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LAB REPORT on

Machine Learning

Submitted by

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in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING



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CERTIFICATE

This is to certify that the Lab work entitled “Machine Learning” carried out by **JAHNAVI SATISH SHANBHAG (1BM19CS065)**, who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2022. The Lab report has been approved as it satisfies the academic requirements in respect of a **Machine Learning - (20CS6PCMAL)** work prescribed for the said degree.

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Course Outcome

CO1	Ability to apply the different learning algorithms.
CO2	Ability to analyze the learning techniques for given dataset
CO3	Ability to design a model using machine learning to solve a problem.
CO4	Ability to conduct practical experiments to solve problems using appropriate machine learning Techniques.

1) Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples.

```
In [14]: import numpy as np
import pandas as pd
```

```
In [15]: data = pd.read_csv("finddata.csv")
print(data,"\n")
```

	Time	Weather	Temperature	Company	Humidity	Goes
0	Morning	Sunny	Warm	Yes	Mild	Yes
1	Evening	Rainy	Cold	No	Mild	No
2	Morning	Sunny	Moderate	Yes	Normal	Yes
3	Evening	Sunny	Cold	Yes	High	Yes

```
In [19]: d = np.array(data)[:,-1]
print("\n The attributes are: ",d)
target = np.array(data)[:,-1]
print("\n The target is: ",target)
```

```
The attributes are: [['Morning' 'Sunny' 'Warm' 'Yes' 'Mild']
['Evening' 'Rainy' 'Cold' 'No' 'Mild']
['Morning' 'Sunny' 'Moderate' 'Yes' 'Normal']
['Evening' 'Sunny' 'Cold' 'Yes' 'High']]

The target is: ['Yes' 'No' 'Yes' 'Yes']
```

```
In [17]: def findS(c,t):
    for i, val in enumerate(t):
        if val == "Yes":
            specific_hypothesis = c[i].copy()
            break

    for i, val in enumerate(c):
        if t[i] == "Yes":
            for x in range(len(specific_hypothesis)):
                if val[x] != specific_hypothesis[x]:
                    specific_hypothesis[x] = '?'
            else:
                pass

    return specific_hypothesis
```

```
In [18]: print("\n The final hypothesis is:",findS(d,target))
```

```
The final hypothesis is: ['?' 'Sunny' '?' 'Yes' '?']
```

```
In [ ]:
```

2) For 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

```
In [4]: import numpy as np
import pandas as pd

#to read the data in the csv file
data = pd.DataFrame(data=pd.read_csv('enjoysport.csv'))
print(data,"\n")

#making an array of all the attributes
concepts = np.array(data.iloc[:,0:-1])
print("The attributes are: ",concepts)

#segregating the target that has positive and negative examples
target = np.array(data.iloc[:,-1])
print("\n The target is: ",target)

#training function to implement candidate_elimination algorithm
def learn(concepts, target):
    specific_h = concepts[0].copy()
    print("\n Initialization of specific_h and general_h")
    print(specific_h)
    general_h = [["?" for i in range(len(specific_h))] for i in
range(len(specific_h))]
    print(general_h)
    for i, h in enumerate(concepts):
        if target[i] == "yes":
            for x in range(len(specific_h)):
                if h[x] != specific_h[x]:
                    specific_h[x] = '?'
                    general_h[x][x] = '?'
            # print(specific_h)
        if target[i] == "no":
            for x in range(len(specific_h)):
                if h[x] != specific_h[x]:
```

```

    print(specific_h)
    print(general_h)
    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)

```

#obtaining the final hypothesis

```

print("\nFinal Specific_h:", s_final, sep="\n")
print("\nFinal General_h:", g_final, sep="\n")

```

	sky	temp	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']

Initialization of specific_h and general_h

```

['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]

```

Steps of Candidate Elimination Algorithm 1

```

['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]

```

Steps of Candidate Elimination Algorithm 1

```

['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]

```

Steps of Candidate Elimination Algorithm 2

```

['sunny' 'warm' '?' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]

```

Steps of Candidate Elimination Algorithm 3

```

['sunny' 'warm' '?' 'strong' 'warm' 'same']
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]

```

Steps of Candidate Elimination Algorithm 4

```

['sunny' 'warm' '?' 'strong' '?' '?']
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]

```

Final Specific_h:

```

['sunny' 'warm' '?' 'strong' '?' '?']

