**Experiment – 1**

**Aim:** Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.

**Program:**

```
import pandas as pd
import numpy as np
data = pd.read_csv("enjoysport.csv")
print(data)
d = np.array(data.iloc[:, 0:-1])
print("The attributes are: ", d)
t = np.array(data.iloc[:, -1])
print("The target is: ", t)
def train(c, t):
   for i, val in enumerate(t):
      if val == 'yes':
         specific_h = c[i].copy()
         break
   for i, val in enumerate(c):
      if t[i] == 'yes':
         for j in range(len(specific_h)):
            if val[j] != specific_h[j]:
               specific_h[j] = '?'
            else:
               pass
   return specific_h
print("The Final hypothesis is : ",train(d, t))
```

**Output:**

```
    Sky AirTemp Humidity    Wind Water Forecast EnjoySport
0  Sunny    Warm   Normal  Strong  Warm    Same       yes
1  Sunny    Warm     High  Strong  Warm    Same       yes
2  Rainy    Cold     High  Strong  Warm  Change        no
3  Sunny    Warm     High  Strong  Cool  Change       yes

The attributes are:  [['Sunny' 'Warm' 'Normal' 'Strong' 'Warm' 'Same']
 ['Sunny' 'Warm' 'High' 'Strong' 'Warm' 'Same']
 ['Rainy' 'Cold' 'High' 'Strong' 'Warm' 'Change']
 ['Sunny' 'Warm' 'High' 'Strong' 'Cool' 'Change']]

The target is:  ['yes' 'yes' 'no' 'yes']

The Final hypothesis is :  ['Sunny' 'Warm' '?' 'Strong' '?' '?']
```

**Experiment – 2**

**Aim: F**or a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate - Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples

**Program:**

```
import numpy as np
import pandas as pd
data = pd.read_csv("enjoysport.csv")
concepts = np.array(data.iloc[:, 0:-1])
print("Instances are : ", concepts)
target = np.array(data.iloc[:, -1])
print("Target values are : ", target)


def learn(concepts, target):
    specific_h = concepts[0].copy()
    print("initialization of specific_h and general_h")
    print("Specific Boundary: ", specific_h)
    general_h = [["?" for i in range(len(specific_h))]
                 for i in range(len(specific_h))]
    print("Generic Boundary: ", general_h)
    for i, h in enumerate(concepts):
        if target[i] == "yes":
            print("Instance is Positive ")
            for x in range(len(specific_h)):
                if h[x] != specific_h[x]:
                    specific_h[x] = '?'
                    general_h[x][x] = '?'
        if target[i] == "no":
            print("Instance is Negative ")
            for x in range(len(specific_h)):
                if h[x] != specific_h[x]:
                    general_h[x][x] = specific_h[x]
                else:
                    general_h[x][x] = '?'
    indices = [i for i, val in enumerate(general_h) if val == [
        '?', '?', '?', '?', '?', '?']]
    for i in indices:
        general_h.remove(['?', '?', '?', '?', '?', '?'])
    return specific_h, general_h


s_final, g_final = learn(concepts, target)
print("Final Specific_h:", s_final, sep="\n")
print("Final General_h:", g_final, sep="\n")
```

**Output:**

```
Instances are :
[['Sunny' 'Warm' 'Normal' 'Strong' 'Warm' 'Same']
 ['Sunny' 'Warm' 'High' 'Strong' 'Warm' 'Same']
 ['Rainy' 'Cold' 'High' 'Strong' 'Warm' 'Change']
 ['Sunny' 'Warm' 'High' 'Strong' 'Cool' 'Change']]
Target values are :  ['yes' 'yes' 'no' 'yes']
initialization of specific_h and general_h
Specific Boundary:  ['Sunny' 'Warm' 'Normal' 'Strong' 'Warm' 'Same']
Generic Boundary:  [['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]
Instance is Positive
Instance is Positive
Instance is Negative
Instance is Positive
Final Specific_h:
['Sunny' 'Warm' '?' 'Strong' '?' '?']
Final General_h:
[['Sunny', '?', '?', '?', '?', '?'], ['?', 'Warm', '?', '?', '?', '?']]
```

