Generating data (data visualization, representations, etc.)

Python basics

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Learning outcomes

1. Generate data sets and create visualizations
2. Create simple plots with Matplotlib and use a scatter plot to explore random walks
3. Create a histogram with Plotly and use a histogram to explore the results of rolling dice of different sizes

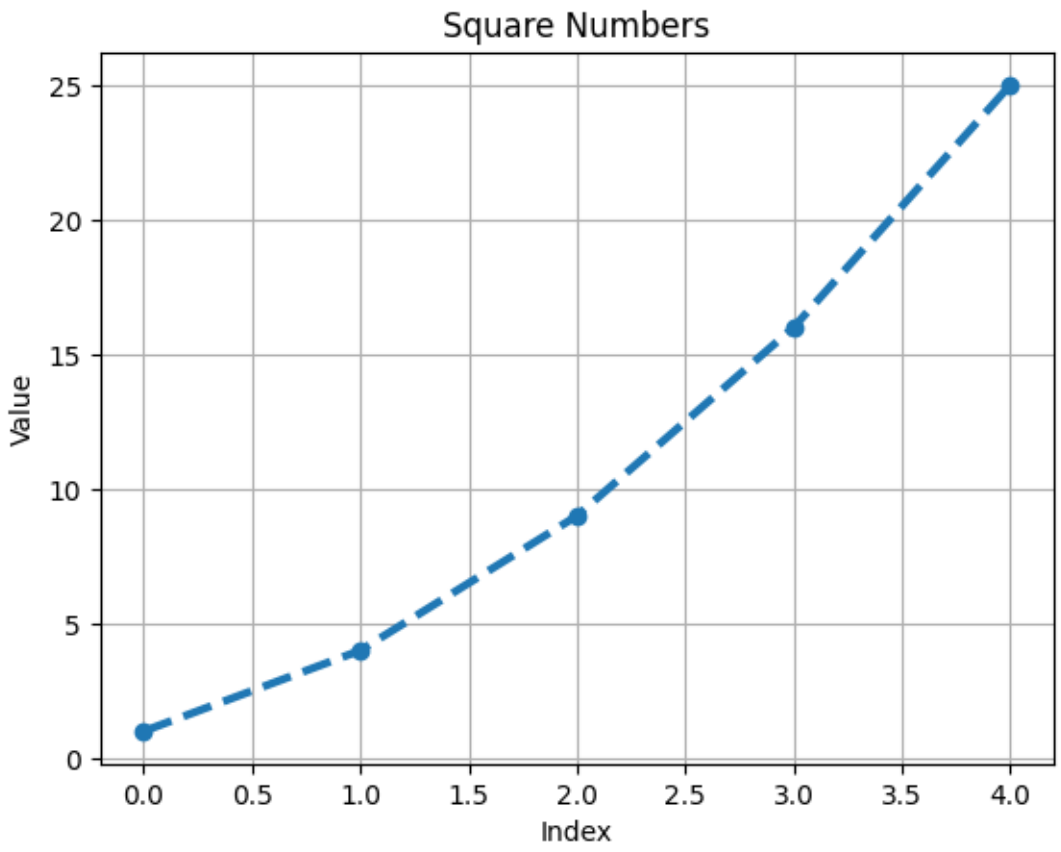
Plotting tools used

1. Matplotlib- mathematical plotting library

2. Plotly- visualizations which work with digital devices.

Plotting a line graph

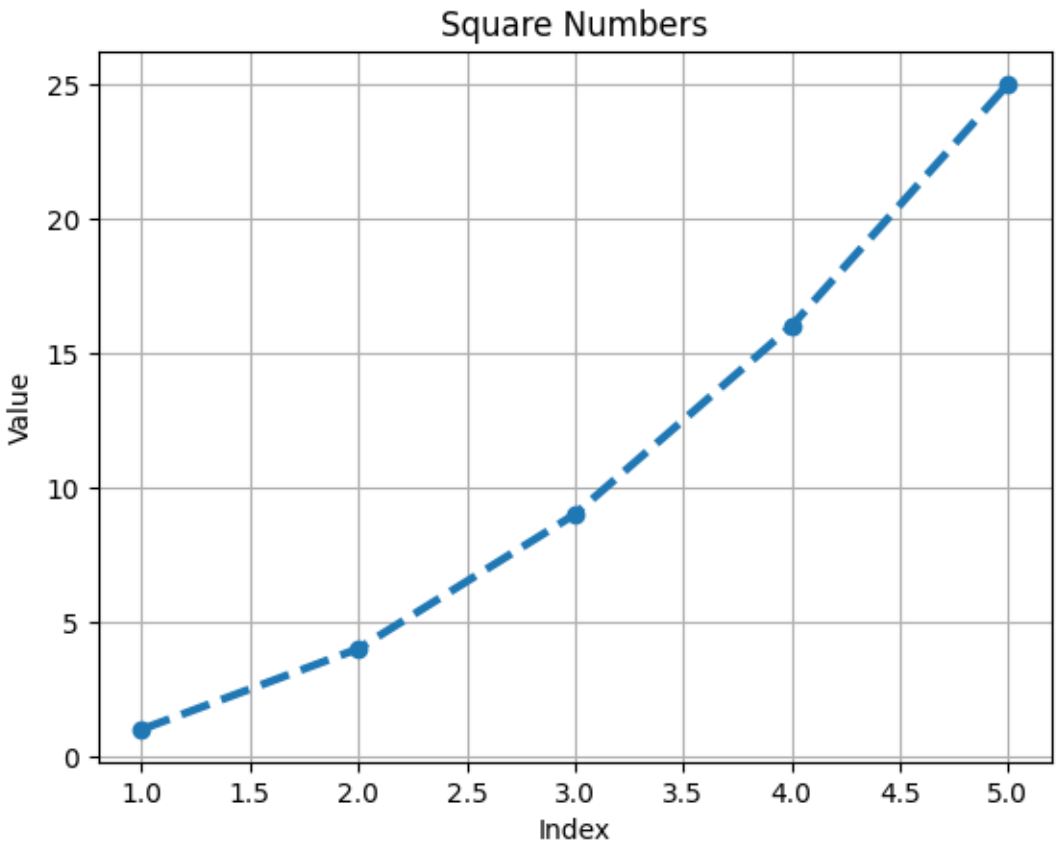
```
import matplotlib.pyplot as plt

squares = [1, 4, 9, 16, 25]

# Create a figure and axis
fig, ax = plt.subplots()

# Plot the squares with a blue line
ax.plot(squares, linewidth=3, marker='o', linestyle='--')

# Customize the plot
ax.set_title('Square Numbers')
ax.set_xlabel('Index')
ax.set_ylabel('Value')
ax.grid(True)

# Show the plot
plt.show()
```



