Introduction to Python for Finance

INTRODUCTION TO PYTHON FOR FINANCE

Adina Howe
Instructor

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Why Python for Finance?

- Easy to Learn and Flexible
  - General purpose
  - Dynamic
  - High-level language
- Integrates with other languages
- Open source
  - Accessible to anyone

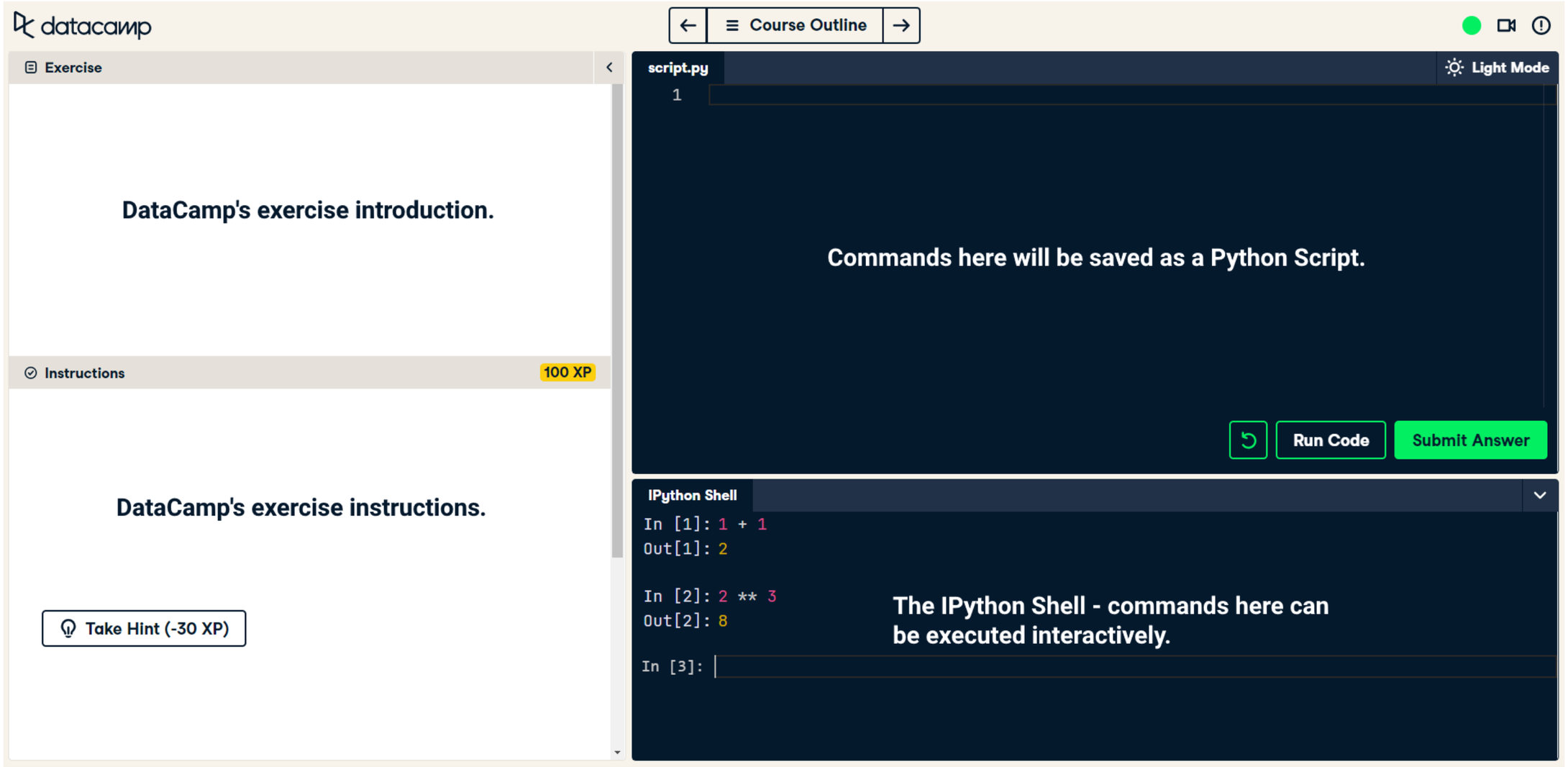
Python Shell

```
In [1]:
```

Calculations in IPython

```
In [1]: 1 + 1
```

```
2
```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Course Outline
Exercise
DataCamp's exercise introduction.
Instructions
100 XP
DataCamp's exercise instructions.
Take Hint (-30 XP)
script.py
Light Mode
1
Commands here will be saved as a Python Script.
Run Code
Submit Answer
IPython Shell
In [1]: 1 + 1
Out[1]: 2
In [2]: 2 ** 3
Out[2]: 8
The IPython Shell - commands here can be executed interactively.
In [3]:

Common mathematical operators

Operator	Meaning
+	Add
-	Subtract
*	Multiply
/	Divide
%	Modulus (remainder of division)
**	Exponent

Common mathematical operators

```
In  [1]: 8 + 4
```

```
Out [1]: 12
```

```
In  [2]: 8 / 4
```

```
Out [2]: 2
```

Comments and variables

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Any comments?

```
# Example, do not modify!
print(8 / 2 )
print(2**2)

# Put code below here
print(1.0 + 0.10)
```

Outputs in IPython vs. script.py

IPython Shell

```
In [1]: 1 + 1
```

```
Out[1]: 2
```

```
In [1]: print(1 + 1)
```

```
2
```

script.py

```
1 + 1
```

```
# No output
```

```
print(1 + 1)
```

```
<script.py> output:
    2
```

Variables

Variable names

- Names can be upper or lower case le ers, digits, and underscores
- Variables cannot start with a digit
- Some variable names are reservedin Python (e.g., class or type) and should be avoided

Variable example

```
# Correct
day_2 = 5


# Incorrect, variable name starts with a digit
2_day = 5
```

Using variables to evaluate stock trends

$$\text{Price to earning ratio} = \frac{\text{Market price}}{\text{Earnings per share}}$$

```
price = 200
earnings = 5
pe_ratio = price / earnings
print(pe_ratio)
```

```
40
```

Variable Data Types

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Python Data Types

Variable Types	Example
Strings	'hello world'
Integers	40
Floats	3.1417
Booleans	True or False

Variable Types

Variable Types	Example	Abbreviations
Strings	'Tuesday'	`str`
Integers	40	`int`
Floats	3.1417	`float`
Booleans	True or False	`bool`

What data type is a variable: type()

To identify the type, we can use the function `type()` :

```
type(variable_name)
```

```
pe_ratio = 40
print(type(pe_ratio))
```

```
<class 'int'>
```

Booleans

operators	descriptions
`==`	equal
`!=`	does not equal
`>`	greater than
`<`	less than

