Hacettepe University

Computer Engineering Department

Programming in  python

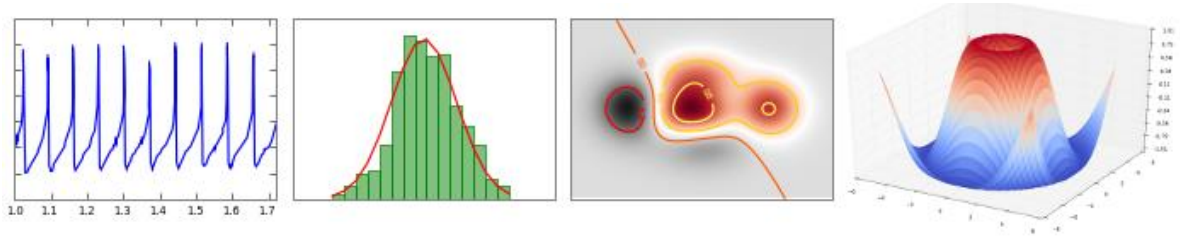
BBM103 Introduction to Programming Lab 1

Week 8

Fall 2019

2D Data Plotting in Python: matplotlib

- **matplotlib** is a Python 2D plotting library
- You can generate plots, histograms, power spectra, bar charts, errorcharts, scatterplots, etc.



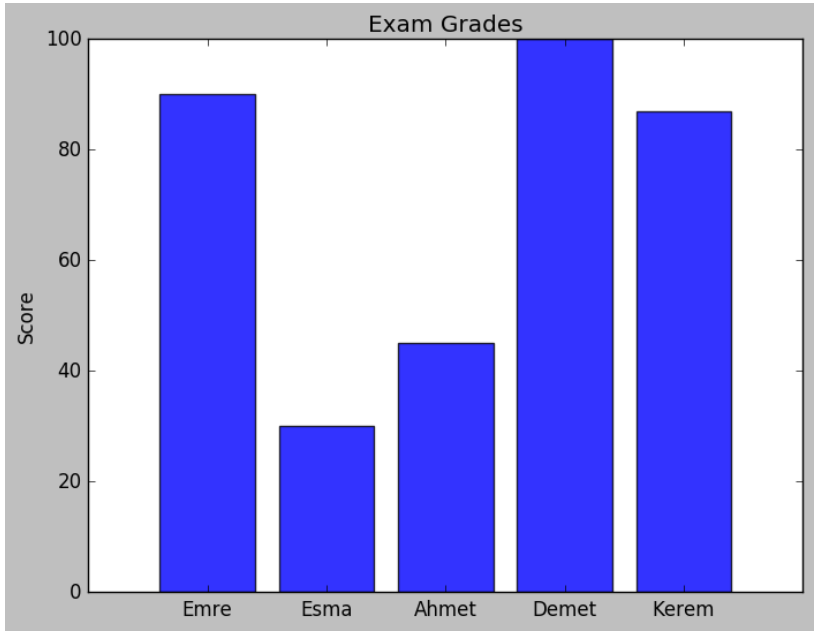
- Installing matplotlib: http://matplotlib.org/users/installing.html
- matplotlib in PyCharm: https://www.jetbrains.com/help/pycharm/2016.1/matplotlib-support.html
- Or use Anaconda that provides numerous built-in Python packages including matplotlib: https://www.continuum.io/downloads

Vertical Bar Chart Plotting

- **Example:**

```
1 import matplotlib.pyplot as plot
2
3 students = ['Emre', 'Esma', 'Ahmet', 'Demet', 'Kerem']
4 grades = [90,30,45,100,87]
5 x_pos = [x for x in range(len(students))]
6
7 plot.bar(x_pos, grades, align='center', color='b', alpha=0.8)
8 plot.xticks(x_pos, students)
9 plot.ylabel('Score')
10 plot.title('Exam Grades')
11
12 plot.show()
```

