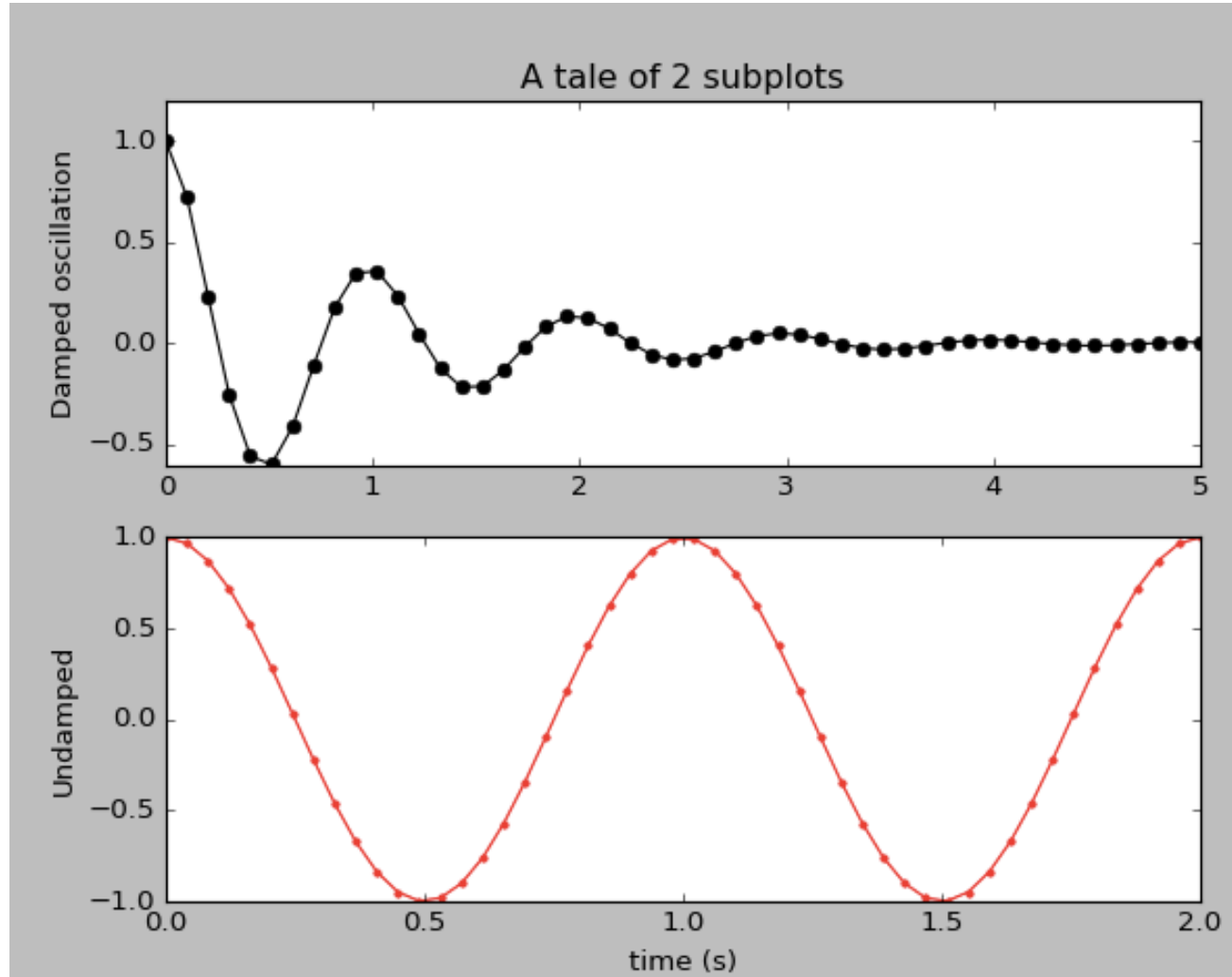


visualizations

Agenda

- **Matplotlib**
- Bokeh
- Tableau
- Final Project

Anatomy of a matplotlib plot



Anatomy of a matplotlib plot

```
import numpy as np
import matplotlib.pyplot as plt
x1 = np.linspace(0.0, 5.0)
x2 = np.linspace(0.0, 2.0)
y1 = np.cos(2 * np.pi * x1) * np.exp(-x1)
y2 = np.cos(2 * np.pi * x2)
plt.subplot(2, 1, 1)
plt.plot(x1, y1, 'ko-')
plt.title('A tale of 2 subplots')
plt.ylabel('Damped oscillation')
plt.subplot(2, 1, 2)
plt.plot(x2, y2, 'r.-')
plt.xlabel('time (s)')
plt.ylabel('Undamped')
plt.show()
```

Import libraries

```
import numpy as np
import matplotlib.pyplot as plt
x1 = np.linspace(0.0, 5.0)
x2 = np.linspace(0.0, 2.0)
y1 = np.cos(2 * np.pi * x1) * np.exp(-x1)
y2 = np.cos(2 * np.pi * x2)
plt.subplot(2, 1, 1)
plt.plot(x1, y1, 'ko-')
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plt.subplot(2, 1, 2)
plt.plot(x2, y2, 'r.-')
plt.xlabel('time (s)')
plt.ylabel('Undamped')
plt.show()
```