Correcting the plot

```
import matplotlib.pyplot as plt

input_values = [1,2,3,4,5]   #adding this would fix it
squares = [1, 4, 9, 16, 25]

# Create a figure and axis
fig, ax = plt.subplots()

# Plot the squares with a blue line
ax.plot(input_values, squares, linewidth=3, marker='o', linestyle='--')

# Customize the plot
ax.set_title('Square Numbers')
```

```
ax.set_xlabel('Index')
ax.set_ylabel('Value')
ax.grid(True)

# Show the plot
plt.show()
```



Using built-in Styles

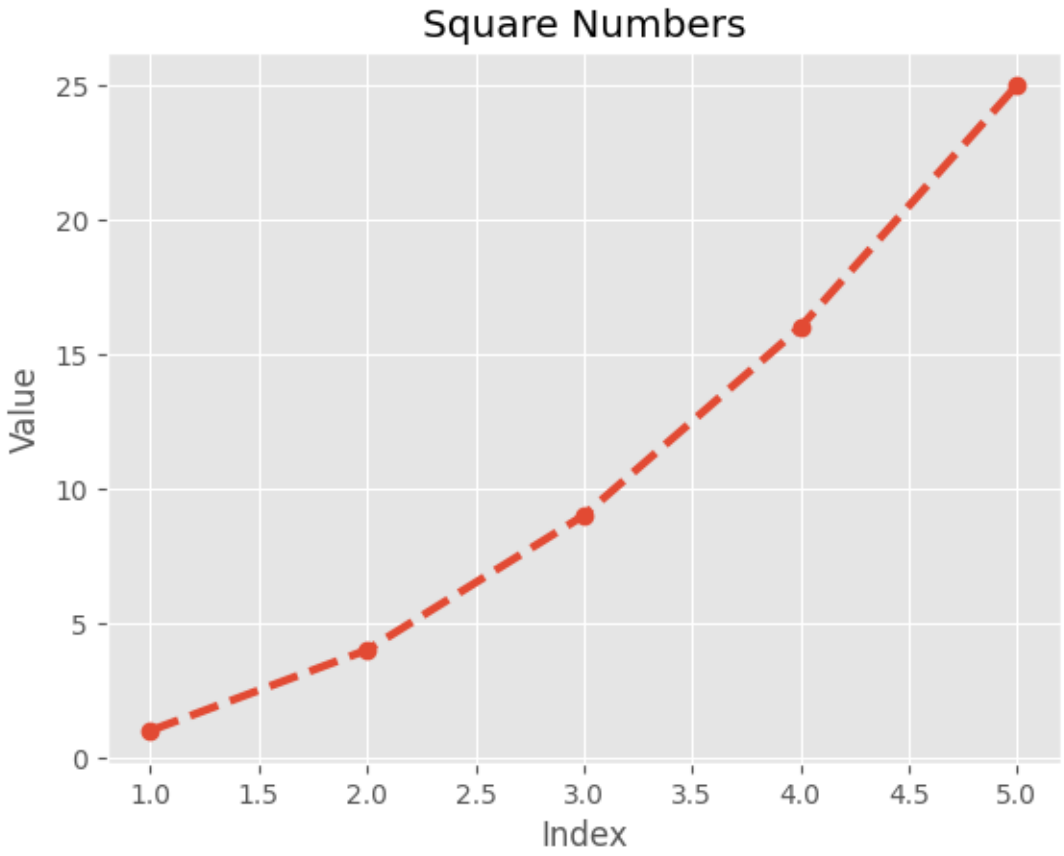
```
import matplotlib.pyplot as plt
plt.style.available
```

```
['Solarize_Light2',
 '_classic_test_patch',
```

```
'_mpl-gallery',
'_mpl-gallery-nogrid',
'bmh',
'classic',
'dark_background',
'fast',
'fivethirtyeight',
'ggplot',
'grayscale',
'seaborn-v0_8',
'seaborn-v0_8-bright',
'seaborn-v0_8-colorblind',
'seaborn-v0_8-dark',
'seaborn-v0_8-dark-palette',
'seaborn-v0_8-darkgrid',
'seaborn-v0_8-deep',
'seaborn-v0_8-muted',
'seaborn-v0_8-notebook',
'seaborn-v0_8-paper',
'seaborn-v0_8-pastel',
'seaborn-v0_8-poster',
'seaborn-v0_8-talk',
'seaborn-v0_8-ticks',
'seaborn-v0_8-white',
'seaborn-v0_8-whitegrid',
'tableau-colorblind10']
```

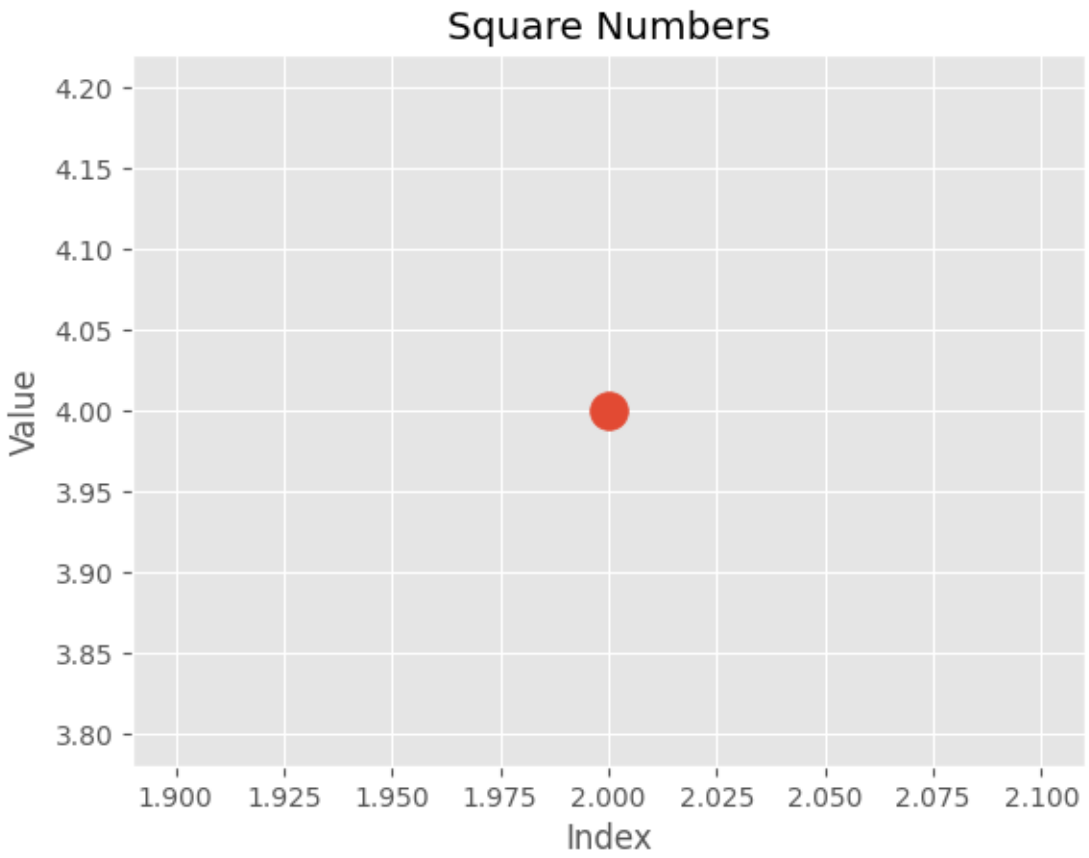
```
# using style
import matplotlib.pyplot as plt

input_values = [1,2,3,4,5]   #adding this would fix it
squares = [1, 4, 9, 16, 25]

#use style
plt.style.use('fast')

# Create a figure and axis
fig, ax = plt.subplots()


# Plot the squares with a blue line
ax.plot(input_values, squares, linewidth=3, marker='o', linestyle='--')
```

```
# Customize the plot
ax.set_title('Square Numbers')
ax.set_xlabel('Index')
ax.set_ylabel('Value')
ax.grid(True)

# Show the plot
plt.show()
```



