Atma Ram Sanatan Dharma College
University of Delhi

MACHINE LEARNING
Practical

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PRACTICAL-1

Objective :

Perform elementary mathematical operations like addition, multiplication, division, and exponentiation.

Code and Output

```
1 + 2
```

```
3
```

```
1 * 2
```

```
2
```

```
1 / 2
```

```
0.5
```

```
2 ** 3
```

```
8
```

PRACTICAL-2

Objective :

Perform elementary logical operations (like OR, AND, Checking for Equality, NOT, XOR).

Code and Output

```
True or False
```

```
True
```

```
True and False
```

```
False
```

```
not False
```

```
True
```

```
True ^ False
```

```
True
```

```
True ^ True
```

```
False
```

PRACTICAL-3

Objective :

Create, initialize, and display simple variables and simple strings and use simple formatting for variables.

Code and Output

```
var_a = 5.4
print(f"Value of var_a is {var_a}")
```

```
Value of var_a is 5.4
```

PRACTICAL-4

Objective :

Create/Define single dimension/multidimensional arrays, and arrays with specific values like array of all ones, all zeros, array with random values within a range, or a diagonal matrix.

Code and Output

```
import numpy as np
np.ones((4, 4))
```

```
array([[1., 1., 1., 1.],
       [1., 1., 1., 1.],
       [1., 1., 1., 1.],
       [1., 1., 1., 1.]])
```

```
np.zeros((4, 4))
```

```
array([[0., 0., 0., 0.],
       [0., 0., 0., 0.],
       [0., 0., 0., 0.],
       [0., 0., 0., 0.]])
```

```
np.random.rand(16).reshape(4, 4)
```

```
array([[0.0606613 , 0.62463632, 0.39359752, 0.26024275],
       [0.96898964, 0.47221527, 0.60819777, 0.88253582],
       [0.20901817, 0.19255731, 0.86897655, 0.51461569],
       [0.68598813, 0.14152689, 0.3721947 , 0.74407958]])
```

```
from scipy.linalg import block_diag
block_diag(1, 2, 3, 4)
```

```
array([[1, 0, 0, 0],
       [0, 2, 0, 0],
       [0, 0, 3, 0],
       [0, 0, 0, 4]], dtype=int32)
```

PRACTICAL-5

Objective :

Use command to compute the size of a matrix, size/length of a particular row/column, load data from a text file, store matrix data to a text file, finding out variables and their features in the current scope.

Code and Output

```
import numpy as np
mat = np.matrix([[1, 2, 3],[4, 5, 6],[7, 8, 9]])
mat
```

```
matrix([[1, 2, 3],
        [4, 5, 6],
        [7, 8, 9]])
```

```
mat.size
```

```
9
```

```
mat.shape
```

```
(3, 3)
```

```
mat[1,].size
```

```
3
```

```
mat[:,2].size
```

```
3
```

```
np.savetxt('mat.txt', mat)
```

```
!type mat.txt
```

```
1.0000000000000000000e+00 2.0000000000000000000e+00
3.0000000000000000000e+00
4.0000000000000000000e+00 5.0000000000000000000e+00
6.0000000000000000000e+00
7.0000000000000000000e+00 8.0000000000000000000e+00
9.0000000000000000000e+00
```

```python
np.loadtxt('mat.txt')
```

```
array([[1., 2., 3.],
       [4., 5., 6.],
       [7., 8., 9.]])
```

```python
print(dir())
```

```
['A', 'B', 'In', 'Out', '_', '_10', '_11', '_12', '_13',
'_17', '_18', '_19', '_2', '_20', '_21', '_22', '_23', '_24',
'_25', '_26', '_27', '_28', '_29', '_3', '_30', '_33', '_34',
'_36', '_39', '_40', '_41', '_42', '_43', '_44', '_45', '_46',
'_47', '_48', '_49', '_5', '_50', '_51', '_53', '_55', '_56',
'_58', '_59', '_6', '_60', '_61', '_67', '_68', '_69', '_7',
'_70', '_71', '_72', '_73', '_74', '_75', '_77', '_78', '_8',
'_81', '_9', '__', '___', '__builtin__', '__builtins__',
'__doc__', '__loader__', '__name__', '__package__',
'__spec__', '_dh', '_exit_code', '_i', '_i1', '_i10', '_i11',
'_i12', '_i13', '_i14', '_i15', '_i16', '_i17', '_i18',
'_i19', '_i2', '_i20', '_i21', '_i22', '_i23', '_i24', '_i25',
'_i26', '_i27', '_i28', '_i29', '_i3', '_i30', '_i31', '_i32',
'_i33', '_i34', '_i35', '_i36', '_i37', '_i38', '_i39', '_i4',
'_i40', '_i41', '_i42', '_i43', '_i44', '_i45', '_i46',
'_i47', '_i48', '_i49', '_i5', '_i50', '_i51', '_i52', '_i53',
'_i54', '_i55', '_i56', '_i57', '_i58', '_i59', '_i6', '_i60',
'_i61', '_i62', '_i63', '_i64', '_i65', '_i66', '_i67',
'_i68', '_i69', '_i7', '_i70', '_i71', '_i72', '_i73', '_i74',
'_i75', '_i76', '_i77', '_i78', '_i79', '_i8', '_i80', '_i81',
'_i82', '_i9', '_ih', '_ii', '_iii', '_oh', 'block_diag',
'exit', 'get_ipython', 'mat', 'np', 'quit', 'var_a']
```

```python
print(dir(mat))
```

```
['A', 'A1', 'H', 'I', 'T', '__abs__', '__add__', '__and__',
'__annotations__', '__array__', '__array_finalize__',
'__array_function__', '__array_interface__',
'__array_prepare__', '__array_priority__', '__array_struct__',
'__array_ufunc__', '__array_wrap__', '__bool__', '__class__',
'__class_getitem__', '__complex__', '__contains__',
'__copy__', '__deepcopy__', '__delattr__', '__delitem__',
'__dict__', '__dir__', '__divmod__', '__dlpack__',
'__dlpack_device__', '__doc__', '__eq__', '__float__',
'__floordiv__', '__format__', '__ge__', '__getattribute__',
'__getitem__', '__gt__', '__hash__', '__iadd__', '__iand__',
'__ifloordiv__', '__ilshift__', '__imatmul__', '__imod__',
'__imul__', '__index__', '__init__', '__init_subclass__',
'__int__', '__invert__', '__ior__', '__ipow__', '__irshift__',
'__isub__', '__iter__', '__itruediv__', '__ixor__', '__le__',
'__len__', '__lshift__', '__lt__', '__matmul__', '__mod__',
'__module__', '__mul__', '__ne__', '__neg__', '__new__',
'__or__', '__pos__', '__pow__', '__radd__', '__rand__',
'__rdivmod__', '__reduce__', '__reduce_ex__', '__repr__',
```

```
'__rfloordiv__', '__rlshift__', '__rmatmul__', '__rmod__',
'__rmul__', '__ror__', '__rpow__', '__rrshift__',
'__rshift__', '__rsub__', '__rtruediv__', '__rxor__',
'__setattr__', '__setitem__', '__setstate__', '__sizeof__',
'__str__', '__sub__', '__subclasshook__', '__truediv__',
'__xor__', '_align', '_collapse', '_getitem', 'all', 'any',
'argmax', 'argmin', 'argpartition', 'argsort', 'astype',
'base', 'byteswap', 'choose', 'clip', 'compress', 'conj',
'conjugate', 'copy', 'ctypes', 'cumprod', 'cumsum', 'data',
'diagonal', 'dot', 'dtype', 'dump', 'dumps', 'fill', 'flags',
'flat', 'flatten', 'getA', 'getA1', 'getH', 'getI', 'getT',
'getfield', 'imag', 'item', 'itemset', 'itemsize', 'max',
'mean', 'min', 'nbytes', 'ndim', 'newbyteorder', 'nonzero',
'partition', 'prod', 'ptp', 'put', 'ravel', 'real', 'repeat',
'reshape', 'resize', 'round', 'searchsorted', 'setfield',
'setflags', 'shape', 'size', 'sort', 'squeeze', 'std',
'strides', 'sum', 'swapaxes', 'take', 'tobytes', 'tofile',
'tolist', 'tostring', 'trace', 'transpose', 'var', 'view']
```