Anatomy of a matplotlib plot

```
import numpy as np
import matplotlib.pyplot as plt
x1 = np.linspace(0.0, 5.0)
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y1 = np.cos(2 * np.pi * x1) * np.exp(-x1)
y2 = np.cos(2 * np.pi * x2)
plt.subplot(2, 1, 1)
plt.plot(x1, y1, 'ko-')
plt.title('A tale of 2 subplots')
plt.ylabel('Damped oscillation')
plt.subplot(2, 1, 2)
plt.plot(x2, y2, 'r.-')
plt.xlabel('time (s)')
plt.ylabel('Undamped')
plt.show()
```

Define 2 x-axis ranges in linear space

```
import numpy as np
import matplotlib.pyplot as plt
x1 = np.linspace(0.0, 5.0)
x2 = np.linspace(0.0, 2.0)
y1 = np.cos(2 * np.pi * x1) * np.exp(-x1)
y2 = np.cos(2 * np.pi * x2)
plt.subplot(2, 1, 1)
plt.plot(x1, y1, 'ko-')
plt.title('A tale of 2 subplots')
plt.ylabel('Damped oscillation')
plt.subplot(2, 1, 2)
plt.plot(x2, y2, 'r.-')
plt.xlabel('time (s)')
plt.ylabel('Undamped')
plt.show()
```

Create 2 sinusoidal functions

```
import numpy as np
import matplotlib.pyplot as plt
x1 = np.linspace(0.0, 5.0)
x2 = np.linspace(0.0, 2.0)
y1 = np.cos(2 * np.pi * x1) * np.exp(-x1)
y2 = np.cos(2 * np.pi * x2)
plt.subplot(2, 1, 1)
plt.plot(x1, y1, 'ko-')
plt.title('A tale of 2 subplots')
plt.ylabel('Damped oscillation')
plt.subplot(2, 1, 2)
plt.plot(x2, y2, 'r.-')
plt.xlabel('time (s)')
plt.ylabel('Undamped')
plt.show()
```


Plot subplot #1

```
import numpy as np
import matplotlib.pyplot as plt
x1 = np.linspace(0.0, 5.0)
x2 = np.linspace(0.0, 2.0)
y1 = np.cos(2 * np.pi * x1) * np.exp(-x1)
y2 = np.cos(2 * np.pi * x2)
plt.subplot(2, 1, 1)
plt.plot(x1, y1, 'ko-')
plt.title('A tale of 2 subplots')
plt.ylabel('Damped oscillation')
plt.subplot(2, 1, 2)
plt.plot(x2, y2, 'r.-')
plt.xlabel('time (s)')
plt.ylabel('Undamped')
plt.show()
```

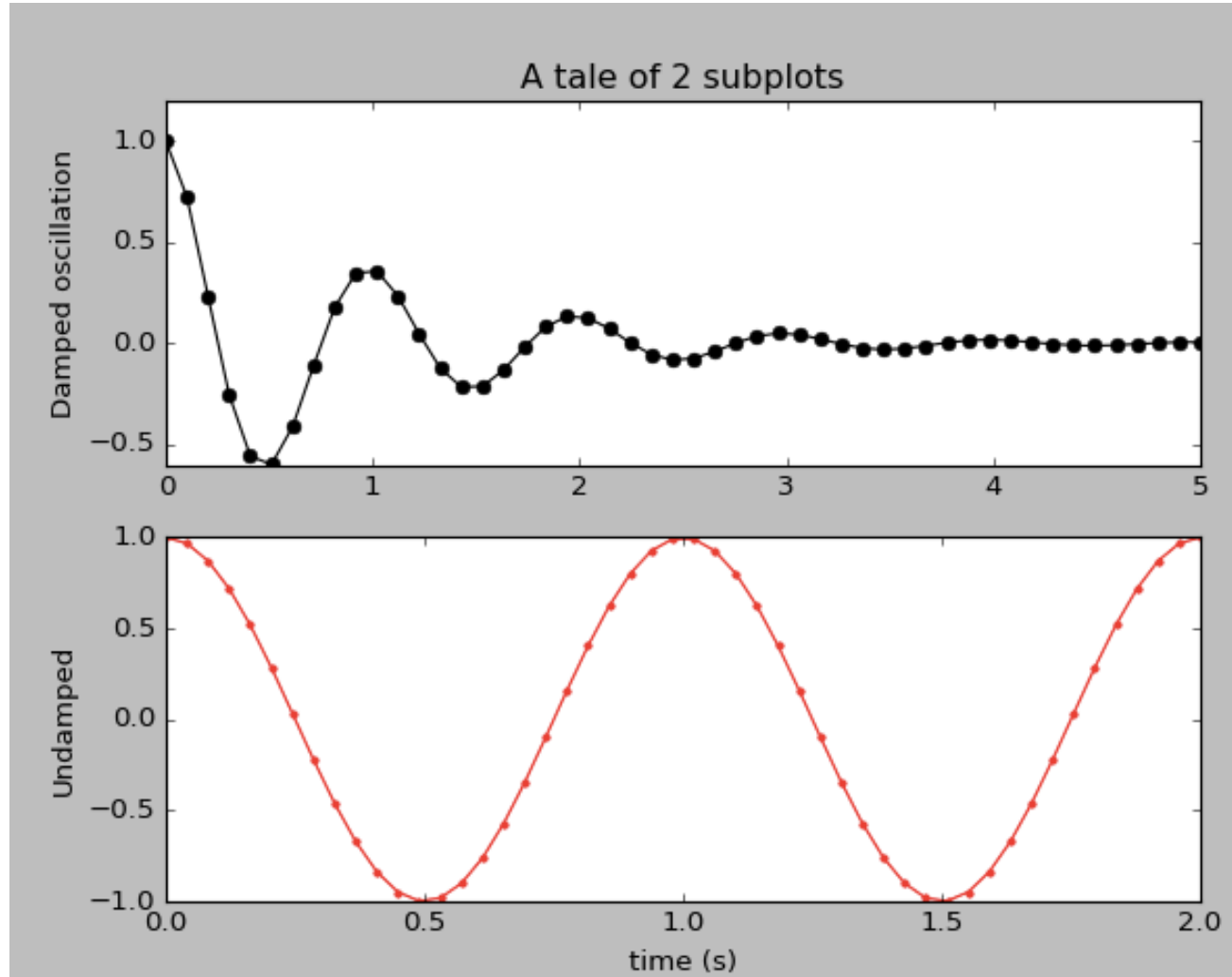
Plot subplot #2

```
import numpy as np
import matplotlib.pyplot as plt
x1 = np.linspace(0.0, 5.0)
x2 = np.linspace(0.0, 2.0)
y1 = np.cos(2 * np.pi * x1) * np.exp(-x1)
y2 = np.cos(2 * np.pi * x2)
plt.subplot(2, 1, 1)
plt.plot(x1, y1, 'ko-')
plt.title('A tale of 2 subplots')
plt.ylabel('Damped oscillation')
plt.subplot(2, 1, 2)
plt.plot(x2, y2, 'r.-')
plt.xlabel('time (s)')
plt.ylabel('Undamped')
plt.show()
```

