Anirban Haldar (12110240) ADA (Tierce-2) Date - 25/10/2021

2)

(i) a) Training set is for model training and test set is for model validation

(ii)
a) (iv) satlin → output → (0,1)
b) (iii) tanh → output → (-1,1)
c) (ii) ReLU → output max (0, a)
d) (i) sigmoid ⇒ output → (0,1)

(iii) (a) ~~One at a time~~. One training sample.

(iv) (d) Activation function.

(v) (1) The first diagram shows underfitting of data.

(vi) (b) ~~[illegible]~~ Sigmoid, so it will ~~output in range 0 to 1, and we can consider 0 as orange and 1 as apple (or vice-versa),~~ ~~and~~

Softmax is used in output layer as it generates a probability distribution.

(vii) the rule is $\left(\sum w * x\right) + b$.

$$\Rightarrow 0.2 \times 0.1 + 0.4 \times (-0.2) + (0.1 \times 0.4) + 0.12$$

$$\Rightarrow (0.02) + (-0.08) + (0.04) + 0.12$$

$$\Rightarrow 0.18 - 0.08$$

$$\Rightarrow 0.1$$

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⟨3⟩ Here in the dataset, we have, 2 Low, 4 High.

⟨a⟩ So, ~~EPS~~ $H(S) = -\frac{2}{6} \cdot \log_2\left(\frac{2}{6}\right) - \frac{4}{6} \cdot \log_2\left(\frac{4}{6}\right)$

$= 0.5283 + 0.38997$

$= 0.91827$

⟨b⟩ If we split it as, age <= 22.5, then

~~age < 22~~

age <= 22.5

True → H H → entropy = 0 (pure)

False → HH LL → entropy = 1 (impure)

So, $IG = H(S) - \frac{|S_1|}{|S|} \cdot H(S_1) - \frac{|S_2|}{|S|} \cdot H(S_2)$

$= 0.91827 - \frac{2}{6} \cdot 0 - \frac{4}{6} \cdot 1$

$= 0.2516$

(IG is quite low, so, not a very good split)

⟨c⟩ If we split as CarType = Sports

True → L L H

False → H H H → Entropy = 0

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for true case entropy will be

$$H(S_1) = -\frac{1}{3} \times \log_2 \frac{1}{3} - \frac{2}{3} \log_2 \frac{2}{3}$$

$$= 0.91827$$

Now,

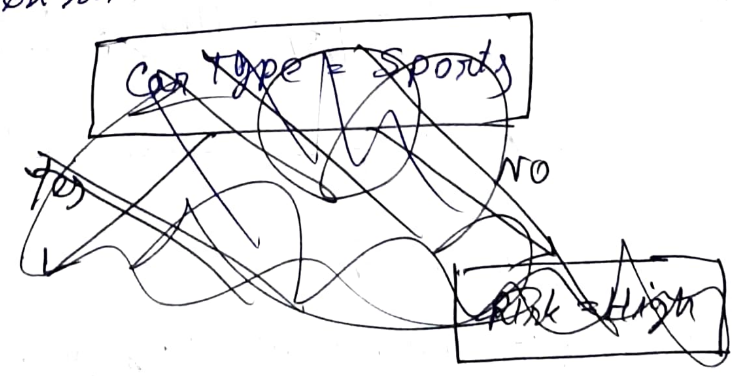
$$I_h = H(S) - \frac{|S_1|}{|S|} \cdot H(S_1) - \frac{|S_2|}{|S|} \cdot H(S_2)$$

$$= 0.91827 - \frac{3}{6} 0.91827 - \frac{3}{6} \cdot 0$$

$$= 0.459135$$

(d) Based on the above two decision criteria, the best choise is to choose CarType = sports, because it has maximum information gain.