Plotting and Styling Individual Points with scatter()

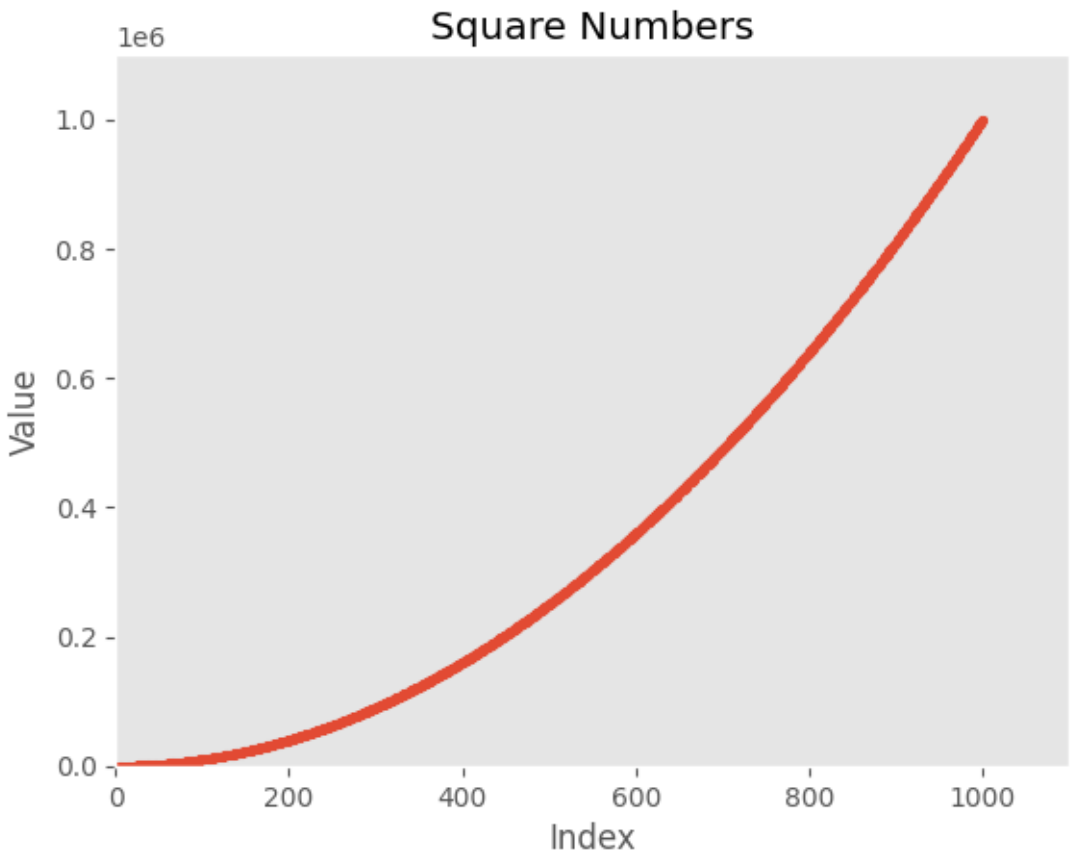
```
# using style
import matplotlib.pyplot as plt

input_values = [1,2,3,4,5]   #adding this would fix it
squares = [1, 4, 9, 16, 25]

#use style
plt.style.use('fast')

# Create a figure and axis
fig, ax = plt.subplots()


# Plot the squares with a blue line
ax.scatter(2,4,s=200)

# Customize the plot
ax.set_title('Square Numbers')
ax.set_xlabel('Index')
ax.set_ylabel('Value')
ax.grid(True)

# Show the plot
plt.show()
```



Caluculating data automatically

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

plt.style.use('fast')
fig, ax = plt.subplots()
ax.scatter(x_values, y_values, s= 10)

# Customize the plot
ax.set_title('Square Numbers')
ax.set_xlabel('Index')
ax.set_ylabel('Value')
ax.grid(False)
```

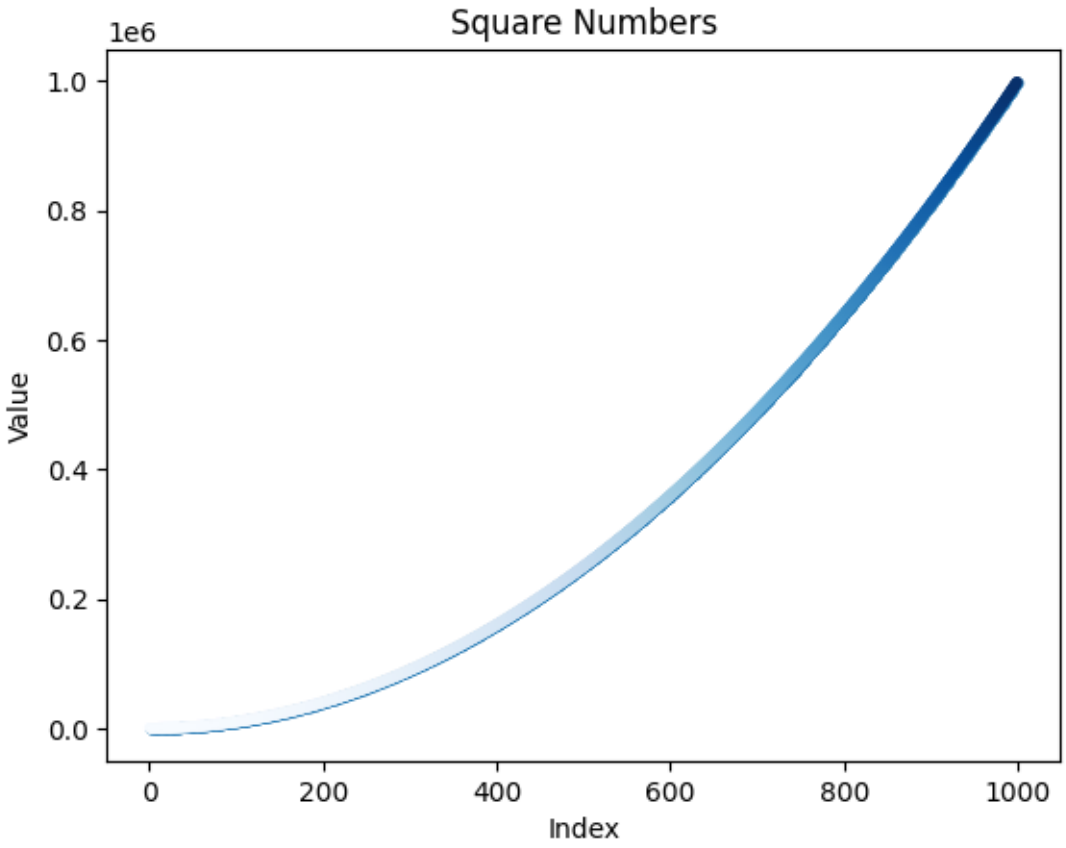
```
#Set the range for each axis
ax.axis([0, 1100, 0, 1100000])

