Python Programming

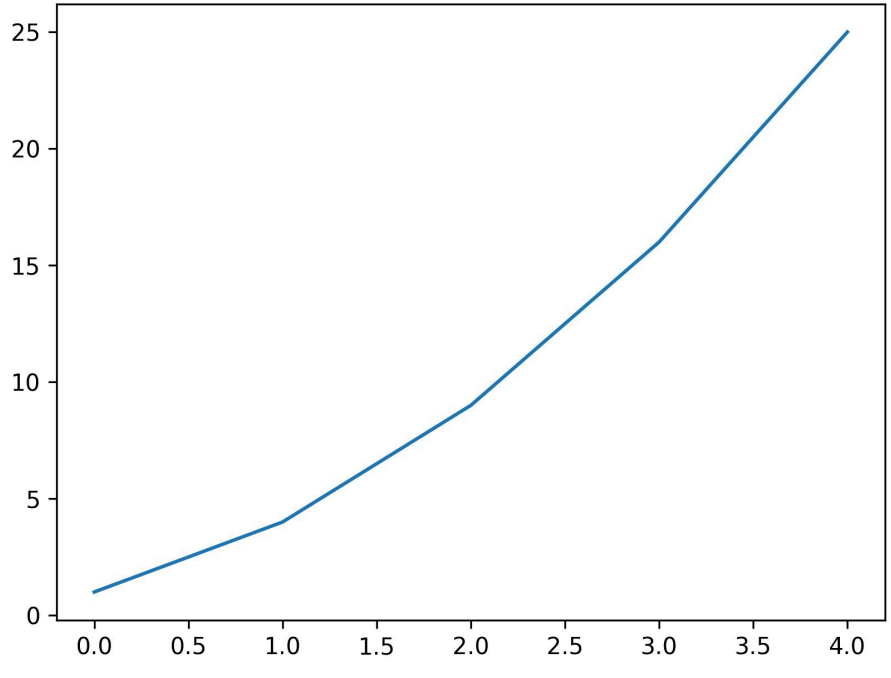
Lecture 11 Data Visualization

11.1 Matplotlib Basics

The matplotlib Gallery

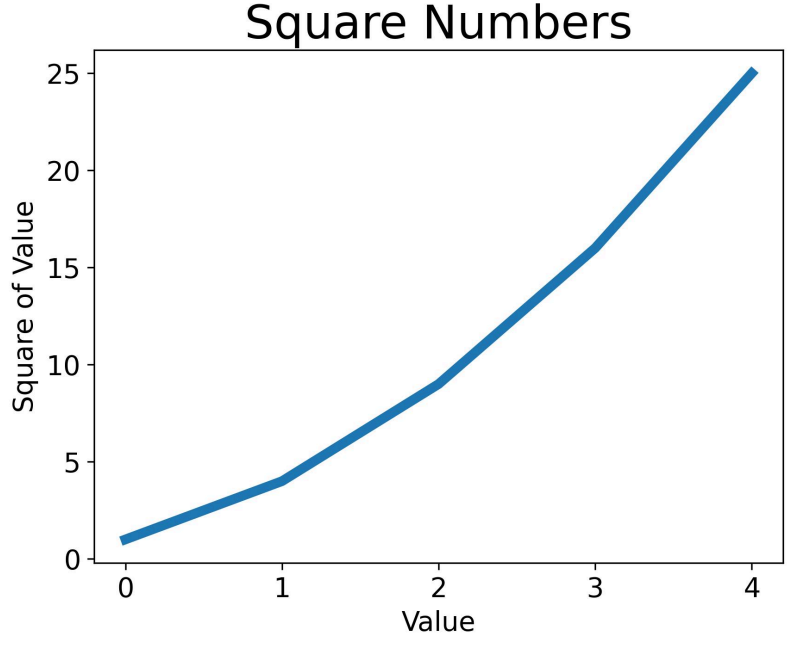
Plotting a Simple Line Graph

```python
import matplotlib.pyplot as plt
squares = [1, 4, 9, 16, 25]

fig, ax= plt.subplots()
ax.plot(squares)
# plt.show()
plt.savefig('simple.jpg',dpi=300)

# 不要在plt.savefig()之前使用plt.show()，否则会保存失败
```