Finally: show it!

```
import numpy as np
import matplotlib.pyplot as plt
x1 = np.linspace(0.0, 5.0)
x2 = np.linspace(0.0, 2.0)
y1 = np.cos(2 * np.pi * x1) * np.exp(-x1)
y2 = np.cos(2 * np.pi * x2)
plt.subplot(2, 1, 1)
plt.plot(x1, y1, 'ko-')
plt.title('A tale of 2 subplots')
plt.ylabel('Damped oscillation')
plt.subplot(2, 1, 2)
plt.plot(x2, y2, 'r.-')
plt.xlabel('time (s)')
plt.ylabel('Undamped')
plt.show()
```

Anatomy of a matplotlib plot



Agenda

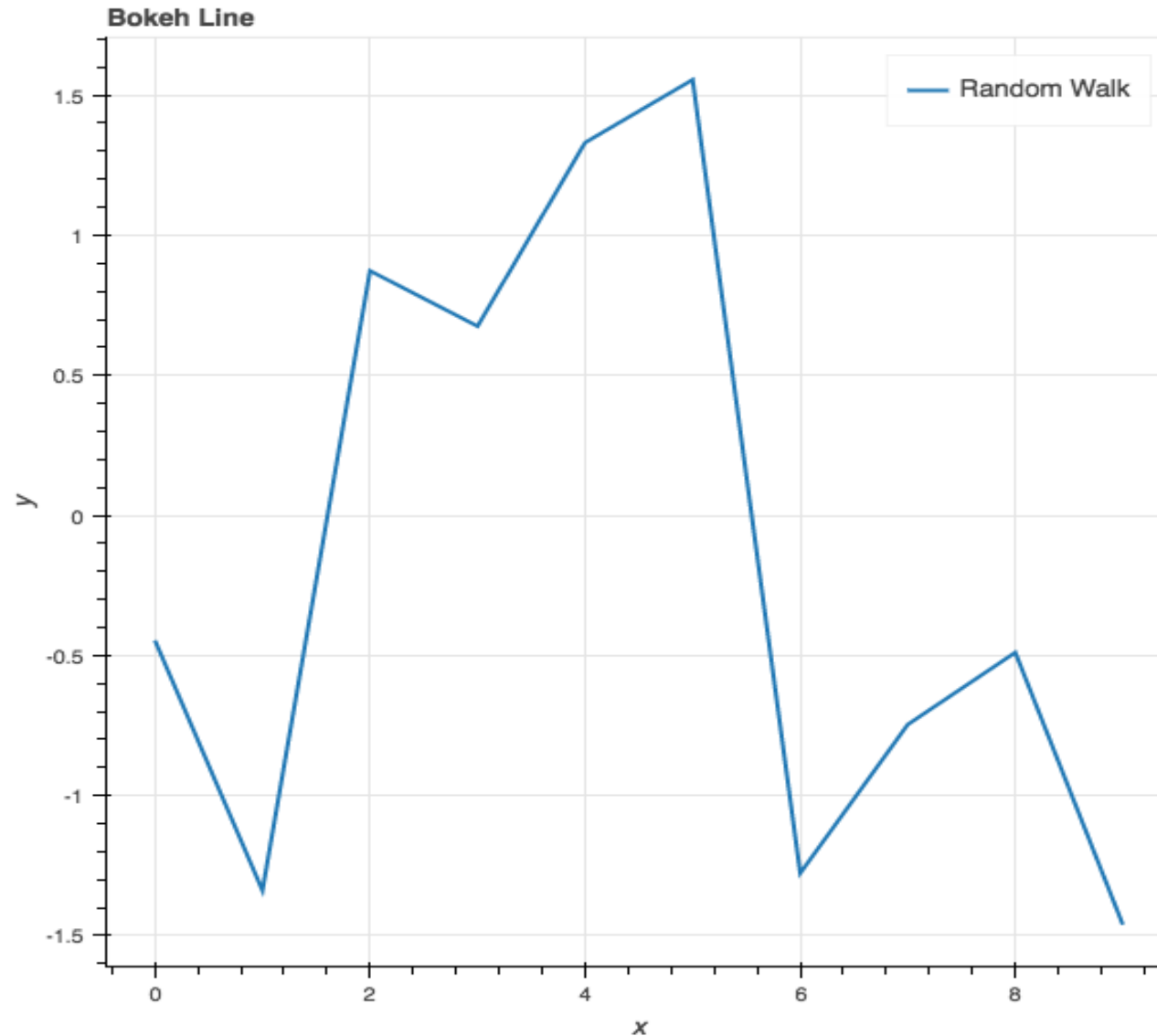
- Matplotlib
- **Bokeh**
- Tableau
- Final Project

Bokeh: web interactive display

Creates interactive visualization for web presentation.

