Introduction to Machine Learning

With Python

Python

In [1]:
```
number = 7
print(number * 2)

name = 'Ali'
print(f'my name is {name}')

friends = ['Reza', 'Mohammad']
friends.append(name)
print(friends)

name_ages = {}
name_ages['Elham'] = 17
name_ages.update({'Masoud': 9})
print(name_ages)
```

```
14
my name is Ali
['Reza', 'Mohammad', 'Ali']
{'Elham': 17, 'Masoud': 9}
```

In [2]:
```
age = int(input('Enter your age: '))
if age >= 18 and age <= 65:
    print(f'You are {age} years old and you must work.')
elif age < 18:
    print('You are too young to work.')
else:
    print('XD')
```

```
Enter your age: 37
You are 37 years old and you must work.
```

In [3]:
```
limit = 5
i = 0
while i < limit:
    print(i ** 2)
    i += 1
```

```
0
1
4
9
16
```

In [4]:
```
for i in range(10, 20, 2):
    if i % 6 == 0:
        continue
    print(i)
```

```
10
14
16
```

In [5]:
```
def list_avg(array):
    return sum(array) / len(array)

primes = [2, 3, 5, 7]
print(list_avg(primes))
```

```
4.25
```

Python is slow, use NumPy

In [10]:
```
import time

start = time.time()
numbers = [i for i in range(1, 9_000_000)]
print(f'The average of numbers between one to 9M is: {list_avg(number
s): .4f}')
finish = time.time()

print(f'The operation took {finish - start:.5f} to complete.')
```

```
The average of numbers between one to 9M is:  4500000.0000
The operation took 1.07883 to complete.
```

In [ ]:
```
! pip install numpy
```

```
Collecting numpy
  WARNING: Retrying (Retry(total=4, connect=None, read=None, redirect
=None, status=None)) after connection broken by 'NewConnectionError
('<pip._vendor.urllib3.connection.VerifiedHTTPSConnection object at 0
x7f4e5272b4e0>: Failed to establish a new connection: [Errno 101] Net
work is unreachable')': /packages/6d/ad/ff3b21ebfe79a4d25b4a4f8e5cf9f
d44a204adb6b33c09010f566f51027a/numpy-1.21.6-cp37-cp37m-manylinux_2_1
2_x86_64.manylinux2010_x86_64.whl
  WARNING: Retrying (Retry(total=3, connect=None, read=None, redirect
=None, status=None)) after connection broken by 'NewConnectionError
('<pip._vendor.urllib3.connection.VerifiedHTTPSConnection object at 0
x7f4e5272b3c8>: Failed to establish a new connection: [Errno 101] Net
work is unreachable')': /packages/6d/ad/ff3b21ebfe79a4d25b4a4f8e5cf9f
d44a204adb6b33c09010f566f51027a/numpy-1.21.6-cp37-cp37m-manylinux_2_1
2_x86_64.manylinux2010_x86_64.whl
  Downloading https://files.pythonhosted.org/packages/6d/ad/ff3b21ebf
e79a4d25b4a4f8e5cf9fd44a204adb6b33c09010f566f51027a/numpy-1.21.6-cp37
-cp37m-manylinux_2_12_x86_64.manylinux2010_x86_64.whl (15.7MB)
     |████████████████████████████████| 15.7MB 546kB/s eta 0:00:011
Installing collected packages: numpy
```

In [7]:
```
import numpy as np
```

In [11]:
```
start = time.time()
np_numbers = np.arange(9_000_001)
avg = np_numbers.mean()
print(f'The average of numbers between one to 9M is: {avg: .4f}')
finish = time.time()

print(f'The operation took {finish - start:.5f} to complete.')
```

```
The average of numbers between one to 9M is:  4500000.0000
The operation took 0.04682 to complete.
```

In [16]:
```
np_array = np.array([
    [1, 2, 3],
    [4, 5, 6]
])
print(f'Shape: {np_array.shape}')
print(f'Sum across columns: {np_array.sum(0)}')
print(f'Sum across rows: {np_array.sum(1)}')
print(f'Sum of all elements: {np_array.reshape(-1).sum()}')
```

```
Shape: (2, 3)
Sum across columns: [5 7 9]
Sum across rows: [ 6 15]
Sum of all elements: 21
```

In [18]:
```
all_ones = np.ones(5)
all_sevens = np.zeros(5) + 7
print(f'Inner product: all_ones @ all_sevens')
```

```
Inner product: all_ones @ all_sevens
```

In [21]:
```
i_3d = np.eye(3)
diag_pi_halved = i_3d * np.pi / 6
print(np.sin(diag_pi_halved))
```

```
[[0.5 0.  0. ]
 [0.  0.5 0. ]
 [0.  0.  0.5]]
```