- **Output:**

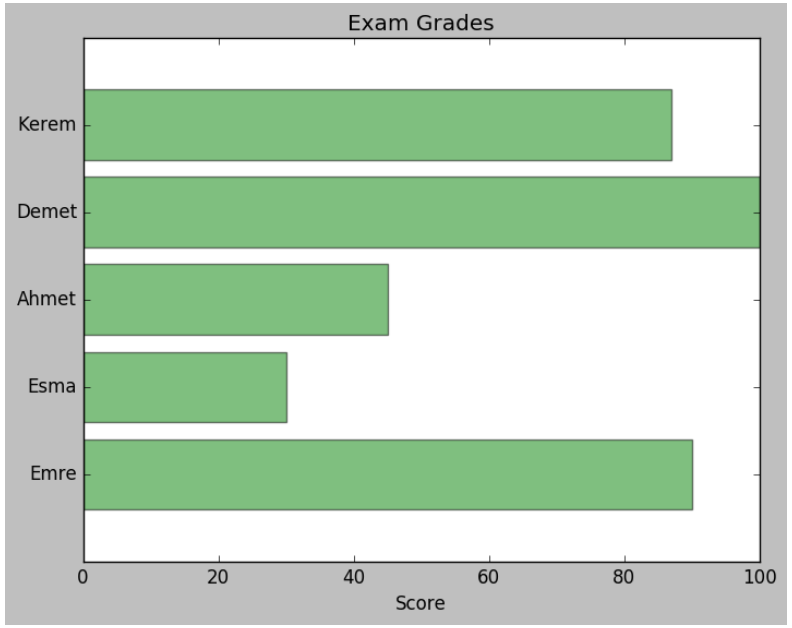


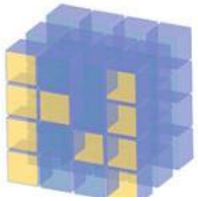
Horizontal Bar Chart Plotting

- **Example:**

```
1 import matplotlib.pyplot as plot
2
3 students = ['Emre', 'Esma', 'Ahmet', 'Demet', 'Kerem']
4 grades = [90,30,45,100,87]
5 y_pos = [x for x in range(len(students))]
6
7 plot.barh(y_pos, grades, align='center', color='g', alpha=0.5)
8 plot.yticks(y_pos, students)
9 plot.xlabel('Score')
10 plot.title('Exam Grades')
11
12 plot.show()
```

- **Output:**





NumPy - scientific computing with Python

- **NumPy** (http://www.numpy.org) is the fundamental package for scientific computing with Python. It supports among other things:
  - a powerful N-dimensional array object,
  - sophisticated (broadcasting) functions,
  - useful linear algebra, Fourier transform, and random number capabilities,
  - efficient multi-dimensional container of generic data,
  - arbitrary data-types.

- Installing Packages in PyCharm (search for numpy): https://www.jetbrains.com/help/pycharm/2016.1/installing-uninstalling-and-upgrading-packages.html

- Or use Anaconda that provides numerous built-in Python packages including NumPy: https://www.continuum.io/downloads

A simple plot with a custom dashed line

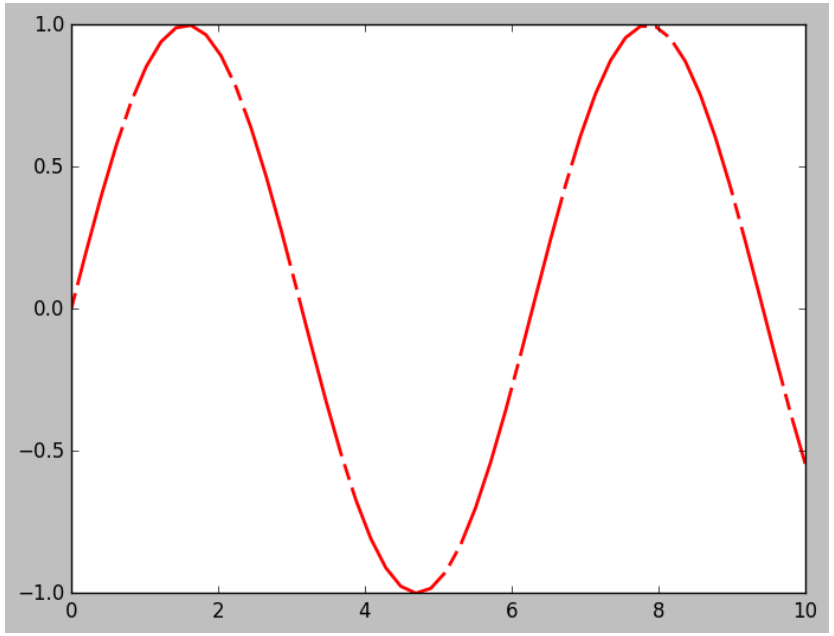
- **Example:**

```
1 import matplotlib.pyplot as plt
2 import numpy as np
3
4 x = np.linspace(0, 10)
5
6 line, = plt.plot(x, np.sin(x), '--', linewidth=2, color="r")
7
8 dashes = [10, 5, 100, 5]  # 10 points on, 5 off, 100 on, 5 off
9 line.set_dashes(dashes)
10
11 plt.show()
```

New function: `numpy.linspace(start, stop)`

Returns evenly spaced numbers over a specified interval [*start*, *stop*].