**Experiment – 3**

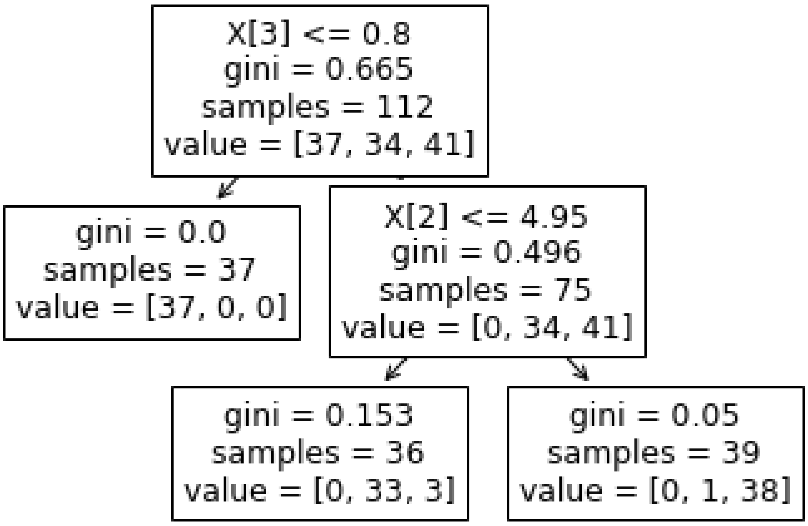
**Aim:** Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

**Program:**

```
import matplotlib.pyplot as plt
from sklearn.datasets import load_iris
from sklearn.tree import DecisionTreeClassifier
from sklearn.model_selection import train_test_split
import pandas as pd
import numpy as np
from sklearn import tree
data = load_iris()
df = pd.DataFrame(data.data, columns=data.feature_names)
df['target'] = data.target
x_train, x_test, y_train, y_test = train_test_split(df[data.feature_names], df['target'], random_state=0)
dt = DecisionTreeClassifier(max_depth=2, random_state=0)
dt.fit(x_train, y_train)
dt.predict(x_test)
tree.plot_tree(dt)
fn = ['sepal length (cm)', 'sepal width (cm)', 'petal length (cm)', 'petal width (cm)']
cn = ['setosa', 'versicolor', 'virginica']
fig,axes = plt.subplots(nrows=1, ncols=1, figsize=(4, 4), dpi=300)
tree.plot_tree(dt, feature_names=fn, class_names=cn, filled=True)
fig.savefig('imagename.png')
y_pred = dt.predict(x_test)
print(y_pred)
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
print(cm)
```

**Output:**

```
[2 1 0 2 0 2 0 1 1 1 2 1 1 1 1 0 1 1 0 0 1 1 0 0 1 0 0 1 1 0 2 1 0 1 2 1 0
 2]
[[13  0  0]
 [ 0 15  1]
 [ 0  3  6]]
```


X[3] <= 0.8
gini = 0.665
samples = 112
value = [37, 34, 41]
gini = 0.0
samples = 37
value = [37, 0, 0]
X[2] <= 4.95
gini = 0.496
samples = 75
value = [0, 34, 41]
gini = 0.153
samples = 36
value = [0, 33, 3]
gini = 0.05
samples = 39
value = [0, 1, 38]

**Experiment – 4**

**Aim:** Exercises to solve the real-world problems using the following machine learning methods: a) Linear Regression b) Logistic Regression c) Binary Classifier

**a) Linear Regression**

**Program:**

```
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
data_set = pd.read_csv("salary_data.csv")
x = data_set.iloc[:, :-1].values
y = data_set.iloc[:, 1].values
x_train, x_test, y_train, y_test = train_test_split(
   x, y, test_size=1/3, random_state=0)
model = LinearRegression()
model.fit(x_train, y_train)
y_pred = model.predict(x_test)
x_pred = model.predict(x_train)
plt.scatter(x_train, y_train, color="green")
plt.plot(x_train, x_pred, color="red")
plt.title("Salary vs Experience(Training Dataset)")
plt.xlabel("Years of Experience")
plt.ylabel("Salary(In rupees)")
plt.show()
plt.scatter(x_test, y_test, color="blue")
plt.plot(x_train, x_pred, color="red")
plt.title("Salary vs Experience(Test Dataset)")
plt.xlabel("years of Experience")
plt.ylabel("Salary(In rupees)")
plt.show()
```

