ITEC 3040 – Assignment 1

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I have read and understood the Academic Honesty Statement specified in the course outline, and I have adhered fully at all times to the academic honesty rules and policies laid by the instructor, the School of Information Technology and York University Senate's Academic Integrity Policy.

QUESTION 1

Use the same in-class Play Tennis training example (which includes 14 days).
(a) Construct a Naive-Bayes classifier to determine
Outlook Rain; Temperature Hot; Humidity High; Wind Weak; Play Tennis =?

Answer

DAY	OUTLOOK	TEMPERATURE	HUMIDITY	WIND	PLAY TENNIS
D1	SUNNY	HOT	HIGH	WEAK	NO
D2	SUNNY	HOT	HIGH	STRONG	NO
D3	OVERCAST	HOT	HIGH	WEAK	YES
D4	RAIN	MILD	HIGH	WEAK	YES
D5	RAIN	COOL	NORMAL	WEAK	YES
D6	RAIN	COOL	NORMAL	STRONG	NO
D7	OVERCAST	COOL	NORMAL	STRONG	YES
D8	SUNNY	MILD	HIGH	WEAK	NO
D9	SUNNY	COOL	NORMAL	WEAK	YES
D10	RAIN	MILD	NORMAL	WEAK	YES
D11	SUNNY	MILD	NORMAL	STRONG	YES
D12	OVERCAST	MILD	HIGH	STRONG	YES
D13	OVERCAST	HOT	NORMAL	WEAK	YES
D14	RAIN	MILD	HIGH	STRONG	NO

$$P[YES] = 9/14$$

$$P[NO] = 5/14$$

OUTLOOK	YES	NO
SUNNY	2/9	3/5
OVERCAST	4/9	0/5
RAIN	3/9	2/5

TEMPERATURE	YES	NO
HOT	2/9	2/5
MILD	4/9	2/5
COLD	3/9	1/5

WIND	YES	NO
WEAK	6/9	2/5
STRONG	3/9	3/5

HUMIDITY	YES	NO
HIGH	3/9	4/5
NORMAL	6/9	1/5

$$P[X|YES] = P[YES] * P[RAINY|YES] * P[HOT|YES] * P[HIGH|YES] * P[WEAK|YES]$$

$$P[X|YES] = \frac{9}{14} * \frac{3}{9} * \frac{2}{9} * \frac{3}{9} * \frac{6}{9} = 0.010582$$

$$P[X|NO] = P[NO] * P[RAINY|NO] * P[HOT|NO] * P[HIGH|NO] * P[WEAK|NO]$$

$$P[X|NO] = \frac{8}{14} * \frac{2}{5} * \frac{2}{5} * \frac{4}{5} * \frac{2}{5} = 0.018285$$

$$P[X|NO] > P[X|YES]$$

X= Outlook Rain; Temperature Hot; Humidity High; Wind Weak; Play Tennis = NO

QUESTION 2

a) Use the Play Tennis training example again.
   Construct a Decision Tree. Note that the order of attributes selection is based on the entropy theory for information gain.
b) Us the classifier to determine
   Outlook Rain; Temperature Hot; Humidity High; Wind Weak; Play Tennis =?

ANSWER

Part A

Step 1

Information gain measures the expected reduction in entropy by partitioning the examples according to an attribute.

Gain(S,A) =Entropy(S) — (|Sv| / |S|) Entropy(Sv)

S — a collection of examples

A — an attribute

Values(A) — possible values of attribute

Sv – the subset of S for which attribute A has value v

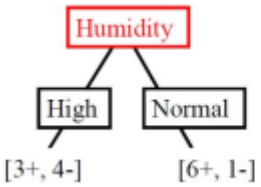
Step 2

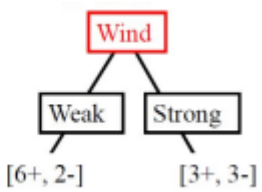
ID3 - Selecting Next Attribute

Entropy([9+,5-] = - (9/14) log2(9/14) -(5/14) log,(5/14) = 0.940

S=[9+,5-] S=[9+,5-]