Boolean Example

```
print(1 == 1)
```

```
True
```

```
print(type(1 == 1))
```

```
<class 'bool'>
```

Variable manipulations

```
x = 5
print(x * 3)
```

```
15
```

```
y = 'stock'
print(y * 3)
```

```
'stockstockstock'
```

```
print(x + 3)
```

```
8
```

```
print(y + 3)
```

```
TypeError: must be str, not int
```

Changing variable types

```
pi = 3.14159
print(type(pi))
```

```
<class 'float'>
```

```
pi_string = str(pi)
print(type(pi_string))
```

```
<class 'str'>
```

```
print('I love to eat ' + pi_string + '!')
```

```
I love to eat 3.14159!
```

Lists in Python

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Lists - square brackets [ ]

```
months = ['January', 'February', 'March', 'April', 'May', 'June']
```

Python is zero-indexed

```
months = ['January', 'February', 'March', 'April', 'May', 'June']
Index:      0          1          2         3       4       5
```

Subset lists

```
months = ['January', 'February', 'March', 'April', 'May', 'June']
```

```
months[0]
```

```
'January'
```

```
months[2]
```

```
'March'
```

Negative indexing of lists

```
months = ['January', 'February', 'March', 'April', 'May', 'June']
```

```
months[-1]
```

```
'June'
```

```
months[-2]
```

```
'May'
```

Subsetting multiple list elements with slicing

Slicing syntax

```
# Includes the start and up to (but not including) the end
mylist[startAt:endBefore]
```

Example

```
months = ['January', 'February', 'March', 'April', 'May', 'June']
```

```
months[2:5]
```

```
['March', 'April', 'May']
```

```
months[-4:-1]
```

```
['March', 'April', 'May']
```

Extended slicing with lists

```
months = ['January', 'February', 'March', 'April', 'May', 'June']
```

```
months[3:]
```

```
['April', 'May', 'June']
```

```
months[:3]
```

```
['January', 'February', 'March']
```

Slicing with Steps

```
# Includes the start and up to (but not including) the end
mylist[startAt:endBefore:step]
```

```
months = ['January', 'February', 'March', 'April', 'May', 'June']
```

```
months[0:6:2]
```

```
['January', 'March', 'May']
```

```
months[0:6:3]
```

```
['January', 'April']
```

Lists in Lists

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Lists in Lists

- Lists can contain various data types, including lists themselves.
- Example: a nested list describing the month and its associated consumer price index

```
cpi = [['Jan', 'Feb', 'Mar'], [238.11, 237.81, 238.91]]
```

Subsetting Nested Lists

```
months = ['Jan', 'Feb', 'Mar']
print(months[1])
```

```
'Feb'
```

```
cpi = [['Jan', 'Feb', 'Mar'], [238.11, 237.81, 238.91]]
print(cpi[1])
```

```
[238.11, 237.81, 238.91]
```

More on Subsetting Nested Lists

How would one subset out a speci c price index?

```
cpi = [['Jan', 'Feb', 'Mar'], [238.11, 237.81, 238.91]]
print(cpi[1])
```

```
[238.11, 237.81, 238.91]
```

```
print(cpi[1][0])
```

```
238.11
```

Methods and functions

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Methods vs. Functions

Methods

- All methods are functions
- List methods are a subset of built-in functions in Python
- Used on an object
  - `prices.sort()`

Functions

- Not all functions are methods
- Requires an input of an object
  - `type(prices)`

List Methods - sort

- Lists have several built-in methods that can help retrieve and manipulate data
- Methods can be accessed as `list.method()`

`list.sort()` sorts list elements in ascending order

```
prices = [238.11, 237.81, 238.91]
prices.sort()
print(prices)
```

```
[237.81, 238.11, 238.91]
```

Adding to a list with append and extend

`list.append()` adds a single element to a list

```
months = ['January', 'February', 'March']
months.append('April')
print(months)
```

```
['January', 'February', 'March', 'April']
```

`list.extend()` adds each element to a list

```
months.extend(['May', 'June', 'July'])
print(months)
```

```
['January', 'February', 'March', 'April', 'May', 'June', 'July']
```

Useful list methods - index

`list.index(x)` returns the lowest index where the element x appears

```
months = ['January', 'February', 'March']
prices = [238.11, 237.81, 238.91]
```

```
months.index('February')
```

```
1
```

```
print(prices[1])
```

```
237.81
```

More functions ...

- `min(list)` : returns the smallest element
- `max(list)` : returns the largest element

Find the month with smallest CPI

```
months = ['January', 'February', 'March']
prices = [238.11, 237.81, 238.91]
```

```
# Identify min price
min_price = min(prices)
# Identify min price index
min_index = prices.index(min_price)
# Identify the month with min price
min_month = months[min_index]
print(min_month)
```

```
February
```

Arrays

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Installing packages

```
pip3 install package_name_here
```

```
pip3 install numpy
```

Importing packages

```
import numpy
```

NumPy and Arrays

```
import numpy
my_array = numpy.array([0, 1, 2, 3, 4])
print(my_array)
```

```
[0, 1, 2, 3, 4]
```

```
print(type(my_array))
```

```
<class 'numpy.ndarray'>
```

Using an alias

```
import package_name
package_name.function_name(...)
```

```
import numpy as np
my_array = np.array([0, 1, 2, 3, 4])
print(my_array)
```

```
[0, 1, 2, 3, 4]
```

Why use an array for financial analysis?

- Arrays can handle very large datasets e ciently
  - Computationally-memory e cient
  - Faster calculations and analysis than lists
  - Diverse functionality (many functions in Python packages)

What's the difference?

Numpy arrays

```
my_array = np.array([3, 'is', True])  True
print(my_array)
```

```
['3' 'is' 'True']
```

Lists

```
my_list = [3, 'is', True]  True
print(my_list)
```

```
[3, 'is', True]
```

Array operations

Arrays

```
import numpy as np

array_A = np.array([1, 2, 3])
array_B = np.array([4, 5, 6])

print(array_A + array_B)
```

```
[5 7 9]
```

Lists

```
list_A = [1, 2, 3]
list_B = [4, 5, 6]

print(list_A + list_B)
```

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

Array indexing

```
import numpy as np

months_array = np.array(['Jan', 'Feb', 'March', 'Apr', 'May'])
print(months_array[3])
```

```
Apr
```

```
print(months_array[2:5])
```

```
['March' 'Apr' 'May']
```

Array slicing with steps

```
import numpy as np


months_array = np.array(['Jan', 'Feb', 'March', 'Apr', 'May'])
```

```
print(months_array[0:5:2])
```

```
['Jan' 'March' 'May']
```

