1.

a.

$$P(BuyJersey = Yes) = 7/11$$
$$P(BuyJersey = No) = 4/11$$

b.

$$P(Weather|BuyJersey)$$
$$P(Weather = clear|BuyJersey = Yes) = 3/7$$
$$P(Weather = clear|BuyJersey = No) = 1/4$$
$$P(Weather = cloudy|BuyJersey = Yes) = 2/7$$
$$P(Weather = cloudy|BuyJersey = No) = 1/4$$
$$P(Weather = rainy|BuyJersey = Yes) = 2/7$$
$$P(Weather = rainy|BuyJersey = No) = 1/2$$

c.

$$P(Uniform|BuyJersey)$$
$$P(Uniform = crimson|BuyJersey = Yes) = 6/7$$
$$P(Uniform = crimson|BuyJersey = No) = 0/4$$
$$P(Uniform = gray|BuyJersey = Yes) = 1/7$$
$$P(Uniform = gray|BuyJersey = No) = 4/4$$

d.

$$P(Uniform|BuyJersey)$$
$$P(Win = Yes|BuyJersey = Yes) = 4/7$$
$$P(Win = Yes|BuyJersey = No) = 1/4$$
$$P(Win = No|BuyJersey = Yes) = 3/7$$
$$P(Win = No|BuyJersey = No) = 3/4$$

e.

$$P(BuyJersey = Yes|Weather = cloudy, Uniform = gray, Win = Yes)$$
$$= \frac{P(Weather = cloudy, Uniform = gray, Win = Yes|BuyJersey = Yes) * P(BuyJersey = Yes)}{P(Weather = cloudy, Uniform = gray, Win = Yes)}$$
$$= \alpha P(Weather = cloudy, Uniform = gray, Win = Yes|BuyJersey = Yes) * P(BuyJersey = Yes)$$
$$= \alpha P(BuyJersey = Yes) * P(Weather = cloudy|BuyJersey = Yes)$$
$$* P(Uniform = gray|BuyJersey = Yes) * P(Win = Yes|BuyJersey = Yes) = \alpha \frac{7}{11} * \frac{2}{7} * \frac{1}{7} * \frac{4}{7}$$
$$= \alpha * \frac{56}{3773} = \alpha * \frac{8}{539} \approx \alpha * 0.015 \approx 0.39$$

$$P(BuyJersey = No|Weather = cloudy, Uniform = gray, Win = Yes)$$
$$= \frac{P(Weather = cloudy, Uniform = gray, Win = Yes|BuyJersey = No) * P(BuyJersey = No)}{P(Weather = cloudy, Uniform = gray, Win = Yes)}$$
$$= \alpha P(Weather = cloudy, Uniform = gray, Win = Yes|BuyJersey = No) * P(BuyJersey = No)$$
$$= \alpha P(BuyJersey = No) * P(Weather = cloudy|BuyJersey = No)$$
$$* P(Uniform = gray|BuyJersey = No) * P(Win = Yes|BuyJersey = No) = \alpha \frac{4}{11} * \frac{1}{4} * \frac{4}{4} * \frac{1}{4} = \alpha * \frac{1}{44}$$
$$\approx \alpha * 0.023 \approx 0.61$$

$$\alpha = \frac{1}{0.015 + 0.023} = \frac{1}{0.038}$$

f.

It will choose “No”.

2.

a.

	WEATHER	UNIFORM	WIN	BUYJERSEY
1	0	0	1	1
2	0	0	0	1
3	0	1	1	1
4	0	1	0	0
5	1	0	1	1
6	1	0	0	1
7	1	1	0	0
8	2	0	1	1
9	2	0	0	1
10	2	1	1	0
11	2	1	0	0

b.

