AI. hw 10. Yu-Chieh Wang #1164132

1. a. $P(Pass)$

$$P(Pass = Yes) = \frac{3}{7}$$

$$P(Pass = No) = \frac{4}{7}$$

b. $P(Party \mid Pass)$

$$P(Party = yes \mid pass = yes) = \frac{0}{3}$$

$$P(party = yes \mid pass = No) = \frac{3}{4}$$

$$P(party = No \mid pass = yes) = \frac{3}{3} = 1$$

$$P(party = No \mid pass = No) = \frac{1}{4}$$

c. $P(sleep \mid pass)$

$$P(sleep = yes \mid pass = yes) = \frac{2}{3}$$

$$p(sleep = yes \mid Pass = No) = \frac{1}{4}$$

$$p(sleep = No \mid Pass = yes) = \frac{1}{3}$$

$$p(sleep = No \mid Pass = No) = \frac{3}{4}$$

d. $P(study \mid pass)$

$P(study = yes \mid pass = yes) = \frac{2}{3}$

$P(study = yes \mid pass = No) = \frac{1}{4}$

$P(study = No \mid pass = yes) = \frac{1}{3}$

$P(study = No \mid pass = No) = \frac{3}{4}$

e. $P(Pass = yes \mid Party = yes, sleep = yes, study = yes)$

$$= \frac{P(party = yes \wedge sleep = yes \wedge study = yes \mid pass = yes)\, P(pass = yes)}{P(party = yes \wedge sleep = yes \wedge study = yes)}.$$

$$= \alpha P(party = yes \wedge sleep = yes \wedge study = yes \mid pass = yes)\, P(pass = yes)$$

$$= \alpha P(pass = yes)\, P(party = yes \mid pass = yes)\, P(sleep = yes \mid pass = yes).$$
$$P(study = yes \mid pass = yes)$$

$$= \alpha \left(\frac{3}{7}\right)\left(\frac{0}{3}\right)\left(\frac{2}{3}\right)\left(\frac{2}{3}\right)$$

↑ sol. $\frac{0+1}{3+2}$ ← there are two types of values yes / no.

$$= \alpha \left(\frac{3}{7}\right)\left(\frac{1}{5}\right)\left(\frac{2}{3}\right)\left(\frac{2}{3}\right) = \frac{4}{105}\alpha = 0.038\,\alpha = 0.59.$$

$$P(pass=no \mid party=yes, sleep=yes, study=yes)$$

$$= \frac{P(party=yes \wedge sleep=yes \wedge study=yes \mid pass=no)\, P(pass=no)}{P(party=yes \wedge sleep=yes \wedge study=yes)}$$

$$= \alpha P(party=yes \wedge sleep=yes \wedge study=yes)\, P(pass=no)$$

$$= \alpha P(pass=no)\, P(party=yes \mid pass=no)\, P(sleep=yes \mid pass=no) \cdot P(study=yes \mid pass=no).$$

$$= \alpha \left(\frac{4}{7}\right)\left(\frac{3}{4}\right)\left(\frac{1}{4}\right)\left(\frac{1}{4}\right) = \frac{3}{112}\alpha = 0.026\,\alpha = 0.40$$

$$\alpha = \frac{1}{0.026 + 0.038} = \frac{1}{0.064}$$

f. "yes" should be

because $P(party=yes \mid pass=yes) = \frac{0}{3}$.

In order to make this probability not become zero, we use the method "add $\frac{1}{|values|}$ to solve it.

2. Perceptron.

a.

#	Party	sleep	Study	Pass
1	1	1	0	0
2	1	0	1	0
3	1	0	0	0
4	0	1	1	1
5	0	1	0	1
6	0	0	1	1
7	0	0	0	0

b. $\eta = 0.5$

1st round

$x_0 w_0$ $x_1 w_1$ $x_2 w_2$ $x_3 w_3$ $\hat{y}$ Pass

1. $(1)(1) + (1)(1) + (1)(1) + (0)(1) = 3 \geq 0 \rightarrow$ Pass $\leftarrow$ X