Two Dimensional Arrays

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Two-dimensional arrays

```
import numpy as np

months = [1, 2, 3]
prices = [238.11, 237.81, 238.91]
```

```
cpi_array = np.array([months, prices])


print(cpi_array)
```

```
[[  1.    2.    3.  ]
 [238.11 237.81 238.91]]
```

Array Methods

```
print(cpi_array)
```

```
[[   1.     2.     3.  ]
 [ 238.11  237.81  238.91]]
```

`.shape` gives you dimensions of the array

```
print(cpi_array.shape)
```

```
(2, 3)
```

`.size` gives you total number of elements in the array

```
print(cpi_array.size)
```

```
6
```

Array Functions

```
import numpy as np

prices = [238.11, 237.81, 238.91]
prices_array = np.array(prices)
```

`np.mean()` calculates the mean of an input

```
print(np.mean(prices_array))
```

```
238.27666666666667
```

`np.std()` calculates the standard deviation of an input

```
print(np.std(prices_array))
```

```
0.46427960923946671
```

The `arange()` function

`numpy.arange()` creates an array with start, end, step

```
import numpy as np

months = np.arange(1, 13)
print(months)
```

```
[ 1  2  3  4  5  6  7  8  9 10 11 12]
```

```
months_odd = np.arange(1, 13, 2)
print(months_odd)
```

```
[ 1  3  5  7  9 11]
```

The `transpose()` function

`numpy.transpose()` switches rows and columns of a numpy array

```
print(cpi_array)
```

```
[[   1.     2.     3.  ]
 [ 238.11  237.81  238.91]]
```

```
cpi_transposed = np.transpose(cpi_array)
```

```
print(cpi_transposed)
```

```
[[   1.    238.11]
 [   2.    237.81]
 [   3.    238.91]]
```

Array Indexing for 2D arrays

```
print(cpi_array)
```

```
[[   1.     2.     3.  ]
 [ 238.11  237.81  238.91]]
```

```
# row index 1, column index 2
cpi_array[1, 2]
```

```
238.91
```

```
# all row slice, third column
print(cpi_array[:, 2])
```

```
[   3.    238.91]
```

Using Arrays for Analyses

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Indexing Arrays

```
import numpy as np


months_array = np.array(['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun'])
indexing_array = np.array([1, 3, 5])
```

```
months_subset = months_array[indexing_array]
print(months_subset)
```

```
['Feb' 'Apr' 'Jun']
```

More on indexing arrays

```
import numpy as np

months_array = np.array(['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun'])

negative_index = np.array([-1, -2])

print(months_array[negative_index])
```

```
['Jun' 'May']
```

Boolean arrays

```
import numpy as np

months_array = np.array(['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun'])

boolean_array = np.array([True, True, True, False, False, False])
print(months_array[boolean_array])
```

```
['Jan' 'Feb' 'Mar']
```

More on Boolean arrays

```
prices_array = np.array([238.11, 237.81, 238.91])
# Create a Boolean array
boolean_array = (prices_array > 238)


print(boolean_array)
```

```
[ True False  True]
```

```
print(prices_array[boolean_array])
```

```
[ 238.11  238.91]
```

Visualization in Python

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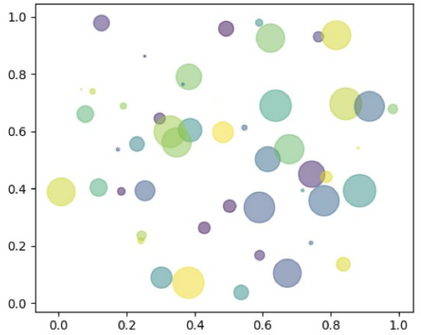
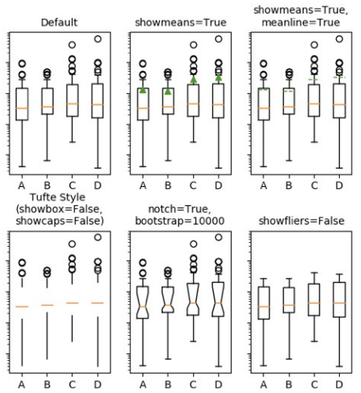
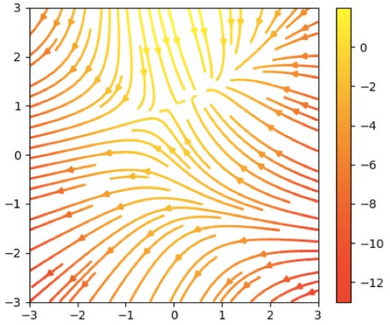
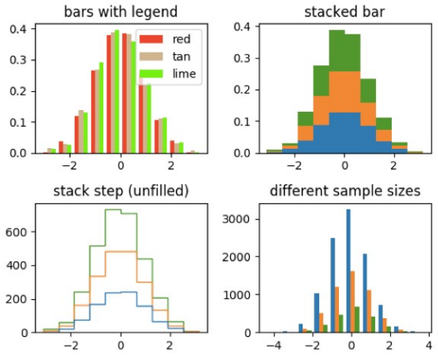
Matplotlib: A visualization package

See more of the Matplotlib gallery by clicking this link.









matplotlib.pyplot - diverse plotting functions

```
import matplotlib.pyplot as plt
```

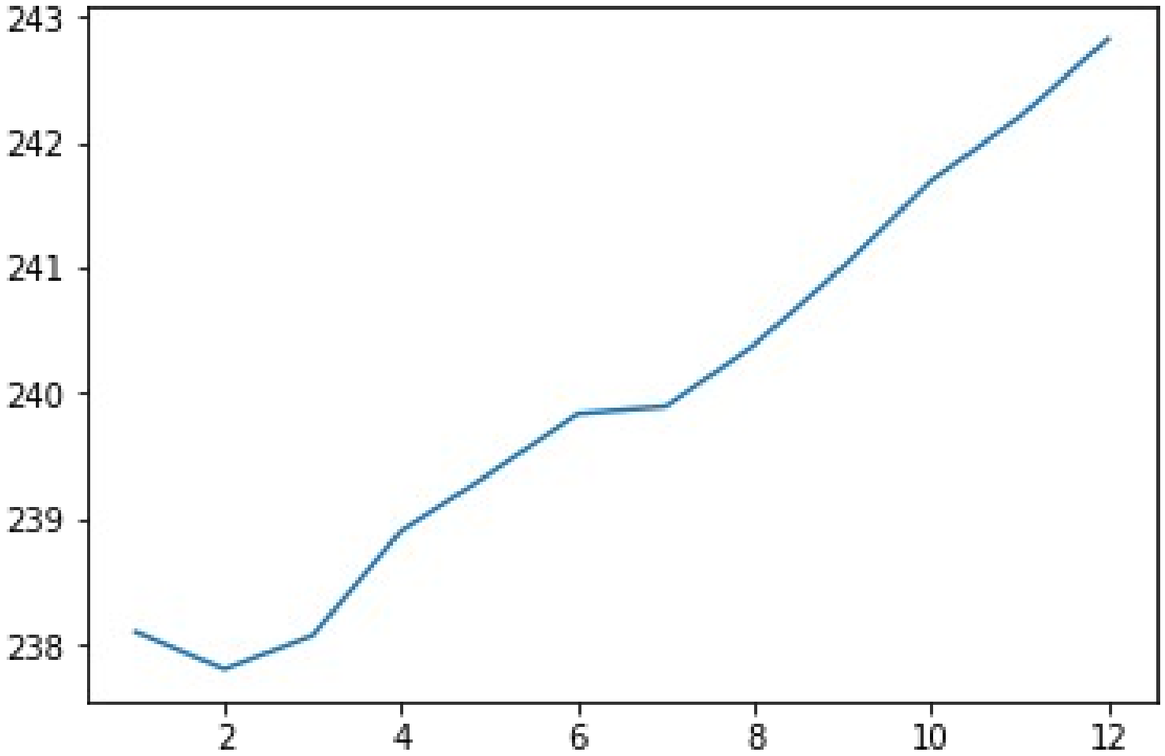
matplotlib.pyplot - diverse plotting functions

