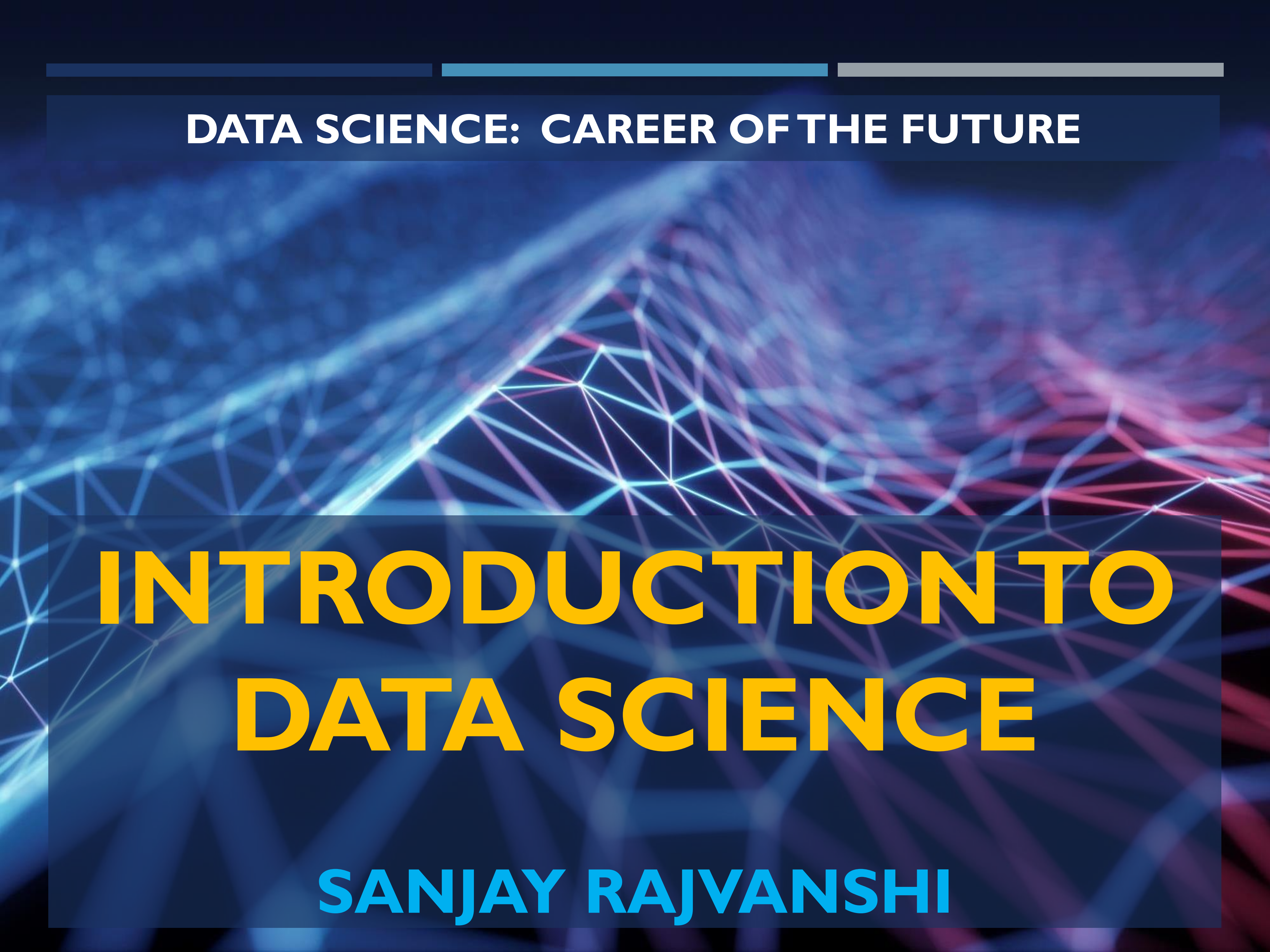
DATA SCIENCE: CAREER OF THE FUTURE

INTRODUCTION TO DATA SCIENCE

SANJAY RAJVANSHI



SCHEDULE

Session	Date	Time	Topic
1	Sep 25	7:00 pm – 8:00 pm	Introduction to data science and associated tools.
2	Oct 2	7:00 pm – 8:00 pm	Introduction to Python. Learn how to use Python for data analysis. Python is simple, yet powerful language that is often used in data science.
3	Oct 9	7:00 pm – 8:00 pm	Data wrangling with Python. Learn how to gather data and make it useful for analysis.
4	Oct 16	7:00 pm – 8:00 pm	Data visualization and analysis with Python. Learn how to create useful visualizations to aid in the analysis of the data.
5	Oct 23	7:00 pm – 8:00 pm	Brief introduction to artificial intelligence and machine learning. Get a peek into how to make data based predictions.