Modify weights

$\Delta w_0 = (0.5)(0-1)(1) = -0.5$, $w_0 = 1 - 0.5 = 0.5$

$\Delta w_1 = (0.5)(0-1)(1) = -0.5$, $w_1 = 1 - 0.5 = 0.5$

$\Delta w_2 = (0.5)(0-1)(1) = -0.5$, $w_2 = 1 - 0.5 = 0.5$

$\Delta w_3 = (0.5)(0-1)(0) = 0$, $w_3 = 1 - 0 = 1$

2. $(1)(0.5) + (1)(0.5) + (0)(0.5) + 1(1) = 2.5 \geq 0 \rightarrow$ Pass $\leftarrow$ X

Modify weights

$\Delta w_0 = (0.5)(0-1)(1) = -0.5$, $w_0 = 0.5 - 0.5 = 0.5$

$\Delta w_1 = (0.5)(0-1)(1) = -0.5$, $w_1 = 0.5 - 0.5 = 0.5$

$\Delta w_2 = (0.5)(0-1)(0) = 0$, $w_2 = 0.5 - 0 = 0.5$

$\Delta w_3 = (0.5)(0-1)(1) = -0.5$, $w_3 = 1 - 0.5 = 0.75$

3. $w_0 x_0 \quad w_1 x_1 \quad w_2 x_2 \quad w_3 x_3$ $\hat{y}$ Pass
$(0.5)(1) + (0.5)(1) + (0.75)(0) + (0.75)(0) = 1 \geq 0 \rightarrow$ Pass $\leftarrow$ X

Modify weights.

$\Delta w_0 = (0.5)(0-1)(1) = -0.5$, $w_0 = 0.5 - 0.5 = 0.5$
$\Delta w_1 = (0.5)(0-1)(1) = -0.5$, $w_1 = 0.5 - 0.5 = 0.5$
$\Delta w_2 = (0.5)(0-1)(0) = 0$, $w_2 = 0.75 - 0 = 0.75$
$\Delta w_3 = (0.5)(0-1)(0) = 0$, $w_3 = 0.75 - 0 = 0.75$

4. $(0.5)(1) + (0.5)(0) + (0.75)(1) + (0.75)(1) = 1.75 \geq 0 \rightarrow$ Pass $\leftarrow$ V

5. $(0.5)(1) + (0.5)(0) + (0.75)(1) + (0.75)(0) = 1 \geq 0 \rightarrow$ Pass $\leftarrow$ V

6. $(0.5)(1) + (0.5)(0) + (0.75)(0) + (0.75)(1) = 1 \geq 0 \rightarrow$ Pass $\leftarrow$ V

7. $(0.5)(1) + (0.5)(0) + (0.75)(0) + (0.75)(0) = 0.5 \geq 0 \rightarrow$ Pass $\leftarrow$ X

Modify weights

$\Delta w_0 = (0.5)(0-1)(1) = -0.5$, $w_0 = 0.5 - 0.5 = 0$
$\Delta w_1 = (0.5)(0-1)(0) = 0$, $w_1 = 0.5 - 0 = 0.5$
$\Delta w_2 = (0.5)(0-1)(0) = 0$, $w_2 = 0.75 - 0 = 0.75$
$\Delta w_3 = (0.5)(0-1)(0) = 0$, $w_3 = 0.75 - 0 = 0.75$

2nd round.

$\hat{y}$ Pass
$w_0 x_0 \quad w_1 x_1 \quad w_2 x_2 \quad w_3 x_3$
1. $(0)(1) + (0.5)(1) + (0.75)(1) + (0.75)(0) = 1 \geq 0 \rightarrow$ Pass $\leftarrow$ X

Modify weight

$\Delta w_0 = (0.5)(0-1)(1) = -0.5$, $w_1 = 0 - 0.5 = -0.5$
$\Delta w_1 = (0.5)(0-1)(1) = -0.5$, $w_2 = 0.5 - 0.5 = 0$
$\Delta w_2 = (0.5)(0-1)(1) = -0.5$, $w_3 = 0.75 - 0.5 = 0.5$
$\Delta w_3 = (0.5)(0-1)(0) = 0$, $w_4 = 0.75 - 0 = 0.75$

W_0 X_0 W_1 X_1 W_2 X_2 W_3 X_3 $\hat{y}$ Pass

2. $(-0.25)(1)+(0)(1)+(0.5)(0)+(0.75)(1) = 0.5 \geq 0 \rightarrow$ Pass $\leftarrow$ ✗

Modify Weights.