PRACTICAL-6

Objective :

Perform basic operations on matrices (like addition, subtraction, multiplication) and display specific rows or columns of the matrix.

Code and Output

```
import numpy as np
```

```
A = np.array([0, 1, -1, 0]).reshape(2, 2)
A
```

```
array([[ 0,  1],
       [-1,  0]])
```

```
B = np.array([1, 2, 3, 4][::-1]).reshape(2, 2)
B
```

```
array([[4, 3],
       [2, 1]])
```

```
A + B
```

```
array([[4, 4],
       [1, 1]])
```

```
A * B
```

```
array([[ 0,  3],
       [-2,  0]])
```

```
A / B
```

```
array([[ 0.        ,  0.33333333],
       [-0.5       ,  0.        ]])
```

```
A ** B
```

```
array([[0, 1],
       [1, 0]])
```

```
np.logical_or(A, B)
```

```
array([[ True,  True],
       [ True,  True]])
```

```
np.logical_and(A, B)
```

```
array([[False,  True],
       [ True, False]])
```

```
np.logical_not(A, B)
```

```
array([[1, 0],
       [0, 1]])
```

```
np.logical_xor(A, B)
```

```
array([[ True,  True],
       [ True,  True]])
```

```
np.equal(A, B)
```

```
array([[False, False],
       [False, False]])
```

```
np.equal(A, A)
```

```
array([[ True,  True],
       [ True,  True]])
```

```
B[1, ]
```

```
array([0, 1])
```

```
A[:,0]
```

```
array([ 0, -1])
```

PRACTICAL-7

Objective :

Perform other matrix operations like converting matrix data to absolute values, taking the negative of matrix values, editing/removing rows/columns from a matrix, finding the maximum or minimum values in a matrix or in a row/column, and finding the sum of some/all elements in a matrix.

Code and Output

```
import numpy as np
```

```
A = np.array([0, 1, -1, 0]).reshape(2, 2)
A
```

```
array([[ 0,  1],
       [-1,  0]])
```

```
B = np.array([1, 2, 3, 4][::-1]).reshape(2, 2)
B
```

```
array([[4, 3],
       [2, 1]])
```

```
abs(A)
```

```
array([[0, 1],
       [1, 0]])
```

```
np.negative(mat)
```

```
matrix([[-1, -2, -3],
        [-4, -5, -6],
        [-7, -8, -9]])
```

```
np.append(A, [[2, 3]], axis=0)
```

```
array([[ 0,  1],
       [-1,  0],
       [ 2,  3]])
```

```
np.append(A, [[2], [3]], axis=1)
```

```
array([[ 0,  1,  2],
       [-1,  0,  3]])
```

```
np.delete(mat, 1, 0)
```

```
matrix([[1, 2, 3],
        [7, 8, 9]])
```

```
np.delete(mat, 0, 1)
```

```
matrix([[2, 3],
        [5, 6],
        [8, 9]])
```

```
np.min(mat)
```

```
1
```

```
np.max(mat)
```

```
9
```

```
np.sum(mat)
```

```
45
```

PRACTICAL-8

Objective :

Create various type of plots/charts like histograms, plot based on sine/cosine function based on data from a matrix. Further label different axes in a plot and data in a plot.

