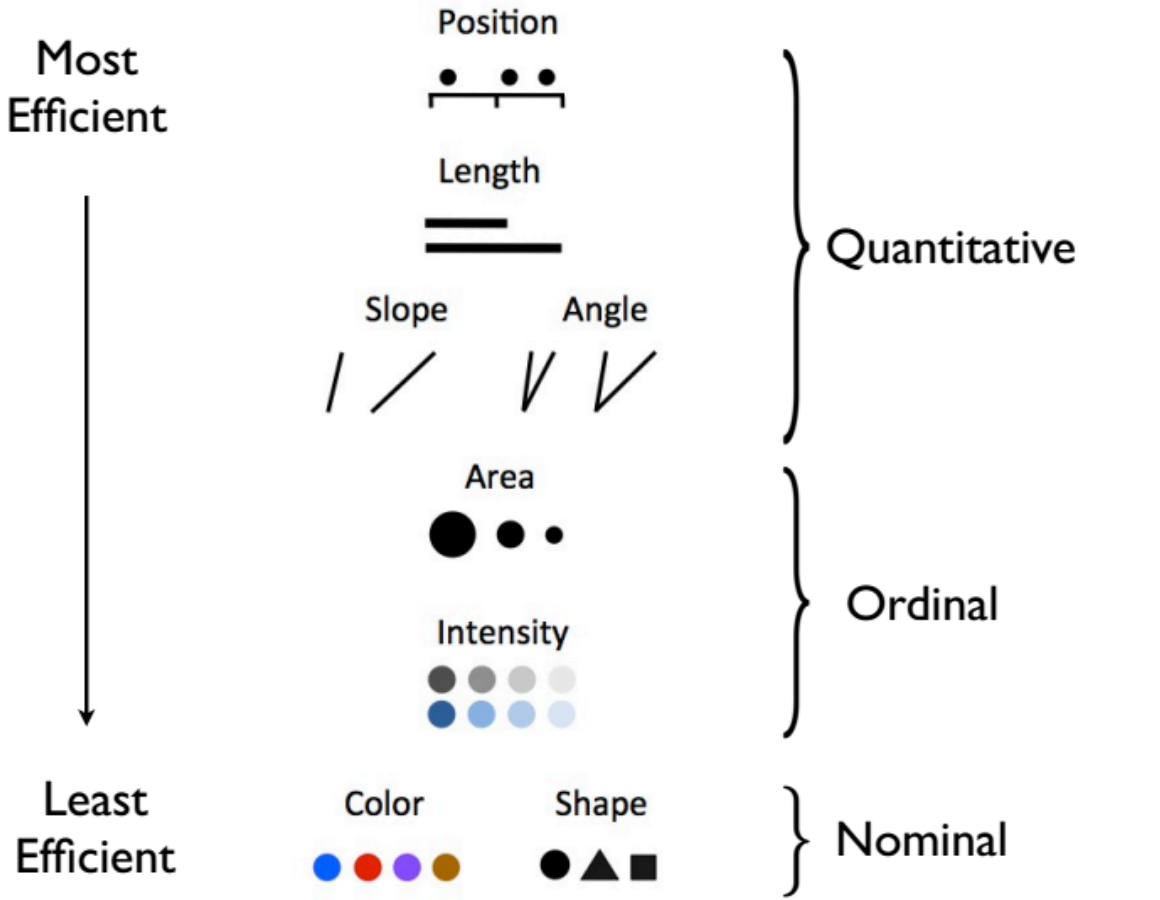
18

Guidelines

Chart Suggestions—A Thought-Starter




Most Efficient
Position
Length
Slope
Angle
Quantitative
Area
Intensity
Ordinal
Least Efficient
Color
Shape
Nominal
C. Mulbrandon
VisualizingEconomics.com

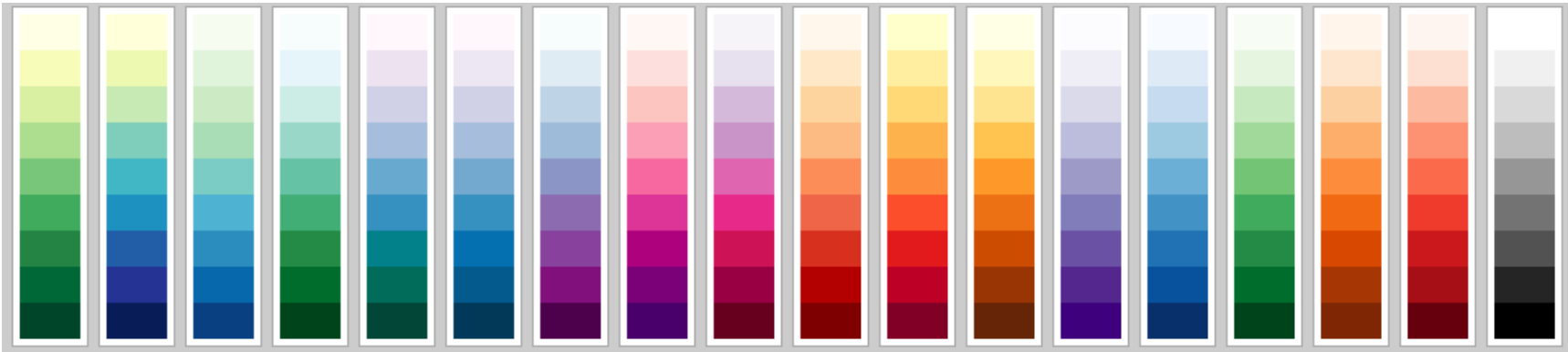
Color

As a data scientist I want:

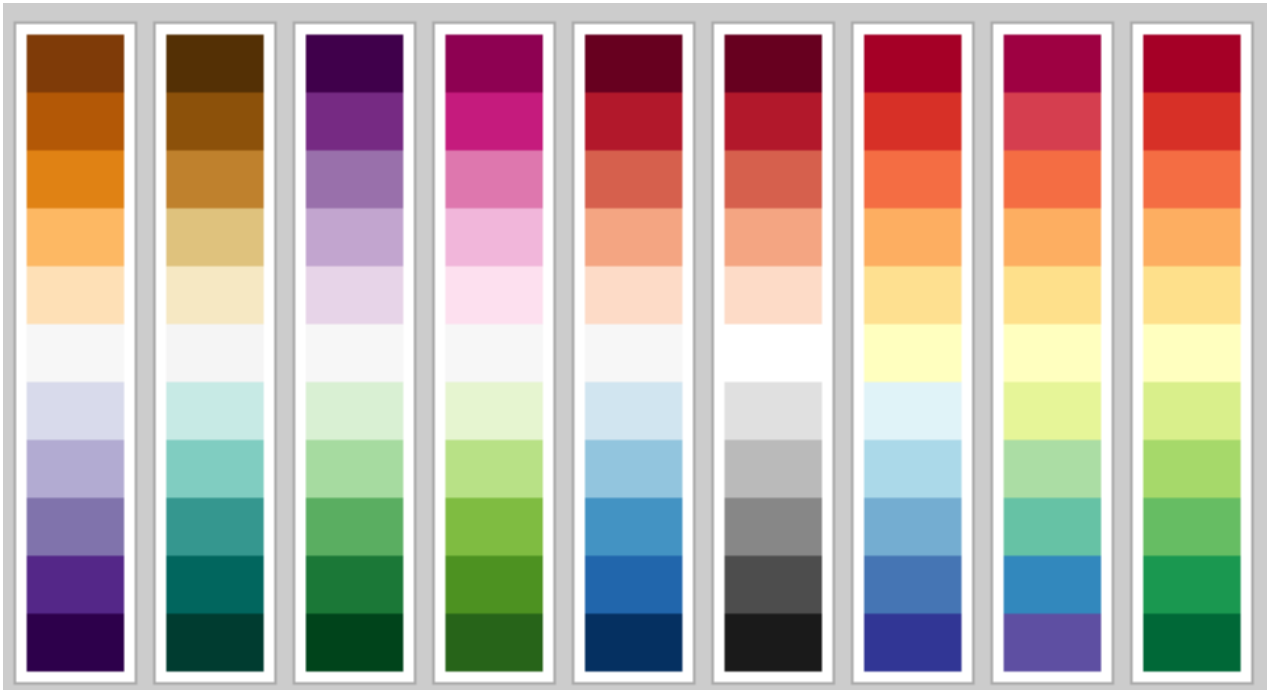
- To **avoid distracting colors**
- To keep **homogeneity**
- To control attention (ability to **mute** certain elements, or to **put focus** somewhere)

...and of course to have **distinct colors**.