- In the style of D3.js
- High-performance interactivity over very large or streaming datasets
- Quick creation of plots, dashboards, data apps

Anatomy of a Simple Bokeh App



Anatomy of a Simple Bokeh App

```
import numpy as np
from bokeh.plotting import figure, output_file, show
a = np.arange(10)
b = np.random.randn(10)
output_file("lines.html")
p = figure(title="Bokeh Line", x_axis_label='x', y_axis_label='y')
p.line(a, b, legend="Random Walk", line_width=2)
show(p)
```


Import the libraries

```
import numpy as np
from bokeh.plotting import figure, output_file, show
a = np.arange(10)
b = np.random.randn(10)
output_file("lines.html")
p = figure(title="Bokeh Line", x_axis_label='x', y_axis_label='y')
p.line(a, b, legend="Random Walk", line_width=2)
show(p)
```

Define the x and y ranges

```
import numpy as np
from bokeh.plotting import figure, output_file, show
a = np.arange(10)
b = np.random.randn(10)
output_file("lines.html")
p = figure(title="Bokeh Line", x_axis_label='x', y_axis_label='y')
p.line(a, b, legend="Random Walk", line_width=2)
show(p)
```

Define name of the HTML file

```
import numpy as np
from bokeh.plotting import figure, output_file, show
a = np.arange(10)
b = np.random.randn(10)
output_file("lines.html")
p = figure(title="Bokeh Line", x_axis_label='x', y_axis_label='y')
p.line(a, b, legend="Random Walk", line_width=2)
show(p)
```

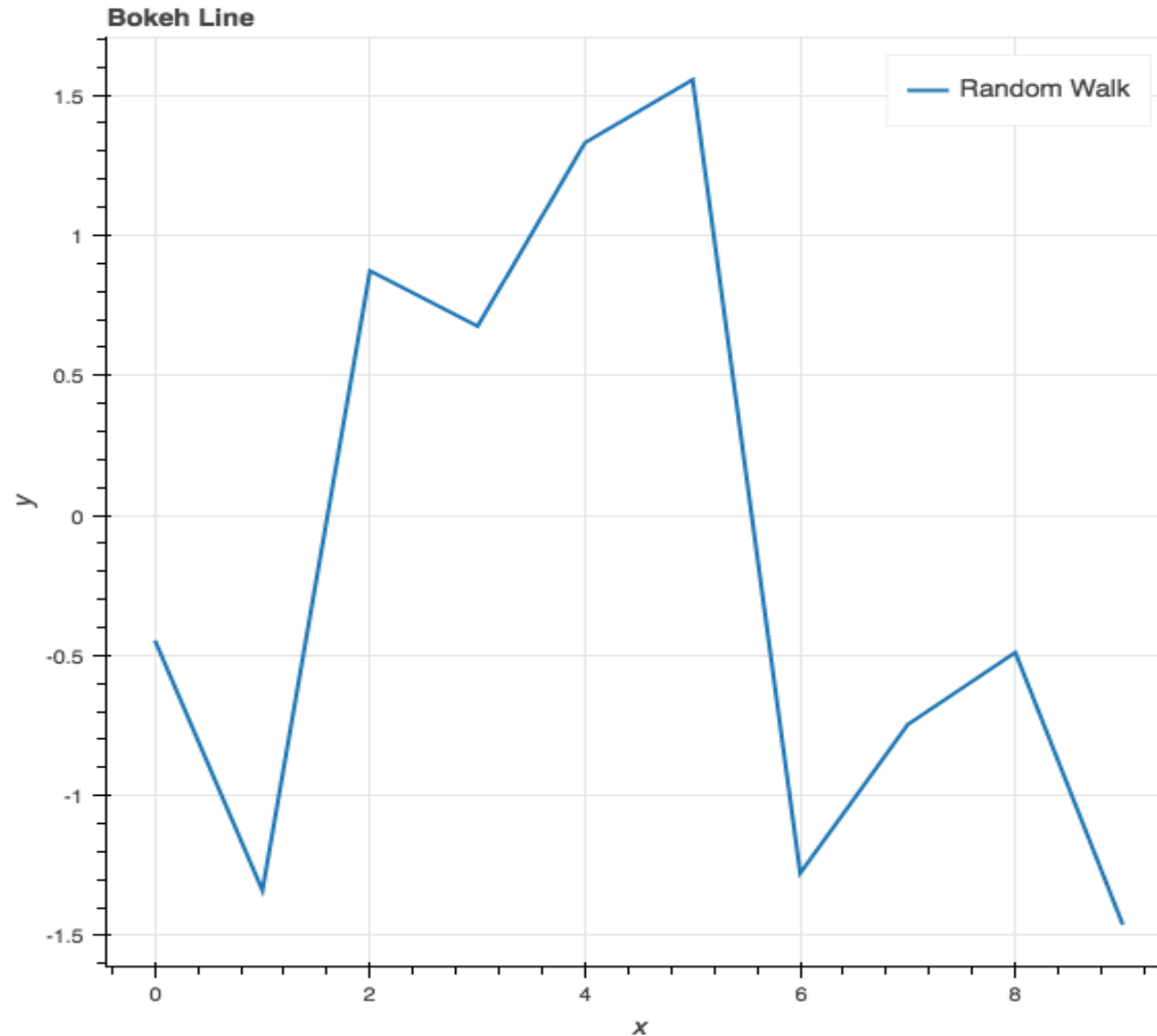
Create the actual figure

```
import numpy as np
from bokeh.plotting import figure, output_file, show
a = np.arange(10)
b = np.random.randn(10)
output_file("lines.html")
p = figure(title="Bokeh Line", x_axis_label='x', y_axis_label='y')
p.line(a, b, legend="Random Walk", line_width=2)
show(p)
```