Code and Output

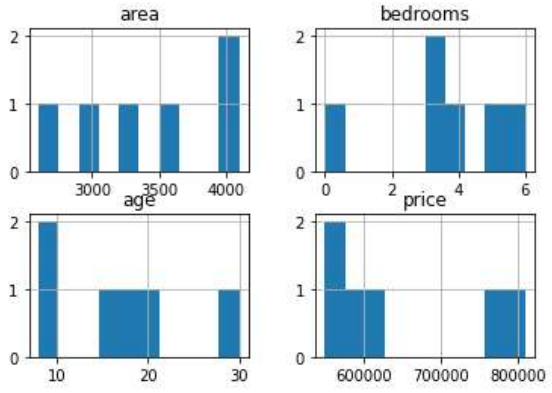
```
import matplotlib.pyplot as plt
```

```
import pandas as pd
df = pd.read_csv('homeprices.csv')
df.head()
```

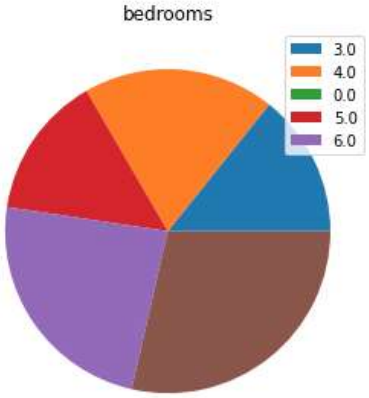
	area	bedrooms	age	price
0	2600	3.0	20	550000
1	3000	4.0	15	565000
2	3200	NaN	18	610000
3	3600	3.0	30	595000
4	4000	5.0	8	760000

```
df = df.fillna(0)
```

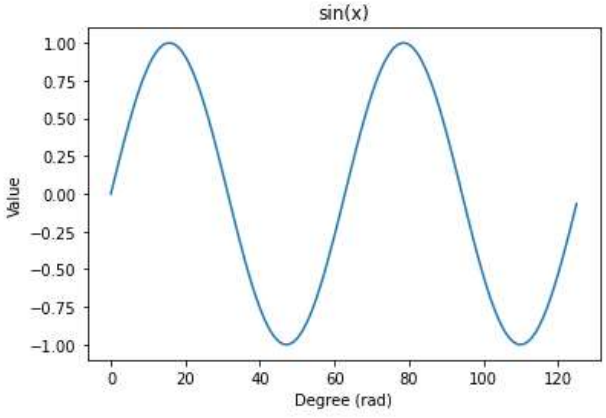
```
df.hist()
plt.show()
```



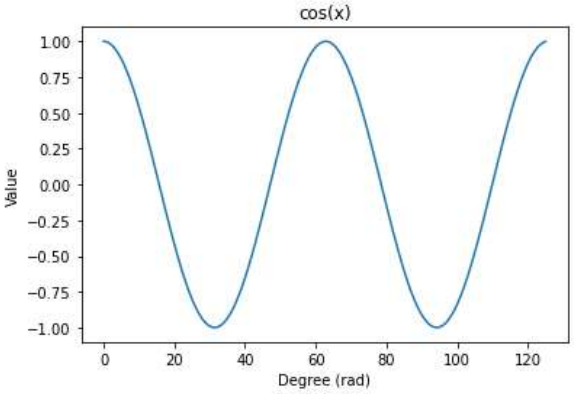
```
patches, _ = plt.pie(df['bedrooms'])
text = pd.unique(df['bedrooms'])
plt.legend(patches, text, loc="best")
plt.tight_layout()
plt.title('bedrooms')
plt.show()
```



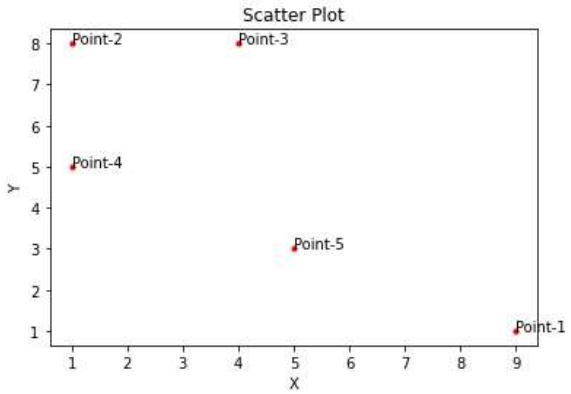

```
import numpy as np
x = np.arange(0, 4 * np.pi, 0.1)
y = np.sin(x)
df_sin = pd.DataFrame({'x': x, 'y': y})
plt.plot(df_sin['y'])
plt.title('sin(x)')
plt.ylabel('Value')
plt.xlabel('Degree (rad)')
plt.show()
```



```
import numpy as np
x = np.arange(0, 4 * np.pi, 0.1)
y = np.cos(x)
df_cos = pd.DataFrame({'x': x, 'y': y})
plt.plot(df_cos['y'])
plt.title('cos(x)')
plt.ylabel('Value')
plt.xlabel('Degree (rad)')
plt.show()
```




```
X = np.random.randint(10, size=(5))
Y = np.random.randint(10, size=(5))

annotations=["Point-1",
             "Point-2",
             "Point-3",
             "Point-4",
             "Point-5"]

plt.scatter(X, Y, s=10, color='r')
plt.xlabel("X")
plt.ylabel("Y")
plt.title("Scatter Plot")
for i, label in enumerate(annotations):
    plt.annotate(label, (X[i], Y[i]))

plt.show()
```



PRACTICAL-9

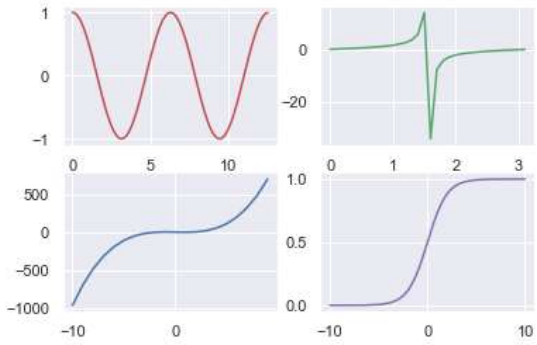
Objective :

Generate different subplots from a given plot and colour plotted data.