**Output:**

**b) Logistic Regression**

**Program:**

```
from sklearn.metrics import accuracy_score
from sklearn.metrics import confusion_matrix
from sklearn.linear_model import LogisticRegression
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
data_set = pd.read_csv("User_Data.csv")
x = data_set.iloc[:,[2, 3]].values
y = data_set.iloc[:, 4].values
x_train, x_test, y_train, y_test = train_test_split(
   x, y, test_size=1/3, random_state=0)
st_x = StandardScaler()
x_train = st_x.fit_transform(x_train)
x_test = st_x.transform(x_test)
model = LogisticRegression()
model.fit(x_train, y_train)
y_pred = model.predict(x_test)
cm = confusion_matrix(y_test, y_pred)
print("confusion matrix\n", cm)
print("Accuracy : ", accuracy_score(y_test, y_pred))
```

**Output:**

```
confusion matrix
 [[79  6]
 [11 38]]
Accuracy :  0.8731343283582089
```

**Experiment – 5**

**Aim:** Develop a program for Bias, Variance, Remove duplicates, Cross Validation

**Program:**

```
import pandas as pd
data = {"A": ["TeamA", "TeamB", "TeamB", "TeamC", "TeamA"], "B": [
   50, 40, 40, 30, 50], "C": [True, False, False, False, True]}
df = pd.DataFrame(data)
print(df)
display(df.drop_duplicates())
```

**Output:**

```
      A   B     C
0  TeamA  50   True
1  TeamB  40  False
2  TeamB  40  False
3  TeamC  30  False
4  TeamA  50   True
      A   B     C
0  TeamA  50   True
1  TeamB  40  False
3  TeamC  30  False
```

**Cross Validation:**

**Program:**

```
from sklearn import datasets
from sklearn.tree import DecisionTreeClassifier
from sklearn.model_selection import KFold, cross_val_score
x, y = datasets.load_iris(return_X_y=True)
clf = DecisionTreeClassifier(random_state=0)
k_folds = KFold(n_splits=5)
Scores = cross_val_score(clf, x, y, cv=k_folds)
print("cross validation scores:", Scores)
print("Average cv scores :", Scores.mean())
print("Number of cv scores used in Average", len(Scores))
```

**Output:**

```
cross validation scores: [1.         0.96666667 0.83333333 0.93333333 0.8       ]

Average cv scores : 0.9066666666666666

Number of cv scores used in Average 5
```

**Bias, Variance:**

**Program:**

```
from mlxtend.evaluate import bias_variance_decomp
from sklearn.tree import DecisionTreeClassifier
from mlxtend.data import iris_data
from sklearn.model_selection import train_test_split
x, y = iris_data()
x_train, x_test, y_train, y_test = train_test_split(
    x, y, test_size=0.3, random_state=123, shuffle=True, stratify=y)
tree = DecisionTreeClassifier(random_state=123)
avg_expected_loss, avg_bias, avg_var = bias_variance_decomp(
    tree, x_train, y_train, x_test, y_test, loss='0-1_loss', random_seed=123, num_rounds=1000)
print(f'Average Expected loss:{round(avg_expected_loss,4)}n')
print(f'Average Bias:{round(avg_bias,4)}n')
print(f'Average Variance:{round(avg_var,4)}n')
```

**Output:**

```
Average Expected loss:0.0607n
Average Bias:0.0222n
Average Variance:0.0393n
```

**Experiment – 6**

**Aim:** Write a program to implement Categorical Encoding, One-hot Encoding

**Program:**

```
from numpy import asarray
from sklearn.preprocessing import OneHotEncoder
data = asarray([['red',], ['green'], ['blue']])
print(data)
encoder = OneHotEncoder(sparse=False)
onehot = encoder.fit_transform(data)
print(onehot)
```

