Kia Cooperative Systems
Summer High School Outreach
Module 1

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2021
Python Programming ("Hello World")

Introduction to Python (KCS LAB)

We will be just going through some basics of Python Programming

```
print('Hello World')
```

Hello World

Press Ctrl+Enter or Just use the play button in the cell above

DATA TYPES

1. Numbers - Integers, floats
2. Strings
3. Booleans

```
x = 4
print(x, type(x))
# Replace 4, with x = 4.00, x = 'Summer', x = True to check the data types
```

4 <class 'int'>

Go to this link for above description: https://colab.research.google.com/drive/1BLfoWaeBpJTPb2w_0ahmMewdmTtrJ-f?usp=sharing
Tutorial about using python in Google-colab
- https://www.youtube.com/watch?v=i-HnvsehuSw&ab_channel=ProgrammingKnowledge
Python Programming: Basics (links)

Data type
https://youtu.be/gCCVsvgR2KU

Arrays and matrices
https://www.youtube.com/watch?v=biLz7KPqHJA&ab_channel=TechWithTim (Arrays)
https://www.youtube.com/watch?v=Blzp9iuhZgo&ab_channel=Telusko (Matrix in python using numpy)
https://www.youtube.com/watch?v=phRshQSU-xA

For loop
https://youtu.be/0ZvaDa8eT5s

While loop
https://youtu.be/HZARImviDxg

If condition
https://youtu.be/PqFKRqpHrjw

Plotting (using Matplotlib)
https://www.youtube.com/watch?v=wB9C0Mz9gSo&ab_channel=DerekBanas
https://deparkes.co.uk/2015/03/11/how-to-plot-polygons-in-python/ (plotting, polygons and filled polygons using Shapely)

Python (Full Tutorial)
https://www.youtube.com/watch?v=rfscVS0vtbw&ab_channel=freeCodeCamp.org
https://www.youtube.com/watch?v=YYXdT2L-Gg&list=PL-osiE80TeTl2d9bfVyTiXJA-UTHn6WwU&ab_channel=CoreySchafer
https://www.youtube.com/watch?v=8ext9G7xspg&ab_channel=freeCodeCamp.org
How to represent my problem in the best way possible in Python

Assignment 1, Problem no 1

Write a program to sort the list of distances stored in an array in descending order?

Example: Input: distances = [9, 6, 7, 1, 4, 5, 8]  
Output: distances = [9, 7, 8, 6, 5, 4, 1]

How to write a program for the robot to choose the shortest path?

### KCS LAB  
## finding the shortest path in the array

```python
import numpy as np

paths = np.array([5, 6, 4.5, 7])

# initializing the first item to be the minimum
min = paths[0]

# for loop to run through every elements in the list
for i in range(len(paths)):
    # comparing minimum values with the elements in the list
    if min >= paths[i]:
        # update the minimum value
        min = paths[i]

print('The shortest path is:', min)
```

Output: The shortest path is: 4.5

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You can also find the code here:
https://colab.research.google.com/drive/1BL5vWaeBcjUTPb2w_0ahmMewdm7rkj?usp=sharing
Python Programming (Numpy libraries and Array)

**Numpy:**
Numpy is the core library for scientific computing in Python

-> import numpy as np

**Array:** Represents a data structure where number are arranged in rows and column

**Matrix** is a two dimensional array. Example:

```
import numpy as np

a = np.array([1, 2, 3])  # Creating an array, rank 1
print(type(a),a[0],a[1],a[2])  # Printing type and elements of array
a[0] = 5  # You can change element in an array
print(a)
```

Output
```
<class 'numpy.ndarray'> 1 2 3
[5 2 3]
```

**Tutorial on Numpy, Array and Matrices**
- [https://www.programiz.com/python-programming/matrix](https://www.programiz.com/python-programming/matrix) (Good Blog about matrices and array using numpy and Python)
- [https://youtu.be/GB9ByFA1AH4?list=PLZHQObOWTQDPD3MizzM2xVFitgF8hE_ab&ab_channel=3Blue1Brown](https://youtu.be/GB9ByFA1AH4?list=PLZHQObOWTQDPD3MizzM2xVFitgF8hE_ab&ab_channel=3Blue1Brown) (Complete Tutorial on Numpy)