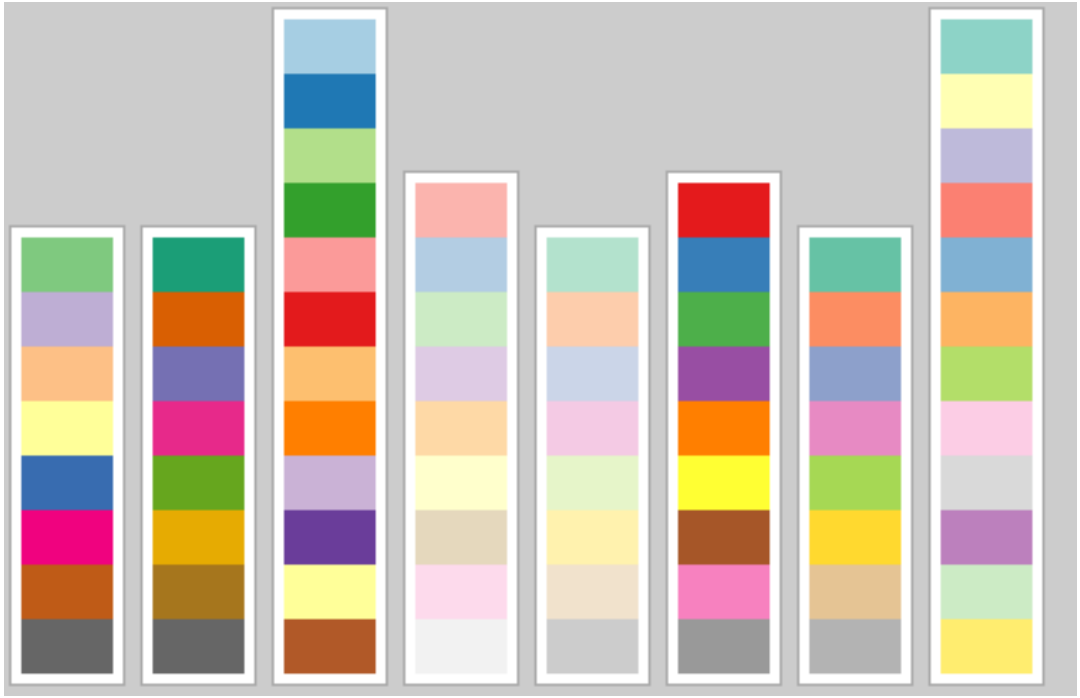
Sequential



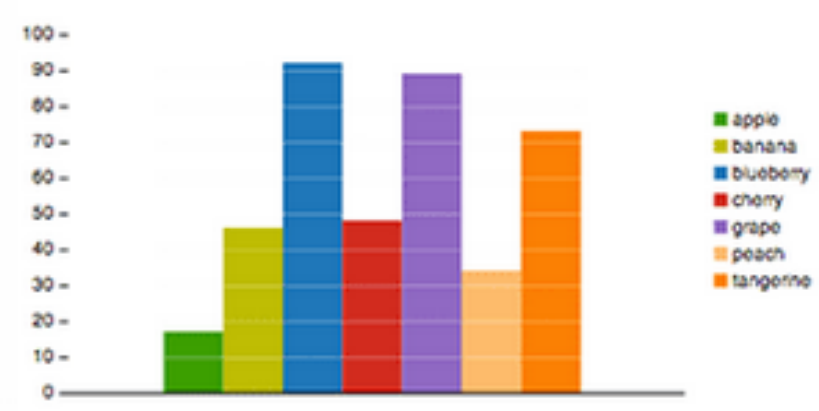
Diverging

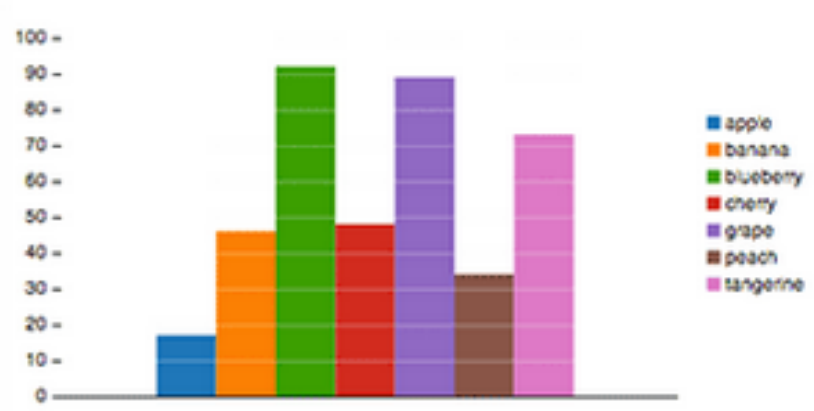


Qualitiative

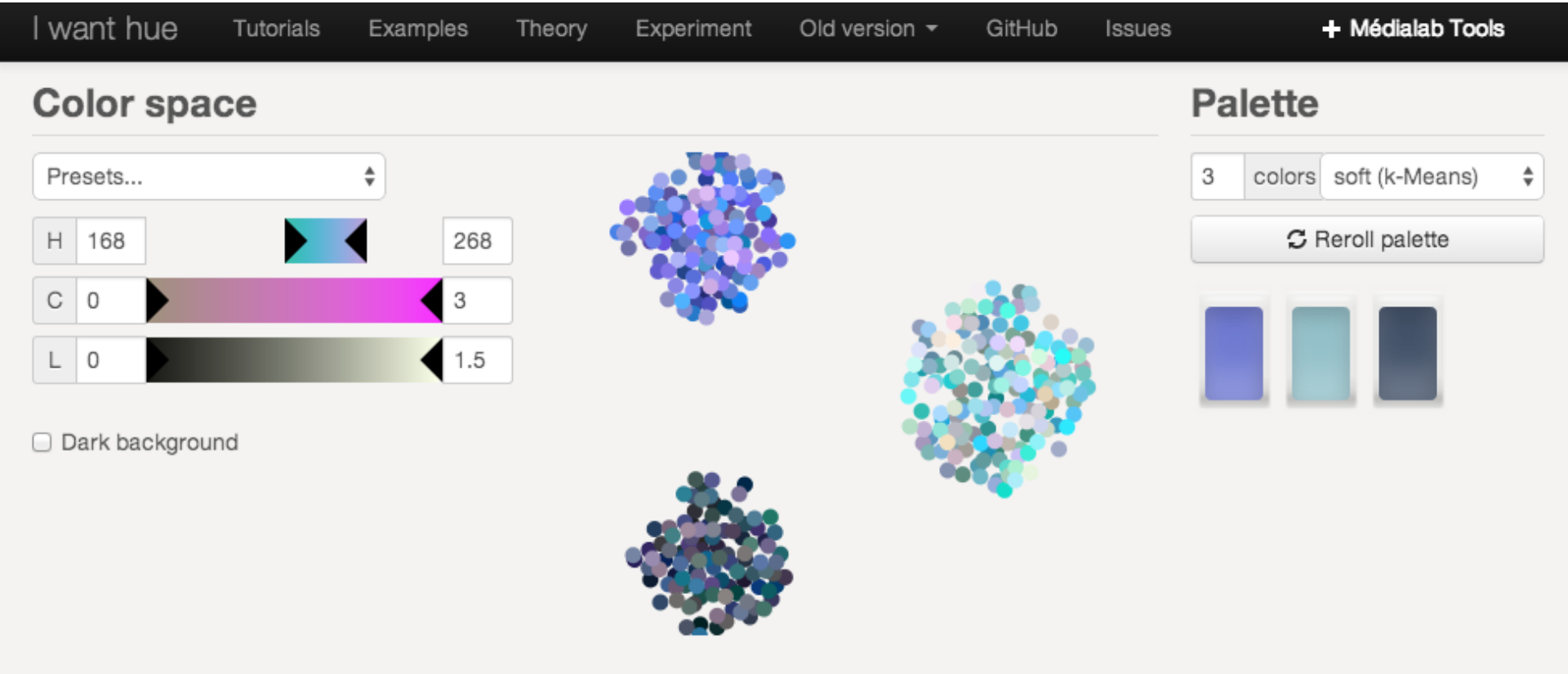


Semantic Colors