plt.show()
```



Using a Colormap

```
import matplotlib.pyplot as plt

x_values = range(1, 1000)
y_values = [x**2 for x in x_values]
fig, ax = plt.subplots()
ax.scatter(x_values, y_values, s= 10)
```

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


# Customize the plot
ax.set_title('Square Numbers')
ax.set_xlabel('Index')
ax.set_ylabel('Value')
ax.grid(False)

plt.show()
```



Saving the plots automatically

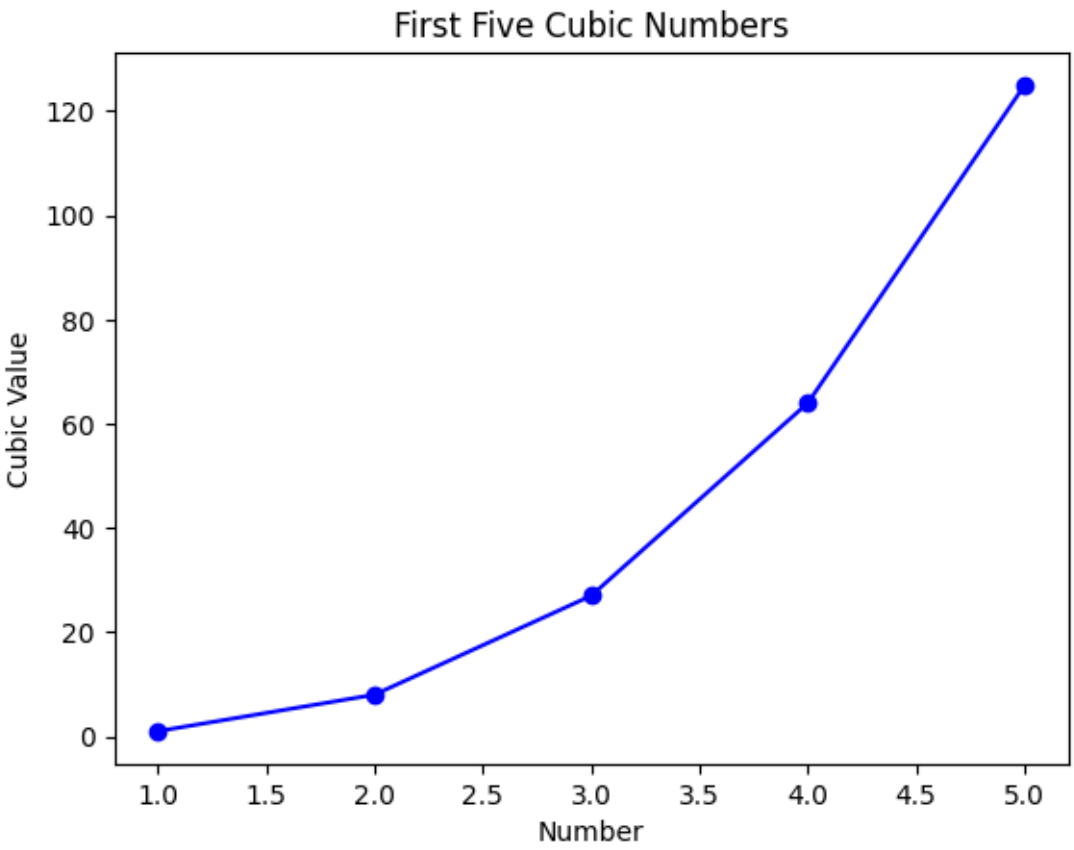
```
plt.savefig('squares_plot.png', bbox_inches= 'tight')   #second argument trims extra white
```

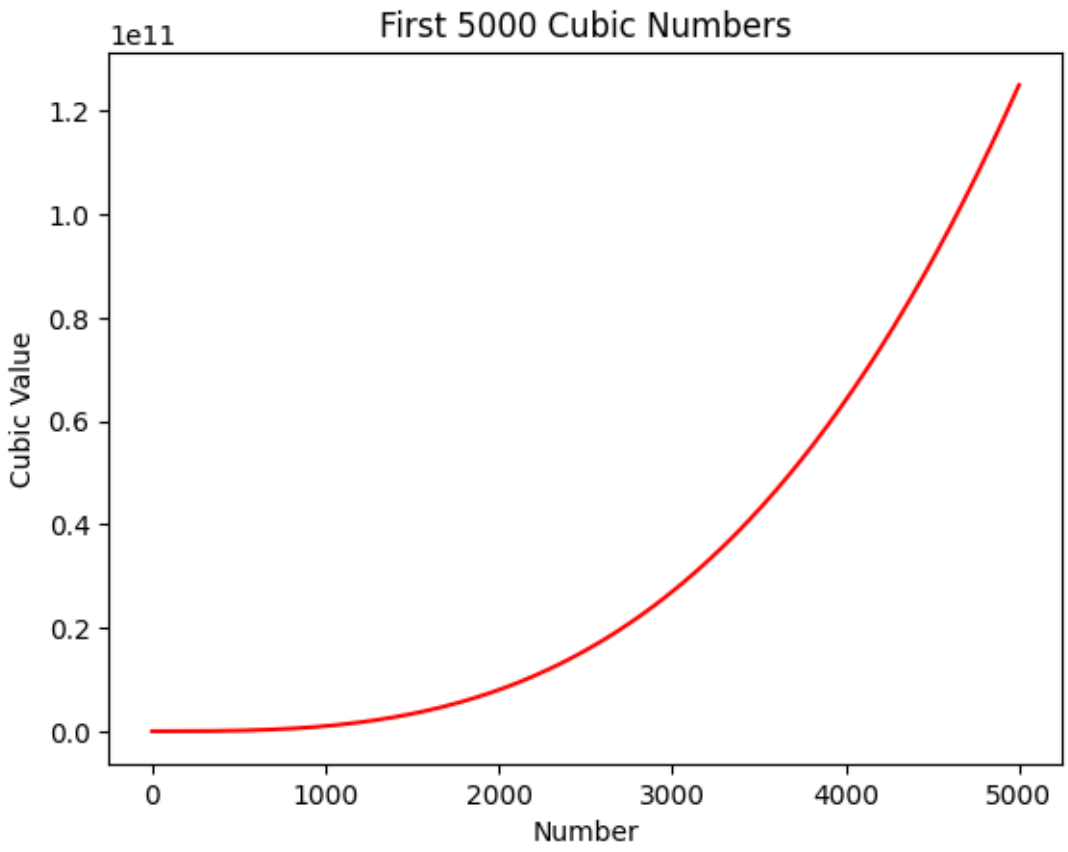
```
<Figure size 640x480 with 0 Axes>
```