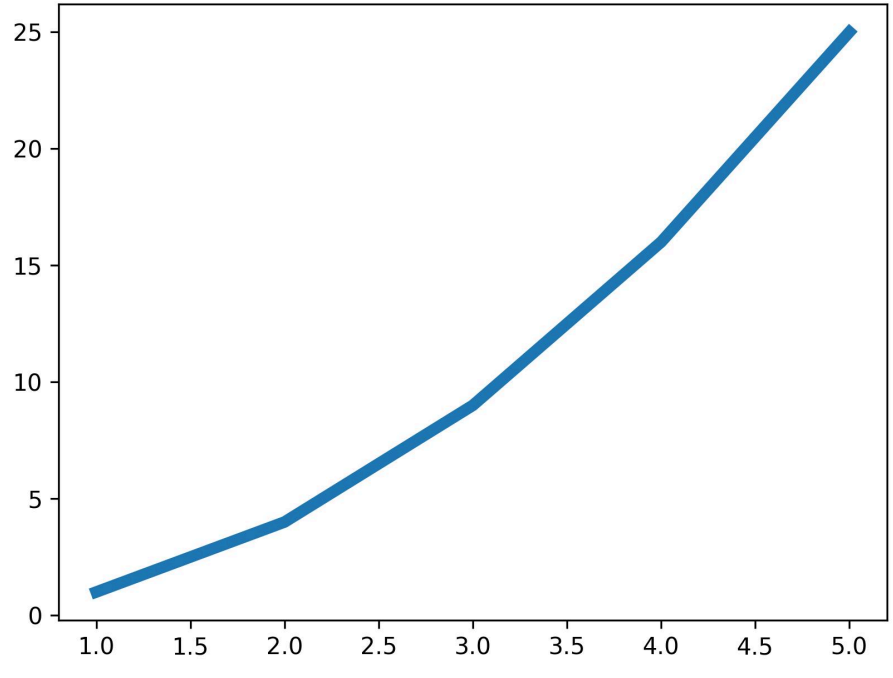
Changing the Label Type and Graph Thickness

```
import matplotlib.pyplot as plt
squares = [1, 4, 9, 16, 25]

fig, ax= plt.subplots()
ax.plot(squares, linewidth=5)

# Set chart title and label axes.
ax.set_title("Square Numbers", fontsize=24)
ax.set_xlabel("Value", fontsize=14)
ax.set_ylabel("Square of Value", fontsize=14)

# Set size of tick labels.
ax.tick_params(labelsize=14)
plt.savefig('simple.jpg',dpi=300)
```



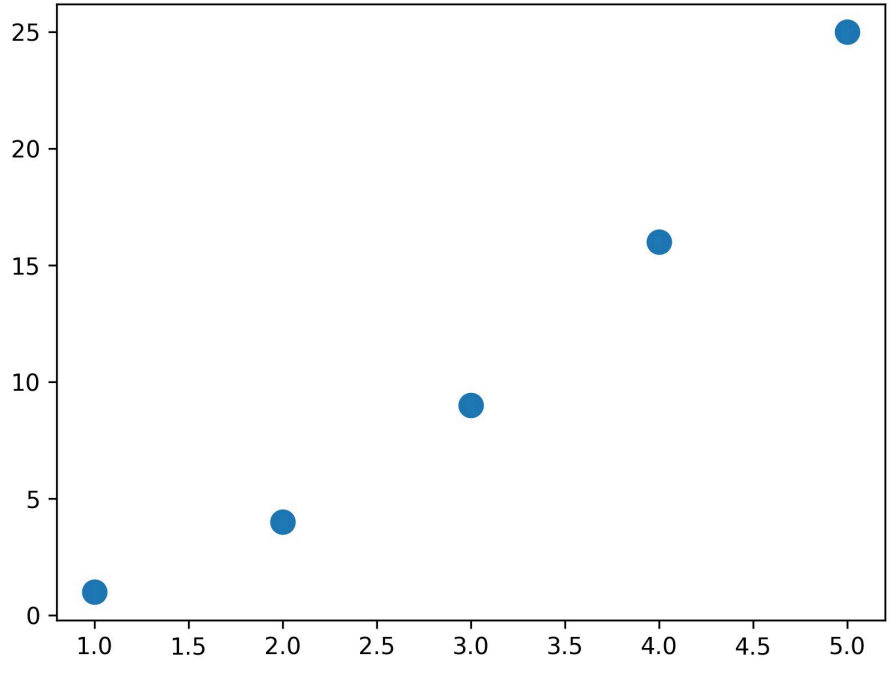
Correcting the Plot

```
1 import matplotlib.pyplot as plt
2 input_values = [1, 2, 3, 4, 5]
3 squares = [1, 4, 9, 16, 25]
4
5 fig, ax= plt.subplots()
6 ax.plot(input_values, squares, linewidth=5)
7 plt.savefig('simple.jpg',dpi=300)
```