I Want Hue


I want hue
Tutorials
Examples
Theory
Experiment
Old version
GitHub
Issues
+ Médialab Tools
Color space
Presets...
H
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C
0
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L
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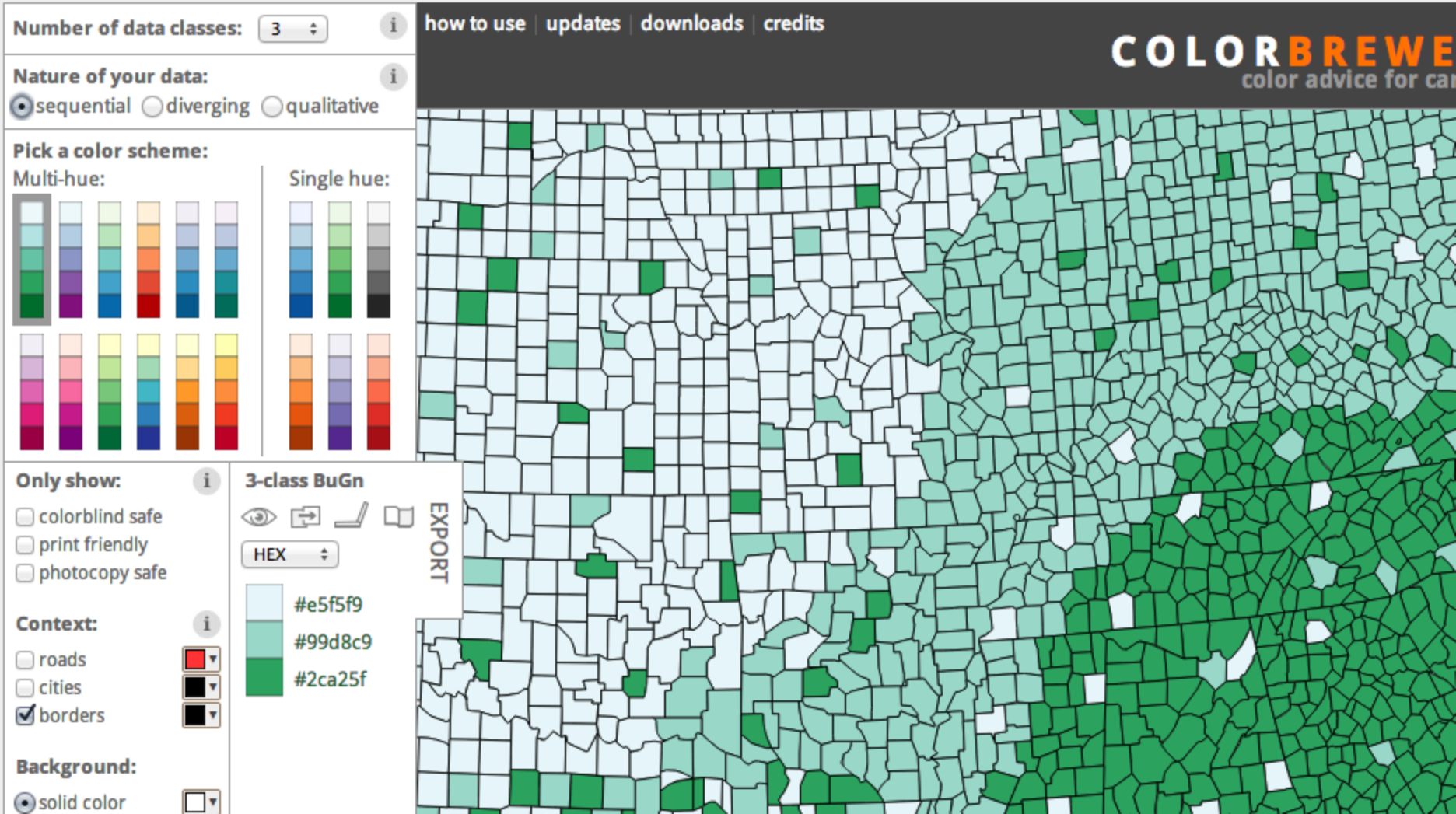
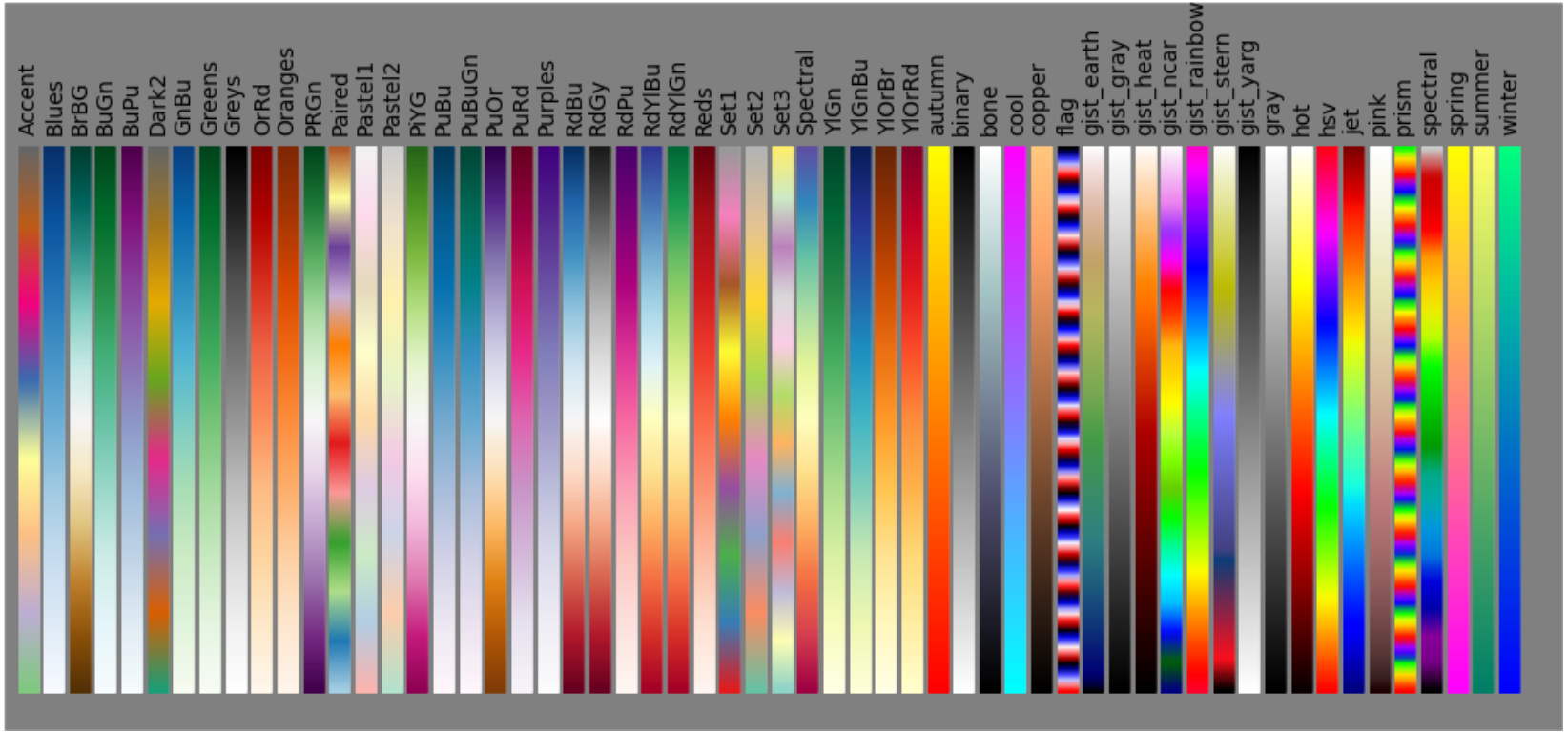
1.5
Dark background
Palette
3
colors
soft (k-Means)
Reroll palette