- `plt.plot()`
  - takes arguments that describe the data to be plo ed
- `plt.show()`
  - displays plot to screen

Plotting with pyplot

```
import matplotlib.pyplot as plt
plt.plot(months, prices)
plt.show()
```

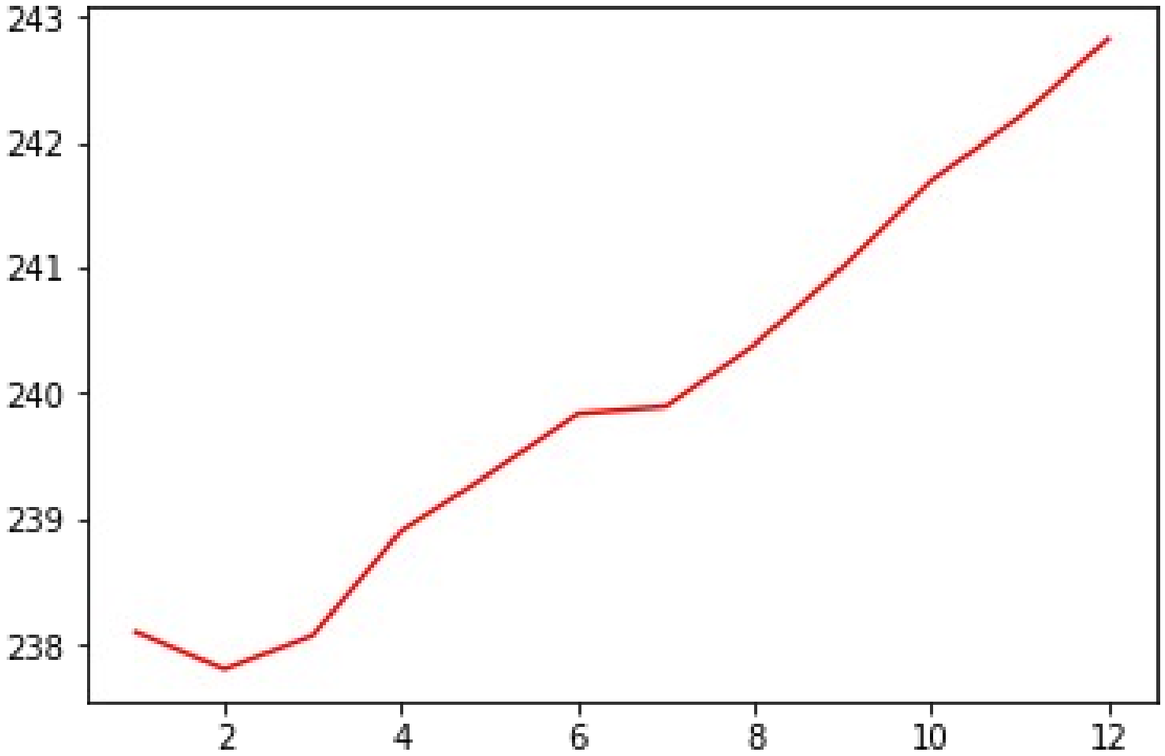
Plot result



Red solid line

```
import matplotlib.pyplot as plt
plt.plot(months, prices, color = 'red')
plt.show()
```

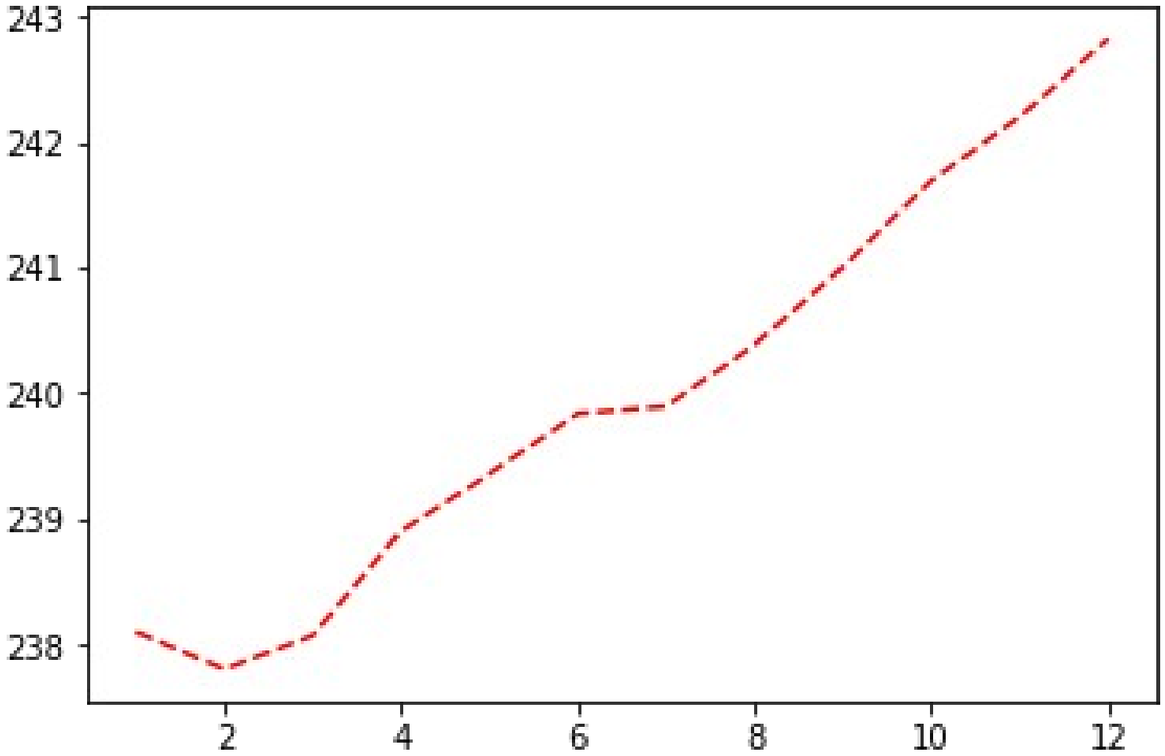
Plot result



Dashed line

```
import matplotlib.pyplot as plt
plt.plot(months, prices, color = 'red', linestyle = '--')
plt.show()
```

Plot result



Colors and linestyles

	color
'green'	green
'red'	red
'cyan'	cyan
'blue'	blue

	linestyle
'-'	solid line
'--'	dashed line
'-.'	dashed dot line
':'	do ed

More documentation on colors and lines can be found here.

