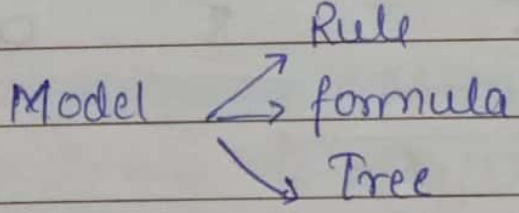
Unit-02

Basic concepts- Classification

Classification Process:- It is a data mining technique / functionality that classifies or categorizes a given test data / given test tuple into a particular category (class)

It has 2 steps:-

1) Model Building step (Training the model)
2) Testing the model or evaluating the performance of the model that is built



Classification accuracy is the measure of accuracy of the classification of a concept that is given by a certain theory.

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Naive Bayes Classifier

→ It is based on Bayes Theorem

→ $P(A|B) = \frac{P(B|A)\,P(A)}{P(B)}$

- $P(A|B)$ → posterior probability
- $P(B|A)$ → predictor probability given the class
- $P(A)$ → prior probability of the class
- $P(B)$ → prior predictor probability
- A → class label
- B → predictor variables

Data:	Cold	Temp	Body_Pain	Class (F/M)
	Y	H	S	F
	N	H	M	M
	N	M	L	M
	Y	L	L	M

Y-yes N-no

M-moderate L-low

S-severe H-high

F-flu M-malaria.

Test: (yes, Moderate, Moderate)

It is called as naive because

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i) it assumes all attributes are independent
→ i.e changing value of any one of the attr doesn't change other
ii) it assumes equal priority for all attributes

$$P(F|B) = \frac{P(C|F) * P(T|F) * P(BP|F) \times P(F)}{P(C) \times P(T) \times P(BP)}$$

$$P(M|B) = \frac{P(C|M) \times P(T|M) \times P(BP|M) \times P(M)}{P(C) \times P(T) \times P(BP)}$$

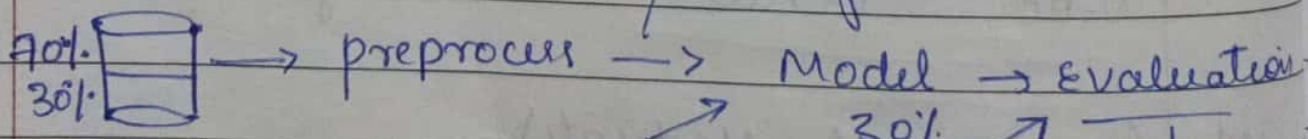
Tuples = 9
Flu = 5
M = 4

Cold: (5: yes)(4: No)

	F	M
yes	4	1
No	1	3

Both for classification & regression

K-nn



↳ Eages learner
Lazy learner – No training only test.

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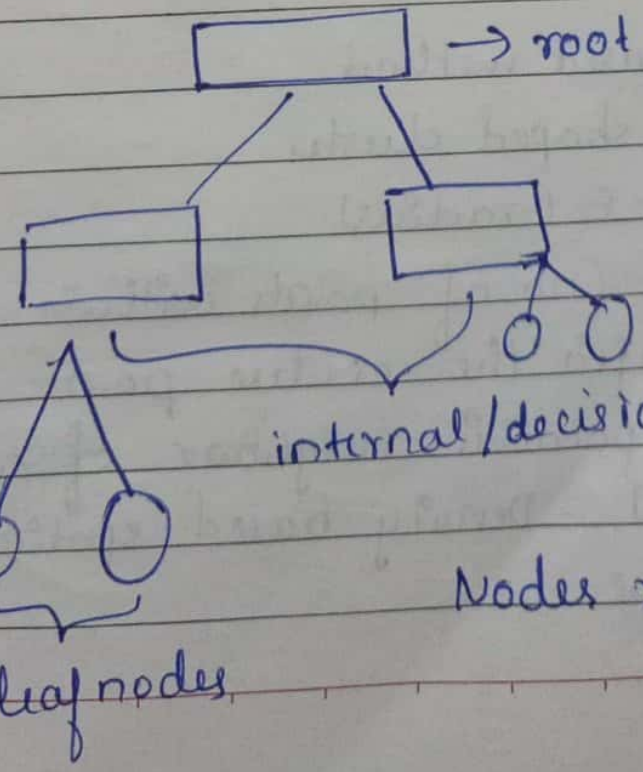
Decision tree Induction