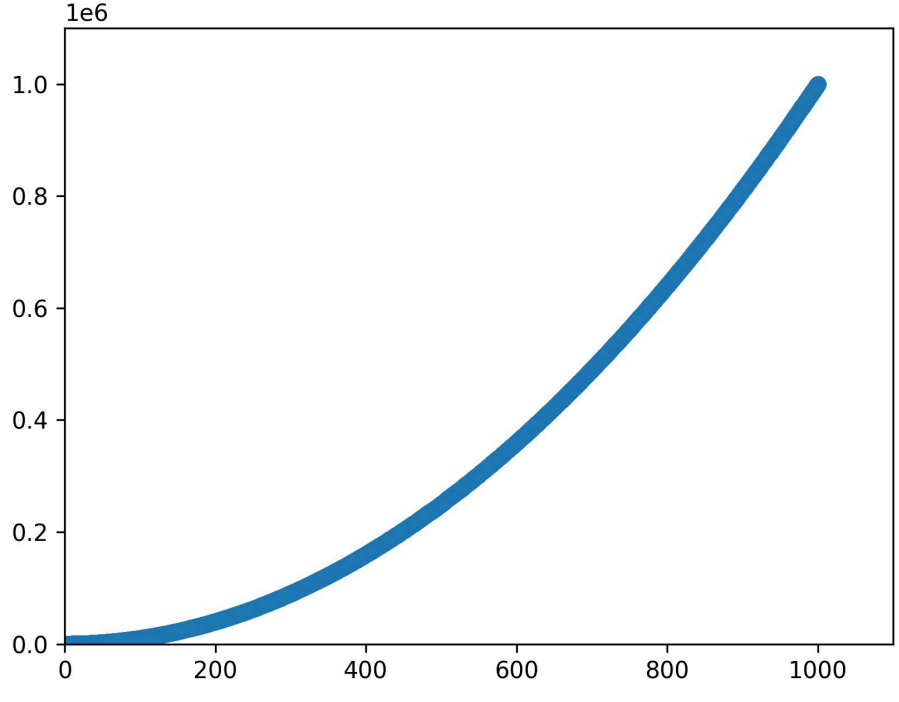


Plotting and Styling Individual Points with scatter()