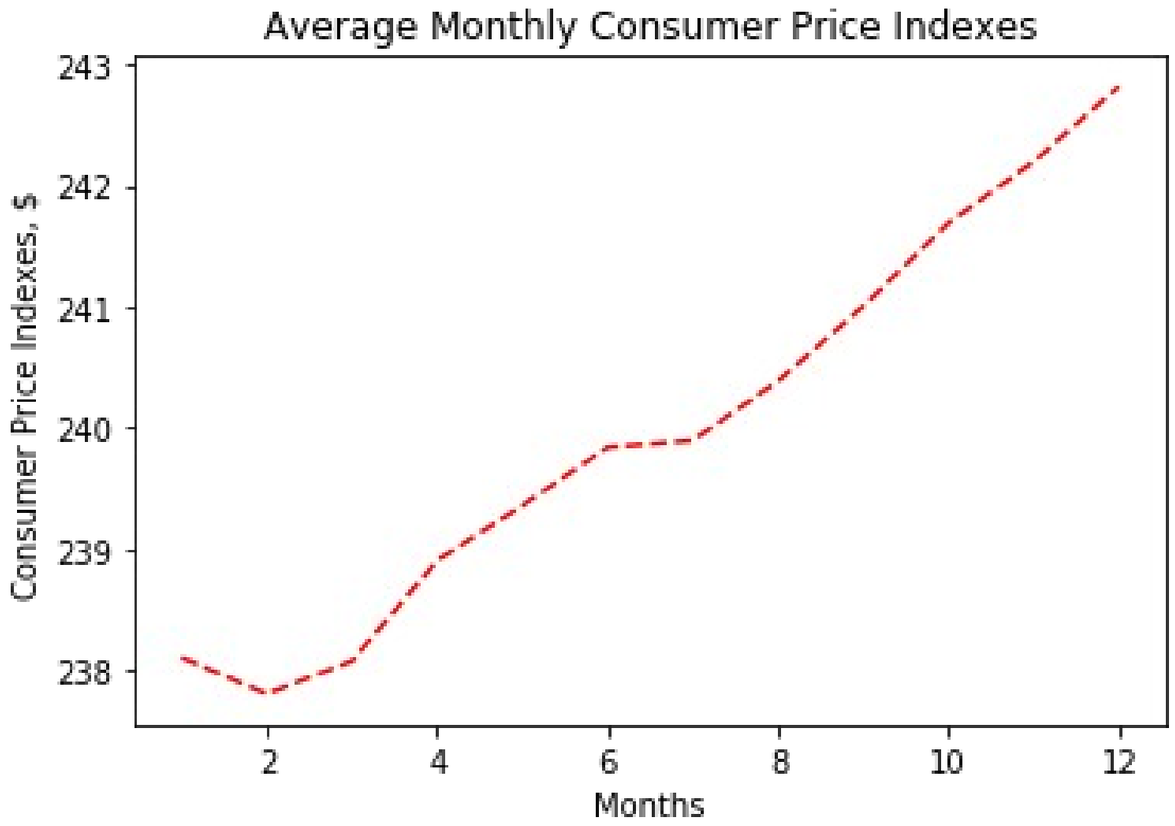
Adding Labels and Titles

```
import matplotlib.pyplot as plt
plt.plot(months, prices, color = 'red', linestyle = '--')

# Add labels
plt.xlabel('Months')
plt.ylabel('Consumer Price Indexes, $')
plt.title('Average Monthly Consumer Price Indexes')

# Show plot
plt.show()
```

Plot result


Average Monthly Consumer Price Indexes
Consumer Price Indexes, $
243
242
241
240
239
238
2
4
6
8
10
12
Months

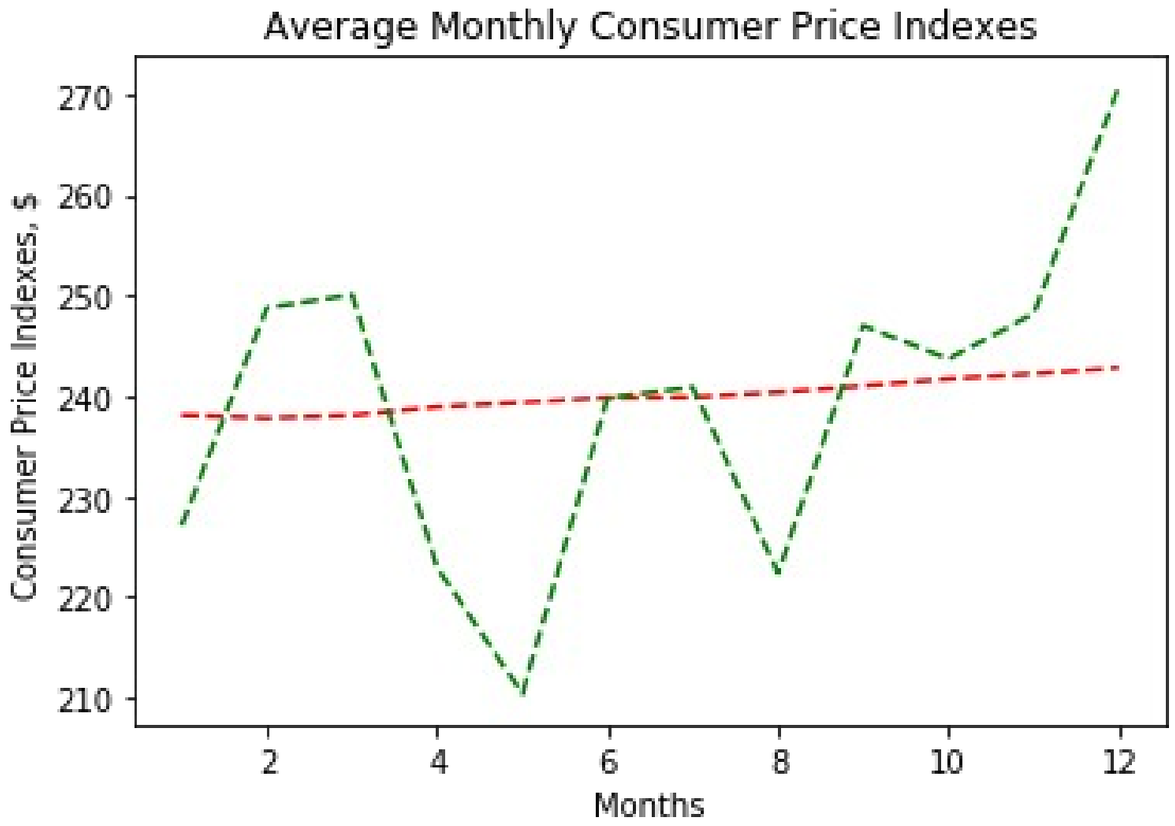
Adding additional lines

```
import matplotlib.pyplot as plt
plt.plot(months, prices, color = 'red', linestyle = '--')

# adding an additional line
plt.plot(months, prices_new, color = 'green', linestyle = '--')

plt.xlabel('Months')
plt.ylabel('Consumer Price Indexes, $')
plt.title('Average Monthly Consumer Price Indexes')
plt.show()
```