Number of data classes: 3
Nature of your data:
sequential diverging qualitative
Pick a color scheme:
Multi-hue:
Single hue:
Only show:
colorblind safe
print friendly
photocopy safe
Context:
roads
cities
borders
Background:
solid color
3-class BuGn
HEX
#e5f5f9
#99d8c9
#2ca25f
EXPORT
how to use | updates | downloads | credits
COLORBREWE
color advice for ca

Matplotlib Colors



http://wiki.scipy.org/Cookbook/Matplotlib/Show_colormaps

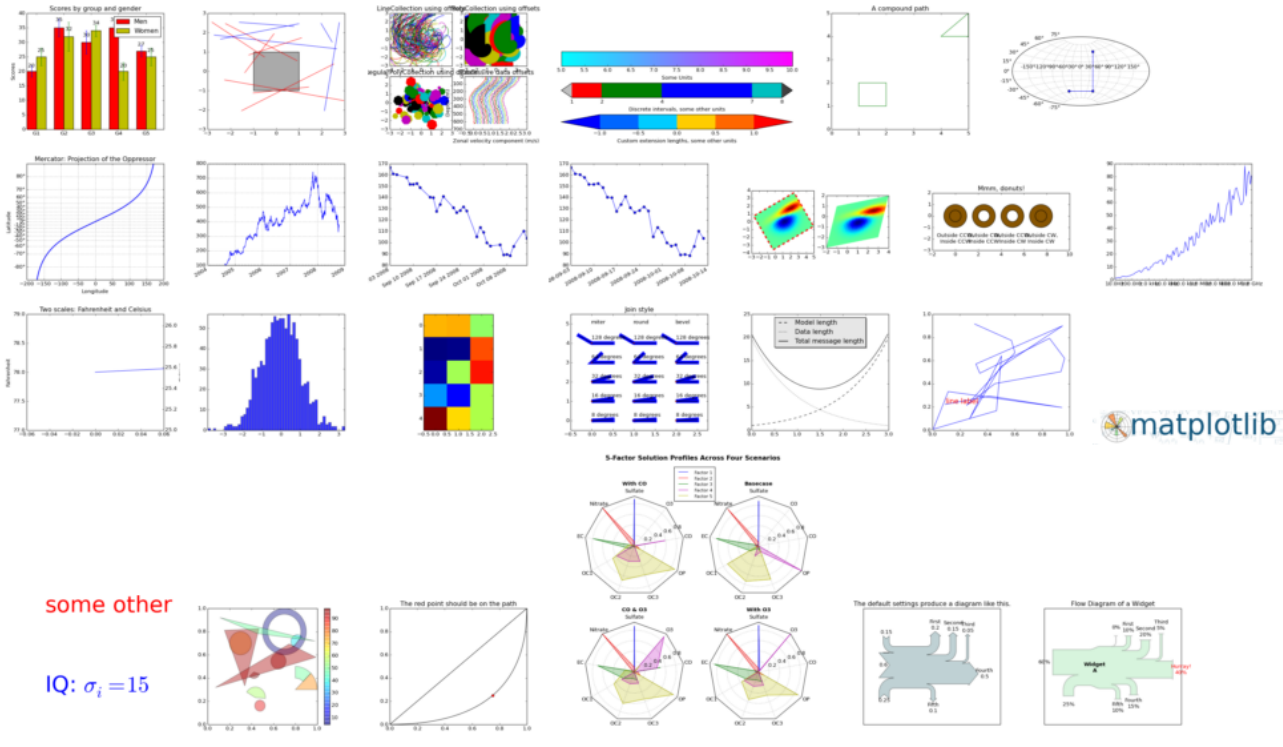
Matplotlib

Matplotlib

matplotlib tries to make easy things easy and hard things possible.

You can generate plots, histograms, power spectra, bar charts, errorcharts, scatterplots, etc, with just a few lines of code.