**Output:**

```
[['red']
 ['green']
 ['blue']]
[[0. 0. 1.]
 [0. 1. 0.]
 [1. 0. 0.]]
```

**Experiment – 8**

**Aim:** Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions.

**Program:**

```
import numpy as np
import matplotlib.pyplot as mtp
import pandas as pd
data_set = pd.read_csv("Iris.csv")
x = data_set.iloc[:, [2, 3]].values
y = data_set.iloc[:, 4].values

from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(
    x, y, test_size=0.25, random_state=0)

from sklearn.preprocessing import StandardScaler
st_x = StandardScaler()
x_train = st_x.fit_transform(x_train)
x_test = st_x.transform(x_test)

from sklearn.neighbors import KNeighborsClassifier
classifier = KNeighborsClassifier(n_neighbors=5, metric='minkowski', p=2)
classifier.fit(x_train, y_train)
y_pred = classifier.predict(x_test)
print(y_pred)
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
print(cm)
```

**Output:**

```
['Iris-virginica' 'Iris-versicolor' 'Iris-setosa' 'Iris-virginica'
 'Iris-setosa' 'Iris-virginica' 'Iris-setosa' 'Iris-versicolor'
 'Iris-versicolor' 'Iris-versicolor' 'Iris-virginica' 'Iris-versicolor'
 'Iris-versicolor' 'Iris-versicolor' 'Iris-versicolor' 'Iris-setosa'
 'Iris-versicolor' 'Iris-versicolor' 'Iris-setosa' 'Iris-setosa'
 'Iris-virginica' 'Iris-versicolor' 'Iris-setosa' 'Iris-setosa'
 'Iris-virginica' 'Iris-setosa' 'Iris-setosa' 'Iris-versicolor'
 'Iris-versicolor' 'Iris-setosa' 'Iris-virginica' 'Iris-versicolor'
 'Iris-setosa' 'Iris-virginica' 'Iris-virginica' 'Iris-versicolor'
 'Iris-setosa' 'Iris-versicolor']
[[13  0  0]
 [ 0 16  0]
 [ 0  0  9]]
```

**Experiment – 9**

**Aim:** Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.

**Program:**

```
import numpy as np
import matplotlib.pyplot as plt
from moepy import lowess
x = np.linspace(0, 5, num=150)
y = np.sin(x)+(np.random.normal(size=len(x)))/10
lowess_model = lowess.Lowess()
lowess_model.fit(x, y)
x_pred = np.linspace(0, 5, 26)
y_pred = lowess_model.predict(x_pred)
plt.plot(x_pred, y_pred, '--', label='Lowess', color='r', zorder=3)
plt.scatter(x, y, label='Noisy sin wave', color='m', s=10, zorder=1)
```

**Output:**

**Experiment – 10**

**Aim:** Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.

**Program:**

```
import numpy as np
import matplotlib.pyplot as mtp
import pandas as pd
data_set = pd.read_csv("User_Data.csv")
x = data_set.iloc[:, [2, 3]].values
y = data_set.iloc[:,4].values
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(
   x, y, test_size=0.25, random_state=0)
from sklearn.preprocessing import StandardScaler
st_x = StandardScaler()
x_train = st_x.fit_transform(x_train)
x_test = st_x.transform(x_test)
from sklearn.naive_bayes import GaussianNB
classifier = GaussianNB()
classifier.fit(x_train, y_train)
y_pred = classifier.predict(x_test)
print(y_pred)
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
print(cm)
from sklearn.metrics import precision_score
precision = precision_score(y_test, y_pred)
from sklearn.metrics import recall_score
recall = recall_score(y_test, y_pred)
from sklearn.metrics import accuracy_score
accuracy = accuracy_score(y_test, y_pred)
print('precision:', precision)
print('recall:', recall)
print('Accuracy:', accuracy)
```