Example

1. plot for first five cubic numbers.
2. plot for first 5000 cubic numbers.

```
import matplotlib.pyplot as plt

# Function to calculate the cube of a number
def cube(x):
    return x**3

# Generate the first five cubic numbers
first_five_cubic = [cube(x) for x in range(1, 6)]

# Generate the first 5000 cubic numbers
first_5000_cubic = [cube(x) for x in range(1, 5001)]

# Plot the first five cubic numbers
plt.figure(1)
plt.plot(range(1, 6), first_five_cubic, marker='o', linestyle='-', color='b')
plt.title("First Five Cubic Numbers")
plt.xlabel("Number")
plt.ylabel("Cubic Value")

# Plot the first 5000 cubic numbers
plt.figure(2)
plt.plot(range(1, 5001), first_5000_cubic, color='r')
plt.title("First 5000 Cubic Numbers")
plt.xlabel("Number")
plt.ylabel("Cubic Value")

# Show the plots
plt.show()
```


First Five Cubic Numbers
Cubic Value
Number
0
20
40
60
80
100
120
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0



Random walks (creating and plotting)

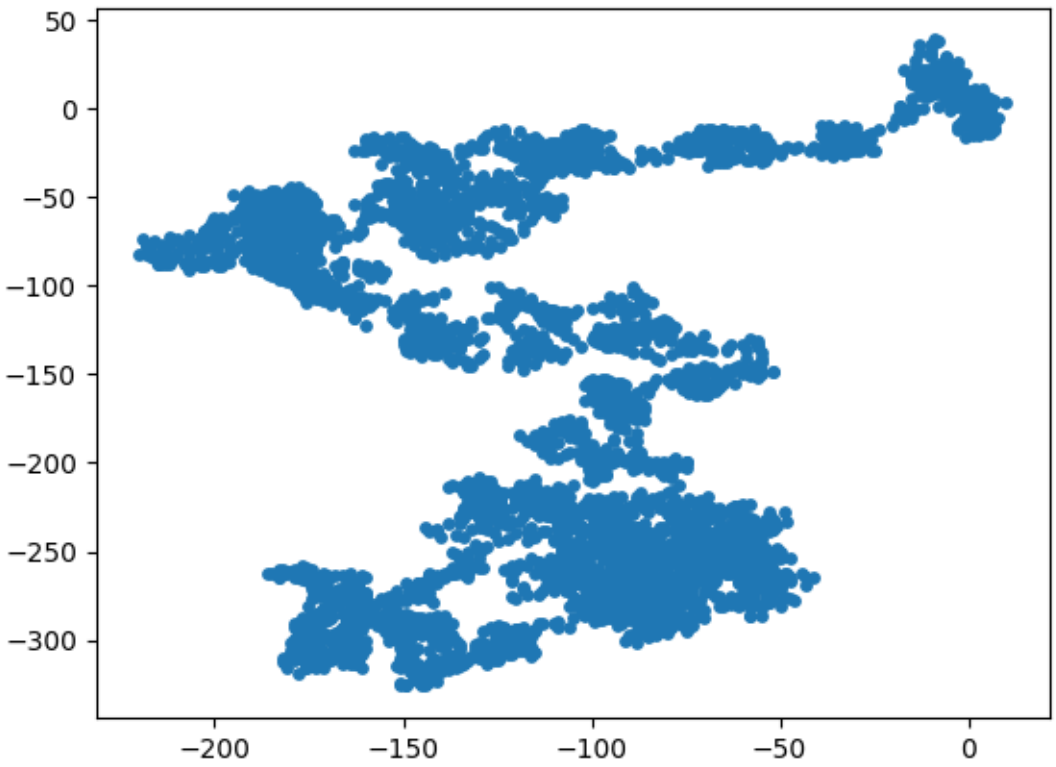
Creating

```
import random

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

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

```
            y_step = random.choice([-1, 1]) * random.choice([0, 1, 2, 3, 4])

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

            x = self.x_values[-1] + x_step
            y = self.y_values[-1] + y_step

            self.x_values.append(x)
            self.y_values.append(y)
```

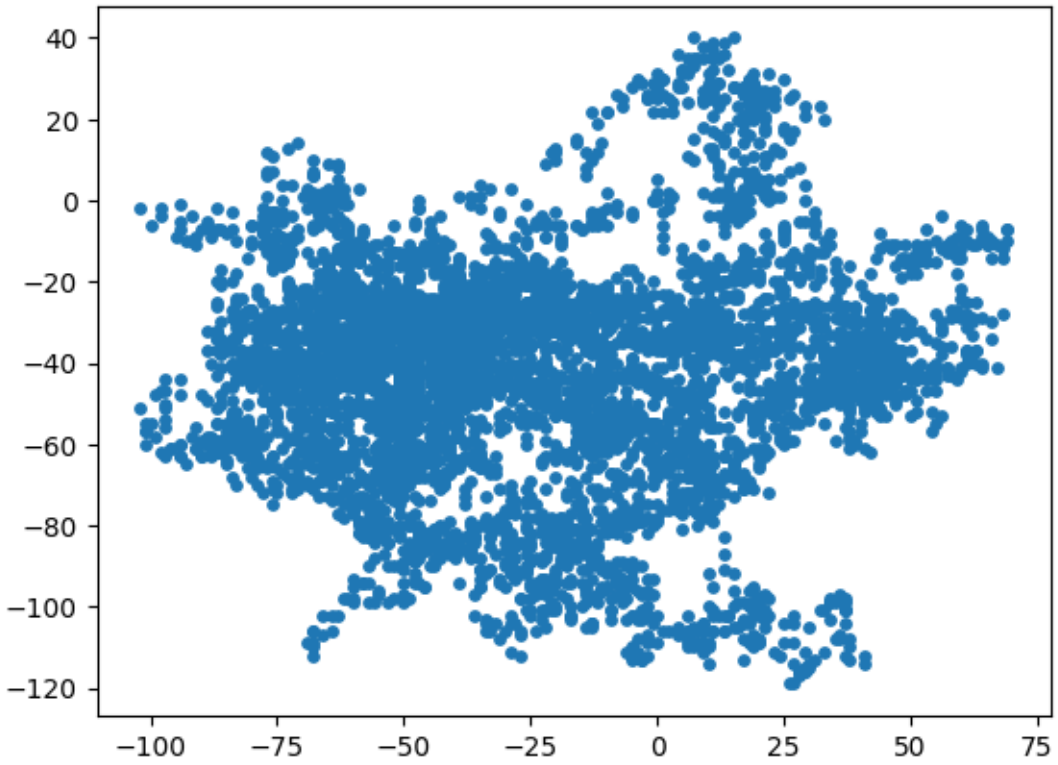
Plotting