- **Output:**



A simple plot of fill function

- **Example:**

```
1 import numpy as np
2 import matplotlib.pyplot as plt
3
4 x = np.linspace(0, 1)
5 y = np.sin(4 * np.pi * x) * np.exp(-5 * x)
6
7 plt.fill(x, y, 'y')
8 plt.grid(True)
9 plt.show()
```

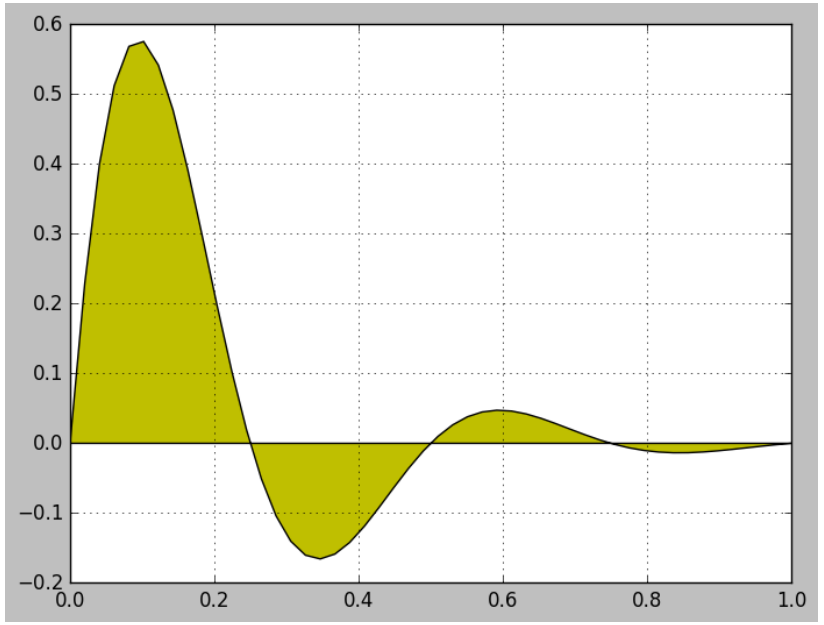
New functions:

`numpy.sin()` – Trigonometric sine, element-wise

`numpy.exp()` – Calculate the exponential of all elements in the input array

`numpy.pi()` – π mathematical constant

- **Output:**



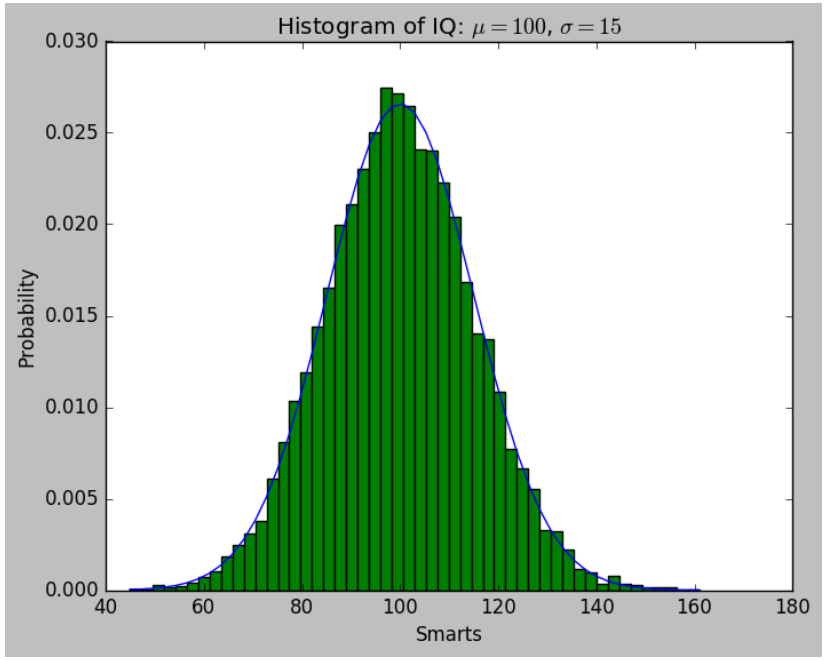
Histogram Plotting

A *histogram* is a graphical representation of the distribution of numerical data.

