Generating data (data visualization, representations, etc.)

Python basics

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Table of contents

| Learning outcomes | 2 |
|---|---|
| Plotting tools used | 2 |
| | 3 |
| | 4 |
| | 5 |
| Plotting and Styling Individual Points with scatter() | 8 |
| Caluculating data automatically | 9 |
| Using a Colormap | 0 |
| Saving the plots automatically | 2 |
| Example | 2 |
| Random walks (creating and plotting) | 4 |
| Generating Multiple Random Walks | 6 |
| Styling the walk | 8 |
| Plotting the starting and ending points | 0 |
| Removing the Axes | 1 |
| Altering the size to fit screen | 2 |
| Rolling dice with Plotly | 3 |
| Analyzing the results | 4 |
| Histogram | 5 |
| Rolling two die | 5 |
| Rolling two die of different sizes | 6 |
| Rolling three dice | 7 |

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

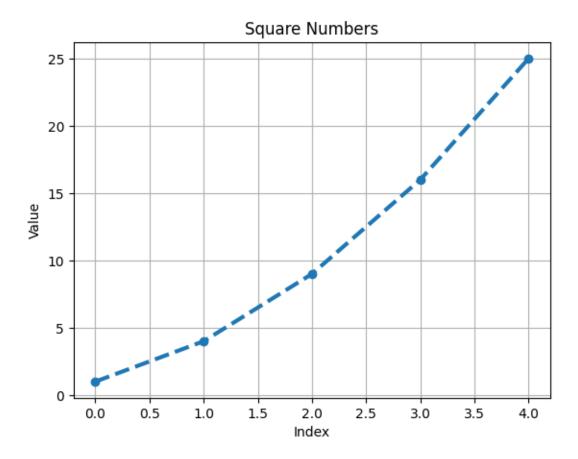
squares = [1, 4, 9, 16, 25]

# 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]

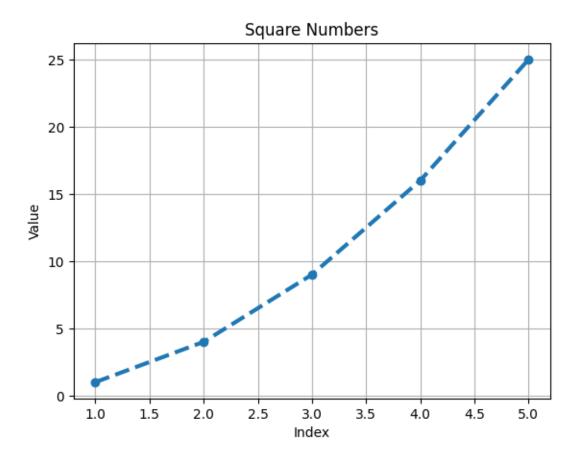
# Create a figure and axis
fig, ax = plt.subplots()

# 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

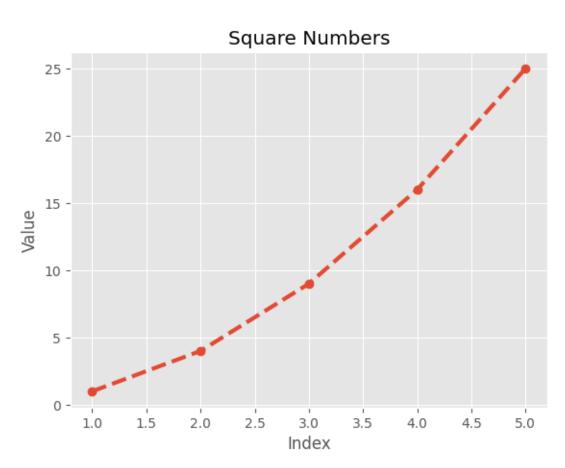
```
import matplotlib.pyplot as plt
plt.style.available

['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='--')
```

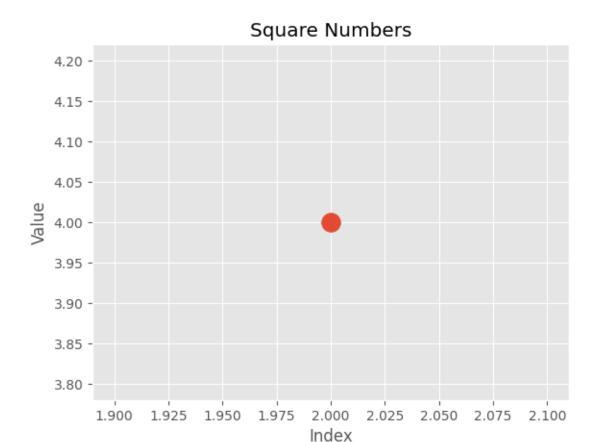
```
# Customize the plot
ax.set_title('Square Numbers')
ax.set_xlabel('Index')
ax.set_ylabel('Value')
ax.grid(True)

# 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()
```