**Additional links (Essence of Linear Algebra)**
- [https://www.youtube.com/watch?v=fNk_zzaMoSs&list=PLZHQQbOWTQDPD3MizzM2xVFitgF8hE_ab&ab_channel=3Blue1Brown](https://www.youtube.com/watch?v=fNk_zzaMoSs&list=PLZHQQbOWTQDPD3MizzM2xVFitgF8hE_ab&ab_channel=3Blue1Brown)
How to represent my problem in the best way possible in Python

**Problem 1:** create and store the map of obstacles for a robot operation

Obstacles can be approximated by tightest enclosing polygons
O1~ v1: (5.5,15), v2: (9.2,15), v3: (9.2,11.5), v4: (5.5,11.5)

What is the best way to enter this data to a computer program?

We have multiple obstacles. How can we handle multiple obstacles so we can work more efficiently?

Figure: A map depicting different obstacles
# plotting lines between two vertices and creating a polygon

```python
import numpy as np
import matplotlib.pyplot as plt

## the vertices for the obstacles
# O1~ v1: (5.5,15), v2: (9.2,15), v3:(9.2,11.5), v4: (5.5,11.5)
# O1~ v1: (1,5), v2: (1,8), v3:(3,8), v4: (3,5)

plt.figure(1, figsize=(10,10), dpi=80)
vertices = np.array([
    [(5.5,15.0),(9.2,15.0),(9.2,11.5),(5.5,11.5)],
    [(1,5),(1,8),(3,8),(3,5)]
])

# using for loop to go through every polygons
for i in range(len(vertices)):
    # looping every vertices in the polygon
    for j in range(len(vertices[i])):
        if j+1 < len(vertices[i]):
            # separating the x and y coordinates of two vertices
            x_cord = np.array([vertices[i][j][0],vertices[i][j+1][0]])
            y_cord = np.array([vertices[i][j][1],vertices[i][j+1][1]])
            # plotting the line segment between two vertices
            plt.plot(x_cord,y_cord,color='blue')
        elif j+1 == len(vertices[i]):
            x_cord = np.array([vertices[i][j][0],vertices[i][0][0]])
            y_cord = np.array([vertices[i][j][1],vertices[i][0][1]])
            plt.plot(x_cord,y_cord,color='blue')

# Represents the boundary of x and y coordinate
plt.xlim([0, 20]); plt.ylim([0, 20])
plt.ylabel('Y-AXIS'); plt.xlabel('X-AXIS')
plt.title('Plotting Polygons')
plt.show()
```

Assignment 1, Problem 2:

Write a code to visualize these obstacles from the above picture, details on previous slide using python matplotlib library?

You can also find the code here:
https://colab.research.google.com/drive/1BLfoWaeBplJTPb2w_0ahmMewSmTrI-Tj7usp?usp=sharing
Matplotlib.pyplot is a collection of function that makes matplotlib work like MATLAB.

```python
import matplotlib.pyplot as plt  ## importing the libraries
x = [1,2,3]
y = [1,2,3]
plt.plot(x,y)  ## plotting the coordinates
plt.ylabel('y-axis')
plt.xlabel('x-axis')
plt.show()
```

Another alternative for Drawing Polygons in python

```python
import matplotlib.pyplot as plt  ## importing matlab pyplot lib
from shapely.geometry import Polygon
import LinearRing, Polygon, Point

fig = plt.figure(1, figsize=(10,10), dpi=50)

# Defining vertices of a polygon
poly1 = Polygon(((0, 5), (4,3),(6,3),(6,5)))  # this is a square
poly2= Polygon(((0,10), (2,8),(4,7),(4,11)))  # this is the trapezoid
poly3 = Polygon(((0,9),(11,9),(10,12)))  # triangles

plt.plot(*poly1.exterior.xy,*poly2.exterior.xy,*poly3.exterior.xy)
plt.title("Plotting polygons")
plt.show()
```