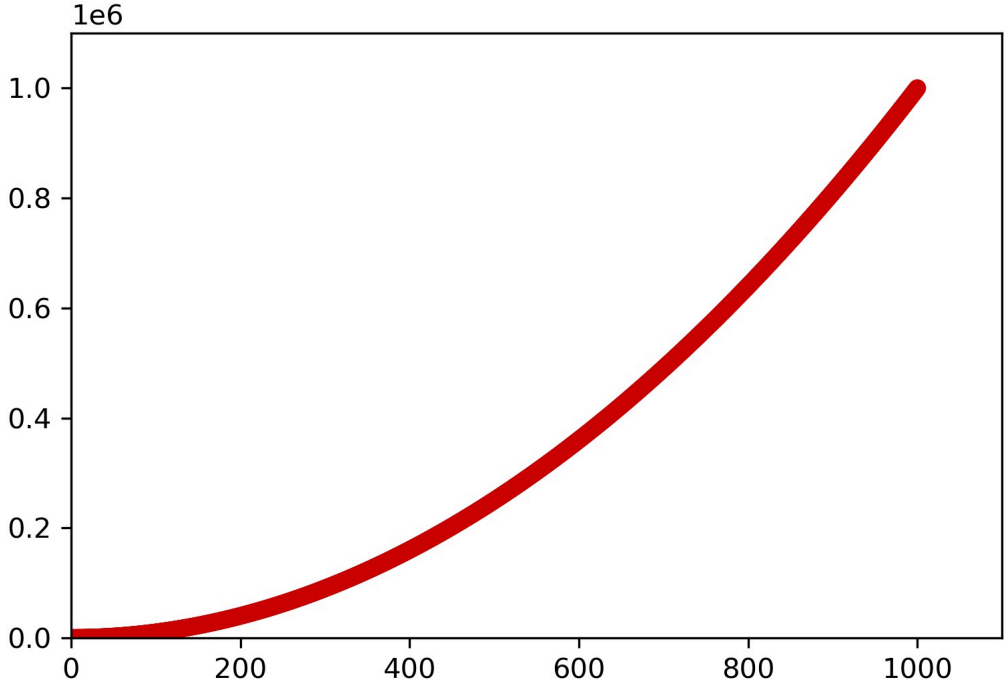
```
1 import matplotlib.pyplot as plt
2
3 x_values = [1, 2, 3, 4, 5]
4 y_values = [1, 4, 9, 16, 25]
5
6 fig, ax= plt.subplots()
7 ax.scatter(x_values, y_values, s=100)
8 plt.savefig('simple.jpg',dpi=300)
```



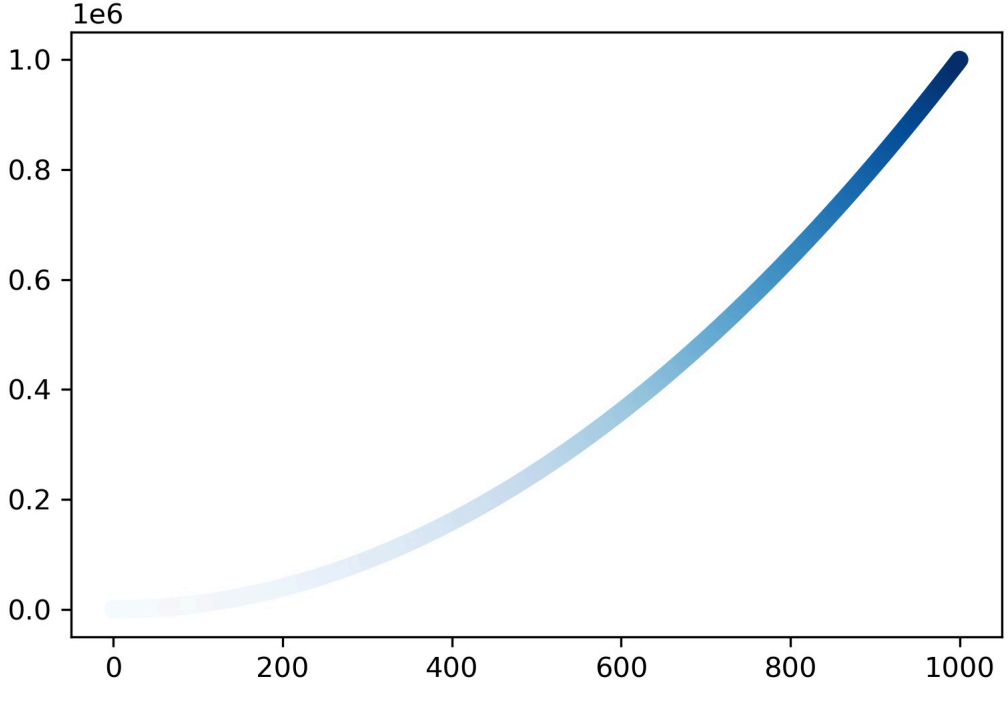
```python
import matplotlib.pyplot as plt

x_values = list(range(1, 1001))
y_values = [x**2 for x in x_values]

fig, ax= plt.subplots()
ax.scatter(x_values, y_values, s=40)

# Set the range for each axis.
ax.axis([0, 1100, 0, 1100000])
plt.savefig('simple.jpg',dpi=300)
```



```
1 ax.scatter(x_values, y_values, color='red', s=10)
2 ax.scatter(x_values, y_values, color=(0, 0.8, 0), s=10) #RGB
```



```python
import matplotlib.pyplot as plt

x_values = range(1001)
y_values = [x**2 for x in x_values]

fig, ax= plt.subplots()
ax.scatter(x_values, y_values, c=y_values, cmap=plt.cm.Blues, s=10)

plt.savefig('simple.jpg',dpi=300, bbox_inches='tight')
```