```
rw = RandomWalk()
rw.fill_walk()

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

ax.scatter(rw.x_values, rw.y_values, s=15)
plt.show()
```

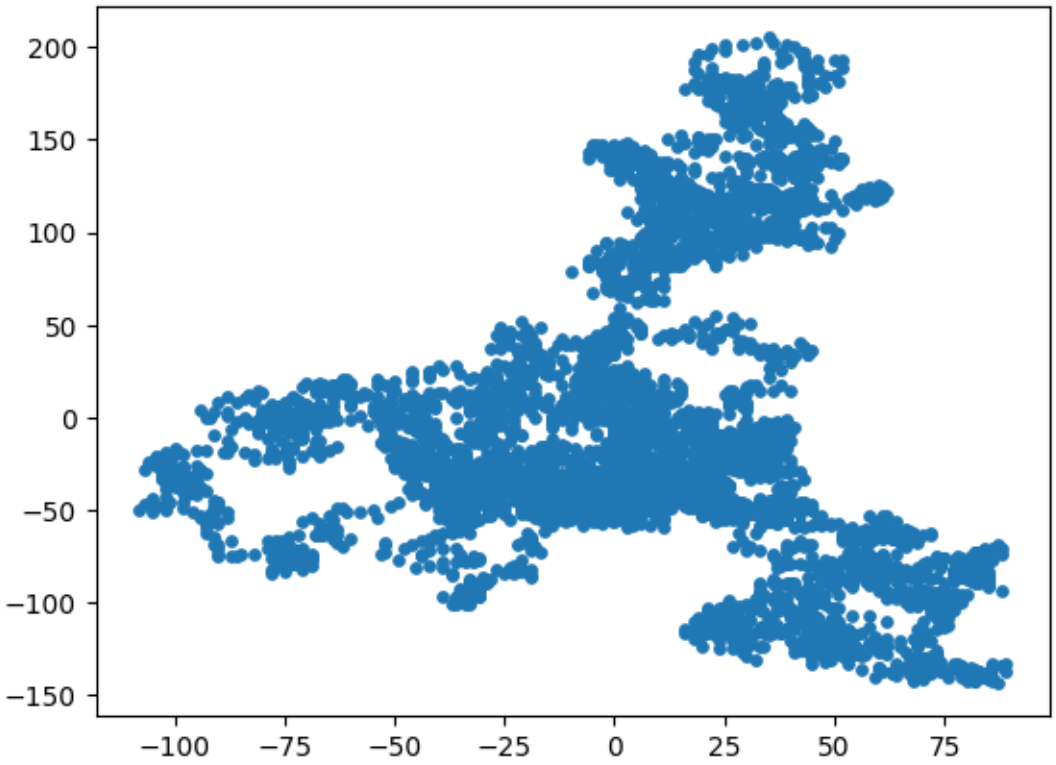


Generating Multiple Random Walks

```
# just by wrapping the above code in a while loop

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

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

    ax.scatter(rw.x_values, rw.y_values, s=15)
    plt.show()

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




```
Make another walk? (y/n): y
Make another walk? (y/n): n
```