→ Model: Decision tree, mathematical formula, Rule
→ When domain knowledge is not required
→ Construction of decision tree doesn't require domain knowledge
→ We can work on high dimensional data
→ Building of tree is simple & fast
→ Visual representation of tree is easy to understand
→ decision rules infered from the tree " " "



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* Clustering (Image processing, pattern recognition
→ Unsupervised Business Intelligence, Websearch

Partioning method
→ Grouping of objects takes place iteratively the cluster objects will be changed based on iterative relocation technique
→ Useful for small to med size datasets
→ Data transformation is necessary in pre-processing
Eg: K-means

Hierarchial Method
1) Bottom up 2) Top down.
→ Once grouped can't be undone in BU
Ex: Agglomerative

Density based method
→ Random shaped clusters
→ Epsilon - ε (radius)
Minpts - (no of points within circle of radius
If satisfies the centre point is core point
Border point is neighbor of core point
DBSCAN - Density based spatial clustering app
with noise

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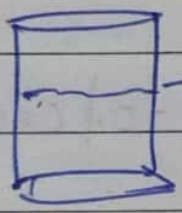
K-NN

→ Lazy learner

→ Data is stored in memory & used only during testing so it's called memory-based classifier

→ It is uses train data when test instance comes into picture. so it's called instance based. classifieder

Eager learners :-



→ preprocessing → Quality data → Model training →

Raw data

Evaluation

↓

accuracy

* Similarity measure / similarity metric

Distance → Manhattan

→ Euclidean

K = no. of neighbors

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$d(p,q) = \sqrt{(x_1-x_2)^2+(y_2-y_1)^2}$ Euclid

$d(p,q) = |x_1-x_2| + (y_1-y_2|$ Manhattan

$k = \sqrt{\text{No. of data points}}$

Cons.

It is very slow when no. of records & dimension is more

Whole data in memory (expensive)

Scaling of attributes is needed

Pros

Simple & easy to understand

No assumptions is made and is called non-parametric

App's.

Image Recognition

Handwriting "

Speech "

List of sandioning loan

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Decision Tree:

Top down recursive divide & conquer - construction of tree.

Information Gain
Gain Ratio
Gini Index.

Decision tree induction.

Attribute selection measure:-

* It minimizes the info or expects no of tests that need to classify a tuple to particular class.

Info gain = Info before partition − Info after partition

(no. of bits used to transfer 'x' from sample)

Entropy
(measure of uncertainty / impurity)

$$H(x) = -\sum_{i=1}^{n} p_i \log_2 p_i$$

$$0 \leq H(x) \leq 1$$

↓ varied distn

↳ impure (large no of attr)

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$$H(x) = -\sum_{i=1}^{n} P_i \log_2 P_i$$

N = 14

yes = 9

No = 5.

$$\text{Info}(D) = H(x) = +\left(\frac{9}{14} \log_2 \frac{9}{4} + \frac{5}{14} \log_2 \frac{5}{14} \right) = 0.940$$

$$\text{After partition} = \sum_{j=1}^{v} \frac{|D_j|}{|D|} \text{Info}(D_j)$$

Info gain = Info before partiation / Entropy / H(x) / Info(D) − Info after partition.

$$= -\sum_{i=i}^{n} P_i \log_2 P_i - \left(\sum_{j=1}^{v} \frac{|D_j|}{D} \text{Info}|D_j| \right)$$

For age

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|D|- Total no of tuple
Dj - No of tuple with attribute

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RID	Age	Income	student	CreditRating	Class
1	Y	H	No	Fair	Yes
2	M-A	M	Yes	Excellent	No
3	S	L			

$$\text{Gain(age)} = H(x) - \sum_{j=1}^{v} \frac{|D_j|}{|D|} \text{Info}(D_j)$$

$= 0.940$

Age — Y N — $\text{Info}(2,3) = \frac{5}{14}\left(\frac{2}{5}\log_2\frac{2}{5} + \frac{3}{5}\log_2\frac{3}{5}\right)$

Youth = 5 — (2, 3)

MA = 4 — (4, 0) — $= \frac{4}{14} - \left(\frac{4}{4}\log_2\frac{4}{4} + \frac{0}{4}\log_2\frac{0}{4}\right)$