**Output:**

```
[0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 1 0 1 0 1 0 0 0 0 0 1 0 0 0 0
 0 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 0 0 0 1 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0
 0 0 0 0 1 1 1 1 0 0 1 0 0 1 0 0 0 1 0 0 0 0 0 1 1 1]
[[65  3]
 [ 7 25]]
precision: 0.8928571428571429
recall: 0.78125
Accuracy: 0.9
```

**Experiment – 12**

**Aim:** Exploratory Data Analysis for Classification using Pandas or Matplotlib.

**Program:**

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as mtp
import seaborn as sns
df = pd.read_csv("User_Data.csv")
print(df)
df.head()
df.tail()
df.Age.describe()
df.info()
df.Gender.value_counts()
sns.catplot(x="Purchased", y="EstimatedSalary",
        data=df, kind="box", aspect=1.5)
mtp.title("Boxplot for target vs proline")
mtp.show()
```

**Output:**

```
    User ID  Gender  Age  EstimatedSalary  Purchased
0   15624510   Male  19        19000       0
1   15810944   Male  35        20000       0
2   15668575  Female  26        43000       0
3   15603246  Female  27        57000       0
4   15804002   Male  19        76000       0
..      ...    ... ...          ...      ...
395  15691863  Female  46        41000       1
396  15706071   Male  51        23000       1
397  15654296  Female  50        20000       1
398  15755018   Male  36        33000       0
399  15594041  Female  49        36000       1

[400 rows x 5 columns]

   User ID  Gender  Age  EstimatedSalary  Purchased
0  15624510   Male  19        19000       0
1  15810944   Male  35        20000       0
2  15668575  Female  26        43000       0
3  15603246  Female  27        57000       0
4  15804002   Male  19        76000       0

    User ID  Gender  Age  EstimatedSalary  Purchased
395  15691863  Female  46        41000       1
396  15706071   Male  51        23000       1
397  15654296  Female  50        20000       1
398  15755018   Male  36        33000       0
```

```
399  15594041  Female   49        36000        1

count    400.000000
mean      37.655000
std       10.482877
min       18.000000
25%       29.750000
50%       37.000000
75%       46.000000
max       60.000000
Name: Age, dtype: float64

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 400 entries, 0 to 399
Data columns (total 5 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   User ID          400 non-null    int64
 1   Gender           400 non-null    object
 2   Age              400 non-null    int64
 3   EstimatedSalary  400 non-null    int64
 4   Purchased        400 non-null    int64
dtypes: int64(4), object(1)
memory usage: 15.8+ KB

Female    204
Male      196
Name: Gender, dtype: int64
```

**Experiment – 14**

**Aim:** Write a program to Implement Support Vector Machines and Principle Component Analysis

**Program:**

```
import pandas as pd
from sklearn import svm
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
iris=pd.read_csv("Iris.csv",names=['speal_length','sepal_width','petal_length','petal_width','class'])
x_train,x_test,y_train,y_test=train_test_split(iris.drop('class',axis=1),iris['class'],test_size=0.3,random_state
=42)
clf=svm.svc(kernak='rbf')
clf.fit(x_train,y_train)
y_pred=clf.predict(x_test)
accuracy=accuracy_score(y_test,y_pred)
print("Accuracy:",accuracy)
```

**Output:**

```
Accuracy: 0.9
```

**Experiment – 15**

**Aim:** Write a program to Implement Principle Component Analysis

**Program:**

```
from sklearn.decomposition import PCA
from sklearn.preprocessing import StandardScaler
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.datasets import load_breast_cancer
cancer = load_breast_cancer()
df = pd.DataFrame(cancer['data'], columns=cancer['feature_names'])
scalar = StandardScaler()
scalar.fit(df)
scalar_data = scalar.transform(df)
pca = PCA(n_components=2)
pca.fit(scalar_data)
x_pca = pca.transform(scalar_data)
x_pca.shape
plt.figure(figsize=(8, 6))
plt.scatter(x_pca[:, 0], x_pca[:, 1], c=cancer['target'], cmap='plasma')
plt.xlabel('First Pricipal Component')
plt.ylabel('Second Principal Component')
```

**Output:**