```

Final General_h:

```

[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?']]

```

3) 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.

```
In [24]: import pandas as pd
import math
import numpy as np
```

```
In [34]: data = pd.read_csv("data.csv")
features = [feat for feat in data]
features.remove("answer")
```

```
In [37]: class Node:
    def __init__(self):
        self.children = []
        self.value = ""
        self.isLeaf = False
        self.pred = ""
```

```
In [38]: def entropy(examples):
    pos = 0.0
    neg = 0.0
    for _, row in examples.iterrows():
        if row["answer"] == "yes":
            pos += 1
        else:
            neg += 1
    if pos == 0.0 or neg == 0.0:
        return 0.0
    else:
        p = pos / (pos + neg)
        n = neg / (pos + neg)
        return -(p * math.log(p, 2) + n * math.log(n, 2))
```

```
In [39]: def info_gain(examples, attr):
    uniq = np.unique(examples[attr])
    #print ("\n", uniq)
    gain = entropy(examples)
    #print ("\n", gain)
    for u in uniq:
        subdata = examples[examples[attr] == u]
        #print ("\n", subdata)
        sub_e = entropy(subdata)
        gain -= (float(len(subdata)) / float(len(examples))) * sub_e
        #print ("\n", gain)
    return gain
```



```
In [40]: def ID3(examples, attrs):
    root = Node()

    max_gain = 0
    max_feat = ""
    for feature in attrs:
        #print ("\n",examples)
        gain = info_gain(examples, feature)
        if gain > max_gain:
            max_gain = gain
            max_feat = feature
    root.value = max_feat
    #print ("\nMax feature attr",max_feat)
    uniq = np.unique(examples[max_feat])
    #print ("\n",uniq)
    for u in uniq:
        #print ("\n",u)
        subdata = examples[examples[max_feat] == u]
        #print ("\n",subdata)
        if entropy(subdata) == 0.0:
            newNode = Node()
            newNode.isLeaf = True
            newNode.value = u
            newNode.pred = np.unique(subdata["answer"])
            root.children.append(newNode)
        else:
            dummyNode = Node()
            dummyNode.value = u
            new_attrs = attrs.copy()
            new_attrs.remove(max_feat)
            child = ID3(subdata, new_attrs)
            dummyNode.children.append(child)
            root.children.append(dummyNode)

    return root
```

```
In [41]: def printTree(root: Node, depth=0):
    for i in range(depth):
        print("\t", end="")
    print(root.value, end="")
    if root.isLeaf:
        print(" -> ", root.pred)
    print()
    for child in root.children:
        printTree(child, depth + 1)
```

```
In [42]: root = ID3(data, features)
printTree(root)
```

```
outlook
  overcast -> ['yes']
  rain
    wind
      strong -> ['no']
      weak -> ['yes']
    sunny
      humidity
        high -> ['no']
        normal -> ['yes']
```


4) Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets

```
In [1]: import numpy as np
import pandas as pd
```

```
In [2]: data = pd.read_csv('/content/dataset.csv')
data.head()
```

```
Out[2]:
```