Use the Gallery



Search the Examples

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Matplotlib Examples

Release: 1.3.1

Date: October 10, 2013

- animation Examples
  - animate_decay
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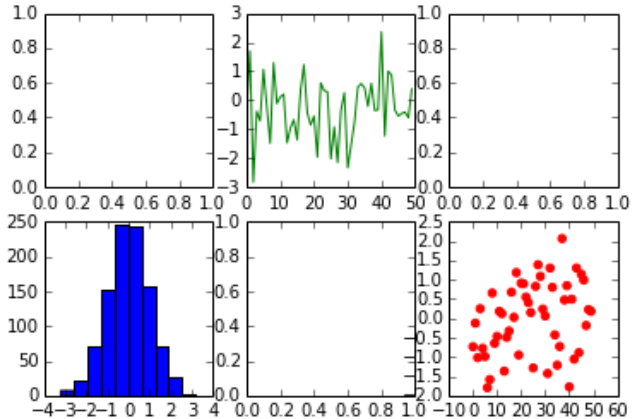
  - basic_example_writer
  - bayes_update
  - double_pendulum_animated
  - dynamic_image
  - dynamic_image2
  - histogram
  - moviewriter
  - random_data
  - simple_3danim
  - simple_anim
  - strip_chart_demo
  - subplots
- api Examples
  - agg_oo
  - barchart_demo
  - bbox_intersect
  - collections_demo
  - colorbar_only
  - compound_path
  - custom_projection_example
  - custom_scale_example
  - date_demo
  - date_index_formatter
  - demo_affine_image
  - donut_demo
  - engineering_formatter
  - fahrenheit_celsius_scales
  - font_family_rc
  - font_file
  - histogram_path_demo
  - image_zcoord
  - joinstyle
  - legend_demo
  - line_with_text
  - logo2
  - mathtext_asarray
  - patch_collection
  - quad_bezier
  - radar_chart
  - sankey_demo_basics
  - sankey_demo_links
  - sankey_demo_old
  - sankey_demo_rankine
  - scatter_piecharts
  - span_regions
  - two_scales
  - unicode_minus
  - watermark_image
  - watermark_text

Figures and Subplots

```
fig, ax = plt.subplots(2,3)

ax[0,1].plot(randn(50), color='green', linestyle='-')
ax[1,2].scatter(np.arange(50), randn(50), color='red')
ax[1,0].hist(randn(1000))
plt.show() #Similar to print()

# Exercise: Swap the top row and bottom row plots
# Excecise: Change the line style to dotted and add circles as markers
# Exercise: change the bins to 100 for the histogram
```

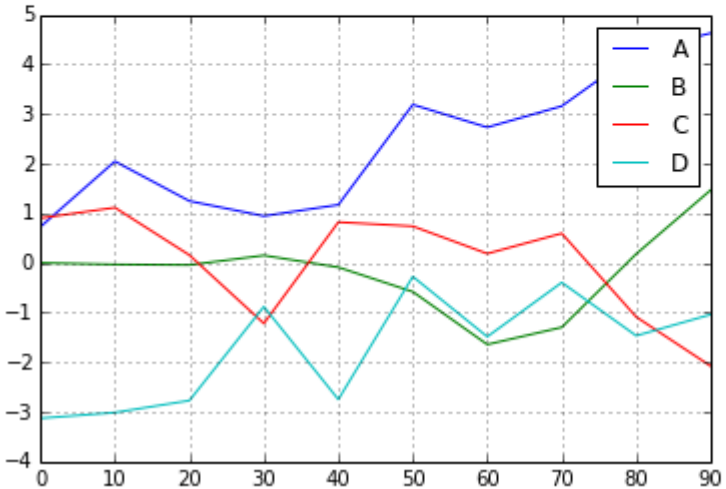


Plotting with Pandas

Line Plots

```
# Pandas data frames have a built in plot function with defaults
df = DataFrame(np.random.randn(10, 4).cumsum(0),
columns=['A', 'B', 'C', 'D'],
index=np.arange(0, 100, 10))
df.plot()
```

```
<matplotlib.axes.AxesSubplot at 0x10681b090>
```



Bar Plots

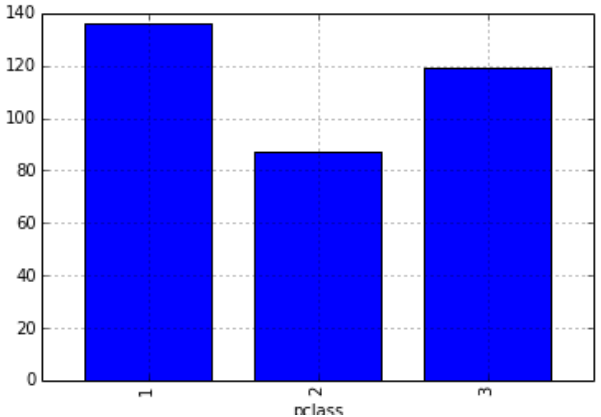
```
Data columns (total 11 columns):
survived    891  non-null values
pclass      891  non-null values
name        891  non-null values
sex         891  non-null values
age         714  non-null values
sibsp       891  non-null values
parch       891  non-null values
ticket      891  non-null values
fare        891  non-null values
cabin       204  non-null values
embarked    889  non-null values
dtypes: float64(2), int64(4), object(5)
```

```
]:
```

Slide

```
# Append .plot to dataframe
titanic.groupby('pclass').survived.sum().plot(kind='bar')
```

```
]: <matplotlib.axes.AxesSubplot at 0x106cc7f90>
```