S = 5 — (3, 2)

$= \{0.940 - 0.694\}$ — $= \frac{5}{14} - \left(\frac{3}{5}\log_2\frac{3}{5} + \frac{2}{5}\log_2\frac{2}{5}\right)$

$= \{0.246 \text{ bits}\}$

Gain (age) = 0.246 bits (1) - root
Gain (Income) = 0.029 bits
Gain (student) = 0.151 bits (2)
Gain (credit rating) = 0.048 bits

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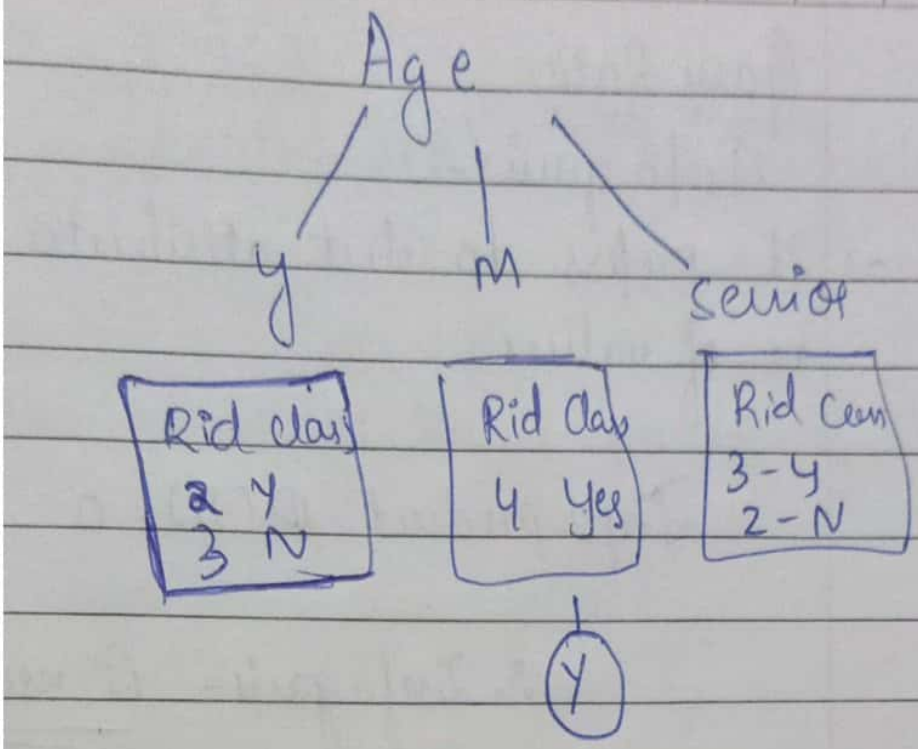

Rules.

→ Traverse from root to leaf

→ If ( ) then

sum

{

leaf nodes no = no. of rules.

Accuracy = $\frac{n_{correct}}{n_{covers}}$

$Coverage_{(R_i)} = \frac{n_{covers}}{|D|}$ ← for every rule

↳ Total tuple

↳ Tuples satisfying rule

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Gain Ratio

Info gain :-

→ It prefers to select attributes having larger no. of values.

Info product - ID(D) = 0

∴ Info gain = is max

but useless

Gain Ratio:

It uses extension of info gain called gain ratio (C4.5 successor of ID3)

$$\text{Split Info}_A(D) = -\sum_{j=1}^{v} \frac{|D_j|}{D} \times \log_2 \frac{|D_j|}{D}$$

↳ applies normalization to info gain using a "

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GainRatio = $\frac{\text{Gain}(A)}{\text{SplitInfo}_A(D)}$ — o (unstable)