The best solution will be,



P.T.O. →

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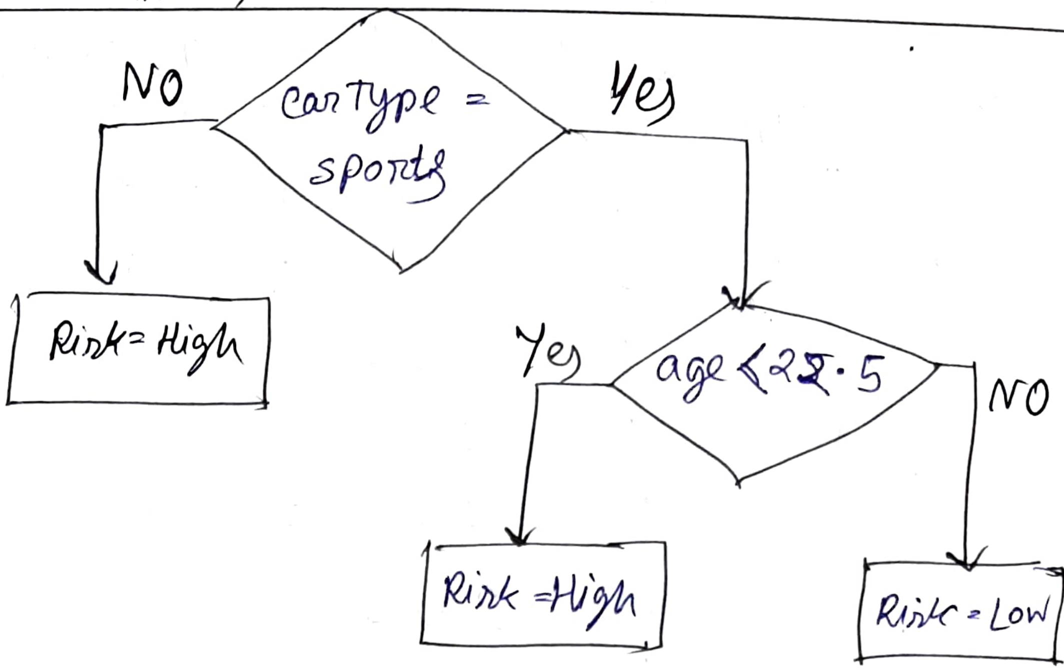


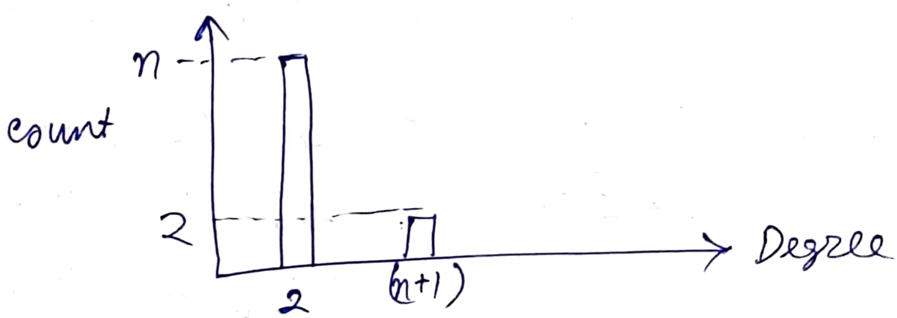
4)

(a) Here both nodes Bhilai and Raipur will have degree $= (n+1)$

and each city (from 1 to n) will have degree $= 2$.

then, the distribution will be,

$$\{2, 2, 2, \ldots n \text{ times}, (n+1), (n+1)\}$$



Now, the mean will be,

$$\frac{n \times 2 + 2 \times (n+1)}{(n+2)} = \frac{4n+2}{n+2}$$

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(b) The adjacency matrix will be a sparse matrix as,

	Raipur	Bhilai	1	2	3	4	5	6	...
Raipur	0	1	1	1	1	1	1	1	...
Bhilai	1	0	1	1	1	1	1	1	...
1	1	1	0	0	0	0	0	0	...
2	1	1	0	0	0	0	0	0	...
3	1	1	0	0	0	0	0	0	...
4	1	1	0	0	0	0	0	0	...
5	1	1	0	0	0	0	0	0	...
6	1	1	0	0	0	0	0	0	...
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	

(c) Clustering coefficient,

$\Rightarrow C_{Bhilai} = \dfrac{2\times n}{n\cdot(n+1)}$ Here, the neighbours of bhilai = {raipur, 1, 2, 3, ... n} and the no of edges between them will be, raipur → to all 1, 2, 3, ... n = n

$\Rightarrow C_1 = \dfrac{2\times 1}{2\times 1}$ The neighbours of 1 = {raipur, bhilai} and there are only one edge between them

$= 1$

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(d) We can calculate betweenness of bhilai as,

$\Rightarrow$ Raipur to all city have shortest path as direct path, so, contribution $= 0$.