- **Example:**

```
1 import numpy as np
2 import matplotlib.mlab as mlab
3 import matplotlib.pyplot as plt
4
5 mu = 100  # mean of distribution
6 sigma = 15  # standard deviation of distribution
7 x = mu + sigma * np.random.randn(10000)
8
9 num_bins = 50
10 # the histogram of the data
11 n, bins, patches = plt.hist(x, num_bins, normed=1, facecolor='green')
12 # add a 'best fit' line
13 y = mlab.normpdf(bins, mu, sigma)
14 plt.plot(bins, y, 'b-')
15 plt.xlabel('Smarts')
16 plt.ylabel('Probability')
17 plt.title(r'Histogram of IQ: $\mu=100$, $\sigma=15$')
18
19 # Tweak spacing to prevent clipping of ylabel
20 plt.subplots_adjust(left=0.15)
21 plt.show()
```

- **Output:**



New function:
`numpy.random.randn(dimension)`

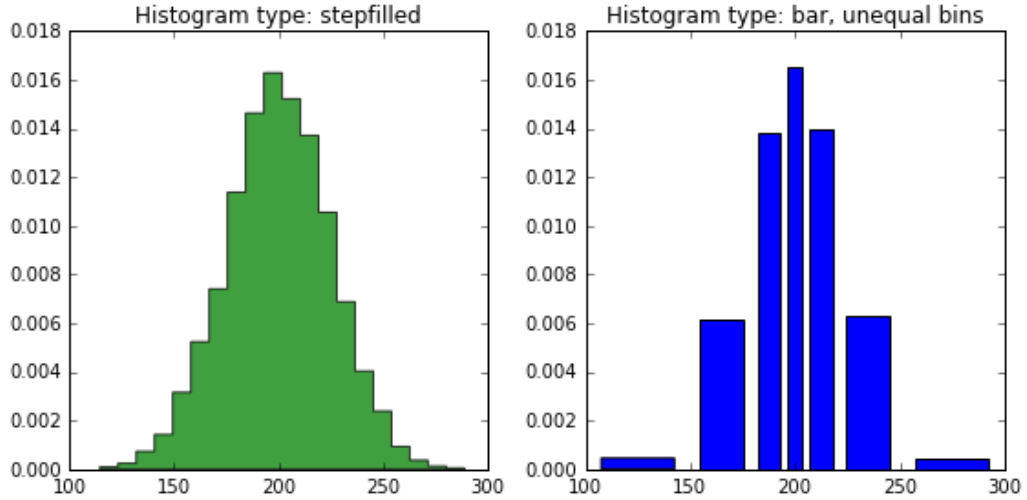
Returns a sample (or samples) from the "standard normal" distribution

Histogram Plotting Continued (Subplots)

- **Example:**

```
1 import numpy as np
2 import matplotlib.pyplot as plt
3
4 mu = 200
5 sigma = 25
6 x = mu + sigma*np.random.randn(10000)
7 print(x)
8 fig, (ax0, ax1) = plt.subplots(ncols=2, figsize=(8, 4))
9
10 ax0.hist(x, 20, normed=1, histtype='stepfilled', facecolor='g', alpha=0.75)
11 ax0.set_title('Histogram type: stepfilled')
12
13 #Create a histogram by providing the bin edges (unequally spaced).
14 bins = [100, 150, 180, 195, 205, 220, 250, 300]
15 ax1.hist(x, bins, normed=1, histtype='bar', rwidth=0.7)
16 ax1.set_title('Histogram type: bar, unequal bins')
17
18 plt.tight_layout()
19 plt.show()
```