Code and Output

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

fig = plt.figure()

plt.subplot(2, 2, 1)
x = np.arange(0, 4 * np.pi, 0.1)
y = np.cos(x)
plt.plot(x, y, c='r')

plt.subplot(2, 2, 2)
x = np.arange(0, 1 * np.pi, 0.1)
y = np.tan(x)
plt.plot(x, y, c='g')

plt.subplot(2, 2, 3)
x = np.arange(-10, 10)
y = x ** 3 - 3 * x + 2
plt.plot(x, y)

plt.subplot(2, 2, 4)
x = np.linspace(-10, 10, 200)
y = 1 / (1 + np.exp(-x))
plt.plot(x, y, c='m')

plt.show()
```

✓ 0.2s



PRACTICAL-10

Objective :

Use conditional statements and different type of loops based on simple example/s.

Code and Output

```
a = 15
b = 4
c = 23

if a < b and a < c:
  print("a is smallest")
elif b < a and b < c:
  print("b is smallest")
else:
  print("c is smallest")
```

✓ 0.2s

```
b is smallest
```

```
for x in range(1, 10):
    if not x % 2:
        print(x)
```

✓ 0.1s

```
2
4
6
8
```

```
i = 1
while i <= 10:
    print(i)
    i += 1
```

✓ 0.2s

```
1
2
3
4
5
6
7
8
9
10
```

PRACTICAL-11

Objective :

Perform vectorized implementation of simple matrix operation like finding the transpose of a matrix, adding, subtracting, or multiplying two matrices.

Code and Output

```
import numpy as np

mat = np.matrix([[1, 2, 3], [4, 5, 6], [7, 8, 9]])
mat
```

✓ 0.8s

```
matrix([[1, 2, 3],
        [4, 5, 6],
        [7, 8, 9]])
```

```
mat.T
```

✓ 0.2s

```
matrix([[1, 4, 7],
        [2, 5, 8],
        [3, 6, 9]])
```

```
A = np.matrix([[0, 1], [-1, 0]])
A
```

✓ 0.2s

```
matrix([[ 0,  1],
        [-1,  0]])
```

```
B = np.matrix([[4, 3], [2, 1]])
B
```

✓ 0.2s

```
matrix([[4, 3],
        [2, 1]])
```

```
A + B
```

✓ 0.2s

```
matrix([[4, 4],
        [1, 1]])
```

```
A - B
```
✓ 0.3s

```
matrix([[-4, -2],
        [-3, -1]])
```

```
A * B
```
✓ 0.4s

```
matrix([[ 2,  1],
        [-4, -3]])
```

PRACTICAL-12

Objective :

Implement a Linear Regression problem.

Code and Output

Preprocessing

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
sns.set_theme(style='darkgrid')
```

```
df = pd.read_csv('homeprices.csv')
df.head()
```

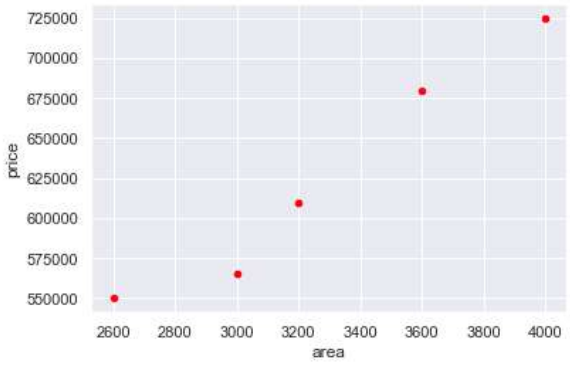
	area	price
0	2600	550000
1	3000	565000
2	3200	610000
3	3600	680000
4	4000	725000

```
df.describe()
```

	area	price
count	5.000000	5.000000
mean	3280.000000	626000.000000
std	540.370243	74949.983322
min	2600.000000	550000.000000
25%	3000.000000	565000.000000
50%	3200.000000	610000.000000
75%	3600.000000	680000.000000
max	4000.000000	725000.000000

```
X_train = df.drop('price', axis=1)
y_train = df['price']
```

```
df.plot.scatter('area', 'price', color='red')
plt.show()
```



Modelling

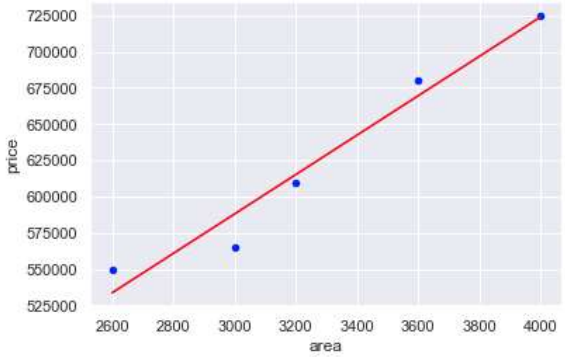
```
from sklearn.linear_model import LinearRegressio
model = LinearRegression()
model.fit(X_train, y_train)
```

```
LinearRegression()
```

```
model.coef_, model.intercept_
```

```
(array([135.78767123]), 180616.43835616432)
```

```
df.plot.scatter('area', 'price', color='blue')
plt.plot(
    np.array(df['area']),
    model.coef_[0] * np.array(df['area'])
        + model.intercept_,
    color='red'
)
plt.show()
```



Evaluation

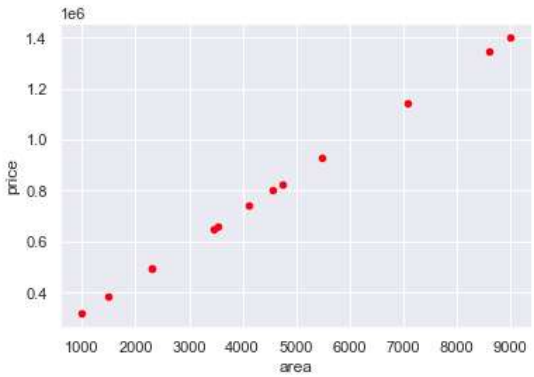
```
test_df = pd.read_csv('areas.csv')
test_df.head()
```

	area
0	1000
1	1500
2	2300
3	3540
4	4120

```
test_df['price'] = model.predict(test_df)
test_df
```

	area	price
0	1000	3.164041e+05
1	1500	3.842979e+05
2	2300	4.929281e+05
3	3540	6.613048e+05
4	4120	7.400616e+05
5	4560	7.998082e+05
6	5490	9.260908e+05
7	3460	6.504418e+05
8	4750	8.256079e+05
9	2300	4.929281e+05
10	9000	1.402705e+06
11	8600	1.348390e+06
12	7100	1.144709e+06

```
test_df.plot.scatter('area', 'price', color='red')
plt.show()
```



PRACTICAL-13

Objective :

Perform Linear Regression based on multiple features.