Gini Index: Measures the impurity of D

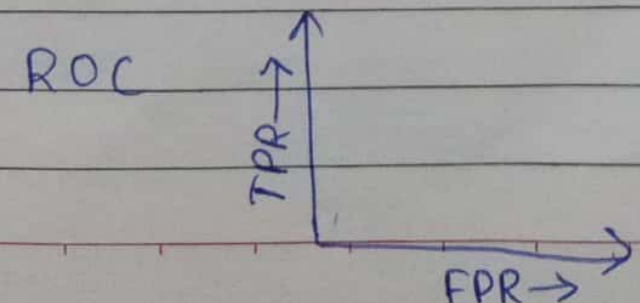
$$Gini(D) = 1 - \sum_{i=1}^{m} p_i^2$$

$$Gini_A(D) = \frac{|D_1|}{|D|} Gini(D_1) + \frac{|D_2|}{D} Gini(D_2)$$

$$\Delta Gini(A) = Gini(D) - Gini_A(D)$$

ROC curve

Actual \ Predicted	Y	N
Y	TP	FN
N	FP	TN



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Sensitivity

$$TPR = \frac{TP}{TP + FN}$$

Specificity

$$TNR = \frac{TN}{FP + TN}$$

$$FPR = \frac{FP}{FP + TN}$$

1 - specificity = FPR

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UPMP 3) $P(A=1 \mid C=c1)$

$$= \frac{P(c1/A=1)}{P(c1)} = \frac{4/10}{6/10}$$

$$P(A=0 \mid C=c1) = \frac{2/10}{6/10}$$

$$P(B=1 \mid C=c1) = \frac{4/10}{6/10} \qquad P(B=0 \mid C=c1) = \frac{2/10}{6/10}$$

$$P(A=1 \mid C=c2) = \frac{1/10}{4/10} \qquad P(A=0 \mid C=c2) = \frac{3/10}{4/10}$$

$$P(B=1 \mid C=c2) = \frac{0/10}{4/10} \qquad P(B=0 \mid C=c2) = \frac{4/10}{4/10}$$

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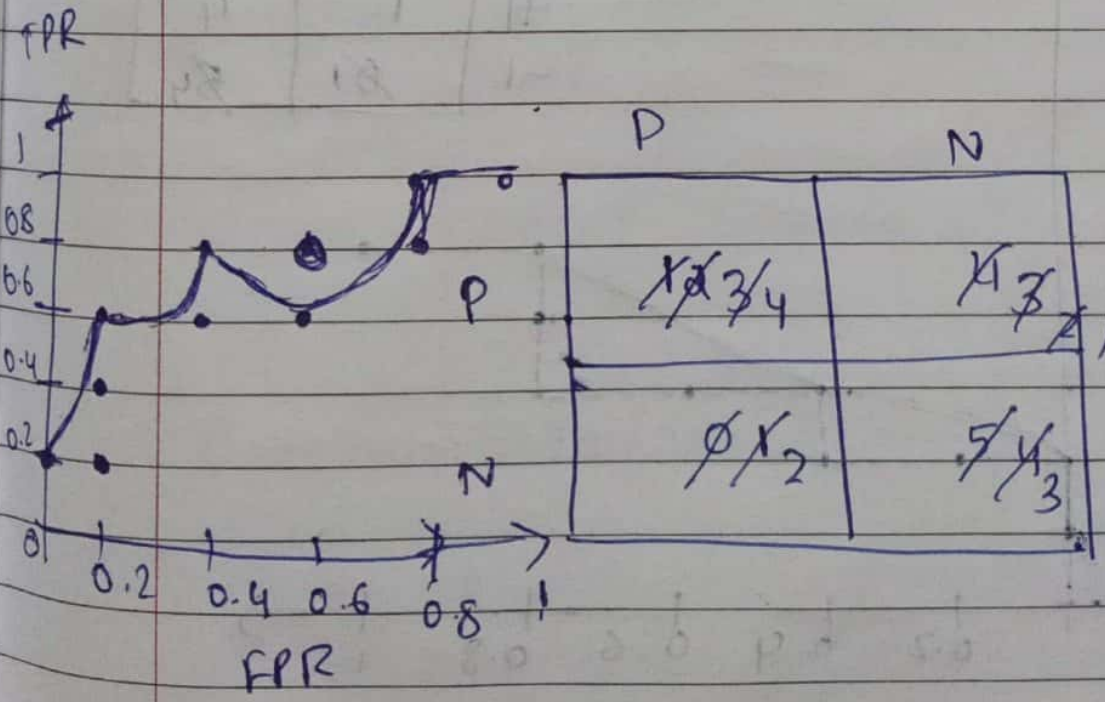
1P3.