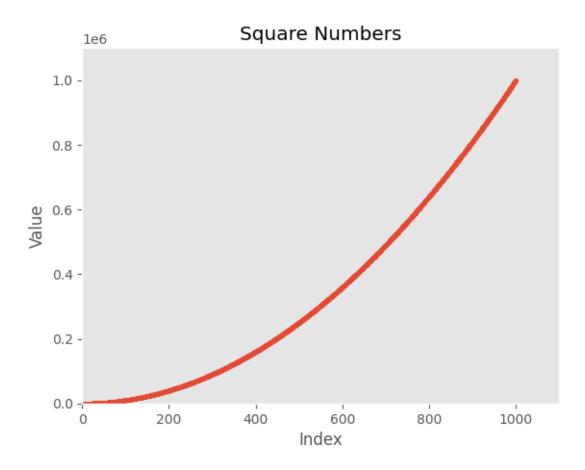
Caluculating data automatically

```
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

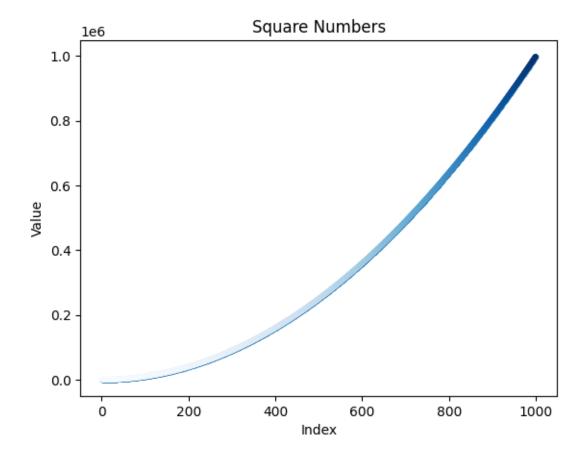
```
import matplotlib.pyplot as plt

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()
```



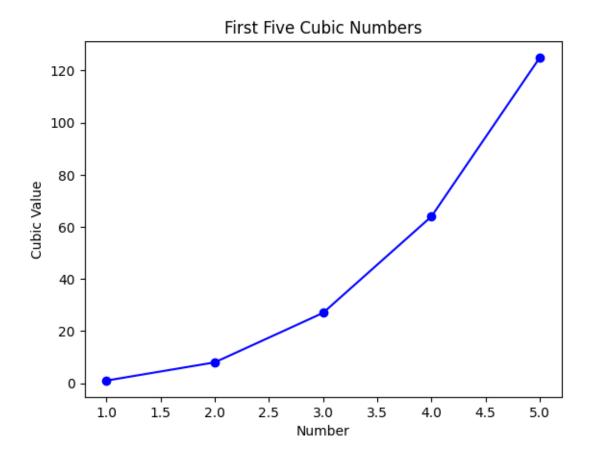
Saving the plots automatically

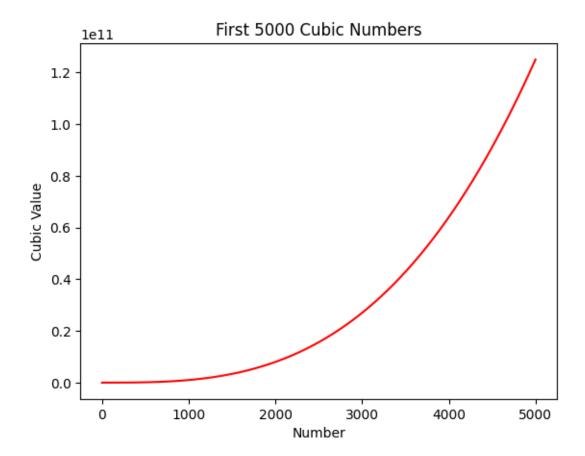
plt.ylabel("Cubic Value")

Show the plots

plt.show()

```
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")
```





Random walks (creating and plotting)

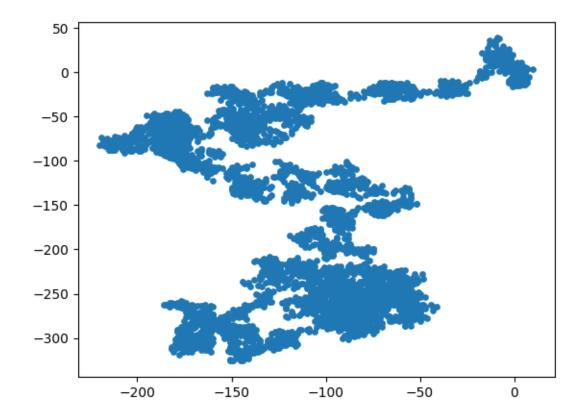
Creating

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

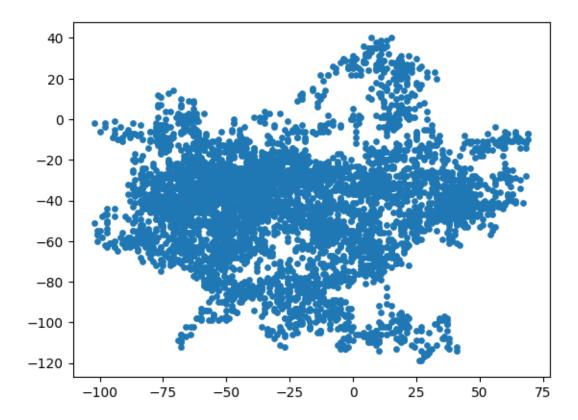
```
# just by wrapping the above code in a while loop