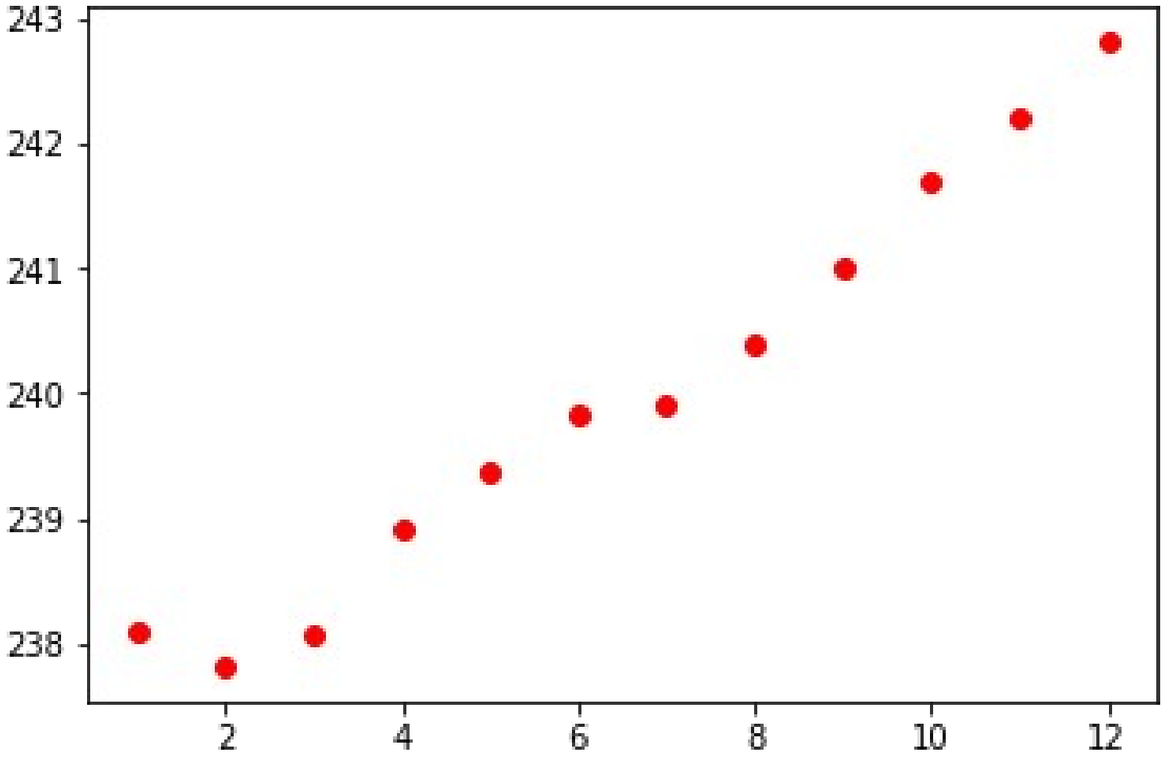
Plot result


Average Monthly Consumer Price Indexes
Consumer Price Indexes, $
270
260
250
240
230
220
210
2
4
6
8
10
12
Months

Scatterplots

```
import matplotlib.pyplot as plt
plt.scatter(x = months, y = prices, color = 'red')
plt.show()
```

Scatterplot result



Histograms

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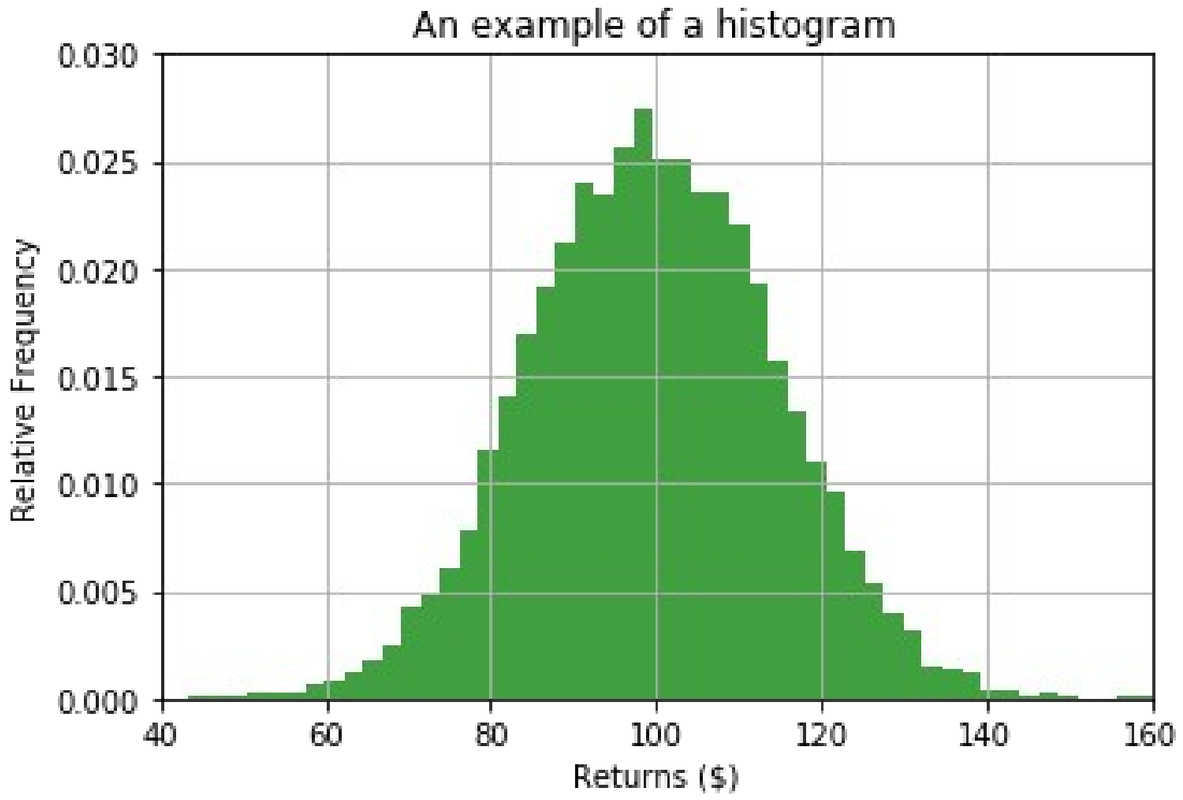
Why histograms for financial analysis?