Weather = cloudy (1), Uniform = gray (1), Win = Yes (1)

(1)(1)+(1)(1)+(1)(1)+(1)(1)=4 ≥ 0 -> BuyJersey

Untrained Perceptron will give us the result that people will Buy Jersey.

c.

$$\eta = 0.5$$

Round 1:

1) (1)(1)+(0)(1)+(0)(1)+(1)(1)=2 ≥ 0 -> BuyJersey <- Correct
2) (1)(1)+(0)(1)+(0)(1)+(0)(1)=1 ≥ 0 -> BuyJersey <- Correct
3) (1)(1)+(0)(1)+(1)(1)+(1)(1)=3 ≥ 0 -> BuyJersey <- Correct
4) (1)(1)+(0)(1)+(1)(1)+(0)(1)=2 ≥ 0 -> BuyJersye <- False
   Modify Weights:
   ΔW_0=(0.5)(0-1)(1) = -0.5, W_0 = 1-0.5 = 0.5
   ΔW_1=(0.5)(0-1)(0) = 0, W_1 = 1
   ΔW_2=(0.5)(0-1)(1) = -0.5, W_2 = 1-0.5 = 0.5
   ΔW_3=(0.5)(0-1)(0) = 0, W_3 = 1
5) (1)(0.5)+(1)(1)+(0)(0.5)+(1)(1)=2.5 ≥ 0 -> BuyJersey <- Correct
6) (1)(0.5)+(1)(1)+(0)(0.5)+(0)(1)=1.5 ≥ 0 -> BuyJersey <- Correct
7) (1)(0.5)+(1)(1)+(1)(0.5)+(0)(1)=2 ≥ 0 -> BuyJersey <- False
   Modify Weights:
   ΔW_0=(0.5)(0-1)(1) = -0.5, W_0 = 0.5-0.5 = 0
   ΔW_1=(0.5)(0-1)(1) = -0.5, W_1 = 1-0.5 = 0.5
   ΔW_2=(0.5)(0-1)(1) = -0.5, W_2 = 0.5-0.5 = 0
   ΔW_3=(0.5)(0-1)(0) = 0, W_3 = 1
8) (1)(0)+(2)(0.5)+(0)(0)+(1)(1)=2 ≥ 0 -> BuyJersey <- Correct

9) (1)(0)+(2)(0.5)+(0)(0)+(0)(1)=1 ≥ 0 -> BuyJersey <- Correct

10) (1)(0)+(2)(0.5)+(1)(0)+(1)(1)=2 ≥ 0 -> BuyJersey <- False

Modify Weights:

ΔW_0=(0.5)(0-1)(1) = -0.5, W_0 = 0-0.5 = -0.5

ΔW_1=(0.5)(0-1)(2) = -1, W_1 = 0.5-1 = -0.5

ΔW_2=(0.5)(0-1)(1) = -0.5, W_2 = 0-0.5 = -0.5

ΔW_3=(0.5)(0-1)(1) = 0.5, W_3 = 1-0.5 = 0.5

11) (1)(-0.5)+(2)(-0.5)+(1)(-0.5)+(0)(0.5)=-2 < 0 -> NotBuyJersey <- Correct

d.

Weather = cloudy (1), Uniform = gray (1), Win = Yes (1)

(1)(-0.5)+(1)(-0.5)+(1)(-0.5)+(1)(0.5)=-1 < 0 -> NotBuyJersey

Trained on one round Perceptron will calculate that people won't Buy Jersey.