Code and Output

Preprocessing

```
import math
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
sns.set_theme(style='darkgrid')
```

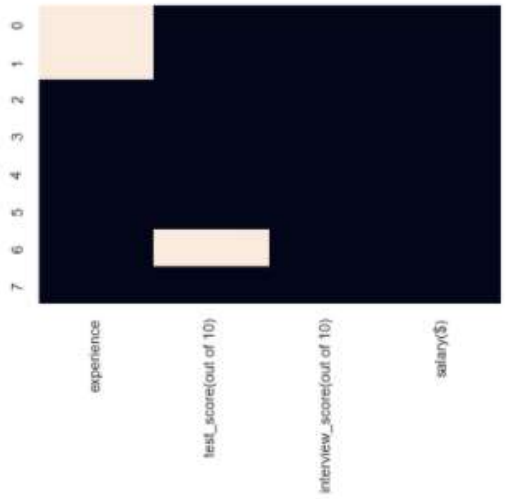
```
df = pd.read_csv('hiring.csv')
df
```

	experience	test_score(out of 10)	interview_score(out of 10)	salary($)
0	NaN	8.0	9	50000
1	NaN	8.0	6	45000
2	five	6.0	7	60000
3	two	10.0	10	65000
4	seven	9.0	6	70000
5	three	7.0	10	62000
6	ten	NaN	7	72000
7	eleven	7.0	8	80000

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8 entries, 0 to 7
Data columns (total 4 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   experience                  6 non-null      object
 1   test_score(out of 10)       7 non-null      float64
 2   interview_score(out of 10)  8 non-null      int64
 3   salary($)                   8 non-null      int64
dtypes: float64(1), int64(2), object(1)
memory usage: 384.0+ bytes
```

```
sns.heatmap(df.isnull(), cbar=False)
plt.show()
```




```
df['experience'].unique()
```

```
array([nan, 'five', 'two', 'seven', 'three', 'ten', 'eleven'],
      dtype=object)
```

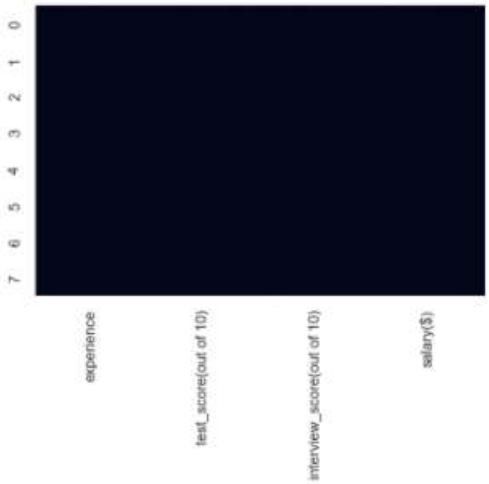
```
df['experience'] = df['experience'].replace({
    'five': 5,
    'two': 2,
    'seven': 7,
    'three': 3,
    'ten': 10,
    'eleven': 11
})
df['experience'] = df['experience'].fillna(0)
df
```

	experience	test_score(out of 10)	interview_score(out of 10)	salary($)
0	0.0	8.0	9	50000
1	0.0	8.0	6	45000
2	5.0	6.0	7	60000
3	2.0	10.0	10	65000
4	7.0	9.0	6	70000
5	3.0	7.0	10	62000
6	10.0	NaN	7	72000
7	11.0	7.0	8	80000

```
df['test_score(out of 10)'] = df['test_score(out of 10)'].fillna(
  df['test_score(out of 10)'].median()
)
df
```

	experience	test_score(out of 10)	interview_score(out of 10)	salary($)
0	0.0	8.0	9	50000
1	0.0	8.0	6	45000
2	5.0	6.0	7	60000
3	2.0	10.0	10	65000
4	7.0	9.0	6	70000
5	3.0	7.0	10	62000
6	10.0	8.0	7	72000
7	11.0	7.0	8	80000

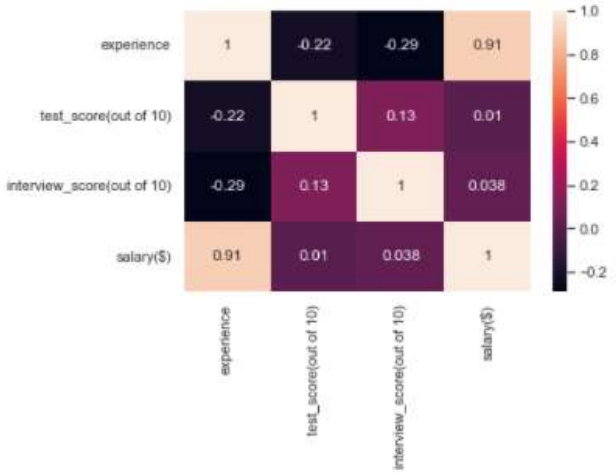
```
sns.heatmap(df.isnull(), cbar=False)
plt.show()
```