$\Rightarrow$ 1 to all $(2 \dots n) \Rightarrow$ each will contribute $\frac{1}{2}$, because both via raipur & bhilai are shortest.

So, betweenness of bhilai

$$= \cancel{\frac{n(n-1)}{2}} = \frac{n \cdot (n-1)}{2} \times \frac{1}{2}$$

Here, the graph is symmetrical for both bhilai & raipur's prerspective. So, both will have same betweenness.

(1)
(a) The minimum price will be,

$$P = c_1 * \max\left(\frac{L}{10}, 50\right) - c_2 * \min(D, 30) + 1000$$

$$= 100 \times 50 - 100 * 0 + 1000$$

min is achieved for $D = 30$

[Consider we are buying ticket ~~dody~~, today, so $D = 0$]

$$= 5000 + 1000 = 6000$$

$$-3000 \qquad -3000 = 3000.$$

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(b) If we calculate, $\nabla_e P$, then,

$$\cancel{\frac{\partial p}{\partial c_1} = \max \Big/ \frac{\partial p}{\partial e_2} = 1}$$

$$\frac{\partial P}{\partial e_1} = \max\left(\frac{L}{10}, 50\right) \qquad \frac{\partial P}{\partial e_2} = -\min(D, 30)$$

so, $$\nabla_e P = \begin{bmatrix} \max\left(\frac{L}{10}, 50\right) \\ -\min(D, 30) \end{bmatrix}$$

again, $$\begin{bmatrix} e_1 \\ e_2 \end{bmatrix} = \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} \pm 0.01 \begin{bmatrix} \max\left(\frac{L}{10}, 50\right) \\ -\min(D, 30) \end{bmatrix}$$

By analysing the price equation,

$\Rightarrow$ price will be higher, if L is high.

$\Rightarrow$ Price will be higher if D is short.

Now, e_1 controls the Distance (L). so, if a person buys, then we update

$$e_1 = e_1 + 0.01 \times (\partial e_1)$$

which actually increases the e_1 so, ultimately the term $e_1 \cdot \max\left(\frac{L}{10}, 50\right)$ will be high and try to increase price.

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again, if a person buys,

$$c_2 = c_2 + 0.01 \times c_2 \cdot \underbrace{(\partial c_2)}_{(-ve)}$$

so, ultimatly c_2 will decrease, which decrease the $\underbrace{-c_2 \cdot \min(D, 30)}$ term, which will again increase the price

So, finally, both upgradation tends to increase the ticket price by some factor by increasing c_1 and decreasing c_2.

Similarly, if a person rejects any ticket, then the ~~sign~~ sign will switch, resulting decrease in price.

(c)

(D, L)	Price Q	status	(c_1, c_2) $(10, 100)$
$(10, 1000)$	$10 \times 100 - 100 \times 10 + 1000 = \underline{1000}$	NO	$\rightarrow \begin{bmatrix} 10 - 0.01 \times 100 \\ 100 + 0.01 \times 10 \end{bmatrix} \Rightarrow \underline{(9, 100.1)}$
$(45, 400)$	$9 \times 50 - 100.1 \times 30 + 1000 = \underline{-1553}$	yes	$\rightarrow \begin{bmatrix} 9 + 0.01 \times 50 \\ 100.1 - 0.01 \times 30 \end{bmatrix} \Rightarrow \underline{(9.5, 99.8)}$

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(e) Revised

(D, L)	Price Q	Status	(Q_1, Q_2) $(100, 100)$
(10, 1000)	$100\times100 - 100\times10 + 1000 = \underline{10000}$	No	$\begin{bmatrix}100 - 0.01\times100 \\ 100 + 0.01\times10\end{bmatrix} = \underline{(99, 100.1)}$
(40, 400)	$99\times50 - 100.1\times30 + 1000 = \underline{2947}$	Yes	$= \begin{bmatrix}99 + 0.01\times50 \\ 100.1 - 0.01\times30\end{bmatrix} = \underline{(99.5, 99.8)}$