Note: All classes are on Wednesdays.

SESSION 1 – RECAP

- Data Science Background
- Environment Setup
- References
- Examples
- Exercises

SESSION 2: INTRODUCTION TO PYTHON

INTRODUCTION TO PYTHON

- Data Types
  - Numbers
  - Strings
  - Lists
- Variables, Assignments, Operations
- Control Flow Statements
  - **if** statement
  - **for** statement
  - **while** statement
  - Remember to indent
- Modules
  - import
- Comments
- Packages
  - pandas
  - numpy
  - pyplot
  - seaborn
  - mplot3d

DATA TYPES

- Numbers
  - int
    - 1, 5, 43, 100…..
  - Float
    - 1.0, 2.0, 4.5, 5.7, 50.9 …..
  - Other ones, FYI only for now
    - Decimal, Fraction, complex numbers
- Strings
  - Enclose in "like this " or 'like this'
  - "I live in N Potomac"
  - 'I live in N Potomac'

- Be careful of special characters like "\" as they have a special meaning
- Use **+** to concatenate two strings
- Index with 1st character as index 0
- Negative index starts from the right
- Slicing allows extracting substrings
- Can not be modified
- **len (*string*)** returns the string length

DATA TYPES

- Lists
  - [1, 5, 43, 100]
  - ['p', 'y', 't', 'h', 'o', 'n']
  - First position is referenced by 0, not 1
  - Indexing and slicing works like strings
  - Lists can be modified using indexing, slicing, **append ()**,
  - **len (**_list_**)** returns the list length
  - FYI only for now, lists can be nested

OPERATORS

- Arithmetic Operators
  - **+** : addition of numbers, concatenation of strings
  - **-** : subtraction
  - ***** : multiplication
  - **/** : division
  - **//** : Floor division (returns only integer result)
  - **%** : modulus (calculates remainder in division)
  - ****** : Exponentiation (to the power of)

- Comparison Operators
  - **==** : equal to
  - **<** : less than
  - **>** : greater than
  - **<=** : less than or equal to
  - **>=** : greater than or equal to
  - **!=** : not equal to

- Assignment Operators
  - **=** : assignment
  - **+=** : addition and assignment

OPERATORS, COMMENTS

- Assignment Operators (contd.)
  - **-=** : subtraction and assignment
  - ***=** : multiplication and assignment
  - **/=** : division and assignment
  - **%=**, **//=**, ****=** are some of the others
- Logical Operators
  - **and** : returns True if both sides are true
  - **or** : returns True if one of the sides is true
  - **not** : negates the results
- Other Operators
  - Identity
  - Membership
  - Bitwise
- Comments
  - Adding information to clarify code
  - Comments are not executed
  - Multiple ways to add comment

```
#This is one way to add a comment
x = 5 #This is second way
          #This is the third way
```

VARIABLES, ASSIGNMENTS, OPERATIONS

- x = 43
- y = 50.9
- z = x + y
- z += 5
- aString = "I live in N Potomac"
- bString = aString + ", MD "
- aString [0:5]
- **len** (aString)
- aString [-5:-1]
- aString [-7:]

- aList = [1, 5, 43, 100]
- anotherList = ['p', 'y', 't', 'h', 'o', 'n']
- **len** (anotherList)
- anotherList [0:3]
- anotherList [-4:]
- anotherList.append ('is great')

CONTROL FLOW

- **if** statement
  - Used for decision making
  - Example:

```
age = 43
if age < 18:
        canVote = 'No'
else:
        canVote = 'Yes'
print (canVote)
```

  - Multiple conditions? Use **elif**

- **for** statement
  - Used for going through a list or performing operation(s) in a loop for a defined number of steps
  - Example:

```
ageList = [5, 17, 18, 27, 43, 55]
for i in ageList:
        if i < 18:
                canVote = 'No'
        else:
                canVote = 'Yes'
        print (i, canVote)
```