```
df.describe()
```

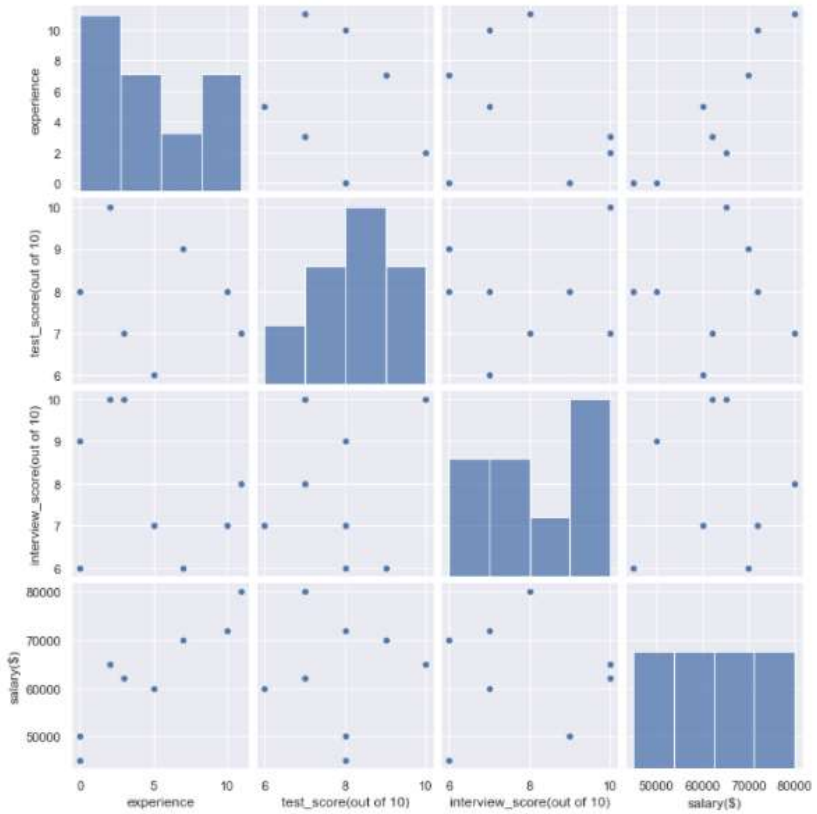
	experience	test_score(out of 10)	interview_score(out of 10)	salary($)
count	8.00000	8.000000	8.000000	8.00000
mean	4.75000	7.875000	7.875000	63000.00000
std	4.26782	1.246423	1.642081	11501.55269
min	0.00000	6.000000	6.000000	45000.00000
25%	1.50000	7.000000	6.750000	57500.00000
50%	4.00000	8.000000	7.500000	63500.00000
75%	7.75000	8.250000	9.250000	70500.00000
max	11.00000	10.000000	10.000000	80000.00000

```
sns.heatmap(df.corr(), annot=True)
plt.show()
```




```
sns.pairplot(df)
plt.show()
```

Python




```
X_train = df.drop('salary($)', axis=1)
y_train = df['salary($)']
```

Python

Modelling

```
from sklearn.linear_model import LinearRegression
model = LinearRegression()
model.fit(X_train, y_train)
```

```
LinearRegression()
```

```
model.coef_, model.intercept_
```

```
(array([2812.95487627, 1845.70596798, 2205.24017467]), 17737.263464337666)
```

Evaluation

- 2 yr experience, 9 test score, 6 interview score
- 12 yr experience, 10 test score, 10 interview score

```
eval_df = pd.DataFrame({
    'experience': [2, 12],
    'test_score(out of 10)': [9., 10.],
    'interview_score(out of 10)': [6, 10],
})
eval_df
```

	experience	test_score(out of 10)	interview_score(out of 10)
0	2	9.0	6
1	12	10.0	10

```
eval_df['salary($)'] = model.predict(eval_df)
eval_df
```

	experience	test_score(out of 10)	interview_score(out of 10)	salary($)
0	2	9.0	6	53205.967977
1	12	10.0	10	92002.183406

PRACTICAL-14

Objective :

Implement a Classification/Logistic Regression problem.

Code and Output

Preprocessing

```python
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
sns.set_theme(style='darkgrid')
```

Python

```python
from sklearn.datasets import load_digits
digits = load_digits()
digits.keys()
```

Python

```
dict_keys(['data', 'target', 'frame', 'feature_names',
'target_names', 'images', 'DESCR'])
```

```python
digits.data
```

Python

```
array([[ 0.,  0.,  5., ...,  0.,  0.,  0.],
       [ 0.,  0.,  0., ..., 10.,  0.,  0.],
       [ 0.,  0.,  0., ..., 16.,  9.,  0.],
       ...,
       [ 0.,  0.,  1., ...,  6.,  0.,  0.],
       [ 0.,  0.,  2., ..., 12.,  0.,  0.],
       [ 0.,  0., 10., ..., 12.,  1.,  0.]])
```

```python
digits.target
```

Python

```
array([0, 1, 2, ..., 8, 9, 8])
```

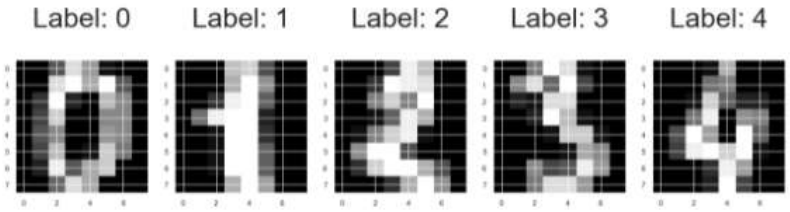
```python
print("Data Shape:", digits.data.shape)
print("Target Shape:", digits.target.shape)
```

Python

```
Data Shape: (1797, 64)
Target Shape: (1797,)
```

```python
plt.figure(figsize=(20, 4))
for index, (image, label) in enumerate(
  zip(digits.data[0:5], digits.target[0:5])
):
    plt.subplot(1, 5, index + 1)
    plt.imshow(np.reshape(image, (8, 8)), cmap=plt.cm.gray)
    plt.title(f'Label: {label}\n', fontsize=40)
```

Python




```python
from sklearn.model_selection import train_test_split

x_train, x_test, y_train, y_test = train_test_split(
    digits.data,
    digits.target,
    test_size=0.3,
    random_state=0
)
```

Python

Modelling