In [29]:
```
below_100 = np.arange(100)
below_100 = below_100.reshape(10, 10)
print(below_100)
print('Slicing...')
print(below_100[4:-1, :3])
```

```
[[ 0  1  2  3  4  5  6  7  8  9]
 [10 11 12 13 14 15 16 17 18 19]
 [20 21 22 23 24 25 26 27 28 29]
 [30 31 32 33 34 35 36 37 38 39]
 [40 41 42 43 44 45 46 47 48 49]
 [50 51 52 53 54 55 56 57 58 59]
 [60 61 62 63 64 65 66 67 68 69]
 [70 71 72 73 74 75 76 77 78 79]
 [80 81 82 83 84 85 86 87 88 89]
 [90 91 92 93 94 95 96 97 98 99]]
Slicing...
[[40 41 42]
 [50 51 52]
 [60 61 62]
 [70 71 72]
 [80 81 82]]
```

In [33]:
```
gaussian_random = np.random.randn(5)
print(gaussian_random)
print(f'Range: {gaussian_random.max() - gaussian_random.min()}')
```

```
[ 0.60353765 -0.03641092 -0.75361008  0.34761475  0.54967185]
Range: 1.357147733868123
```

In [39]:
```
np_fives = np.ones((2, 2)) * 5
np_twos = np.ones((2, 2)) * 2
print('Cat rows:')
print(np.concatenate((np_fives, np_twos), 0))
print('Cat cols:')
print(np.concatenate((np_fives, np_twos), -1))
```

```
Cat rows:
[[5. 5.]
 [5. 5.]
 [2. 2.]
 [2. 2.]]
Cat cols:
[[5. 5. 2. 2.]
 [5. 5. 2. 2.]]
```

In [43]:
```
rand_numbers = np.random.randint(low=3, high=18, size=5)
print(rand_numbers)
is_bigger_than_7_bool = rand_numbers > 7
print(is_bigger_than_7_bool)
print(rand_numbers[is_bigger_than_7_bool])
```

```
[14  4 14  8 11]
[ True False  True  True  True]
[14 14  8 11]
```