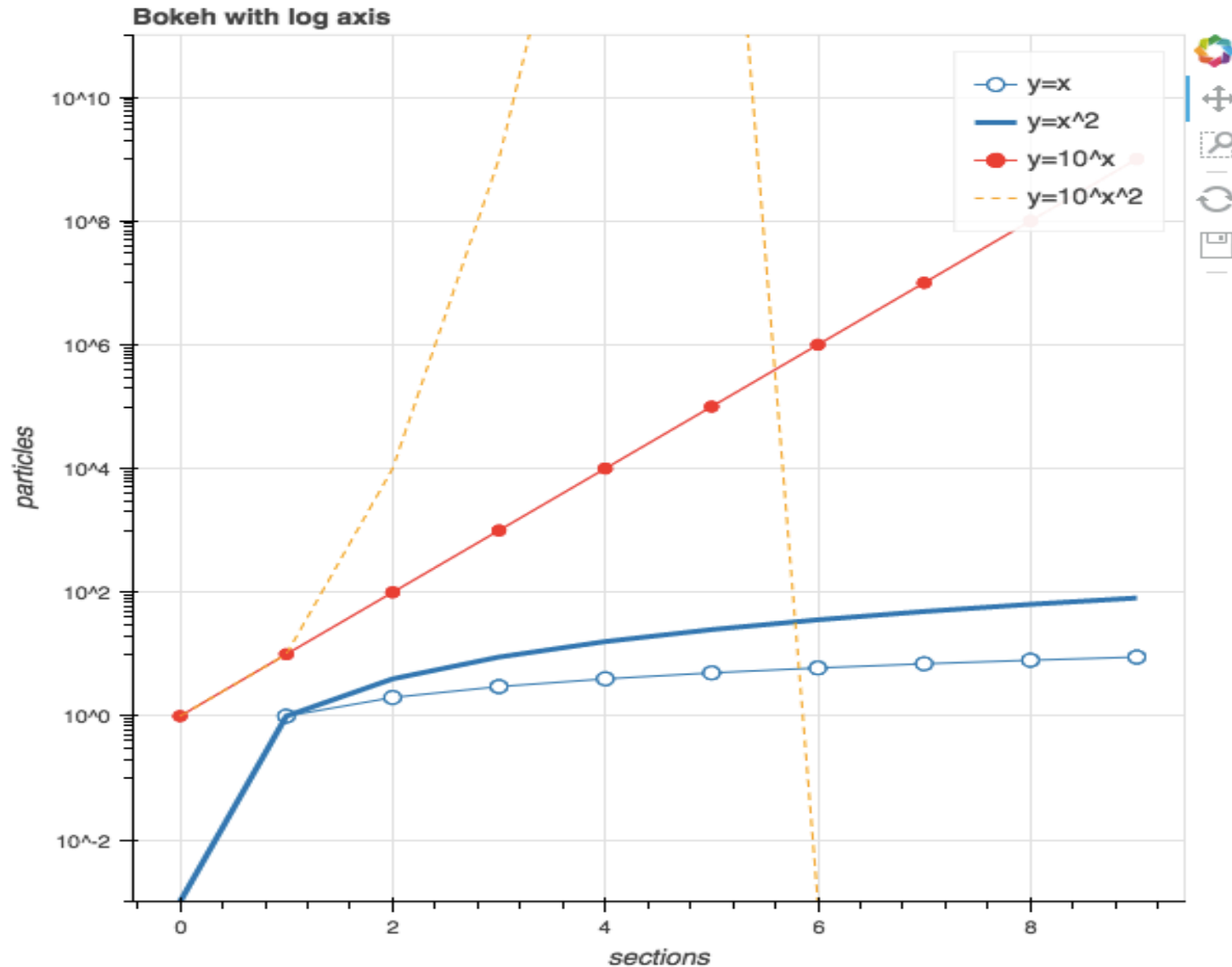
Finally, show it!

```
import numpy as np
from bokeh.plotting import figure, output_file, show
a = np.arange(10)
b = np.random.randn(10)
output_file("lines.html")
p = figure(title="Bokeh Line", x_axis_label='x', y_axis_label='y')
p.line(a, b, legend="Random Walk", line_width=2)
show(p)
```

Anatomy of a Simple Bokeh App



Anatomy of an Interactive Bokeh App



Anatomy of an Interactive Bokeh App

```
x = np.arange(10)
y0 = [i**2 for i in x]
y1 = [10**i for i in x]
y2 = [10**(i**2) for i in x]
output_file("loglines.html")
p = figure(tools="pan,box_zoom,reset,save", y_axis_type="log",
          y_range=[0.001, 10**11], title="Bokeh with log axis",
          x_axis_label='sections', y_axis_label='particles')
p.line(x, x, legend="y=x")
p.circle(x, x, legend="y=x", fill_color="white", size=8)
p.line(x, y0, legend="y=x^2", line_width=3)
p.line(x, y1, legend="y=10^x", line_color="red")
p.circle(x, y1, legend="y=10^x",
         fill_color="red", line_color="red", size=6)
p.line(x, y2, legend="y=10^x^2",
       line_color="orange", line_dash="4 4")
show(p)
```