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

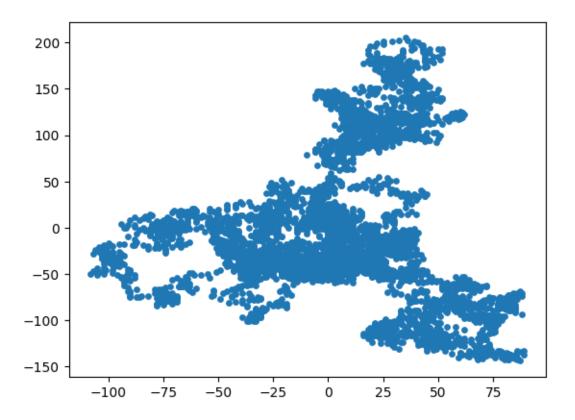
plt.style.use('fast')
    fig, ax = plt.subplots()

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.

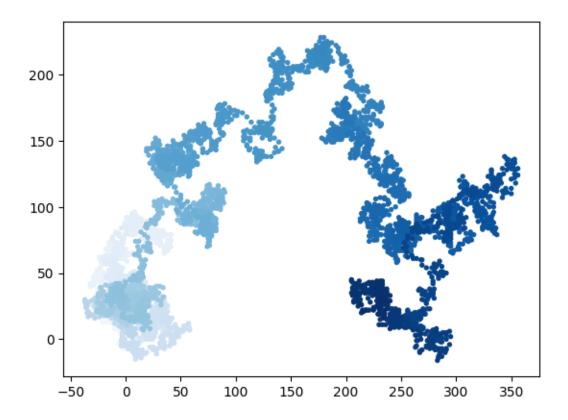
```
while True:
    rw = RandomWalk()
    rw.fill_walk()

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

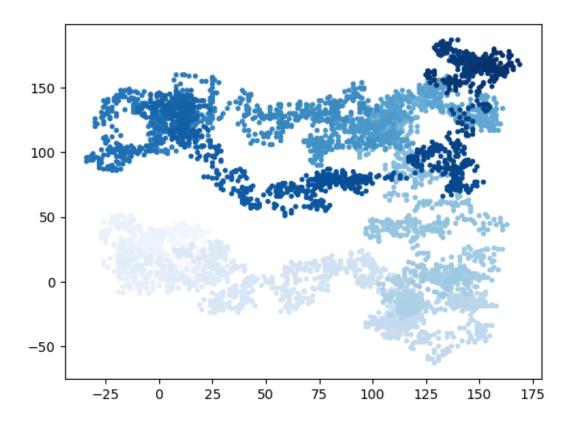
ax.scatter(rw.x_values, rw.y_values, c= point_numbers, cmap= plt.cm.Blues, edgecolors= plt.show()

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)
```

Removing the Axes

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

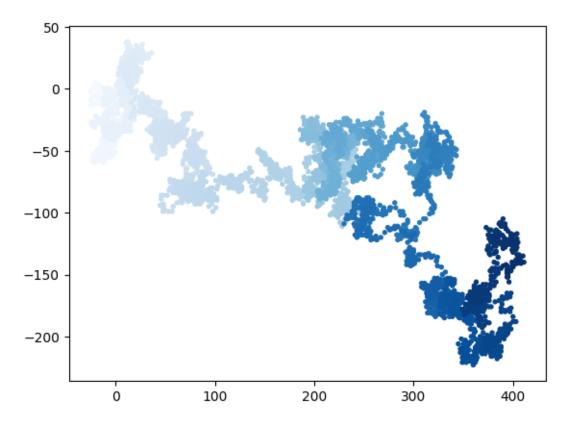
plt.style.use('fast')
    fig, ax = plt.subplots()

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 to

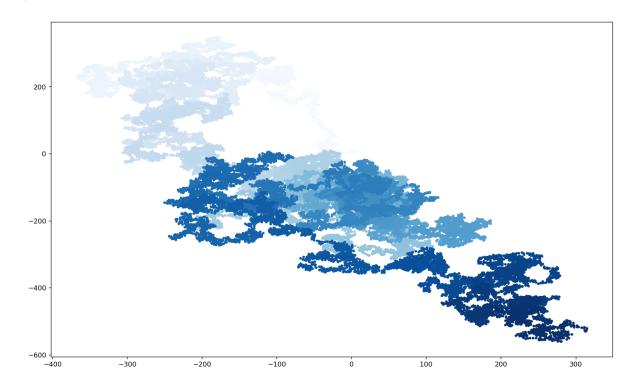
point_numbers = range(rw.num_points)  # added here to style

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)
```

```
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

'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):
```

'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
```

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)]
```

'd6_d6_d6.html'