E=0.940 E=0.940





E=0.985 E-0.592

Gain(S, Humidity) =

0.940-(7/14)*0.985-(7/14)* 0.592 = 0.511

Gain(S, Wind) =

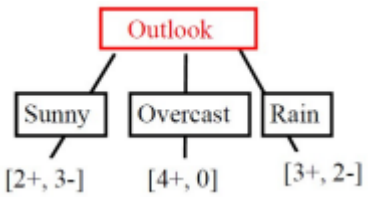
0.940-(8/14)*0.811-(6/14)* 1.0= 0.048

Step 3

ID3 - Selecting Next Attribute

S=[9+,5-]

E=0.940



E=0.971 E=0.0 E=0.971

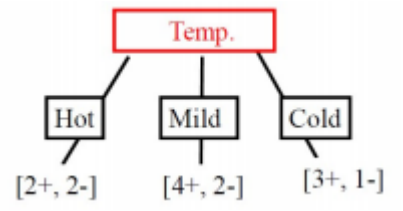
Gain(S, Outlook) = 0.940-(5/14)*0.971 - (4/14)*0.0 -(5/14)*0.0971 = 0.247

Step 4

ID3 - Selecting Next Attribute

S=[9+,5-]

E=0.940



E=1.0 E= 0.911 E=0.811

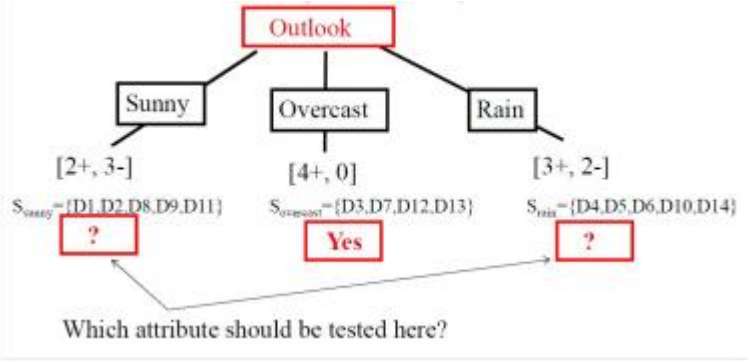
Gain(S, Outlook) = 0.940-(4/14) *1.0 - (6/14)*0.911 - (4/14)*0.811 = 0.029

Step 5

ID3 - Selecting Next Attribute

S=[9+,5-]

S=[D1,D2,……..,D14]



Step 6

ID3 - S sunny

Gain(S sunny , Humidity) = 0.970-(3/5)0.0 - 2/5(0.0) = **0.970**

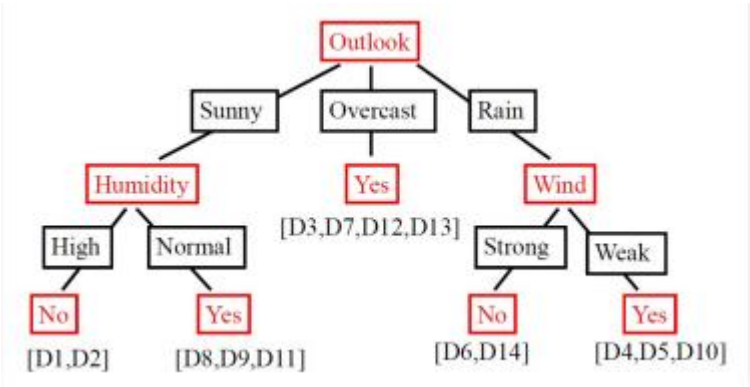
Gain(S sunny , Temp.) = 0.970-(2/5)0.0 -2/5(1.0)-(1/5)0.0 **= 0.570**