class	prob	TP	FP	TN	FN	TPR	FPR
P	0.95	1	0	5	4	0.2	0
N	0.85	1	1	4	4	0.2	0.2
P	0.78	2	1	4	3	0.4	0.2
P	0.66	3	1	4	2	0.6	0.2
N	0.60	3	2	3	2	0.6	0.4
P	0.55	4	2	3	1	0.8	0.4
N	0.53	4	3	2	1	0.8	0.6
N	0.52	4	4	1	1	0.8	0.8
N	0.51	4	5	0	1	0.8	1
P	0.40	5	5	0	0	1	1



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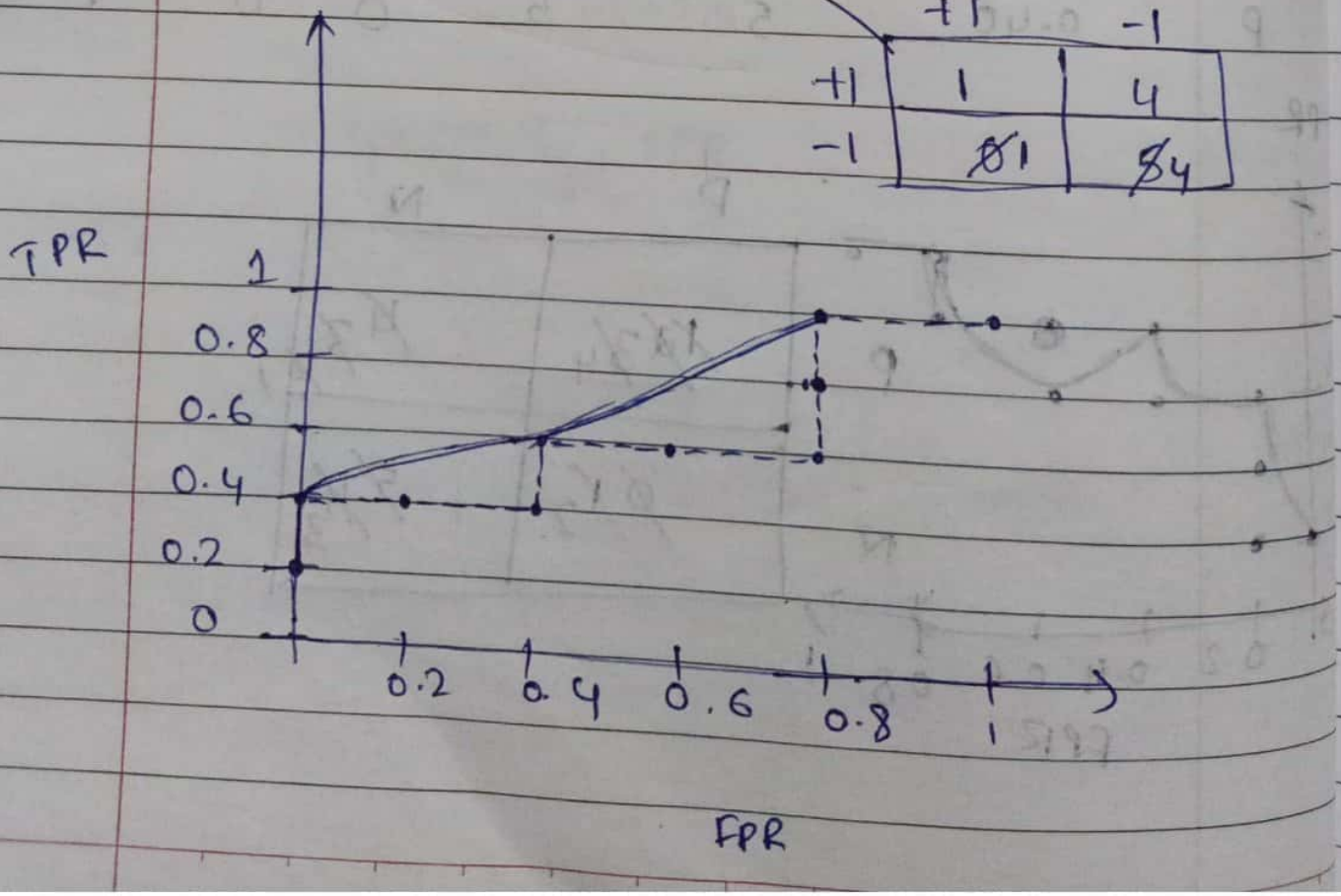
P	class	TP	FP	TN	FN	TPR	FPR
0.95	+1	1	0	5	4	0.2	0
0.94	+1	2	0	5	3	0.4	0
0.87	-1	2	1	4	3	0.4	0.2
0.86	-1	2	2	3	3	0.4	0.4
0.86	+1	3	2	3	2	0.6	0.4
0.86	-1	3	3	2	2	0.6	0.6
0.76	-1	3	4	1	2	0.6	0.8
0.53	+1	4	4	1	1	0.8	0.8
0.44	-1	4	5	0	1	0.8	1
0.25	+1	5	5	0	0	1	1