3.

```
@relation BuyJersey

@attribute Weather {clear, cloudy, rainy}
@attribute Uniform {crimson, gray}
@attribute Win {yes, no}
@attribute BuyJersey {yes, no}

@data
clear,crimson,yes,yes
clear,crimson,no,yes
clear,gray,yes,yes
clear,gray,no,no
cloudy,crimson,yes,yes
cloudy,crimson,no,yes
cloudy,gray,no,no
rainy,crimson,yes,yes
rainy,crimson,no,yes
rainy,gray,yes,no
rainy,gray,no,no
```

```
=== Run information ===

Scheme:       weka.classifiers.bayes.NaiveBayes
Relation:     BuyJersey
Instances:    11
Attributes:   4
              Weather
              Uniform
              Win
              BuyJersey
Test mode:    evaluate on training data

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

Naive Bayes Classifier

                Class
Attribute         yes     no
               (0.62) (0.38)
============================
Weather
  clear           4.0    2.0
  cloudy          3.0    2.0
  rainy           3.0    3.0
  [total]        10.0    7.0

Uniform
  crimson         7.0    1.0
  gray            2.0    5.0
  [total]         9.0    6.0

Win
  yes             5.0    2.0
  no              4.0    4.0
  [total]         9.0    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          10               90.9091 %
Incorrectly Classified Instances         1                9.0909 %
Kappa statistic                          0.8136
Mean absolute error                      0.2047
Root mean squared error                  0.2399
Relative absolute error                 43.6901 %
Root relative squared error             49.8209 %
Total Number of Instances               11

=== Detailed Accuracy By Class ===

               TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
               0,857    0,000    1,000      0,857    0,923      0,828    1,000     1,000     yes
               1,000    0,143    0,800      1,000    0,889      0,828    1,000     1,000     no
Weighted Avg.  0,909    0,052    0,927      0,909    0,911      0,828    1,000     1,000

=== Confusion Matrix ===

 a b   <-- classified as
 6 1 | a = yes
 0 4 | b = no
```

4.

Round 2:

1) (1)(-0.5)+(0)(-0.5)+(0)(-0.5)+(1)(0.5)=0 ≥ 0 -> BuyJersey <- Correct
2) (1)(-0.5)+(0)(-0.5)+(0)(-0.5)+(0)(0.5)=-0.5 < 0 -> NotBuyJersey <- False
   Modify Weights:
   $\Delta W_0=(0.5)(1-0)(1) = 0.5$, $W_0 = -0.5+0.5 = 0$
   $\Delta W_1=(0.5)(1-0)(0) = 0$, $W_1 = -0.5$
   $\Delta W_2=(0.5)(1-0)(0) = 0$, $W_2 = -0.5$
   $\Delta W_3=(0.5)(1-0)(0) = 0$, $W_3 = 0.5$
3) (1)(0)+(0)(-0.5)+(1)(-0.5)+(1)(0.5)=0 ≥ 0 -> BuyJersey <- Correct
4) (1)(0)+(0)(-0.5)+(1)(-0.5)+(0)(0.5)=-0.5 < 0 -> NotBuyJersey <- Correct
5) (1)(0)+(1)(-0.5)+(0)(-0.5)+(1)(0.5)=0 ≥ 0 -> BuyJersey <- Correct
6) (1)(0)+(1)(-0.5)+(0)(-0.5)+(0)(0.5)=-0.5 < 0 -> NotBuyJersey <- False
   Modify Weights:
   $\Delta W_0=(0.5)(1-0)(1) = 0.5$, $W_0 = 0+0.5 = 0.5$
   $\Delta W_1=(0.5)(1-0)(1) = 0.5$, $W_1 = -0.5+0.5 = 0$
   $\Delta W_2=(0.5)(1-0)(0) = 0$, $W_2 = -0.5$
   $\Delta W_3=(0.5)(1-0)(0) = 0$, $W_3 = 0.5$

