# Homework-4

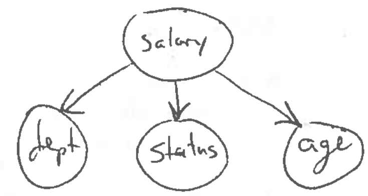
## Question 1

The following table consists of training data from an employee database.

| dept | Salary | |
|---|---|---|
| sales | med | ~~1/3~~ 1/2 |
| system | | ~~1/3~~ 1 |
| mark | | ~~1/3~~ 1/2 |
| sec | | |
| sales | low | 2/3 |
| system | | 0 |
| mark | | 0 |
| sec | | 1/2 |
| sales | high | 0 |
| sys | | 1/2 |
| mark | | 0 |
| sec | | 0 |

| Stat | Sal | |
|---|---|---|
| sr | med | 3/5 |
| jr | | 1/2 |
| sr | low | 0 |
| jr | | 1/2 |
| sr | high | 2/5 |
| jr | | 0 |

| department | status | age | salary |
|---|---|---|---|
| sales | senior | 31-40 | Medium |
| sales | junior | 21-30 | Low |
| sales | junior | 31-40 | Low |
| systems | junior | 21-30 | Medium |
| systems | senior | 31-40 | High |
| systems | junior | 21-30 | Medium |
| systems | senior | 41-50 | High |
| marketing | senior | 31-40 | Medium |
| marketing | junior | 31-40 | Medium |
| secretary | senior | 41-50 | Medium |
| secretary | junior | 21-30 | Low |
| m/h | m/h | m/l | |




$$P(dept/sal)\cdot P(status/sal)\cdot P(age/sal)$$
$\frac{1}{3}$ $\frac{1}{2}$ $\frac{1}{3}$ $P(sal)$ $\frac{6}{11}$

Given an instance with the values: systems, senior, and 21-30 for the attributes department, status, and age, respectively, what would be a naive bayesian classification for the salary of the sample? Medium

$\cancel{\frac{1}{2}\cdot\frac{3}{5}\cdot\frac{1}{2}\cdot\frac{6}{11} = \frac{18}{220} = 0.08}$

$\frac{1}{3}\cdot\frac{1}{2}\cdot\frac{1}{3}\cdot\frac{6}{11} = \frac{6}{198} = 0.03$

## Question 2

You are given the following training data.

| $x$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| label | A | A | A | A | B | A | A | A | A | B | B | B | B | A | B | B | B | B |

**1.** What would be the classification of a test sample with $x = 4.2$ according to 1-NN ?

**Answer:** $A$ / $B$

**2.** What would be the classification of a test sample with $x = 4.2$ according to 2-NN ?

**Answer:** $A$ / $B$ both/tie

**3.** What would be the classification of a test sample with $x = 4.2$ according to 3-NN ?

**Answer:** $A$ / $B$

**4** Use "leave-one-out" cross validation to estimate the error of 1-NN. If you need to choose between two or more examples of identical distance, make your choice so that the number of errors is maximized.

**Answer:** $\frac{?}{18}$ $\{3,4,5,8,9,12,13,14\}$ $\frac{8}{18}$

**5** Use "leave-one-out" cross validation to estimate the error of 2-NN. Whenever you need to make a choice between equal distance data or determining a majority, make your choice so that the number of errors is maximized.

**Answer:** $\frac{?}{18}$ $\{3,4,5,8,9,12,13,14\}$ $\frac{8}{18}$

**6** Use "leave-one-out" cross validation to estimate the error of 3-NN. Whenever you need to make a choice between equal distance data or determining a majority, make your choice so that the number of errors is maximized.

**Answer:** $\frac{?}{18}$ $\{4,8,9,13\}$ $\frac{4}{18}$

**7** Use "leave-one-out" cross validation to estimate the error of 4-NN. Whenever you need to make a choice between equal distance data or determining a majority, make your choice so that the number of errors is maximized.

**Answer:** $\frac{?}{18}$  $\{4,8,9,13\}$  $\frac{4}{18}$

**8** Use "leave-one-out" cross validation to estimate the error of 17-NN. Whenever you need to make a choice between equal distance data or determining a majority, make your choice so that the number of errors is maximized.

