Prob-17

Sample	Age	Credit Score	Risk class
S1	25	610	1
S2	30	640	1
S3	35	620	1
S4	40	680	0
S5	45	700	0
S6	50	720	0
T1	33	660	?

Normalise Function

$$x' = \frac{x - x_{min}}{x_{max} - x_{min}}$$

Applying Normalization

Sample	Age	Credit Score	Age (norm)	Score (norm)
S1	25	610	0.00	0.000
S2	30	640	0.20	0.273
S3	35	620	0.40	0.091
S4	40	680	0.60	0.636
S5	45	700	0.80	0.818
S6	50	720	1.00	1.000
T1	33	660	0.32	0.455

using Euclidean Distance to T_1

Sample	Distance to T_1	Class
S2	0.218	1
S4	0.333	0
S3	0.372	1
S1	0.556	1
S5	0.601	0
S6	0.871	0

K=3 → Nearest Neighbors

Top 3 closest:

Sample	Class
S2	1
S4	0
S3	1

Prob-18

From Question 17 We can take K=3

Nearest Neighbors

Top 3 Closest

Sample	Age	Credit Score	Class	Distance of T
S2	30	640	1	0.218
S4	40	680	0	0.333
S3	35	620	1	0.372

Standard k-NN Classification

* Class 1 (Low Risk) : S2, S3 → 2 votes
* Class 0 (High Risk) : S4 → 1 votes

Details

Neighbors	Class	Vote
S2	1 (Low Risk)	1 Vote
S4	0 (High Risk)	1 Vote
S3	1 (Low Risk)	1 Vote

Prediction Class 1 (Low Risk)

Ques no. 19

Hidden State

$S = \{Low, Medium, High\}$

$O = [710, 650, 680]$

$P(Low \rightarrow Low) = 0.7$

$P(Low \rightarrow Medium) = 0.3$

$P(Medium \rightarrow Medium) = 0.6$

$P(High \rightarrow High) = 0.8$

$P(High \rightarrow Medium) = 0.2$

Emission Probabilities

* observation 710: High = 0.8, Medium =
  Low = 0.1
* observation 650: High = 0.1, Medium = 0.8
  Low = 0.3
* observation 680: High = 0.6 Medium = 0.4
  Low = 0.3

$P(Low) = 1/3$

$P(Medium) = 1/3$

$P(High) = 1/3$

$O_1 = 710$

$P(Low, O_1) = P(Low) \times Emission(Low, 710) = 1/3 \times 0.1 = 0.033$

$P(Medium, O_1) = P(Medium) \times Emission(Medium, 710) = 1/3 \times .2 = 0.06$

$P(High, O_1) = P(High) \times Emission(High, 710) = 1/3 \times 0.8 = 0.266$

Next observation

$O_2 = 650, \; O_3 = 680$

~~For~~ For Low

$P(Low, O_2) = max(0.0333 \times 0.7 \times .03, 0.0667 \times 03 \times 0.3,$
$0.2667 \times 0.1 \times 0.3) = 0.0080$

For Medium

$P(Medium, O_2) = max(0.0333 \times 0.3 \times 0.8, 0.0667 \times 0.6 \times 0.8,$
$0.2667 \times 0.2 \times .08) = 0.0427$

For High:

$$P(\text{High}, O_3) = \max(0.0080 \times 0.3 \times 0.6,\ 0.0427 \times 0.4 \times$$
$$0.0213 \times 0.8 \times 0.6)$$

$$= 0.0205$$

max Probability

$\max(0.0029, 0.0077, 0.0205) \Rightarrow$ High

At $t = 3 \longrightarrow$ High

$t = 2 \longrightarrow$ Medium

$t = 1 \longrightarrow$ High

High $\rightarrow$ Medium $\rightarrow$ High

20.

Hidden Status: Low, Medium, High

P(Low → Low) = 0.7, P(Low → Medium) = 0.3

P(Medium → Medium) = 0.6, P(Medium → High) = 0.4

P(High → High) = 0.8, P(High → Medium) = 0.2

Let's define buckets:

* Low Credit Score : <660

* Medium Credit Score: 660-720

* High Credit Score: >720

705 → Medium bucket

645 → Low bucket

Emission[705] = {Low: 0.2, Medium: 0.7, High: 0.1}

Emission [645] = {Low: 0.6, Medium: 0.3, High: 0.1}

$O_1 = 705$

$O_2 = 645$

P(Low) = P(Medium) = P(High) = 1/3

$\alpha_1(\text{Low}) = \frac{1}{3} \times 0.2 = 0.0667$

$\alpha_1(\text{Medium}) = \frac{1}{3} \times 0.7 = 0.2333$

$\alpha_1(\text{High}) = \frac{1}{3} \times 0.1 = 0.0333$

Now

$$\alpha_2(S_j) = \sum_{S_i} \alpha_1(S_i) \times P(S_i \rightarrow S_j) \times P(O_2 | S_j)$$

For Low

$$\alpha_2(\text{Low}) = 0.0667 \times 0.7 \times 0.6 + 0.2333 \times 0 \times 0.6 = 0.0280$$

For Medium

$$\alpha_2(\text{Medium}) = 0.0667 \times 0.3 \times 0.3 + 0.2333 \times 0.6 \times 0.3 + 0.0333 \times 0.2 \times 0.3$$

$$= 0.0500$$

For High

$$\alpha_2(\text{High}) = 0.0667 \times 0 \times 0.1 + 0.2333 + 0.4 \times 0.1 + 0.0333 \times 0.8 \times 0.1$$

$$= 0.0120$$

Total Probability

$$P(\text{sequence}) = \alpha_2(\text{Low}) + \alpha_2(\text{Medium}) + \alpha_2(\text{High})$$

$$= 0.0280 + 0.0500 + 0.0120$$

$$= 0.0900$$

Probability of observing $[705, 645] \approx 0.0900$