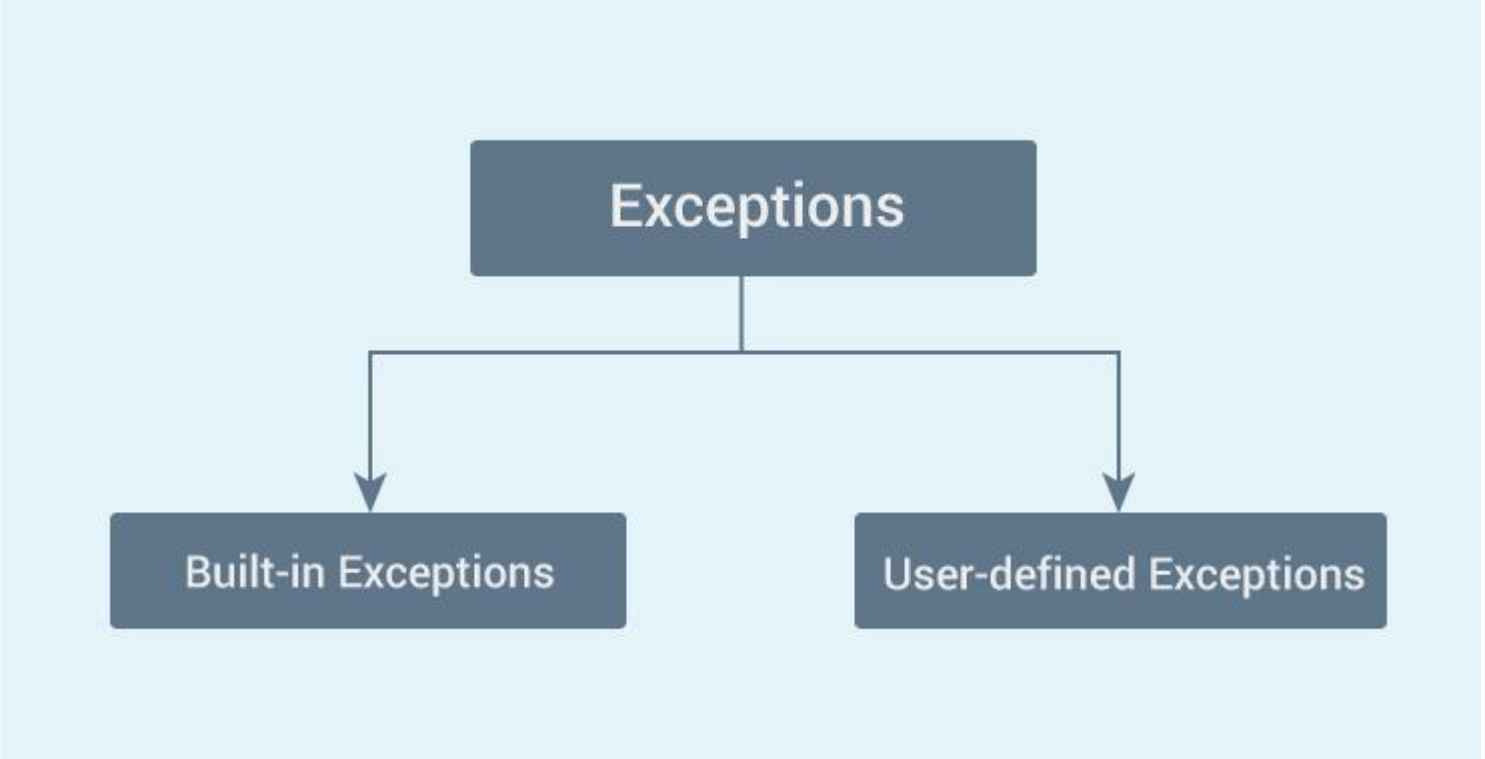
- **Output:**



2D Plotting and Scientific Computing in Python

- **For more matplotlib examples:** http://matplotlib.org/examples/index.html
- **Plotting Commands Summary:** http://matplotlib.org/api/pyplot_summary.html
- **NumPy Manual:** https://docs.scipy.org/doc/numpy/index.html

Exceptions



Built-in Exceptions

The simplest way to handle exceptions is with a "try-except" block:

Example 1:

```
(x,y) = (5,0)
try:
    z = x/y
except ZeroDivisionError:
    print ("divide by zero")
```

```
Output: divide by zero
```

Example 2: except ValueError:

```
first_number = input("First number: ")
second_number = input("Second number: ")
try:
    number1 = int(first_number)
    number2 = int(second_number)
    print(number1, "/", number2, "=", number1 / number2)
except ValueError:
    print("Error! Please enter number!")
```

Example 3: except ZeroDivisionError:

```
first_number = input("First number: ")
second_number = input("Second number: ")
try:
    number1 = int(first_number)
    number2 = int(second_number)
    print(number1, "/", number2, "=", number1 / number2)
except ValueError:
    print("Error! Please enter number!")
except ZeroDivisionError:
    print("You can't divide a number to 0!")
```