	PlayTennis	Outlook	Temperature	Humidity	Wind
0	No	Sunny	Hot	High	Weak
1	No	Sunny	Hot	High	Strong
2	Yes	Overcast	Hot	High	Weak
3	Yes	Rain	Mild	High	Weak
4	Yes	Rain	Cool	Normal	Weak

```
In [3]: y = list(data['PlayTennis'].values)
X = data.iloc[:,1:].values
print(f'Target Values: {y}')
print(f'Features: \n{X}')
```

```
In [4]: y_train = y[:8]
y_val = y[8:]
X_train = X[:8]
X_val = X[8:]
print(f"Number of instances in training set: {len(X_train)}")
print(f"Number of instances in testing set: {len(X_val)}")
```

```
Number of instances in training set: 8
Number of instances in testing set: 6
```

```
In [5]: class NaiveBayesClassifier:
def __init__(self, X, y):
    self.X, self.y = X, y
    self.N = len(self.X)
    self.dim = len(self.X[0])
    self.attrs = [[] for _ in range(self.dim)]
    self.output_dom = {}
    self.data = []
    for i in range(len(self.X)):
        for j in range(self.dim):
            if not self.X[i][j] in self.attrs[j]:
                self.attrs[j].append(self.X[i][j])
            if not self.y[i] in self.output_dom.keys():
                self.output_dom[self.y[i]] = 1
            else:
                self.output_dom[self.y[i]] += 1
        self.data.append([self.X[i], self.y[i]])
def classify(self, entry):
    solve = None
    max_arg = -1
    for y in self.output_dom.keys():
        prob = self.output_dom[y]/self.N
        for i in range(self.dim):
            cases = [x for x in self.data if x[0][i] == entry[i] and x[1] == y]
            n = len(cases)
            prob *= n/self.N
        if prob > max_arg:
            max_arg = prob
            solve = y
    return solve
```

```
In [6]: nbc = NaiveBayesClassifier(X_train, y_train)
total_cases = len(y_val)
good = 0
bad = 0
predictions = []
for i in range(total_cases):
    predict = nbc.classify(X_val[i])
    predictions.append(predict)
    if y_val[i] == predict:
        good += 1
    else:
        bad += 1
print('Predicted values:', predictions)
print('Actual values:', y_val)
print()
print('Total number of testing instances in the dataset:', total_cases)
print('Number of correct predictions:', good)
print('Number of wrong predictions:', bad)
print()
print('Accuracy of Bayes Classifier:', good/total_cases)
```

```
Predicted values: ['No', 'Yes', 'No', 'Yes', 'Yes', 'No']
Actual values: ['Yes', 'Yes', 'Yes', 'Yes', 'Yes', 'No']
```

```
Total number of testing instances in the dataset: 6
Number of correct predictions: 4
Number of wrong predictions: 2
```

```
Accuracy of Bayes Classifier: 0.6666666666666666
```

5) Implement the Linear Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.

```
In [17]: import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.metrics import r2_score
```

```
In [9]: dataset = pd.read_csv('salary_dataset.csv')
X = dataset.iloc[:, :-1].values
y = dataset.iloc[:, 1].values
```

```
In [10]: from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=1/3, random_state=0)
```

```
In [11]: # Fitting Simple Linear Regression to the Training set
from sklearn.linear_model import LinearRegression
regressor = LinearRegression()
regressor.fit(X_train, y_train)
```

```
Out[11]: LinearRegression()
```

```
In [15]: # Predicting the Test set results
y_pred = regressor.predict(X_test)
y_pred
```

```
Out[15]: array([ 40835.10590871, 123079.39940819,  65134.55626083,  63265.36777221,
        115602.64545369, 108125.8914992 , 116537.23969801,  64199.96201652,
        76349.68719258, 100649.1375447 ])
```

```
In [18]: r2_score(y_test, y_pred)
```

```
Out[18]: 0.9749154407708353
```

```
In [19]: # Visualizing the Training set results
viz_train = plt
viz_train.scatter(X_train, y_train, color='red')
viz_train.plot(X_train, regressor.predict(X_train), color='blue')
viz_train.title('Salary VS Experience (Training set)')
viz_train.xlabel('Year of Experience')
viz_train.ylabel('Salary')
viz_train.show()
```



```
In [14]: # Visualizing the Test set results
viz_test = plt
viz_test.scatter(X_test, y_test, color='red')
viz_test.plot(X_train, regressor.predict(X_train), color='blue')
viz_test.title('Salary VS Experience (Test set)')
viz_test.xlabel('Year of Experience')
viz_test.ylabel('Salary')
viz_test.show()
```