Gain(S sunny , Wind) = 0.970- - (2/5)1.0 - 3/5(0.918) = **0.019**

So, Humidity will be selected

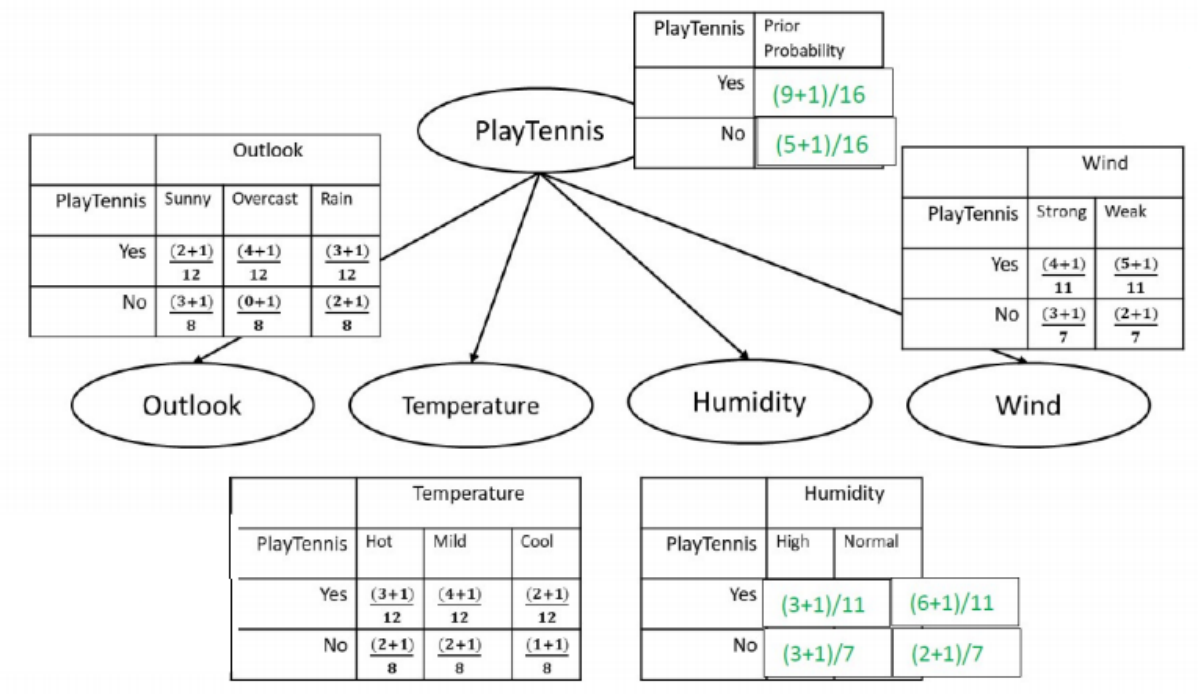
Step 7

Decision Tree for above dataset is



Part B

Predicted value v for Play Tennis by Naive-Bayes model:



For v = Yes: P(Yes) * P(O=Rain | Yes) * P(T=Hot | Yes) * P(H=High | Yes) * P(W=Weak | Yes)

= (10/16) * (4/12) * (4/12) * (4/11) * (6/11) = 0.01377

For v = No: P(No) * P(O=Rain | No) * P(T=Hot | No) * P(H=High | No) * P(W=Weak | No)

= (6/16) * (3/8) * (3/8) * (4/7) * (3/7) = 0.01291

Since 0.01377 > 0.01291, the naïve Bayes model predict **Play Tennis = Yes**.