Matplotlib

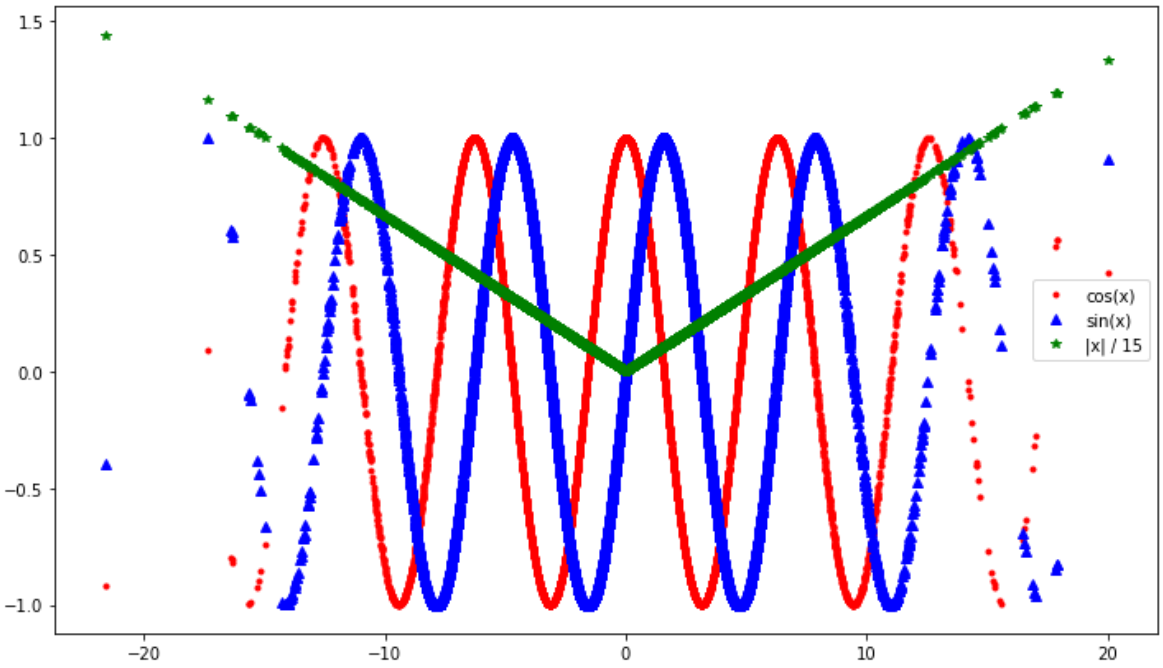
In [26]:
```
! python -m pip install -U pip
! python -m pip install -U matplotlib
```

```
Collecting pip
  Downloading https://files.pythonhosted.org/packages/1f/2c/d9626f045
e7b49a6225c6b09257861f24da78f4e5f23af2ddbdf852c99b8/pip-22.2.2-py3-no
ne-any.whl (2.0MB)
     |████████████████████████████████| 2.0MB 1.1MB/s eta 0:00:01
Installing collected packages: pip
Successfully installed pip-22.2.2
Collecting matplotlib
  Using cached matplotlib-3.5.3-cp37-cp37m-manylinux_2_5_x86_64.manyl
inux1_x86_64.whl (11.2 MB)
Requirement already satisfied: numpy>=1.17 in /home/mastaraan/snap/ju
pyter/common/lib/python3.7/site-packages (from matplotlib) (1.21.6)
Requirement already satisfied: pyparsing>=2.2.1 in /home/mastaraan/sn
ap/jupyter/common/lib/python3.7/site-packages (from matplotlib) (3.0.
9)
Requirement already satisfied: packaging>=20.0 in /home/mastaraan/sna
p/jupyter/common/lib/python3.7/site-packages (from matplotlib) (21.3)
Requirement already satisfied: fonttools>=4.22.0 in /home/mastaraan/s
nap/jupyter/common/lib/python3.7/site-packages (from matplotlib) (4.3
7.4)
Requirement already satisfied: python-dateutil>=2.7 in /snap/jupyter/
6/lib/python3.7/site-packages (from matplotlib) (2.8.0)
Collecting pillow>=6.2.0
  Downloading Pillow-9.2.0-cp37-cp37m-manylinux_2_17_x86_64.manylinux
2014_x86_64.whl (3.1 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 3.1/3.1 MB 2.7 MB/s eta
0:00:00[36m0:00:01m eta 0:00:010m
Requirement already satisfied: cycler>=0.10 in /home/mastaraan/snap/j
upyter/common/lib/python3.7/site-packages (from matplotlib) (0.11.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /home/mastaraan/s
nap/jupyter/common/lib/python3.7/site-packages (from matplotlib) (1.
4.4)
Requirement already satisfied: typing-extensions in /home/mastaraan/s
nap/jupyter/common/lib/python3.7/site-packages (from kiwisolver>=1.0.
1->matplotlib) (4.4.0)
Requirement already satisfied: six>=1.5 in /snap/jupyter/6/lib/python
3.7/site-packages (from python-dateutil>=2.7->matplotlib) (1.12.0)
Installing collected packages: pillow, matplotlib
Successfully installed matplotlib-3.5.3 pillow-9.2.0
```

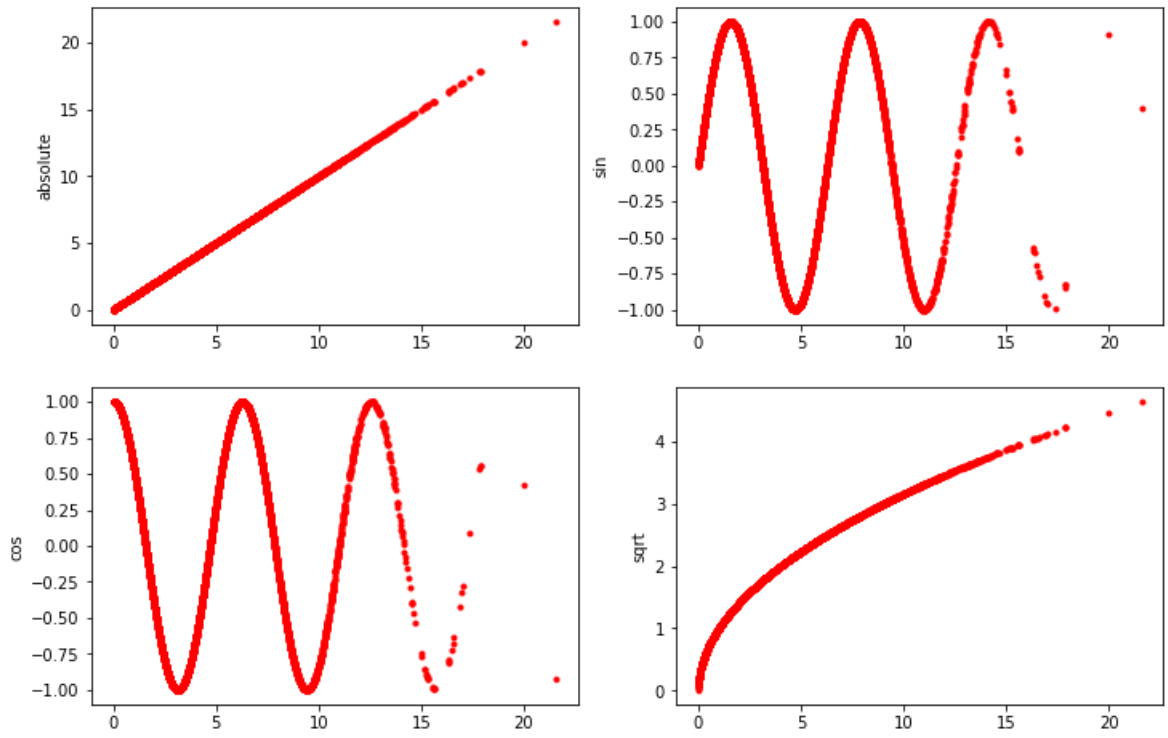
In [27]:
```
import matplotlib.pyplot as plt
```