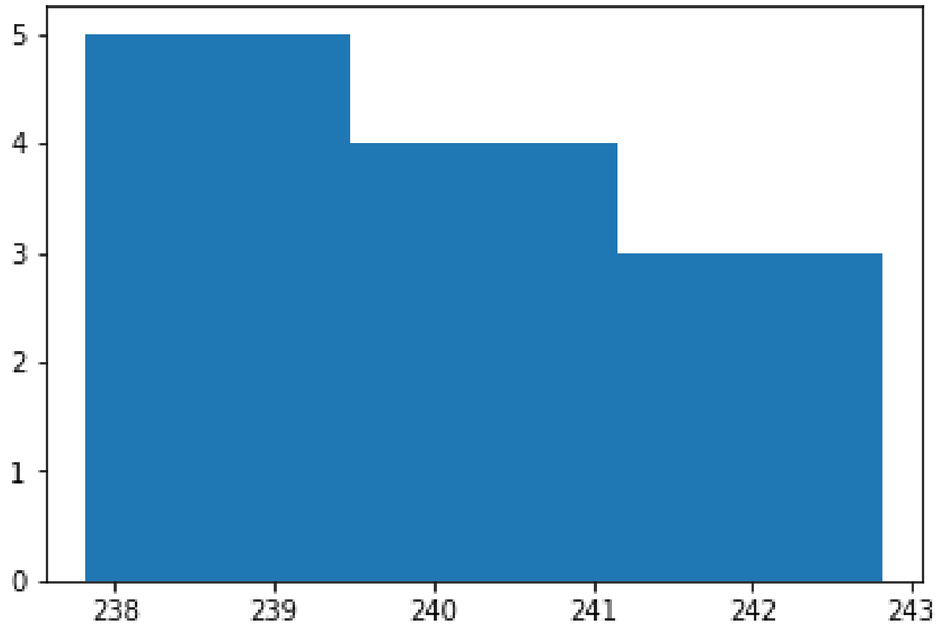


Histograms and Data

- Is your data skewed?
- Is your data centered around the average?
- Do you have any abnormal data points (outliers) in your data?

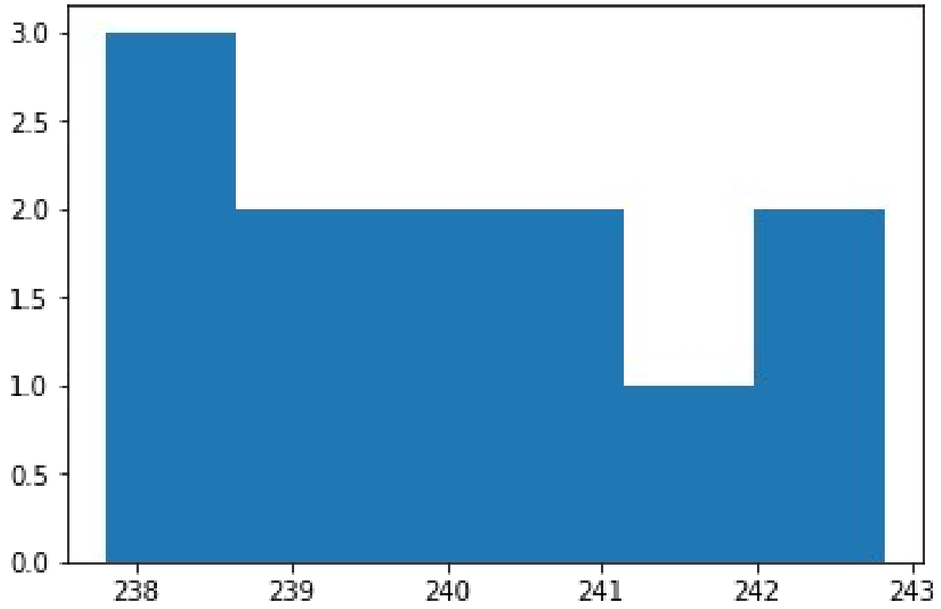
Histograms and matplotlib.pyplot

```
import matplotlib.pyplot as plt
plt.hist(x=prices, bins=3)
plt.show()
```



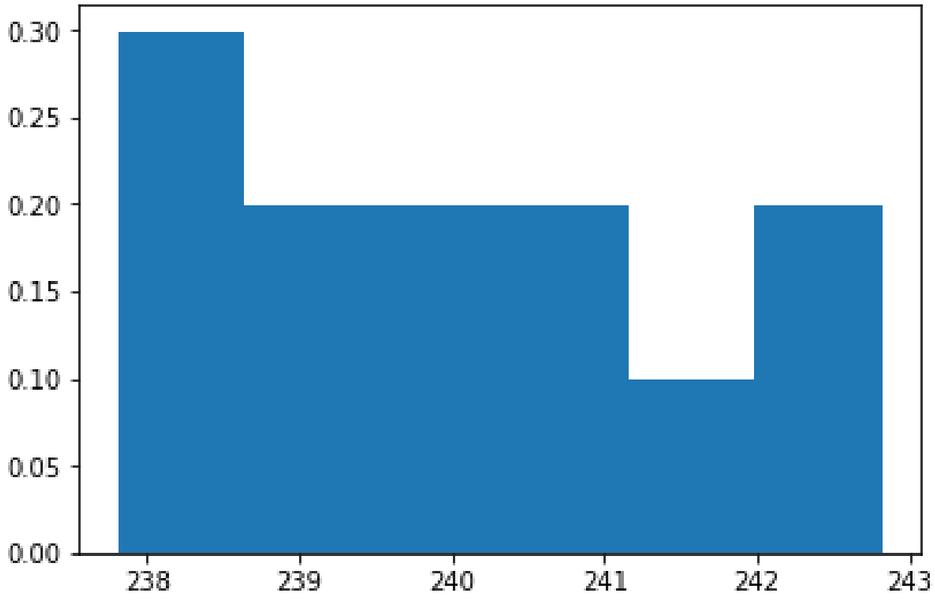
Changing the number of bins

```
import matplotlib.pyplot as plt
plt.hist(prices, bins=6)
plt.show()
```