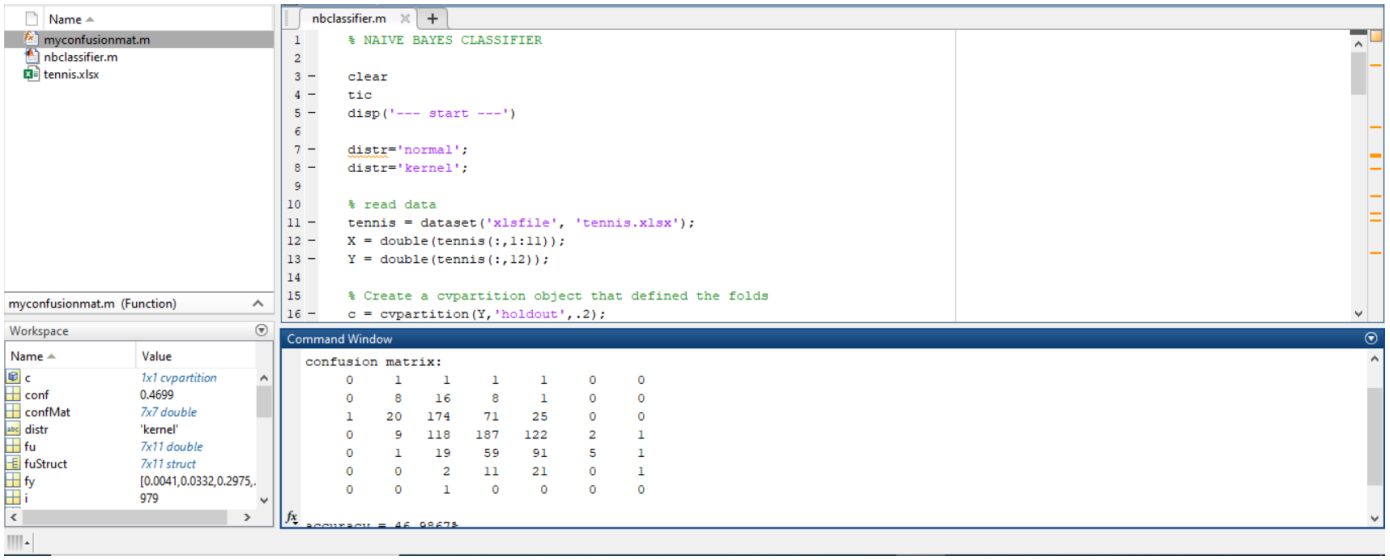
Question 3

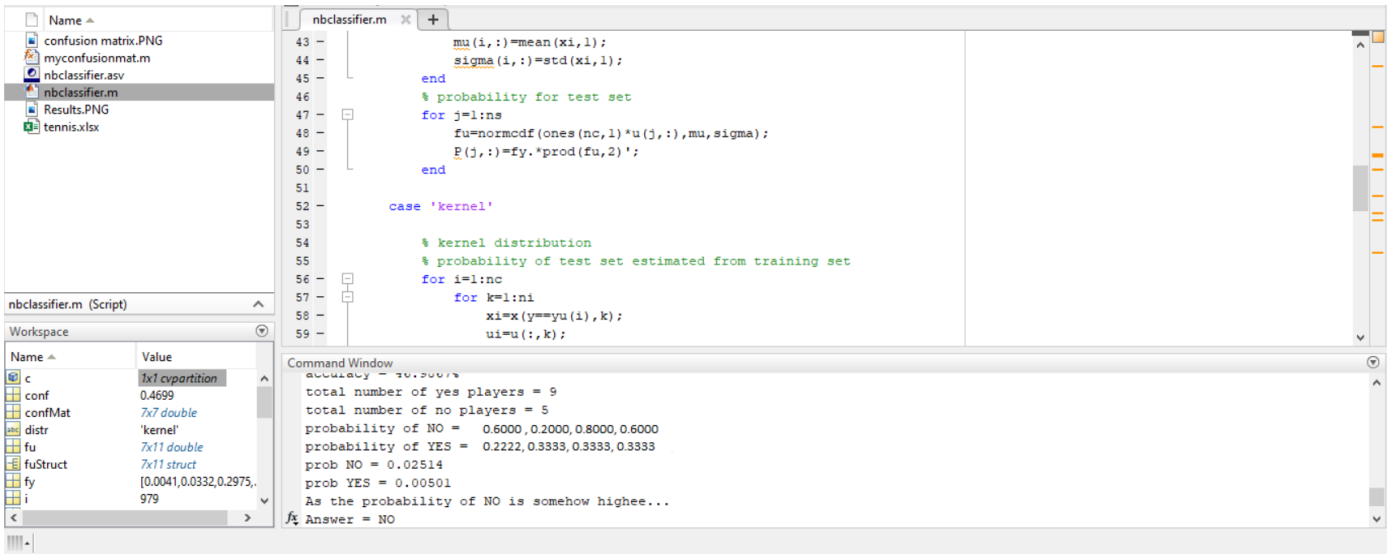
MATLAB Code

```
clear
tic
disp('--- start ---')

distr='normal';
distr='kernel';

% read data
tennis = dataset('xlsfile', 'tennis.xlsx');
X = double(tennis(:,1:11));
Y = double(tennis(:,12));

c = cvpartition(Y,'holdout',.2);

% Create a training set
x = X(training(c,1),:);
y = Y(training(c,1));
% test set
u=X(test(c,1),:);
v=Y(test(c,1),:);

yu=unique(y);
nc=length(yu);
ni=size(x,2);
ns=length(v);

% compute class probability
for i=1:nc
    fy(i)=sum(double(y==yu(i)))/length(y);
end

switch distr

    case 'normal'

        for i=1:nc
            xi=x((y==yu(i)),:);
            mu(i,:)=mean(xi,1);
            sigma(i,:)=std(xi,1);
        end
        % probability for test set
        for j=1:ns
            fu=normcdf(ones(nc,1)*u(j,:),mu,sigma);
            P(j,:)=fy.*prod(fu,2)';
        end

    case 'kernel'

        % kernel distribution
        % probability of test set estimated from training set
        for i=1:nc
            for k=1:ni
                xi=x(y==yu(i),k);
```

```
                ui=u(:,k);
                fuStruct(i,k).f=ksdensity(xi,ui);
            end
        end

        for i=1:ns
            for j=1:nc
                for k=1:ni
                    fu(j,k)=fuStruct(j,k).f(i);
                end
            end
            P(i,:)=fy.*prod(fu,2)';
        end

    otherwise

        disp('invalid distribution stated')
        return

end

[pv0,id]=max(P,[],2);
for i=1:length(id)
    pv(i,1)=yu(id(i));
end

confMat=myconfusionmat(v,pv);
disp('confusion matrix:')
disp(confMat)
conf=sum(pv==v)/length(pv);
disp(['accuracy = ',num2str(conf*100),'%'])

disp('total number of yes players = 9')
disp('total number of no players = 5')
disp('probability of NO = 0.6000,0.2000,0.8000,0.6000')
disp('probability of YES = 0.2222,0.3333,0.3333,0.3333')

disp('prob NO = 0.02514')
disp('prob YES = 0.00501')
disp('As the probability of NO is somehow highee...')
disp('Answer = NO')

toc

function confMat=myconfusionmat(v,pv)

yu=unique(v);
confMat=zeros(length(yu));
for i=1:length(yu)
    for j=1:length(yu)
        confMat(i,j)=sum(v==yu(i) & pv==yu(j));
    end
end
```