Bar Plots

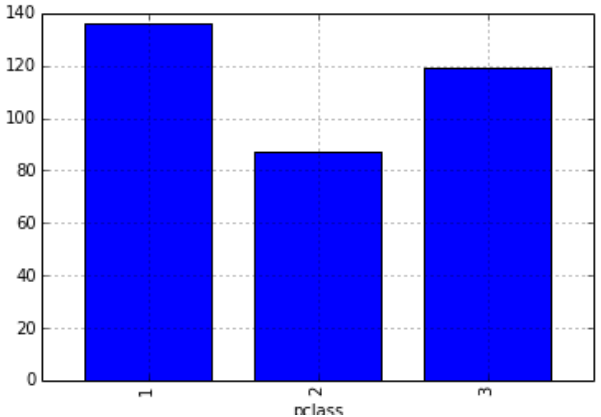
```
Data columns (total 11 columns):
survived    891  non-null values
pclass      891  non-null values
name        891  non-null values
sex         891  non-null values
age         714  non-null values
sibsp       891  non-null values
parch       891  non-null values
ticket      891  non-null values
fare        891  non-null values
cabin       204  non-null values
embarked    889  non-null values
dtypes: float64(2), int64(4), object(5)
```

```
]:
```

Slide

```
# Append .plot to dataframe
titanic.groupby('pclass').survived.sum().plot(kind='bar')
```

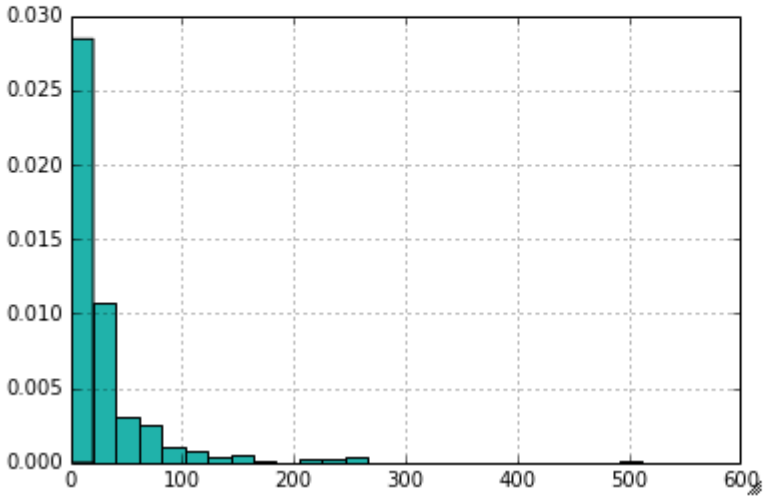
```
]: <matplotlib.axes.AxesSubplot at 0x106cc7f90>
```



Histograms

```
In [22]: titanic.fare.hist(bins=25, normed=True, color='lightseagreen')
```

```
Out[22]: <matplotlib.axes.AxesSubplot at 0x109915310>
```



Read Docs

In [31]:

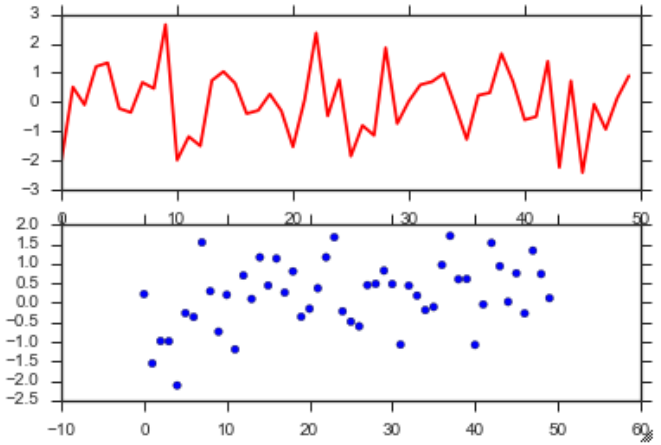
```
fig = figure()

# Two rows, one column, first plot
ax1 = fig.add_subplot(2,1,1)
ax1.plot(randn(50), color='red')

#Two rows, one column, second plot
ax2 = fig.add_subplot(2,1,2)
ax2.scatter(np.arange(50), randn(50))

# Exercise: Try 1 row, two columns
# Exercise: Try 1 row, one column
```

Out[31]: <matplotlib.collections.PathCollection at 0x10bea22d0>



Read Docs

```
help(plt.subplots)
```

```
Help on function subplots in module matplotlib.pyplot:

subplots(nrows=1, ncols=1, sharex=False, sharey=False, squeeze=True, su
kw=None, **fig_kw)
    Create a figure with a set of subplots already made.

    This utility wrapper makes it convenient to create common layouts o
    subplots, including the enclosing figure object, in a single call.

    Keyword arguments:

      *nrows* : int
        Number of rows of the subplot grid.  Defaults to 1.

      *ncols* : int
        Number of columns of the subplot grid.  Defaults to 1.

      *sharex* : string or bool
        If *True*, the X axis will be shared amongst all subplots.  If
        *True* and you have multiple rows, the x tick labels on all but
        the last row of plots will have visible set to *False*
        If a string must be one of "row", "col", "all", or "none".
        "all" has the same effect as *True*, "none" has the same effect
        as *False*.
        If "row", each subplot row will share a X axis.
        If "col", each subplot column will share a X axis and the x tic
        labels on all but the last row will have visible set to *False*
```

Instructional Set