```python
from sklearn.linear_model import LogisticRegression
lr = LogisticRegression(max_iter=1e5)
lr
```

Python

```
LogisticRegression(max_iter=100000.0)
```

```python
lr.fit(x_train, y_train)
```

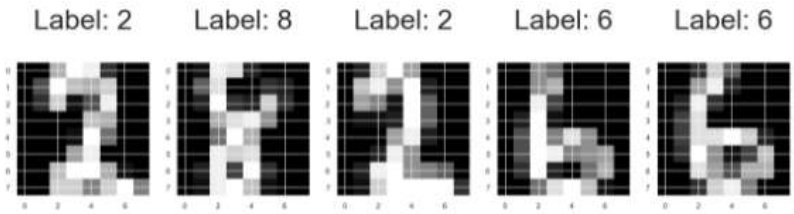
Python

```
LogisticRegression(max_iter=100000.0)
```

Evaluation

```python
plt.figure(figsize=(20, 4))
for index, (image, label) in enumerate(
    zip(x_test[0:5],y_test[0:5])
):
    plt.subplot(1, 5, index + 1)
    plt.imshow(np.reshape(image, (8, 8)), cmap=plt.cm.gray)
    plt.title(f'Label: {label}\n', fontsize=40)
```

Python




```python
lr.predict(x_test[0:5])
```

Python

```
array([2, 8, 2, 6, 6])
```

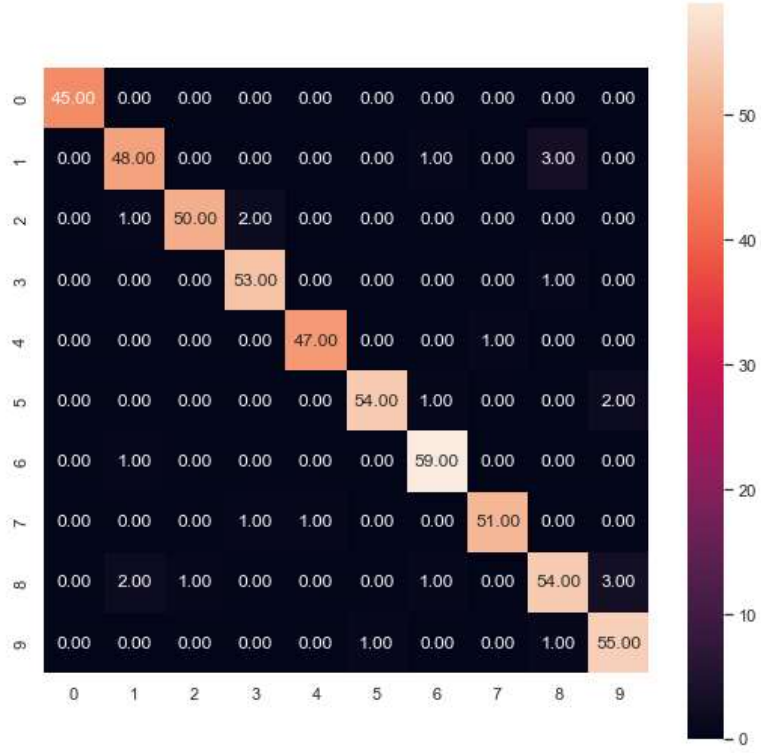
```python
predictions = lr.predict(x_test)
score = lr.score(x_test, y_test)
print(f'Accuracy: {round(score * 100, 5)}%')
```

Python

```
Accuracy: 95.55556%
```

```python
from sklearn import metrics

cm = metrics.confusion_matrix(y_test, predictions)

plt.figure(figsize=(9, 9))
sns.heatmap(cm, annot=True, square=True, fmt='.2f')
plt.show()
```

Python



PRACTICAL-15

Objective :

Use some function for regularization of dataset based on problem 14.

Code and Output

Preprocessing

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
sns.set_theme(style='darkgrid')
```

✓ 1.1s

```
from sklearn.datasets import load_digits
digits = load_digits()
```

✓ 0.1s

```
from sklearn.model_selection import train_test_split

x_train, x_test, y_train, y_test = train_test_split(
    digits.data,
    digits.target,
    test_size=0.3,
    random_state=0
)
```

✓ 0.3s

Modelling

```
from sklearn.linear_model import RidgeClassifier

lr = None
best_alpha = 0
best_score = 0

for alpha in np.logspace(-3, 3, 10):
    lr = RidgeClassifier(alpha=alpha)
    lr.fit(x_train, y_train)
    score = lr.score(x_test, y_test)
    if score > best_score:
        best_score = score
        best_alpha = alpha
    print(f'alpha {alpha:.3f}\t', end='')
    print(f'score: {score:.5f}')
```

✓ 0.7s

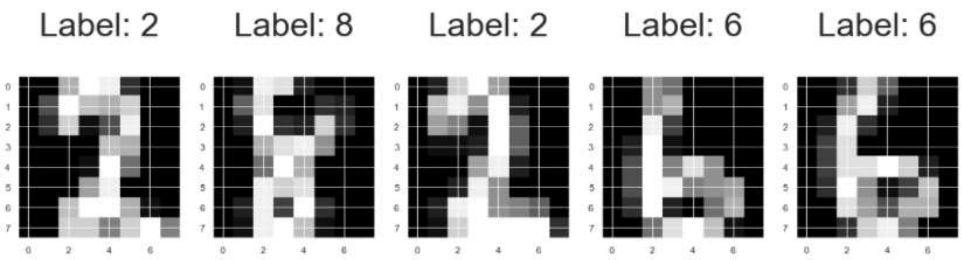
```
alpha 0.001     score: 0.92037
alpha 0.005     score: 0.92037
alpha 0.022     score: 0.92037
alpha 0.100     score: 0.92037
alpha 0.464     score: 0.92037
alpha 2.154     score: 0.92037
alpha 10.000    score: 0.92222
alpha 46.416    score: 0.92222
alpha 215.443   score: 0.92407
alpha 1000.000  score: 0.92037
```

```
lr = RidgeClassifier(alpha=best_alpha)
lr.fit(x_train, y_train)
```
✓ 0.2s

```
RidgeClassifier(alpha=215.44346900318823)
```