7) (1)(0.5)+(1)(0)+(1)(-0.5)+(0)(0.5)=0 ≥ 0 -> BuyJersey <- False
   Modify Weights:
   ΔW_0=(0.5)(0-1)(1) = -0.5, W_0 = 0.5-0.5 = 0
   ΔW_1=(0.5)(0-1)(1) = -0.5, W_1 = 0-0.5 = -0.5
   ΔW_2=(0.5)(0-1)(1) = -0.5, W_2 = -0.5-0.5 = -1
   ΔW_3=(0.5)(0-1)(0) = 0, W_3 = 0.5
8) (1)(0)+(2)(-0.5)+(0)(-1)+(1)(0.5)=-0.5 < 0 -> NotBuyJersey <- False
   Modify Weights:
   ΔW_0=(0.5)(1-0)(1) = 0.5, W_0 = 0+0.5 = 0.5
   ΔW_1=(0.5)(1-0)(2) = 1, W_1 = -0.5+1 = 0.5
   ΔW_2=(0.5)(1-0)(0) = 0, W_2 = -1
   ΔW_3=(0.5)(1-0)(1) = 0.5, W_3 = 0.5+0.5 = 1
9) (1)(0.5)+(2)(0.5)+(0)(-1)+(0)(1)=1.5 ≥ 0 -> BuyJersey <- Correct
10) (1)(0.5)+(2)(0.5)+(1)(-1)+(1)(1)=1.5 ≥ 0 -> BuyJersey <- False
   Modify Weights:
   ΔW_0=(0.5)(0-1)(1) = -0.5, W_0 = 0.5-0.5 = 0
   ΔW_1=(0.5)(0-1)(2) = -1, W_1 = 0.5-1 = -0.5
   ΔW_2=(0.5)(0-1)(1) = -0.5, W_2 = -1-0.5 = -1.5
   ΔW_3=(0.5)(0-1)(1) = 0.5, W_3 = 1-0.5 = 0.5
11) (1)(0)+(2)(-0.5)+(1)(-1.5)+(0)(0.5)=-2.5 < 0 -> NotBuyJersey <- Correct

Round 3:

1) (1)(0)+(0)(-0.5)+(0)(-1.5)+(1)(0.5)=0.5 ≥ 0 -> BuyJersey <- Correct
2) (1)(0)+(0)(-0.5)+(0)(-1.5)+(0)(0.5)=0 ≥ 0 -> BuyJersey <- Correct
3) (1)(0)+(0)(-0.5)+(1)(-1.5)+(1)(0.5)=-1< 0 -> NotBuyJersey <- False
   Modify Weights:
   ΔW_0=(0.5)(1-0)(1) = 0.5, W_0 = 0+0.5 = 0.5
   ΔW_1=(0.5)(1-0)(0) = 0, W_1 = -0.5
   ΔW_2=(0.5)(1-0)(1) = 0.5, W_2 = -1.5+0.5 = -1
   ΔW_3=(0.5)(1-0)(1) = 0.5, W_3 = 0.5+0.5 = 1
4) (1)(0.5)+(0)(-0.5)+(1)(-1)+(0)(1)=-0.5 < 0 -> NotBuyJersey <- Correct
5) (1)(0.5)+(1)(-0.5)+(0)(-1)+(1)(1)=1 ≥ 0 -> BuyJersey <- Correct
6) (1)(0.5)+(1)(-0.5)+(0)(-1)+(0)(1)=0 ≥ 0 -> BuyJersey <- Correct
7) (1)(0.5)+(1)(-0.5)+(1)(-1)+(0)(1)=-1 < 0 -> NotBuyJersey <- Correct
8) (1)(0.5)+(2)(-0.5)+(0)(-1)+(1)(1)=0.5 ≥ 0 -> BuyJersey <- Correct
9) (1)(0.5)+(2)(-0.5)+(0)(-1)+(0)(1)=-0.5 < 0 -> NotBuyJersey <- False
   Modify Weights:
   ΔW_0=(0.5)(1-0)(1) = 0.5, W_0 = 0.5+0.5 = 1
   ΔW_1=(0.5)(1-0)(2) = 1, W_1 = -0.5+1 = 0.5
   ΔW_2=(0.5)(1-0)(0) = 0, W_2 = -1
   ΔW_3=(0.5)(1-0)(0) = 0, W_3 = 1