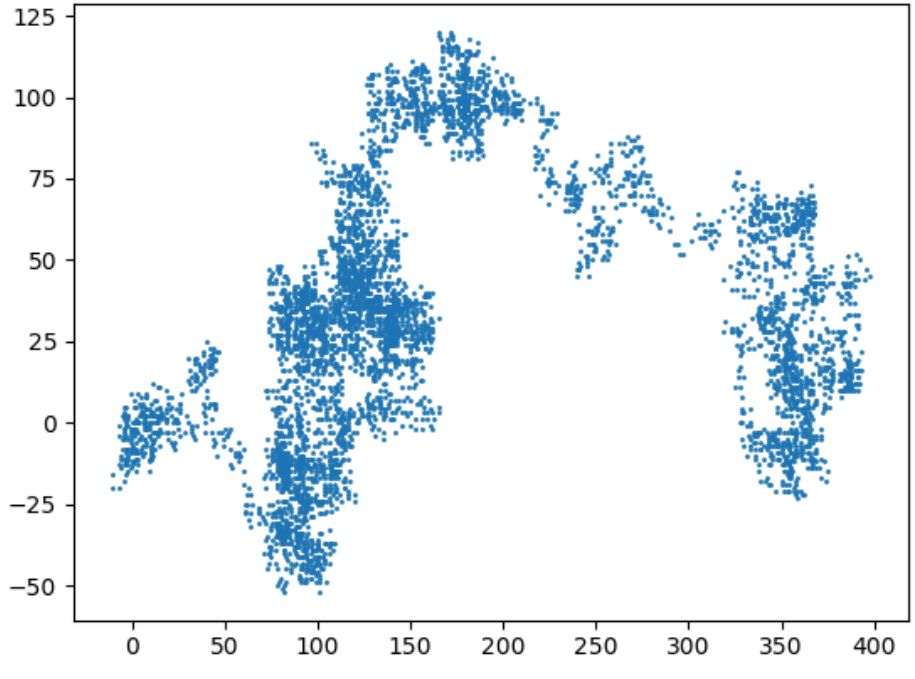


Random Walks

```
from random import choice

class RandomWalk:
    def __init__(self, num_points=5000):
        self.num_points = num_points
        self.x_values = [0]
        self.y_values = [0]
```