Evaluation

```
plt.figure(figsize=(20, 4))
for index, (image, label) in enumerate(
    zip(x_test[0:5],y_test[0:5])
):
    plt.subplot(1, 5, index + 1)
    plt.imshow(np.reshape(image, (8, 8)), cmap=plt.cm.gray)
    plt.title(f'Label: {label}\n', fontsize=40)
plt.show()
```
✓ 0.5s




```
lr.predict(x_test[0:5])
```
✓ 0.2s

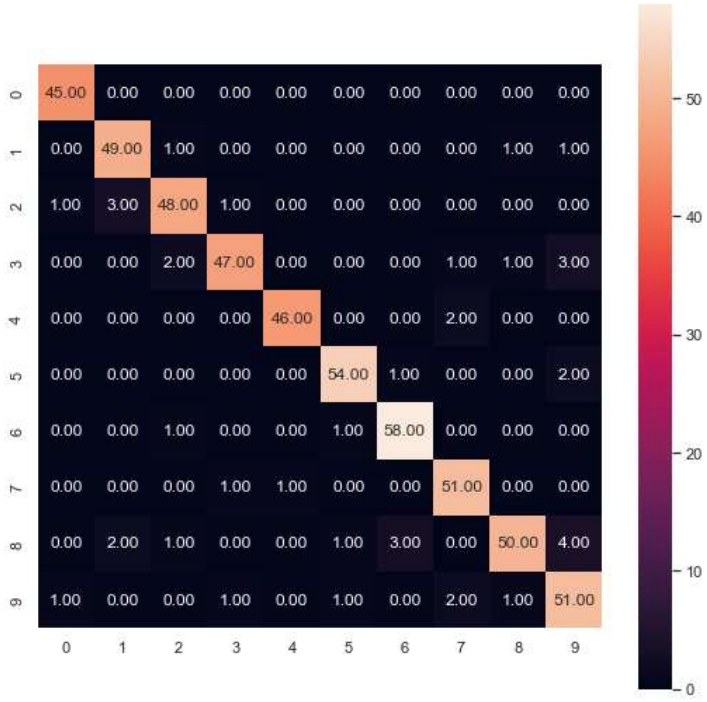
```
array([2, 8, 2, 6, 6])
```

```
predictions = lr.predict(x_test)
score = lr.score(x_test, y_test)
print(f'Accuracy: {round(score * 100, 5)}%')
```
✓ 0.3s

```
Accuracy: 92.40741%
```

```python
from sklearn import metrics

cm = metrics.confusion_matrix(y_test, predictions)

plt.figure(figsize=(9, 9))
sns.heatmap(cm, annot=True, square=True, fmt='.2f')
plt.show()
```

✓ 0.3s



PRACTICAL-16

Objective :

Use some function for neural networks, like Stochastic Gradient Descent or Backpropagation to predict the value of a variable based on the dataset of problem 14.

Code and Output

The Multi-layer Perceptron classifier model optimizes the log-loss function using stochastic gradient descent.

Preprocessing

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
sns.set_theme(style='darkgrid')
```

✓ 1.1s

```
from sklearn.datasets import load_digits
digits = load_digits()
```

✓ 0.1s

```
from sklearn.model_selection import train_test_split

x_train, x_test, y_train, y_test = train_test_split(
    digits.data,
    digits.target,
    test_size=0.3,
    random_state=0
)

x_train, x_validation, y_train, y_validation = train_test_split(
    x_train,
    y_train,
    test_size=0.2,
    random_state=0
)
```

✓ 0.4s

```
from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()
scaler.fit(x_train)

x_train = scaler.transform(x_train)
x_validation = scaler.transform(x_validation)
x_test = scaler.transform(x_test)
```

✓ 0.2s

Modelling

```
import random as r
from sklearn.neural_network import MLPClassifier
from sklearn.metrics import accuracy_score

best_model = {'hls': 0,
              'act': '',
              'lr': '',
              'accuracy': 0,
              'model': None}

for i in range(50):
    hls = r.randint(100, 1000)
    act = r.choice(['identity', 'logistic', 'tanh', 'relu'])
    lr = r.choice(['constant', 'invscaling', 'adaptive'])
    model = MLPClassifier(hidden_layer_sizes=hls,
                          activation=act,
                          learning_rate=lr,
                          solver='sgd',
                          max_iter=10000)
    model.fit(x_train, y_train)
    y_pred = model.predict(x_validation)
    accuracy = accuracy_score(y_validation, y_pred)
    if accuracy > best_model['accuracy']:
        best_model['hls'] = hls
        best_model['act'] = act
        best_model['lr'] = lr
        best_model['accuracy'] = accuracy
        best_model['model'] = model

print('best model parameters:'
      + '\n\thidden_layer_size: ' + str(best_model['hls'])
      + '\n\tactivation:  ' + best_model['act']
      + '\n\tlearning_rate: ' + best_model['lr'])

print(f'accuracy: {str(best_model["accuracy"])}')
```

✓ 13m 9.4s

```
best model parameters:
        hidden_layer_size: 198
        activation:  relu
        learning_rate: adaptive
accuracy: 0.9841269841269841
```

```
model = best_model['model']
model
```

✓ 0.4s

```
MLPClassifier(hidden_layer_sizes=198, learning_rate='adaptive', max_iter=10000,
              solver='sgd')
```

Evaluation

```
y_pred = model.predict(x_test)
accuracy_score(y_test, y_pred)
```

✓ 0.6s

```
0.9685185185185186
```

```
from sklearn.metrics import confusion_matrix

cm = confusion_matrix(y_test, y_pred)

plt.figure(figsize=(9, 9))
sns.heatmap(cm, annot=True, square=True, fmt='.2f')
plt.show()
```

✓ 0.4s