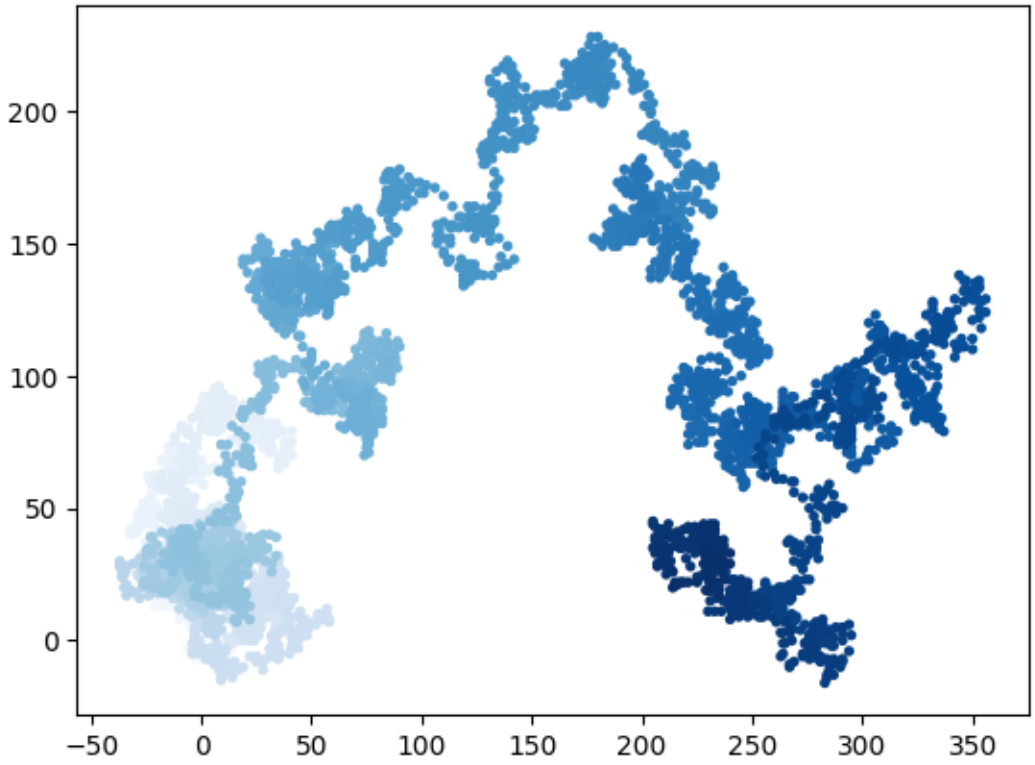


Styling the walk

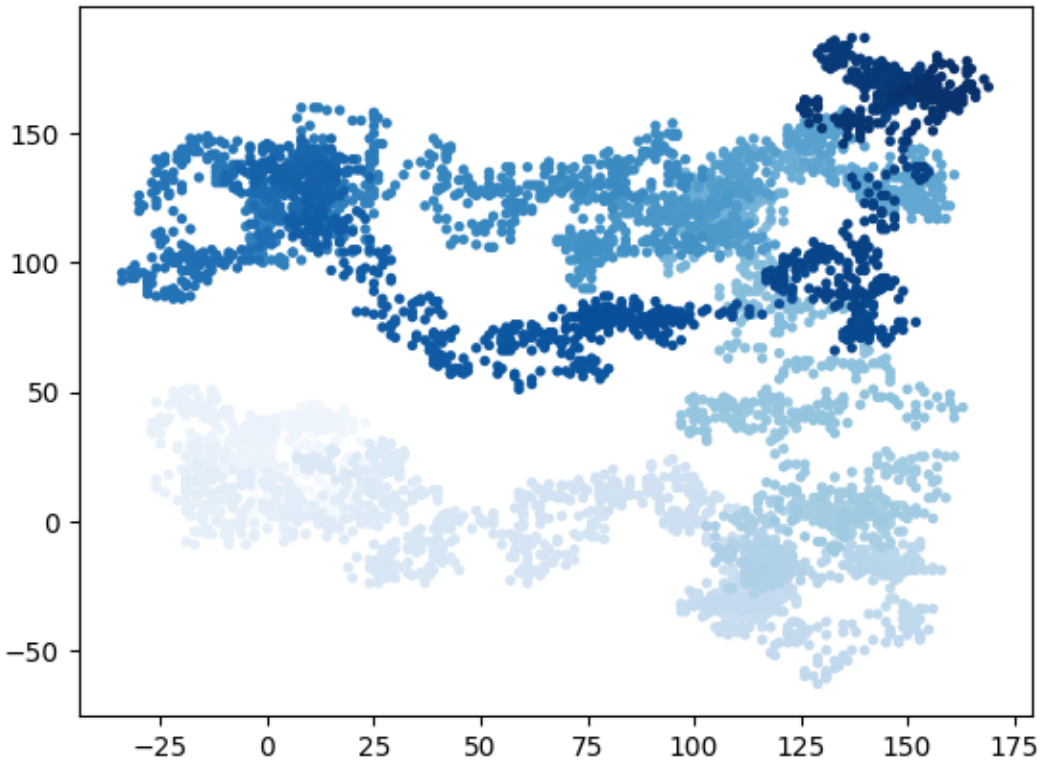
- after generating the list using range() function, we stored them in point_numbers()
- then passing the point_numbers to c argument, we used colormap
- finally, pass edgecolors = 'none' to get rid of black outline.

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

    plt.style.use('fast')
    fig, ax = plt.subplots()
    point_numbers = range(rw.num_points)   # added here to style

    ax.scatter(rw.x_values, rw.y_values, c= point_numbers, cmap= plt.cm.Blues, edgecolors=
    plt.show()

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

```
    if keep_running == 'n':
        break
```




```
Make another walk? (y/n): y
Make another walk? (y/n): n
```



Plotting the starting and ending points

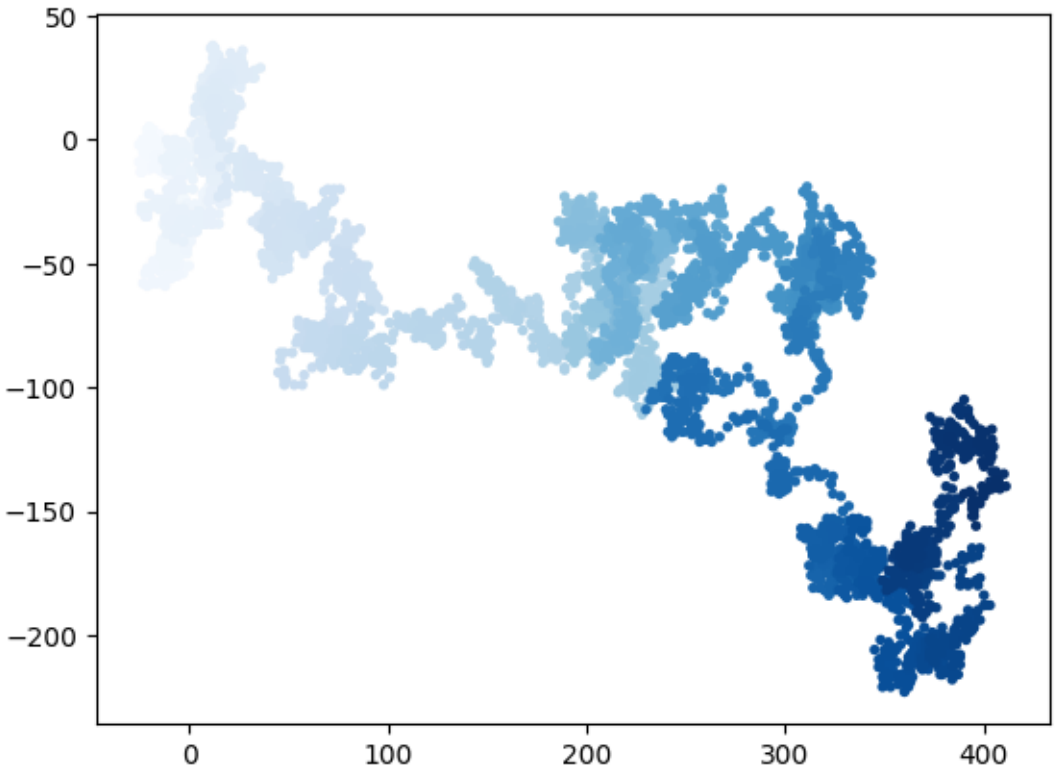
- to see where the walk begins and where it ends (we add first and last points)

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

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

    point_numbers = range(rw.num_points)   # added here to style

    ax.scatter(rw.x_values, rw.y_values, c= point_numbers, cmap= plt.cm.Blues, edgecolors=
    plt.show()

     # Emphasize the first and last points.
    ax.scatter(0, 0, c='green', edgecolors='none', s=100)
```

```
    ax.scatter(rw.x_values[-1], rw.y_values[-1], c='red', edgecolors='none',
        s=100)

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

Removing the Axes

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

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

    point_numbers = range(rw.num_points)   # added here to style

    ax.scatter(rw.x_values, rw.y_values, c= point_numbers, cmap= plt.cm.Blues, edgecolors=
    plt.show()