CONTROL FLOW

- **while** statement
  - Used for performing operation(s) in a until a condition remains true
  - Example:

```
#Sums expenses for Jan-Mar
expenseList = [509.50, 1019.43, 1527.22]
i = 0
totalExpense = 0
while i < 3:
    totalExpense = totalExpense +
                   expenseList [i]
    i = i + 1
print (totalExpense)
```

- Few other things:
  - Indentation is important
  - **range** () function
  - Example:

```
ageList = [5, 17, 18, 27, 43, 55]
print (ageList [1])
ageList  [1] += 2
print (ageList [1])
ageList [1] = ageList [1] ** 2
print (ageList [1])
ageList.append (60)
print ( ageList)
```

PACKAGES/LIBRARIES

- Packages
  - Useful to build and add new capabilities to Python language
  - Also referred to as Libraries
  - Key relevant examples:
    - pandas
      - Example – IO tools (like read_csv)
    - numpy
      - Example – N-dimensional array
    - matplotlib, pyplot
      - Example – Bar graph
    - seaborn
      - Example – Scatter plot
    - mplot3d
      - Example – 3D graphs

INTRODUCTION TO PYTHON

Package	Description	Website
--	Official website for Python	https://www.python.org/
--	Another good Python reference	https://www.w3schools.com/python/default.asp
pandas	Open source library providing data structure and data analysis tools	https://pandas.pydata.org/
numpy	Fundamental package for scientific computing with Python	https://numpy.org/

EXERCISE-1: **IF** AND **FOR** STATEMENTS

- Create a Python file with name "S2-Ex1"
- Type and execute the following code:

```
ageList = [5, 11, 17, 18, 27, 43, 55, 65, 67]
for i in ageList:
        if i < 18:
                canVote = 'No'
        else:
                canVote = 'Yes'
        print (i, canVote)
```

- Now add more classification to this exercise
  - Count and print the number of children (0-12 years), teenagers (13-17 years), adults (18-59 years), and senior adults (60 years and above).

EXERCISE-2: IF AND FOR STATEMENTS

- Create a Python file with name "S2-Ex2"
- Now try another example where you are given score/marks 13 students got in class and you have to
  - assign a letter grade (A for 90-100, B for 70-89, C for 50-69, D for 30-49, E for 10-29, F for < 10)
  - compute the average of all the scores/marks
- Assume the following list of scores/marks is given to you:
  - marks = [7, 11, 29, 30, 50, 57, 69, 75, 88. 89, 90, 92, 97]

EXERCISE-3: WHILE STATEMENT

- Create a Python file with name "S2-Ex3"
- Type and execute the following code:

```
#Sums expenses for Jan-Mar
expenseList = [509.50, 1019.43, 1527.22]
i = 0
totalExpense = 0
while i < 3:
    totalExpense = totalExpense + expenseList [i]
    i = i + 1
print (totalExpense)
```

- Another exercise: Assume you are a soccer player who played 7 games in a championship. Add all the goals you have scored. Use **range** () and **len** () functions.

EXERCISE-4: BINARY SEARCH

- Create a Python file with name "S2-Ex4" to implement binary search algorithm.
- Binary search is used to search for an element in an array sorted in an increasing order.
- Type and execute the following code:

```
idList = (2, 5, 10, 17, 20, 29, 33, 49, 51)

searchForItem = 20 # Try different items

i = 0

j = len (idList) - 1

found = False

while i <= j:

    k = (i + j)//2
```

EXERCISE-4: BINARY SEARCH

```
    if idList [k] < searchForItem:
        i = k + 1
    elif idList [k] > searchForItem:
        j = k - 1
    else:
        found = True
        break
if (found == True):
    print ('Item found at position: ', k)
else:
    print ('Item not found')
```

EXERCISE-5: CREATE A SIMPLE BAR GRAPH

- Create a Python file with name "S2-Ex5"
- This is a sample from pyplot library
- Type and execute the following code:

```
y = (17, 20, 15, 17, 15)
x = ('Class 1', 'Class 2', 'Class 3', 'Class 4', 'Class 5')
plt.xlabel ('Class')
plt.ylabel ('Attendance')
plt.title ('Class Attendance')
plt.bar (x, y)
```

- Share your observations. Any thoughts on why you got an error?