Define x-range

```
x = np.arange(10)
y0 = [i**2 for i in x]
y1 = [10**i for i in x]
y2 = [10**(i**2) for i in x]
output_file("loglines.html")
p = figure(tools="pan,box_zoom,reset,save", y_axis_type="log",
           y_range=[0.001, 10**11], title="Bokeh with log axis",
           x_axis_label='sections', y_axis_label='particles')
p.line(x, x, legend="y=x")
p.circle(x, x, legend="y=x", fill_color="white", size=8)
p.line(x, y0, legend="y=x^2", line_width=3)
p.line(x, y1, legend="y=10^x", line_color="red")
p.circle(x, y1, legend="y=10^x",
         fill_color="red", line_color="red", size=6)
p.line(x, y2, legend="y=10^x^2",
      line_color="orange", line_dash="4 4")
show(p)
```

Define 3 separate functions in terms of x

```
x = np.arange(10)
y0 = [i**2 for i in x]
y1 = [10**i for i in x]
y2 = [10**(i**2) for i in x]
output_file("loglines.html")
p = figure(tools="pan,box_zoom,reset,save", y_axis_type="log",
           y_range=[0.001, 10**11], title="Bokeh with log axis",
           x_axis_label='sections', y_axis_label='particles')
p.line(x, x, legend="y=x")
p.circle(x, x, legend="y=x", fill_color="white", size=8)
p.line(x, y0, legend="y=x^2", line_width=3)
p.line(x, y1, legend="y=10^x", line_color="red")
p.circle(x, y1, legend="y=10^x",
         fill_color="red", line_color="red", size=6)
p.line(x, y2, legend="y=10^x^2",
       line_color="orange", line_dash="4 4")
show(p)
```

Specify name of output HTML file

```
x = np.arange(10)
y0 = [i**2 for i in x]
y1 = [10**i for i in x]
y2 = [10**(i**2) for i in x]
output_file("loglines.html")
p = figure(tools="pan,box_zoom,reset,save", y_axis_type="log",
           y_range=[0.001, 10**11], title="Bokeh with log axis",
           x_axis_label='sections', y_axis_label='particles')
p.line(x, x, legend="y=x")
p.circle(x, x, legend="y=x", fill_color="white", size=8)
p.line(x, y0, legend="y=x^2", line_width=3)
p.line(x, y1, legend="y=10^x", line_color="red")
p.circle(x, y1, legend="y=10^x",
         fill_color="red", line_color="red", size=6)
p.line(x, y2, legend="y=10^x^2",
       line_color="orange", line_dash="4 4")
show(p)
```

Specify the exact set of “tools” on graph

```
x = np.arange(10)
y0 = [i**2 for i in x]
y1 = [10**i for i in x]
y2 = [10**(i**2) for i in x]
output_file("loglines.html")
p = figure(tools="pan,box_zoom,reset,save", y_axis_type="log",
          y_range=[0.001, 10**11], title="Bokeh with log axis",
          x_axis_label='sections', y_axis_label='particles')
p.line(x, x, legend="y=x")
p.circle(x, x, legend="y=x", fill_color="white", size=8)
p.line(x, y0, legend="y=x^2", line_width=3)
p.line(x, y1, legend="y=10^x", line_color="red")
p.circle(x, y1, legend="y=10^x",
         fill_color="red", line_color="red", size=6)
p.line(x, y2, legend="y=10^x^2",
       line_color="orange", line_dash="4 4")
show(p)
```