$\Delta W_0 = (0.25)(0-1)(1) = -0.25$, $W_0 = -0.25 - 0.25 = -0.5$

$\Delta W_1 = (0.25)(0-1)(1) = -0.25$, $W_1 = 0 - 0.25 = -0.25$

$\Delta W_2 = (0.25)(0-1)(0) = 0$, $W_2 = 0.5 - 0 = 0.5$

$\Delta W_3 = (0.25)(0-1)(1) = -0.25$, $W_3 = 0.75 - 0.25 = 0.5$

3. $(-0.5)(1) + (-0.25)(1) + (0.5)(0) + (0.5)(0) = -0.75 < 0 \rightarrow$ ✗ Pass $\leftarrow$ ✗

4. $(-0.5)(1) + (-0.25)(0) + (0.5)(1) + (0.5)(1) = 0.5 \geq 0 \rightarrow$ Pass $\leftarrow$ ✓

5. $(-0.5)(1) + (-0.25)(0) + (0.5)(1) + (0.5)(0) = 0 \geq 0 \rightarrow$ Pass $\leftarrow$ ✓

6. $(-0.5)(1) + (-0.25)(0) + (0.5)(0) + (0.5)(1) = 0 \geq 0 \rightarrow$ Pass $\leftarrow$ ✓

7. $(-0.5)(1) + (-0.25)(0) + (0.5)(0) + (0.5)(0) = -0.5 < 0 \rightarrow$ ✗ Pass $\leftarrow$ ✗

3rd round

W_0 X_0 W_1 X_1 W_2 X_2 W_3 X_3

1. $(-0.5)(1) + (0.25)(1) + (0.5)(1) + (0.5)(0) = -0.25 < 0 \rightarrow$ ✗ Pass $\leftarrow$ ✗

2. $(-0.5)(1) + (-0.25)(1) + (0.5)(0) + (0.5)(1) = -0.25 < 0 \rightarrow$ ✗ Pass $\leftarrow$ ✗

3. Since the weights doesn't change from sample 3

5

7. In 2nd round, sample 3 – 7 in this round will has the same results as 2nd round.

Final weights.

$W_0 = -0.5$, $W_1 = -0.25$, $W_1 = 0.5$, $W_2 = 0.5$

C. 8. Party = yes (1), sleep = yes (1), study = yes (1).

$\hat{y}$

8. $(-0.5)(1) + (-0.25)(1) + (0.5)(1) + (0.5)(1) = 0.25 \geq 0 \rightarrow$ Pass

The prediction result is yes! It will pass!

3.Weka

input file

```
@relation Pass

@attribute Party {yes, no}
@attribute Sleep {yes, no}
@attribute Study {yes, no}
@attribute Pass {yes, no}

@data
yes,yes,no,no
yes,no,yes,no
yes,no,no,no
no,yes,yes,yes
no,yes,no,yes
no,no,yes,yes
no,no,no,no
```

output file

```
=== Run information ===

Scheme:       weka.classifiers.bayes.NaiveBayes
Relation:     Pass
Instances:    7
Attributes:   4
              Party
              Sleep
              Study
              Pass
Test mode:    evaluate on training data

=== Classifier model (full training set) ===

Naive Bayes Classifier

                Class
Attribute         yes     no
               (0.44) (0.56)
============================
Party
  yes             1.0    4.0
  no              4.0    2.0
  [total]         5.0    6.0

Sleep
  yes             3.0    2.0
  no              2.0    4.0
  [total]         5.0    6.0

Study
  yes             3.0    2.0
  no              2.0    4.0
  [total]         5.0    6.0
```

```
Time taken to build model: 0 seconds

=== Evaluation on training set ===

Time taken to test model on training data: 0 seconds

=== Summary ===

Correctly Classified Instances           7               100      %
Incorrectly Classified Instances         0                 0      %
Kappa statistic                          1
Mean absolute error                      0.2413
Root mean squared error                  0.2643
Relative absolute error                 49.0388 %
Root relative squared error             53.381  %
Total Number of Instances                7

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     yes
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     no
Weighted Avg.    1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000

=== Confusion Matrix ===

 a b   <-- classified as
 3 0 | a = yes
 0 4 | b = no
```