EXERCISE-5: CREATE A SIMPLE BAR GRAPH

- We also need to add the libraries to be able to use the plot capabilities to fix the error.
- Create a new cell before the cell in which you entered the code on previous slide.
- Now insert the following code in that new cell:

```
import matplotlib

import matplotlib.pyplot as plt

import numpy as np
```

- Now execute the code in both the cells in sequence
- You should be able to see the bar graph now (you may have to click on "Run" more than once to see the graph – please contact the instructor if the graph doesn't show after repeated clicks on "Run").

SESSION 2 – RECAP

- Data Types
- Control Flow Statements
- Packages/Libraries
- Introduced Plots
- Exercises (reach out to the library or the instructor for solution to the exercises if needed)

SESSION 2 – HOME WORK

- Do more Python programming practice relating to this session.
  - Refer to the following websites:
    - https://docs.python.org/3/tutorial
    - https://www.w3schools.com/python/
  - Experiment with different data types.
  - Experiment with all the control flow statements.
  - Experiment with additional items you find in the above tutorials.
  - Write a program to implement Bubble sort.
  - Now try the binary search we implemented earlier on the data you sorted using Bubble sort.

SESSION 3 – AGENDA

- Data wrangling with Python. Learn how to gather data and make it useful for analysis.
- Learn how to use Python for data analysis. We will start to learn how to make the data suitable for the problem, clean/convert/transform it – sometimes referred to as data wrangling or data munging.
- Specifically we will focus on DataFrames, large amount of data, and how to analyze that.

SESSION 3 – PRE-WORK

- Familiarize with pandas library (https://pandas/pydata.org)
- It provides two primary data structures:
  - Series (1-dimensional)
  - DataFrame (2-dimensional)
- Review and try examples/code from the following:
  - Intro to data structures (https://pandas.pydata.org/pandas-docs/stable/getting_started/dsintro.html)
  - 10 minutes to pandas (https://pandas.pydata.org/pandas-docs/stable/getting_started/10min.html)
  - Try Cookbook on pandas website (https://pandas.pydata.org/pandas-docs/stable/user_guide/cookbook.html#cookbook)

SESSION 3 – PRE-WORK

- Make a copy of S1-Ex2 to see some of the capabilities of DataFrames. Name the new file S3-Ex1.
- Also, make a new copy of the data file and name it "S3-Ex1-US-Presidents.csv" – change the first heading from "No." to "Number" and save the data file.
- Now modify the S3-Ex1 to read from the new data file "S3-Ex1-US-Presidents.csv".
- Execute all of the code in S3-Ex1.
- Now add the following lines, each line in a new cell. Execute each cell.

```
listOfPresDf.columns

listOfPresDf.count ()

listOfPresDf ['Name']

listOfPresDf ['State'] = "
```

SESSION 3 – PRE-WORK

```
listOfPresDf

listOfPresDf.dtypes

listOfPresDf = listOfPresDf.append ({'Number': 11, 'Name': 'James K. Polk', 'Term': '1845-1850', 'State': ''}, ignore_index = True)

listOfPresDf.loc [listOfPresDf.Number == 11, 'Term'] = '1845-1849'

listOfPresDf.head (20)

listOfPresDf.drop (columns = ['State'])

listOfPresDf.head (20)
```

SESSION 3 – PRE-WORK

- Explore large data sets and pick one per your interest:
  - Montgomery County, MD data sets – https://data.montgomerycountymd.gov/
    - Download *Montgomery College Enrollment Data* from https://data.montgomerycountymd.gov/Education/Montgomery-College-Enrollment-Data/wmr2-6hn6
  - US Govt. open data sets – https://www.data.gov/
  - Non Govt. website with lots of data sets – https://www.kaggle.com/
  - **Pay attention to the licensing terms before downloading**
  - You may contact the library or the instructor for any help in identifying data set(s) you might be looking for or for any other questions related to the data set(s).

REFERENCES

Note: you are not required to sign-up for an account on any of the sites to read these articles.

1. *Official website for Python and tutorials* – https://www.python.org/
2. *Another good Python reference and tutorials* – https://www.w3schools.com/python/default.asp
3. *pandas (Open source library providing data structure and data analysis tools)* – https://pandas.pydata.org/
4. *numpy (Fundamental package for scientific computing with Python)* – https://numpy.org/