10) (1)(1)+(2)(0.5)+(1)(-1)+(1)(1)=2 ≥ 0 -> BuyJersey <- False
Modify Weights:
ΔW_0=(0.5)(0-1)(1) = -0.5, W_0 = 1-0.5 = 0.5
ΔW_1=(0.5)(0-1)(2) = -1, W_1 = 0.5-1 = -0.5
ΔW_2=(0.5)(0-1)(1) = -0.5, W_2 = -1-0.5 = -1.5
ΔW_3=(0.5)(0-1)(1) = 0.5, W_3 = 1-0.5 = 0.5
11) (1)(0.5)+(2)(-0.5)+(1)(-1.5)+(0)(0.5)=-2 < 0 -> NotBuyJersey <- Correct

Round 4:

1) (1)(0.5)+(0)(-0.5)+(0)(-1.5)+(1)(0.5)=1 ≥ 0 -> BuyJersey <- Correct
2) (1)(0.5)+(0)(-0.5)+(0)(-1.5)+(0)(0.5)=0.5 ≥ 0 -> BuyJersey <- Correct
3) (1)(0.5)+(0)(-0.5)+(1)(-1.5)+(1)(0.5)=-0.5 < 0 -> NotBuyJersey <- False
Modify Weights:
ΔW_0=(0.5)(1-0)(1) = 0.5, W_0 = 0.5+0.5 = 1
ΔW_1=(0.5)(1-0)(0) = 0, W_1 = -0.5
ΔW_2=(0.5)(1-0)(1) = 0.5, W_2 = -1.5+0.5 = -1
ΔW_3=(0.5)(1-0)(1) = 0.5, W_3 = 0.5+0.5 = 1
4) (1)(1)+(0)(-0.5)+(1)(-1)+(0)(1)=0 ≥ 0 -> BuyJersey <- False
Modify Weights:
ΔW_0=(0.5)(0-1)(1) = -0.5, W_0 = 1-0.5 = 0.5
ΔW_1=(0.5)(0-1)(0) = 0, W_1 = -0.5
ΔW_2=(0.5)(0-1)(1) = -0.5, W_2 = -1-0.5 = -1.5
ΔW_3=(0.5)(0-1)(0) = 0, W_3 = 1
5) (1)(0.5)+(1)(-0.5)+(0)(-1.5)+(1)(1)=1 ≥ 0 -> BuyJersey <- Correct
6) (1)(0.5)+(1)(-0.5)+(0)(-1.5)+(0)(1)=0 ≥ 0 -> BuyJersey <- Correct
7) (1)(0.5)+(1)(-0.5)+(1)(-1.5)+(0)(1)=-1.5 < 0 -> NotBuyJersey <- Correct
8) (1)(0.5)+(2)(-0.5)+(0)(-1.5)+(1)(1)=0.5 ≥ 0 -> BuyJersey <- Correct
9) (1)(0.5)+(2)(-0.5)+(0)(-1.5)+(0)(1)=-0.5 < 0 -> NotBuyJersey <- False
Modify Weights:
ΔW_0=(0.5)(1-0)(1) = 0.5, W_0 = 0.5+0.5 = 1
ΔW_1=(0.5)(1-0)(2) = 1, W_1 = -0.5+1 = 0.5
ΔW_2=(0.5)(1-0)(0) = 0, W_2 = -1.5
ΔW_3=(0.5)(1-0)(0) = 0, W_3 = 1
10) (1)(1)+(2)(0.5)+(1)(-1.5)+(1)(1)=1.5 ≥ 0 -> BuyJersey <- False
Modify Weights:
ΔW_0=(0.5)(0-1)(1) = -0.5, W_0 = 1-0.5 = 0.5
ΔW_1=(0.5)(0-1)(2) = -1, W_1 = 0.5-1 = -0.5
ΔW_2=(0.5)(0-1)(1) = -0.5, W_2 = -1.5-0.5 = -2
ΔW_3=(0.5)(0-1)(1) = 0.5, W_3 = 1-0.5 = 0.5
11) (1)(0.5)+(2)(-0.5)+(1)(-2)+(0)(0.5)=-2.5 < 0 -> NotBuyJersey <- Correct