Results


Name
myconfusionmat.m
nbclassifier.m
tennis.xlsx
myconfusionmat.m (Function)
Workspace
Name
Value
c
1x1 cvpartition
conf
0.4699
confMat
7x7 double
distr
'kernel'
fu
7x11 double
fuStruct
7x11 struct
fy
[0.0041,0.0332,0.2975,.
i
979
nbclassifier.m
1 % NAIVE BAYES CLASSIFIER
2
3 clear
4 tic
5 disp('--- start ---')
6
7 distr='normal';
8 distr='kernel';
9
10 % read data
11 tennis = dataset('xlsfile', 'tennis.xlsx');
12 X = double(tennis(:,1:11));
13 Y = double(tennis(:,12));
14
15 % Create a cvpartition object that defined the folds
16 c = cvpartition(Y,'holdout',.2);
Command Window
confusion matrix:
0 1 1 1 1 0 0
0 8 16 8 1 0 0
1 20 174 71 25 0 0
0 9 118 187 122 2 1
0 1 19 59 91 5 1
0 0 2 11 21 0 1
0 0 1 0 0 0 0


Name
confusion matrix.PNG
myconfusionmat.m
nbclassifier.asv
nbclassifier.m
Results.PNG
tennis.xlsx
nbclassifier.m (Script)
Workspace
Name
Value
c
1x1 cvpartition
conf
0.4699
confMat
7x7 double
distr
'kernel'
fu
7x11 double
fuStruct
7x11 struct
fy
[0.0041,0.0332,0.2975,.
i
979
nbclassifier.m
mu(i,:)=mean(xi,1);
sigma(i,:)=std(xi,1);
end
% probability for test set
for j=1:ns
fu=normcdf(ones(nc,1)*u(j,:),mu,sigma);
P(j,:)=fy.*prod(fu,2)';
end
case 'kernel'
% kernel distribution
% probability of test set estimated from training set
for i=1:nc
for k=1:ni
xi=x(y==yu(i),k);
ui=u(:,k);
Command Window
total number of yes players = 9
total number of no players = 5
probability of NO = 0.6000, 0.2000, 0.8000, 0.6000
probability of YES = 0.2222, 0.3333, 0.3333, 0.3333
prob NO = 0.02514
prob YES = 0.00501
As the probability of NO is somehow highee...
Answer = NO