     # Remove the axes..
    ax.get_xaxis().set_visible(False)
    ax.get_yaxis().set_visible(False)


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

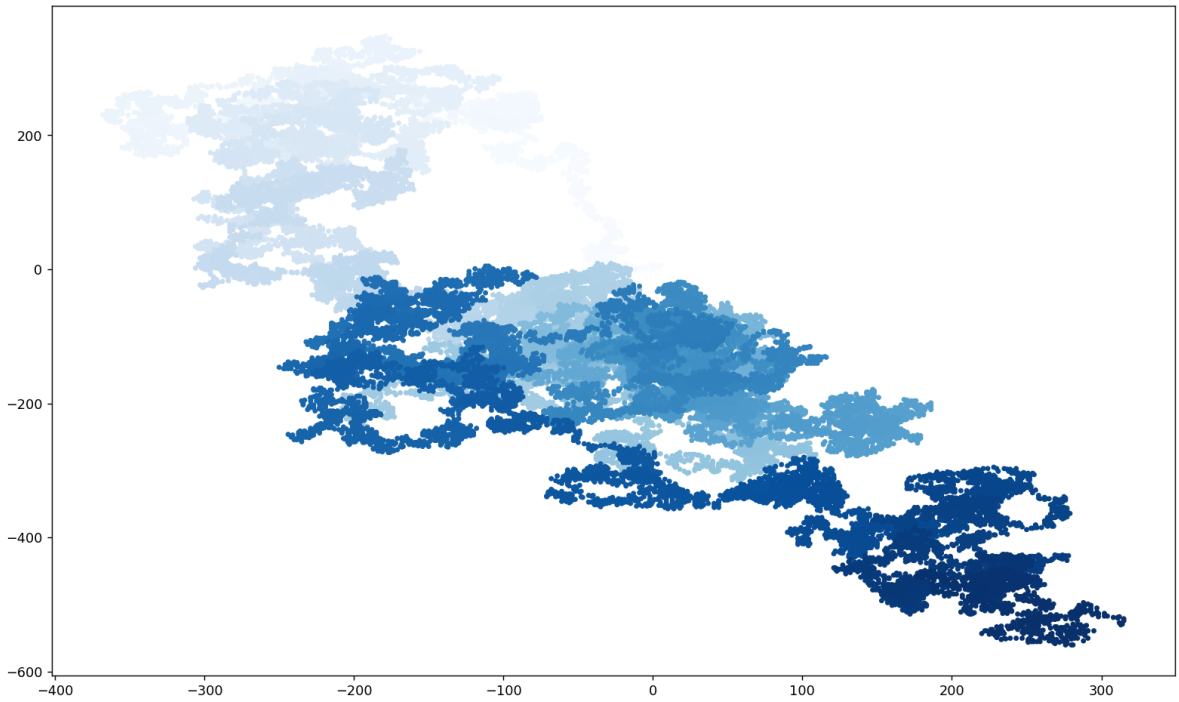



```
Make another walk? (y/n): n
```

Altering the size to fit screen

```
while True:
    rw = RandomWalk(50_000)
    rw.fill_walk()

    plt.style.use('fast')
    fig, ax = plt.subplots(figsize=(15,9), dpi=128)    #here size and if pixels are know t

    point_numbers = range(rw.num_points)   # added here to style

    ax.scatter(rw.x_values, rw.y_values, c= point_numbers, cmap= plt.cm.Blues, edgecolors=
    plt.show()

     # Remove the axes..
```

```
    ax.get_xaxis().set_visible(False)
    ax.get_yaxis().set_visible(False)


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




```
Make another walk? (y/n): n
```

Rolling dice with Plotly

```
from random import randint

class Die:
    "defining method"

    def __init__(self, num_sides=6):
        self.num_sides = num_sides
```

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

```
die = Die()

# make some rolls and store results in the list
results = []
for roll_num in range(100):
    result = die.roll()
    results.append(result)


print(results)
```

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

Analyzing the results

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

print(frequencies)
```

```
[20, 11, 24, 15, 17, 13]
```

```
# printing frequencies for 1000 rolls
for roll_num in range(1000):
    result = die.roll()
    results.append(result)

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

print(frequencies)
```

```
[351, 314, 348, 355, 366, 366]
```

Histogram

```
from plotly.graph_objs import Bar, Layout
from plotly import offline

x_values = list(range(1, die.num_sides+1))
data = [Bar(x=x_values, y=frequencies)]

x_axis_config = {'title': 'Result'}
y_axis_config = {'title': 'Frequency of Result'}

my_layout = Layout(title='Results of rolling 1000 times',
                   xaxis = x_axis_config, yaxis= y_axis_config)

offline.plot({'data': data, 'layout': my_layout}, filename = 'd6.html')
```

```
'd6.html'
```

Rolling two die

```
from plotly.graph_objs import Bar, Layout
from plotly import offline

# creating
die_1 = Die()
die_2 = Die()

results_2= []
for roll_num in range(1000):
    result = die_1.roll()  + die_2.roll()
    results_2.append(result)

# analyzing
frequencies_2 = []
max_result = die_1.num_sides + die_2.num_sides  #here aswell
for value in range(2, max_result+1):
```

```
    frequency = results_2.count(value)
    frequencies_2.append(frequency)

# Visualizing
x_values = list(range(2, max_result+1))           #changed here
data = [Bar(x= x_values, y = frequencies_2)]

x_axis_config = {'title': 'Result', 'dtick' : 1}    #changed here compared to one die
y_axis_config = {'title': 'Frequency of Result'}

my_layout = Layout(title='Results of rolling two D6 dies 1000 times',
                   xaxis = x_axis_config, yaxis= y_axis_config)

offline.plot({'data': data, 'layout': my_layout}, filename = 'd6_d6.html')
```

```
'd6_d6.html'
```

Rolling two die of different sizes

```
from plotly.graph_objs import Bar, Layout
from plotly import offline

# creating
die_1 = Die()
die_2 = Die(10)   #change here

results_2= []
for roll_num in range(1000):
    result = die_1.roll()  + die_2.roll()
    results_2.append(result)

# analyzing
frequencies_2 = []
max_result = die_1.num_sides + die_2.num_sides  #here aswell
for value in range(2, max_result+1):
    frequency = results_2.count(value)
    frequencies_2.append(frequency)

# Visualizing
```

```
x_values = list(range(2, max_result+1))           #changed here
data = [Bar(x= x_values, y = frequencies_2)]

x_axis_config = {'title': 'Result', 'dtick' : 1}    #changed here compared to one die
y_axis_config = {'title': 'Frequency of Result'}

my_layout = Layout(title='Results of rolling two D6 dies 1000 times',
                   xaxis = x_axis_config, yaxis= y_axis_config)

offline.plot({'data': data, 'layout': my_layout}, filename = 'd6_d10.html')
```

```
'd6_d10.html'
```

Rolling three dice

```
from plotly.graph_objs import Bar, Layout
from plotly import offline

# Creating
die_1 = Die()
die_2 = Die()
die_3 = Die() #change here

results_3= []
for roll_num in range(1000):
    result = die_1.roll()  + die_2.roll() + die_3.roll()   #die added
    results_3.append(result)

# Analyzing
frequencies_3 = []
max_result = die_1.num_sides + die_2.num_sides + die_3.num_sides #here aswell
for value in range(2, max_result+1):
    frequency = results_3.count(value)
    frequencies_3.append(frequency)

# Visualizing
x_values = list(range(3, max_result+1))           #range changed
data = [Bar(x= x_values, y = frequencies_3)]
```

```
x_axis_config = {'title': 'Result', 'dtick' : 1}    #changed here compared to one die
y_axis_config = {'title': 'Frequency of Result'}

my_layout = Layout(title='Results of rolling three D6 dies 1000 times',
                   xaxis = x_axis_config, yaxis= y_axis_config)

offline.plot({'data': data, 'layout': my_layout}, filename = 'd6_d6_d6.html')
```

```
'd6_d6_d6.html'
```