Example 4: except (ValueError, ZeroDivisionError)

```
first_number = input("First number: ")
second_number = input("Second number: ")
try:
    number1 = int(first_number)
    number2 = int(second_number)
    print(number1, "/", number2, "=", number1 / number2)
except (ValueError,ZeroDivisionError):
    print("Error!")
```

Example 5: try... except... as...

```
first_number = input("First number: ")
second_number = input("Second number: ")
try:
    number1 = int(first_number)
    number2 = int(second_number)
    print(number1, "/", number2, "=", number1 / number2)
except (ValueError,ZeroDivisionError) as error:
    print("Error!")
    print("Original error message: ", error)
```

Example 6: try... except... else...

```
for arg in sys.argv[1:]:
    try:
        f = open(arg, 'r')
    except IOError:
        print('cannot open', arg)
    else:
        print(arg, 'has', len(f.readlines()), 'lines')
        f.close()
```

Example 7: try... except... finally...

```
try:
    file = open("dosyaadı", "r")
except IOError:
    print("error!")
finally:
    file.close()
```

Some Examples using Exceptions

```
except IOError:
        print('An error occured trying to read the file.')

except ValueError:
        print('Non-numeric data found in the file.')

 except ImportError:
        print ("NO module found«)

except EOFError:
        print('Why did you do an EOF on me?')

except KeyboardInterrupt:
         print('You cancelled the operation.')

except:
        print('An error occured.')
```

raise

Example 8:

```
tr_character = "şçğüöıİ"

password = input("Enter your password: ")

for i in password:
    if i in tr_character:
        raise TypeError("Yo can't use Turkish characters in password!")
    else:
        pass

print("Password is excepted!")
```

Example 9:

```
try:
    while True:
        if int(input('Guess a number: ')) == 5
            raise ZeroDivisionError
except ZeroDivisionError:
    print ('You got it!')
```

Example 10:

```
import sys

try:
    f = open('myfile.txt')
    s = f.readline()
    i = int(s.strip())
except OSError as err:
    print("OS error: {0}".format(err))
except ValueError:
    print("Could not convert data to an integer.")
except:
    print("Unexpected error:", sys.exc_info()[0])
    raise
```

User-Defined Exceptions

Example 11:

```
class MyException(Exception):
    def __init__(self, t=0):
        self.numtries = t
try:
    for tries in range(1, 6):
        if int(input('Guess a number: ')) == 5:
            raise MyException(tries)
except MyException as e:
    print ('You got it in only %d tries!'  % e.numtries)
else:
    print ('Too bad, you ran out of tries!')
```

Example 12 user-defined exceptions

```
class Error(Exception):
    """Base class for other exceptions"""
    pass

class ValueTooSmallError(Error):
    """Raised when the input value is too small"""
    pass

class ValueTooLargeError(Error):
    """Raised when the input value is too large"""
    pass

# our main program
# user guesses a number until he/she gets it right

# you need to guess this number
number = 10
```

This example continues in the next slide ⟶

Example 12 continued

```
while True:
    try:
        i_num = int(input("Enter a number: "))
        if i_num < number:
            raise ValueTooSmallError
        elif i_num > number:
            raise ValueTooLargeError
        break
    except ValueTooSmallError:
        print("This value is too small, try again!")
        print()
    except ValueTooLargeError:
        print("This value is too large, try again!")
        print()

print("Congratulations! You guessed it correctly.")
```

Assert

```
assert <some_test>, <message>
```

Example 13:

```
def test_set_comparison():
    set1 = set("1308")
    set2 = set("8035")
    assert set1 == set2

test_set_comparison()
```

Output:

```
C:\Users\necva\Desktop>py deneme.py
Traceback (most recent call last):
  File "deneme.py", line 8, in <module>
    test_set_comparison()
  File "deneme.py", line 4, in test_set_comparison
    assert set1 == set2
AssertionError
```

Example 14:

```
array = [0,1, 2, 3, 4, 5, 6, 7, 8, 9]

def number(input):
        assert (input in array)


number(10)
number(5)
```

Output:

```
C:\Users\necva\Desktop>py deneme.py
Traceback (most recent call last):
  File "deneme.py", line 7, in <module>
    number(10)
  File "deneme.py", line 4, in number
    assert (input in array)
AssertionError
```

Example 15:

```
def func (a,b):
    max= 0
    if a < b: max= b
    if b < a: max= a
    print(max)
    assert (max == a or max == b) and max >= a and max >= b

func(10,15)
```

Output:

```
C:\Users\necva\Desktop>py deneme.py
15
```