Round 5:

1) (1)(0.5)+(0)(-0.5)+(0)(-2)+(1)(0.5)=1 ≥ 0 -> BuyJersey <- Correct
2) (1)(0.5)+(0)(-0.5)+(0)(-2)+(0)(0.5)=0.5 ≥ 0 -> BuyJersey <- Correct

3) (1)(0.5)+(0)(-0.5)+(1)(-2)+(1)(0.5)=-1 < 0 -> NotBuyJersey <- False
   Modify Weights:
   ΔW_0=(0.5)(1-0)(1) = 0.5, W_0 = 0.5+0.5 = 1
   ΔW_1=(0.5)(1-0)(0) = 0, W_1 = -0.5
   ΔW_2=(0.5)(1-0)(1) = 0.5, W_2 = -2+0.5 = -1.5
   ΔW_3=(0.5)(1-0)(1) = 0.5, W_3 = 0.5+0.5 = 1
4) (1)(1)+(0)(-0.5)+(1)(-1.5)+(0)(1)=-0.5 < 0 -> NotBuyJersey <- Correct
5) (1)(1)+(1)(-0.5)+(0)(-1.5)+(1)(1)=1.5 ≥ 0 -> BuyJersey <- Correct
6) (1)(1)+(1)(-0.5)+(0)(-1.5)+(0)(1)=0.5 ≥ 0 -> BuyJersey <- Correct
7) (1)(1)+(1)(-0.5)+(1)(-1.5)+(0)(1)=-1 < 0 -> NotBuyJersey <- Correct
8) (1)(1)+(2)(-0.5)+(0)(-1.5)+(1)(1)=1 ≥ 0 -> BuyJersey <- Correct
9) (1)(1)+(2)(-0.5)+(0)(-1.5)+(0)(1)=0 ≥ 0 -> BuyJersey <- Correct
10) (1)(1)+(2)(-0.5)+(1)(-1.5)+(1)(1)=-0.5 < 0 -> NotBuyJersey <- Correct
11) (1)(1)+(2)(-0.5)+(1)(-1.5)+(0)(1)=-1.5 < 0 -> NotBuyJersey <- Correct

Round 6:

1) (1)(1)+(0)(-0.5)+(0)(-1.5)+(1)(1)=2 ≥ 0 -> BuyJersey <- Correct
2) (1)(1)+(0)(-0.5)+(0)(-1.5)+(0)(1)=1 ≥ 0 -> BuyJersey <- Correct
3) (1)(1)+(0)(-0.5)+(1)(-1.5)+(1)(1)=0.5 ≥ 0 -> BuyJersey <- Correct
4) (1)(1)+(0)(-0.5)+(1)(-1.5)+(0)(1)=-0.5 < 0 -> NotBuyJersey <- Correct
5) (1)(1)+(1)(-0.5)+(0)(-1.5)+(1)(1)=1.5 ≥ 0 -> BuyJersey <- Correct
6) (1)(1)+(1)(-0.5)+(0)(-1.5)+(0)(1)=0.5 ≥ 0 -> BuyJersey <- Correct
7) (1)(1)+(1)(-0.5)+(1)(-1.5)+(0)(1)=-1 < 0 -> NotBuyJersey <- Correct
8) (1)(1)+(2)(-0.5)+(0)(-1.5)+(1)(1)=1 ≥ 0 -> BuyJersey <- Correct
9) (1)(1)+(2)(-0.5)+(0)(-1.5)+(0)(1)=0 ≥ 0 -> BuyJersey <- Correct
10) (1)(1)+(2)(-0.5)+(1)(-1.5)+(1)(1)=-0.5 < 0 -> NotBuyJersey <- Correct
11) (1)(1)+(2)(-0.5)+(1)(-1.5)+(0)(1)=-1.5 < 0 -> NotBuyJersey <- Correct