Actually creating the 3 separate graphs

```
x = np.arange(10)
y0 = [i**2 for i in x]
y1 = [10**i for i in x]
y2 = [10**(i**2) for i in x]
output_file("loglines.html")
p = figure(tools="pan,box_zoom,reset,save", y_axis_type="log",
           y_range=[0.001, 10**11], title="Bokeh with log axis",
           x_axis_label='sections', y_axis_label='particles')

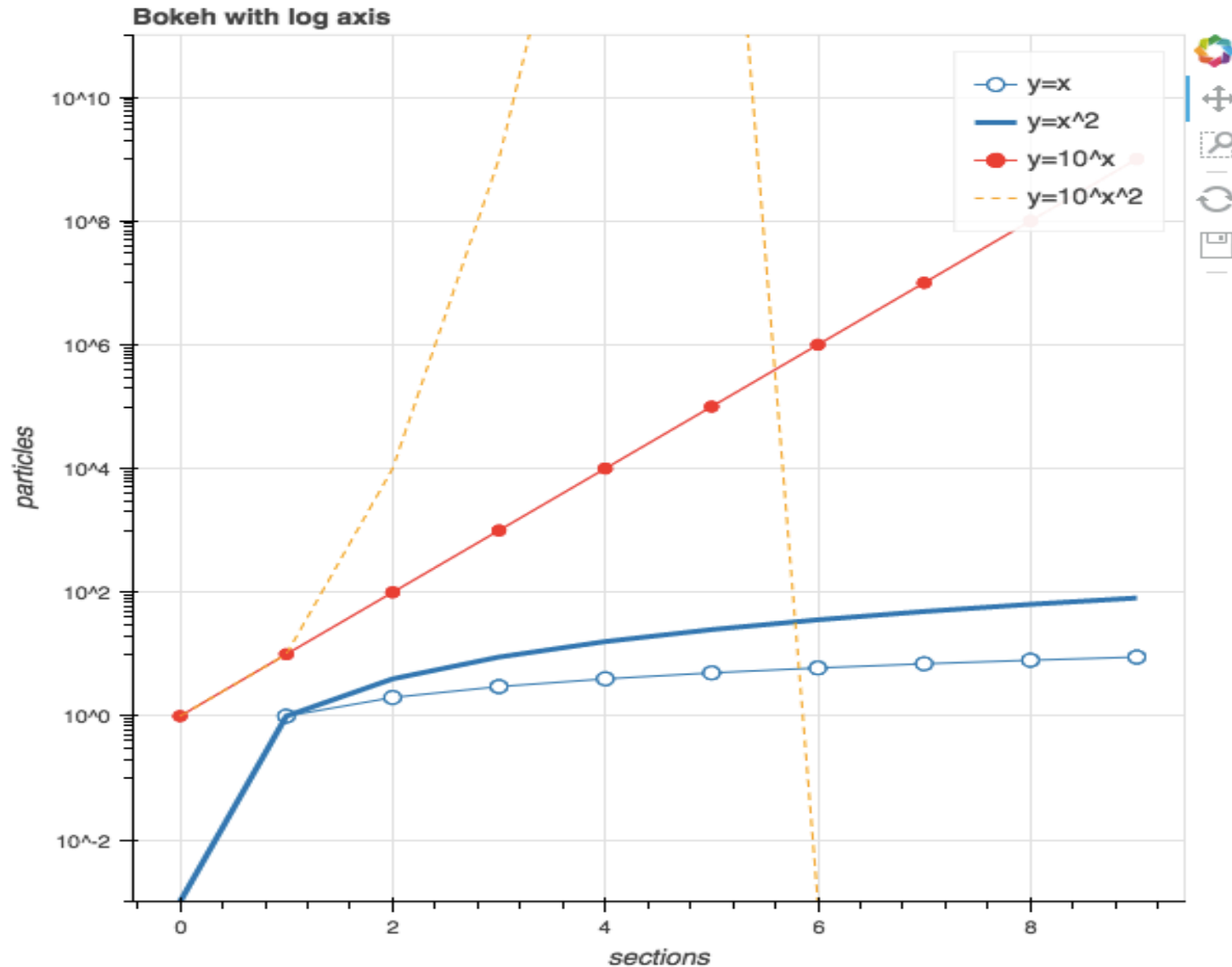
p.line(x, x, legend="y=x")
p.circle(x, x, legend="y=x", fill_color="white", size=8)
p.line(x, y0, legend="y=x^2", line_width=3)
p.line(x, y1, legend="y=10^x", line_color="red")
p.circle(x, y1, legend="y=10^x",
         fill_color="red", line_color="red", size=6)
p.line(x, y2, legend="y=10^x^2",
         line_color="orange", line_dash="4 4")

show(p)
```

Finally, show it!

```
x = np.arange(10)
y0 = [i**2 for i in x]
y1 = [10**i for i in x]
y2 = [10**(i**2) for i in x]
output_file("loglines.html")
p = figure(tools="pan,box_zoom,reset,save", y_axis_type="log",
           y_range=[0.001, 10**11], title="Bokeh with log axis",
           x_axis_label='sections', y_axis_label='particles')
p.line(x, x, legend="y=x")
p.circle(x, x, legend="y=x", fill_color="white", size=8)
p.line(x, y0, legend="y=x^2", line_width=3)
p.line(x, y1, legend="y=10^x", line_color="red")
p.circle(x, y1, legend="y=10^x",
         fill_color="red", line_color="red", size=6)
p.line(x, y2, legend="y=10^x^2",
       line_color="orange", line_dash="4 4")
show(p)
```

Anatomy of an Interactive Bokeh App



Agenda

- Matplotlib
- Bokeh
- **Tableau**
- Final Project



Dashboard

- Performance
- Forecast
- What If Forecast
- SaleMap
- SalesbyProduct
- SalesbySegment

- Horizontal
- Vertical
- Text
- Image
- Web Page
- Blank

New objects:

Tiled

Floating

Layout

Dashboard

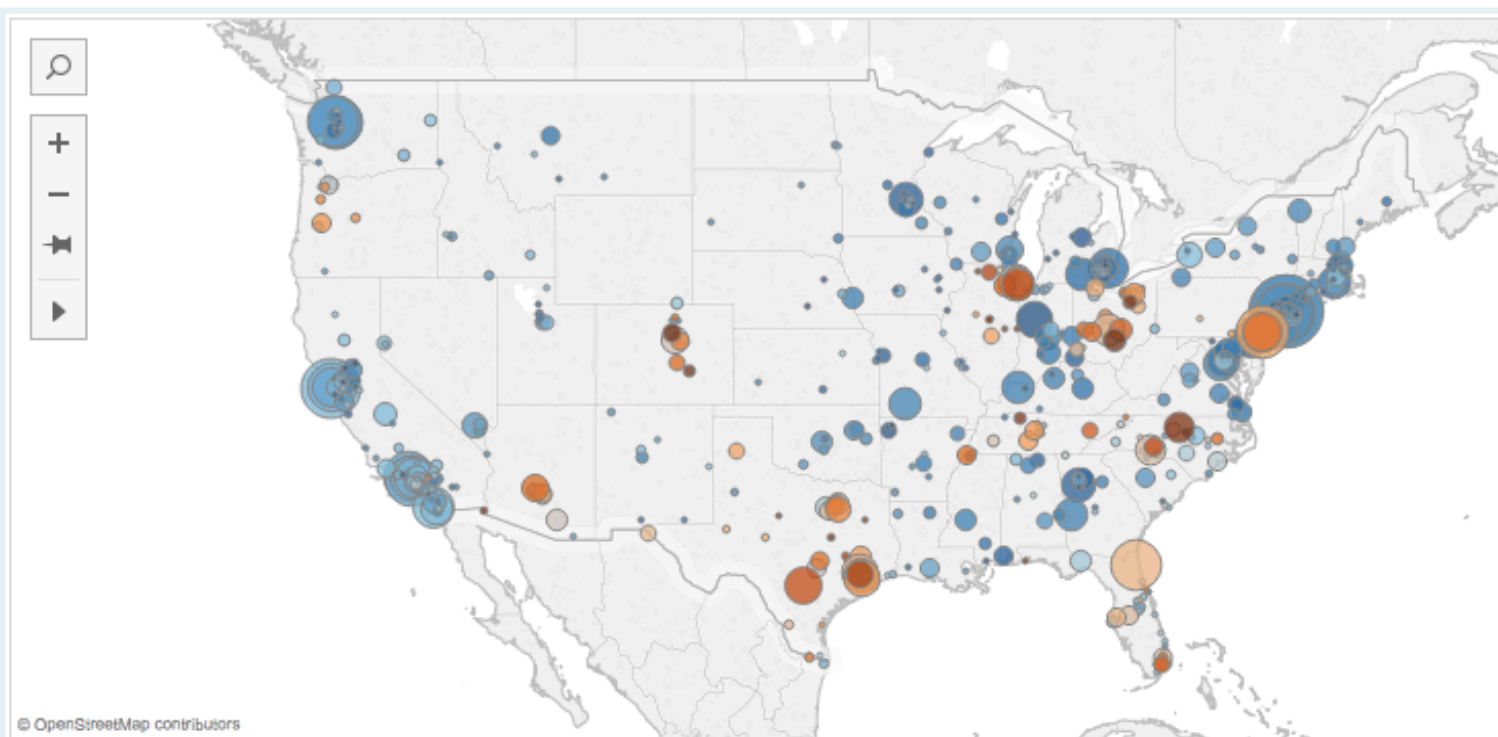
Tiled

Dashboard

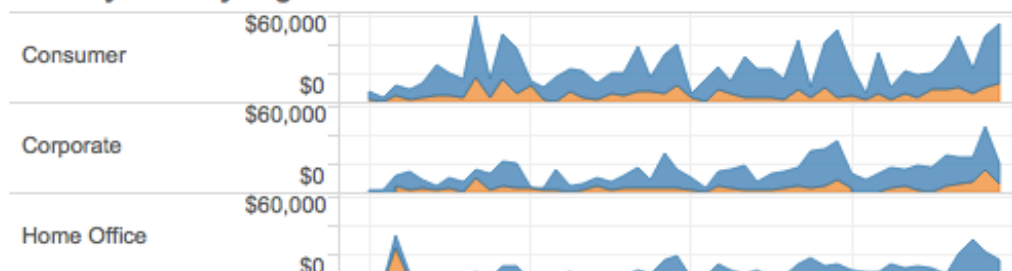
Size: Range

- ☒ Min: w 1000 h 620
- ☐ Max: w 1000 h 620
- ☒ Show Title

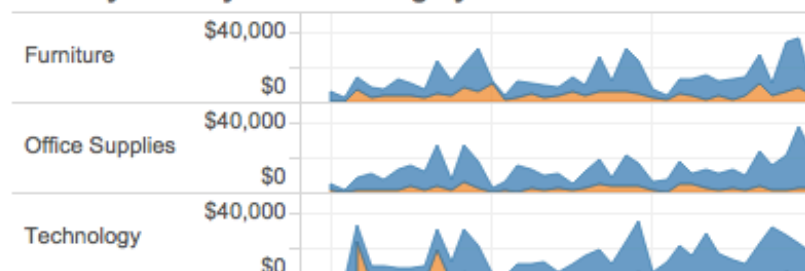
Executive Overview - Profitability



Monthly Sales by Segment - States: All



Monthly Sales by Product Category - States: All



Show Me



Select view

Data Source

Overview

Product

Customers

Shipping

Performance

Forecast

What If Forecast

Show Me

Agenda

- Matplotlib
- Bokeh
- Tableau
- **Final Project**

Your final project : guidelines

- Goal: **apply** what you have learned in this class to a realistic data science challenge + exercise your creativity + have fun!
- This is meant to be a significant **individual effort** to learn by practicing what you are learning to a real-world data science problem.
- The **writeup** of your final project is in the form of a Jupyter notebook and associated data – to be uploaded to the final project assignment in Camino.
- You are to submit your final notebook by September 3 @ 11:59pm.

Your final project : topic selection

- Goal: **apply** what you have learned in this class to a realistic data science challenge + exercise your creativity + have fun!
- You can choose any "significant" data set via downloadable sites, APIs, or use any of the datasets from the class.
- You need to propose an interesting data insight investigation that you would like to explore, analyze the data, visualize the data, and finally write up your conclusion on what insights you have reached.
- Grading of your final project will be based on the following rubric.

Your final project : grading rubric

Area	Details	Grading %
Topic Selection	Did you create a reasonably interesting data insight hypothesis for your investigation?	10%
Packaging	Did you create a Jupyter project packaging that looks professional and understandable?	10%
Analysis Competence	Does your notebook show competence in using the data science tools we learned in class?	40%
Insight	Does your project show useful or interesting insights from the data analysis you have done?	40%