Normalizing histogram data

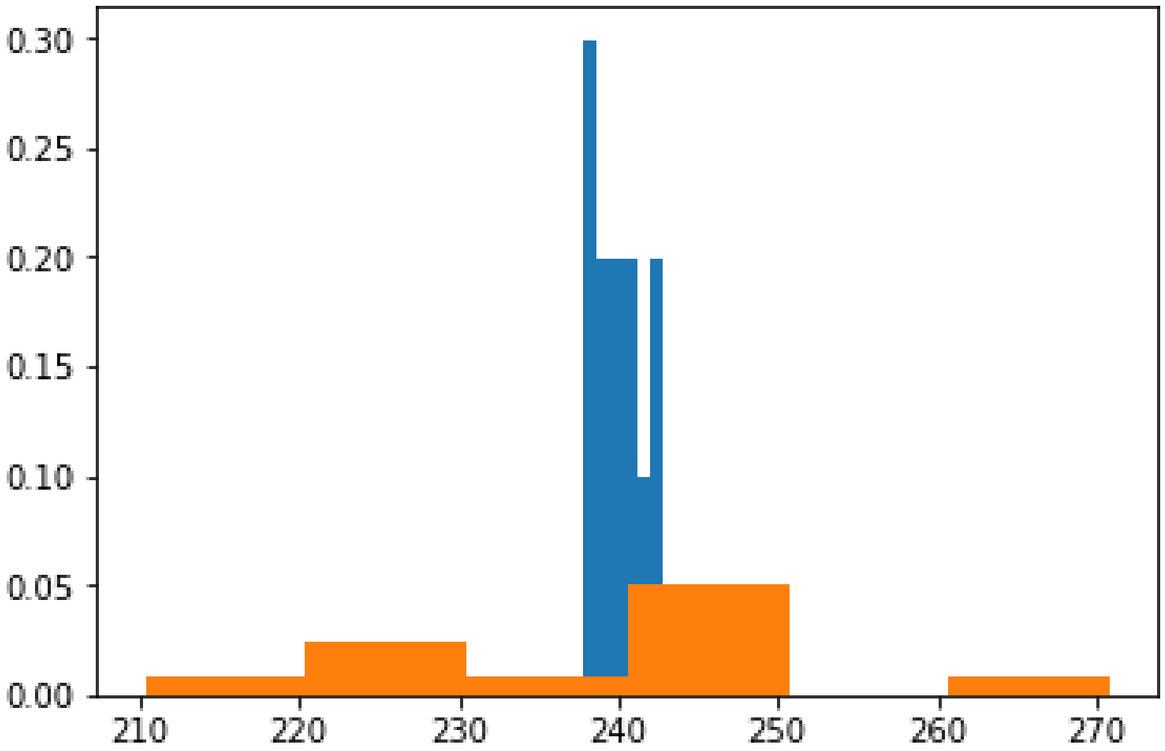
```
import matplotlib.pyplot as plt
plt.hist(prices, bins=6, normed=1)
plt.show()
```



Layering histograms on a plot

```
import matplotlib.pyplot as plt
plt.hist(x=prices, bins=6, normed=1)
plt.hist(x=prices_new, bins=6, normed=1)
plt.show()
```

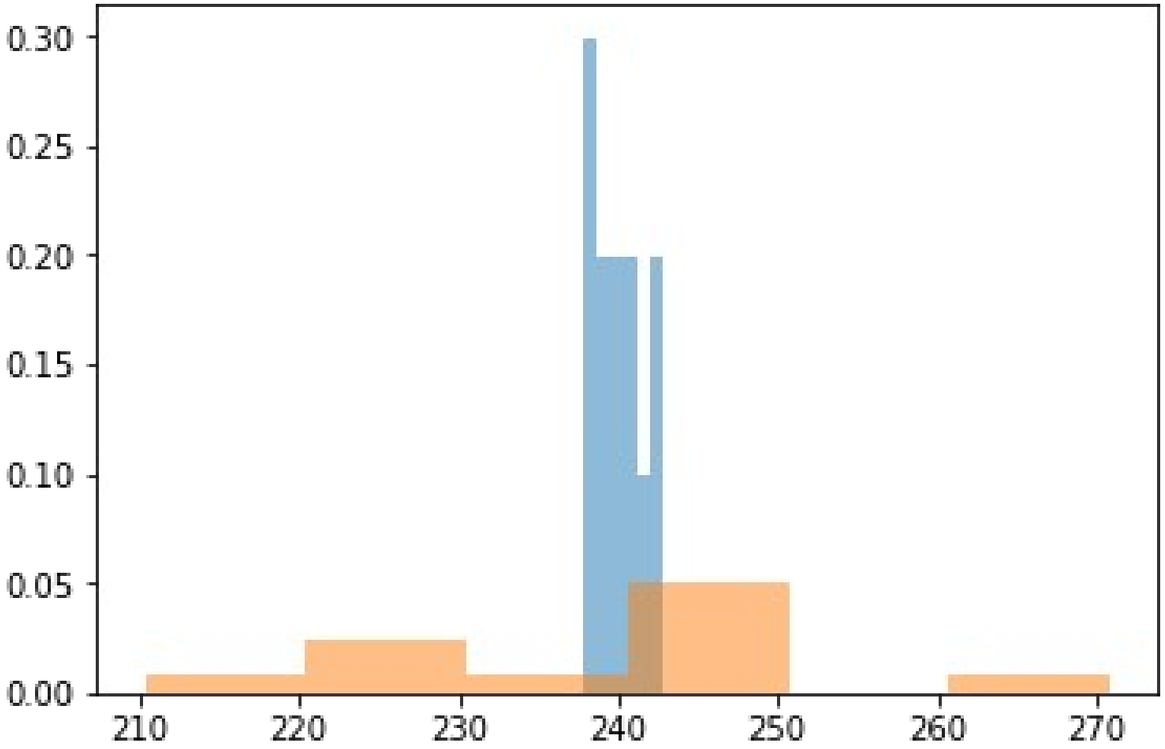
Histogram result



Alpha: Changing transparency of histograms

```
import matplotlib.pyplot as plt
plt.hist(x=prices, bins=6, normed=1, alpha=0.5)
plt.hist(x=prices_new, bins=6, normed=1, alpha=0.5)
plt.show()
```

Histogram result



Adding a legend

```
import matplotlib.pyplot as plt
plt.hist(x=prices, bins=6, normed=1, alpha=0.5, label="Prices 1")
plt.hist(x=prices_new, bins=6, normed=1, alpha=0.5, label="Prices New")
plt.legend()
plt.show()
```

Histogram result