In [80]:
```
x = np.random.randn(10000) * 5

plt.plot(x, np.cos(x), 'r.')
plt.plot(x, np.sin(x), 'b^')
plt.plot(x, np.abs(x) / 15, 'g*')
plt.legend(['cos(x)', 'sin(x)', '|x| / 15'])
fig = plt.gcf()
fig.set_size_inches(12, 7)
plt.show()
```



In [86]:
```
fig, axs = plt.subplots(2, 2)
funcs = [np.abs, np.sin, np.cos, np.sqrt]
for ax, func in zip(axs.reshape(-1), funcs):
    ax.plot(np.abs(x), func(np.abs(x)), 'r.')
    ax.set_ylabel(str(func).split(' ')[-1][1:-2])
fig.set_size_inches(12, 8)
```



Sklearn

In [6]:
```
! pip install -U scikit-learn
```

```
Collecting scikit-learn
  Downloading https://files.pythonhosted.org/packages/6d/09/75d4dccea
54627920db3cfeb5183ba9f0be2c9b18c4ad00ca6621d009d4f/scikit_learn-1.0.
2-cp37-cp37m-manylinux_2_12_x86_64.manylinux2010_x86_64.whl (23.0MB)
     |████████████████████████████████| 23.0MB 2.5MB/s eta 0:00:01
Collecting threadpoolctl>=2.0.0 (from scikit-learn)
  Downloading https://files.pythonhosted.org/packages/61/cf/6e354304b
cb9c6413c4e02a747b600061c21d38ba51e7e544ac7bc66aecc/threadpoolctl-3.
1.0-py3-none-any.whl
Collecting joblib>=0.11 (from scikit-learn)
  Downloading https://files.pythonhosted.org/packages/91/d4/3b4c8e5a3
0604df4c7518c562d4bf0502f2fa29221459226e140cf846512/joblib-1.2.0-py3-
none-any.whl (297kB)
     |████████████████████████████████| 307kB 5.8MB/s eta 0:00:01
Requirement already satisfied, skipping upgrade: numpy>=1.14.6 in /ho
me/mastaraan/snap/jupyter/common/lib/python3.7/site-packages (from sc
ikit-learn) (1.21.6)
Collecting scipy>=1.1.0 (from scikit-learn)
  Downloading https://files.pythonhosted.org/packages/58/4f/11f34cfc5
7ead25752a7992b069c36f5d18421958ebd6466ecd849aeaf86/scipy-1.7.3-cp37-
cp37m-manylinux_2_12_x86_64.manylinux2010_x86_64.whl (38.1MB)
     |████████████████████████████████| 38.1MB 10.2MB/s eta 0:00:01
|████                            | 5.3MB 4.9MB/s eta 0:00:07     |███
██████████                     | 16.6MB 5.1MB/s eta 0:00:05
Installing collected packages: threadpoolctl, joblib, scipy, scikit-l
earn
Successfully installed joblib-1.2.0 scikit-learn-1.0.2 scipy-1.7.3 th
readpoolctl-3.1.0
```

In [10]:
```
X = np.random.randn(100, 2)
w = np.array([2, -1.5]).reshape(2, 1)
b = 0.5

y = (X @ w) + b
```

In [17]:
```
from sklearn.linear_model import LinearRegression

model = LinearRegression()

model.fit(X=X, y=y)

print(f'Weights: {model.coef_}')

model.predict(
    np.array(
        [[1, 1],
         [0, 0]]
    )
)
```

```
Weights: [[ 2.  -1.5]]
```

Out[17]:
```
array([[1. ],
       [0.5]])
```