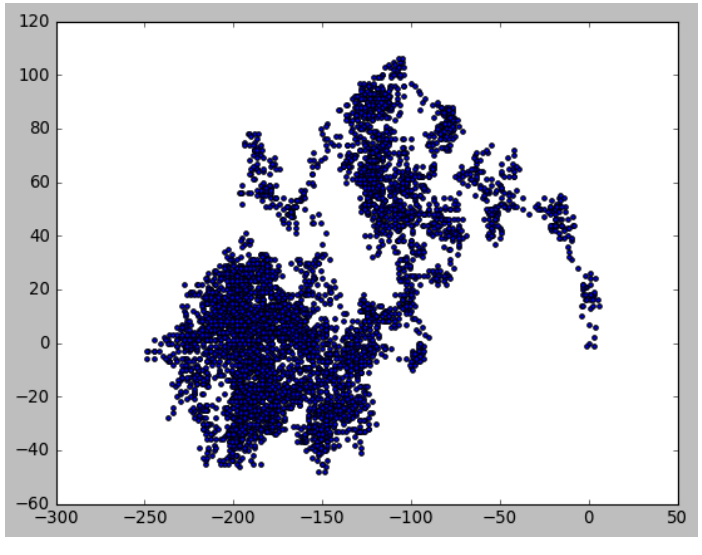
```
#continue
    def fill_walk(self):
        while len(self.x_values) < self.num_points:
            x_direction = choice([1, -1])
            x_distance = choice([0, 1, 2, 3, 4])
            x_step = x_direction * x_distance

            y_direction = choice([1, -1])
            y_distance = choice([0, 1, 2, 3, 4])
            y_step = y_direction * y_distance

            if x_step == 0 and y_step == 0:
                continue

            next_x = self.x_values[-1] + x_step
            next_y = self.y_values[-1] + y_step
            self.x_values.append(next_x)
            self.y_values.append(next_y)
```

```
import matplotlib.pyplot as plt

rw = RandomWalk()
rw.fill_walk()

plt.style.use('classic')
fig, ax= plt.subplots()


ax.scatter(rw.x_values, rw.y_values, s=1)
ax.set_aspect('equal')
```

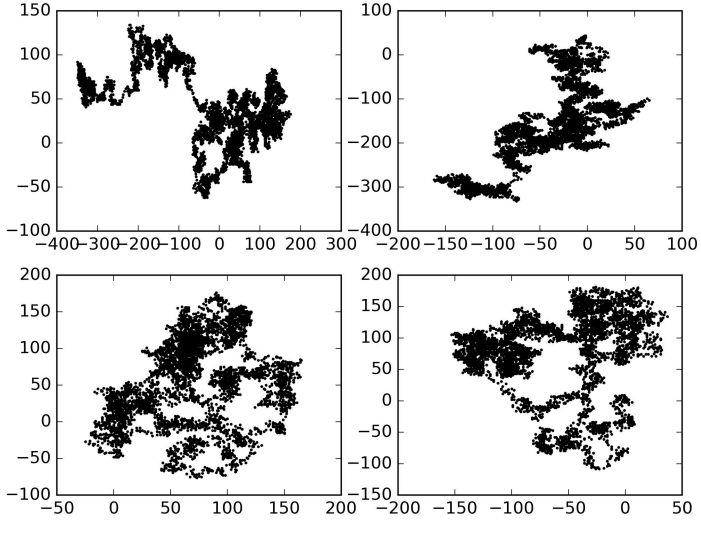


Generating Multiple Random Walks

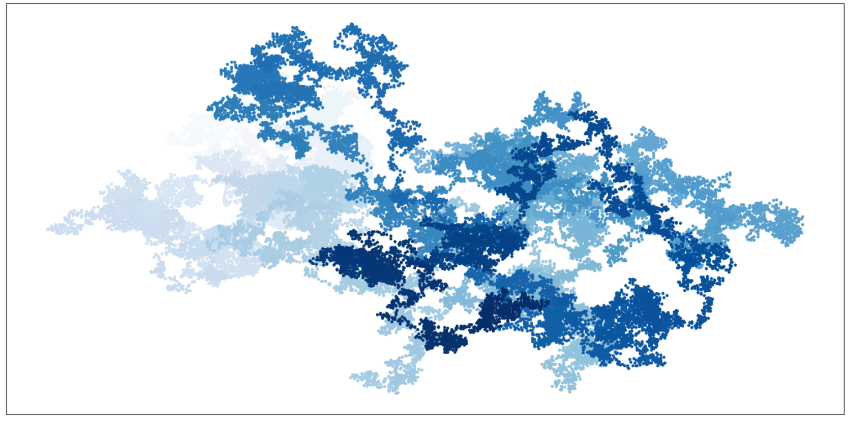
```
import matplotlib.pyplot as plt

while True:
    rw = RandomWalk()
    rw.fill_walk()

    plt.style.use('classic')
    fig, ax = plt.subplots()
    ax.scatter(rw.x_values, rw.y_values, s=15)

    keep_running = input("Make another walk? (y/n): ")
    if keep_running == 'n':
        break
```



```python
import matplotlib.pyplot as plt
plt.style.use('classic')

fig, ax = plt.subplots(2,2)
rw1 = RandomWalk()
rw2 = RandomWalk()
rw3 = RandomWalk()
rw4 = RandomWalk()

rw1.fill_walk()
rw2.fill_walk()
rw3.fill_walk()
rw4.fill_walk()

ax[0,0].scatter(rw1.x_values, rw1.y_values, s=1)
ax[0,1].scatter(rw2.x_values, rw2.y_values, s=1)
ax[1,0].scatter(rw3.x_values, rw3.y_values, s=1)
ax[1,1].scatter(rw4.x_values, rw4.y_values, s=1)

plt.savefig('simple.jpg',dpi=300, bbox_inches='tight')
```



```
import matplotlib.pyplot as plt

rw = RandomWalk(50000)
rw.fill_walk()

plt.style.use('classic')
fig, ax = plt.subplots(figsize = (16,9), dpi=128)

point_numbers = range(rw.num_points)
ax.scatter(rw.x_values, rw.y_values, c=point_numbers,
           cmap=plt.cm.Blues, edgecolor='none', s=8)
ax.get_xaxis().set_visible(False)
ax.get_yaxis().set_visible(False)

plt.show()
```