**Answer:** $\frac{?}{18}$  $\frac{18}{18}$

$$\begin{pmatrix} -\frac{1}{6} & \frac{2}{6} \end{pmatrix} \begin{bmatrix} 1 & 1 \\ 2 & 1 \\ 1 & 2 \\ 0 & 0 \\ 1 & 0 \\ 2 & 0 \\ 3 & 0 \\ 0 & 3 \\ 3 & 3 \end{bmatrix}$$

| | | |
|---|---|---|
| 1/6 | | |
| 0 | 1 | |
| 1/2 | + | |
| 0 | . | |
| -1/6 | - | |
| -1/3 | - | |
| -1/2 | - | |
| 1 | - | |
| 1/2 | - | |

## Question 3

Consider the following training data:

$P(+) = \frac{3}{9}$

$P(-) = \frac{6}{9}$

| $x_1$ | $x_2$ | $y$ |
|---|---|---|
| 1 | 1 | + |
| 2 | 1 | + |
| 1 | 2 | + |
| 0 | 0 | − |
| 1 | 0 | − |
| 2 | 0 | − |
| 3 | 0 | − |
| 0 | 3 | − |
| 3 | 3 | − |

$\mu_1 = \begin{pmatrix} 4/3 \\ 4/3 \end{pmatrix}$  $\mu_2 = \begin{pmatrix} 9/6 \\ 1 \end{pmatrix}$  $W = \begin{pmatrix} -1/6 \\ 2/6 \end{pmatrix}$

Here is an illustration of the data as 2D points:

| | | | |
|---|---|---|---|
| − | − | − | − |
| . | + | + | . |
| . | + | . | . |
| − | . | . | − |

6

| $-\frac{1}{2}$ | $-\frac{1}{3}$ | $-\frac{1}{6}$ | 0 | 0 | $\frac{1}{6}$ | .5 | .5 | 1 |
|---|---|---|---|---|---|---|---|---|
| − | − | − | − | + | + | + | − | − |

**1.** Assume Gaussian distribution where both covariance matrices are a multiple of the identity matrix (Case 1.). What is the discriminat function?

$b = \frac{1}{2}(-0.306 - 0.7\sigma^2)$

$$\frac{2X_2}{6} - \frac{X_1}{6} + 0$$

**2.** Assume Gaussian distribution where the covariance matrix is the same for both classes (Case 2.). What is the discriminat function?

$$\mu = \begin{pmatrix} 13/9 \\ 10/9 \end{pmatrix} = \begin{pmatrix} 1.44 \\ 1.11 \end{pmatrix} \begin{pmatrix} -.44 \\ -.11 \end{pmatrix} \begin{pmatrix} .56 \\ -.11 \end{pmatrix} \begin{pmatrix} -.44 \\ .89 \end{pmatrix} \cancel{\begin{pmatrix} -1.44 \\ -1.11 \end{pmatrix}} \cancel{\begin{pmatrix} -.44 \\ -1.11 \end{pmatrix}} \cancel{\begin{pmatrix} .56 \\ -1.11 \end{pmatrix}} \cancel{\begin{pmatrix} 1.56 \\ -1.11 \end{pmatrix}} \begin{pmatrix} -1.44 \\ 1.89 \end{pmatrix} \begin{pmatrix} 1.56 \\ 1.89 \end{pmatrix}$$

$$\frac{1}{9}\left( \begin{bmatrix} .1936 & .05 \\ .05 & .012 \end{bmatrix} + \cancel{\begin{bmatrix} 2.07 & 1.6 \\ 1.6 & 1.23 \end{bmatrix}} + \begin{bmatrix} .31 & -.06 \\ -.06 & .012 \end{bmatrix} + \begin{bmatrix} .1936 & -.4 \\ -.4 & 0.8 \end{bmatrix} + \begin{bmatrix} 2.07 & 1.6 \\ 1.6 & 1.23 \end{bmatrix} + \begin{bmatrix} .1936 & .49 \\ .49 & 1.23 \end{bmatrix} + \begin{bmatrix} .31 & -.62 \\ -.62 & 1.23 \end{bmatrix} \right.$$

**3.** Assume equal priors and the most general Gaussian distribution (Case 3). What is the discriminat function?

$$+ \begin{bmatrix} 2.43 & -1.73 \\ -1.73 & 1.23 \end{bmatrix} + \begin{bmatrix} 2.07 & -2.72 \\ -2.72 & 3.57 \end{bmatrix} + \left.\begin{bmatrix} 2.43 & 2.95 \\ 2.95 & 3.57 \end{bmatrix}\right)$$

$$= \begin{bmatrix} 10.2 & -.44 \\ -.44 & 12.88 \end{bmatrix} \frac{1}{9} = \begin{bmatrix} 1.13 & -.05 \\ -.05 & 1.43 \end{bmatrix} = C$$

$$W = \begin{pmatrix} -1/6 \\ 2/6 \end{pmatrix} \begin{pmatrix} .88 & .03 \\ .03 & .7 \end{pmatrix} = \begin{pmatrix} -.136 \\ .228 \end{pmatrix}$$

$$\frac{1}{1.61} \begin{bmatrix} 1.43 & .05 \\ .05 & 1.13 \end{bmatrix} = \begin{bmatrix} 0.88 & .03 \\ .03 & 0.7 \end{bmatrix} = C^{-1}$$

$$.228X_2 - .136X_1 + 0$$

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