11.2 Plotly

Plotly and D3

In Anaconda Prompt

```
pip install plotly
```

- Rolling Dice with Plotly

```
from random import randint
class Die():

    def __init__(self, num_sides=6):
        self.num_sides = num_sides
    def roll(self):
        return randint(1, self.num_sides)
```

```
die = Die()
results = []
for roll_num in range(100):
    result = die.roll()
    results.append(result)
print(results)
```

```
[3, 4, 1, 3, 4, 3, 4, 6, 4, 4, 1, 3, 6, 5, 2, 6, 2, 5, 4, 3, 5, 4, 2, 4, 3, 1, 2, 6, 6,
 2, 3, 2, 1, 6, 6, 4, 3, 2, 3, 5, 2, 4, 3, 6, 3, 2, 1, 3, 2, 1, 4, 6, 6, 3, 3, 3, 2, 2,
  6, 3, 1, 6, 3, 4, 2, 6, 4, 6, 6, 3, 5, 5, 5, 5, 5, 3, 3, 1, 3, 2, 4, 2, 3, 1, 1, 4, 4,
   2, 4, 2, 5, 2, 6, 2, 5, 6, 2, 2, 6, 5]
```

- Analyzing the Results

```
die = Die()
results = []
for roll_num in range(1000):
    result = die.roll()
    results.append(result)

frequencies = []
poss_results = range(1, die.num_sides+1)
for value in poss_results:
    frequency = results.count(value)
    frequencies.append(frequency)

print(frequencies)
#[155, 167, 168, 170, 159, 181]
```

```
import plotly.express as px

fig = px.bar(x=poss_results, y=frequencies)
fig.write_html('dice_visual.html')
```

```
import plotly.express as px

title = "Results of Rolling One D6 1000 Times"
labels = {'x': 'Results', 'y': 'Frequency of Result'}
fig = px.bar(x=poss_results, y=frequencies, title=title, labels=labels)
fig.write_html('dice_visual.html')
```

Rolling one D6 1000 times

```
import plotly.express as px

# Create two D6 dice.
die_1 = Die()
die_2 = Die()

results = []
for roll_num in range(1000):
    result = die_1.roll() + die_2.roll()
    results.append(result)
```

```
# Analyze the results.
frequencies = []
max_result = die_1.num_sides + die_2.num_sides
poss_results = range(2, max_result+1)

for value in poss_results:
    frequency = results.count(value)
    frequencies.append(frequency)
```

```
title = "Results of Rolling Two D6 1000 Times"
labels = {'x': 'Results', 'y': 'Frequency of Result'}
fig = px.bar(x=poss_results, y=frequencies, title=title, labels=labels)
# fig.update_layout(xaxis_dtick = 1)
fig.write_html('d6_d6.html')
```

Rolling two D6 dice 1000 times

Summary

- Data Visualization
  - Reading: Python Crash Course, Chapter 15