	+1	-1
+1	1	4
-1	~~1~~	~~4~~



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3b

TP = 100

FN = 40

TN = 300

FP = 60

Precision = $\frac{TP}{\text{predicted yes}}$

$= \frac{TP}{FP + TP}$

Accuracy = $\frac{TP + TN}{TP + TN + FP + FN}$

TPR / Sensitivity / Recall $= \frac{TP}{TP + FN}$

Specificity $= \frac{TN}{TN + FP}$

Precision $= \frac{TP}{TP + FP}$

FPR = 1 - specificity $= \frac{FP}{TN + FP}$

f-measure = $2a / 2a + b + c$

a - TP

b - FN

c - FP

d - TN

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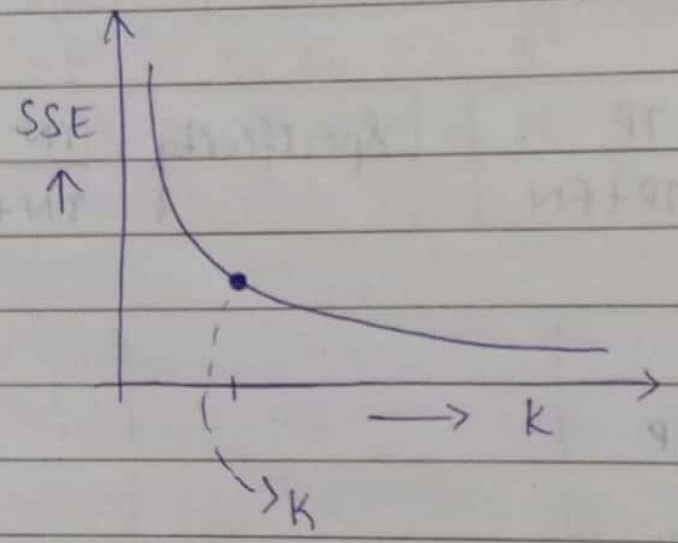
K-means

→ Initial guess as to cluster centroids
→ Defined distance metric
→ No. of clusters
→ Rescaling is required as distance is calculated

k value can be obtained from plotting K v/s SSE (sum of squared errors)



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K-means: Assignment

Manhattan

1. K=3

$C_1 = \{x_1, x_2, x_3\}$ $C_2 = \{x_4, x_5, x_6\}$ $C_3 = \{x_7, x_8\}$

$C_1 = \left\{\left(\frac{2+2+8}{3}\right), \left(\frac{10+5+4}{3}\right)\right\} = C_1 = (4, 6.33)$

$C_2 = \left(\frac{5+7+6}{3}, \frac{8+5+4}{3}\right) = (6, 5.67)$

$C_3 = \left(\frac{1+4}{2}, \frac{2+9}{2}\right) = (2.50, 5.50)$

Iteration 2

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
C_1	5.67	3.33	6.33	2.67	4.33	7.33	7.33	2.67
C_2	8.33	4.67	3.67	3.33	1.67	1.67	8.67	5.3
C_3	5	1	7	5	5	5	5	5
Cluster	C_3	C_3	C_2	C_1	C_2	C_2	C_3	C_1

Calculation

$C_1, x_1 = |4-2| + |6.33-10| = 5.67$

$C_1, x_2 = |4-2| + |6.33-5| = 3.33$

$C_1, x_3 = |4-8| + |6.33-4| = 6.33$

$C_1, x_4 = |4-5| + |6.33-8| = 2.67$

$C_1, x_5 = |4-7| + |6.33-5| = 4.33$

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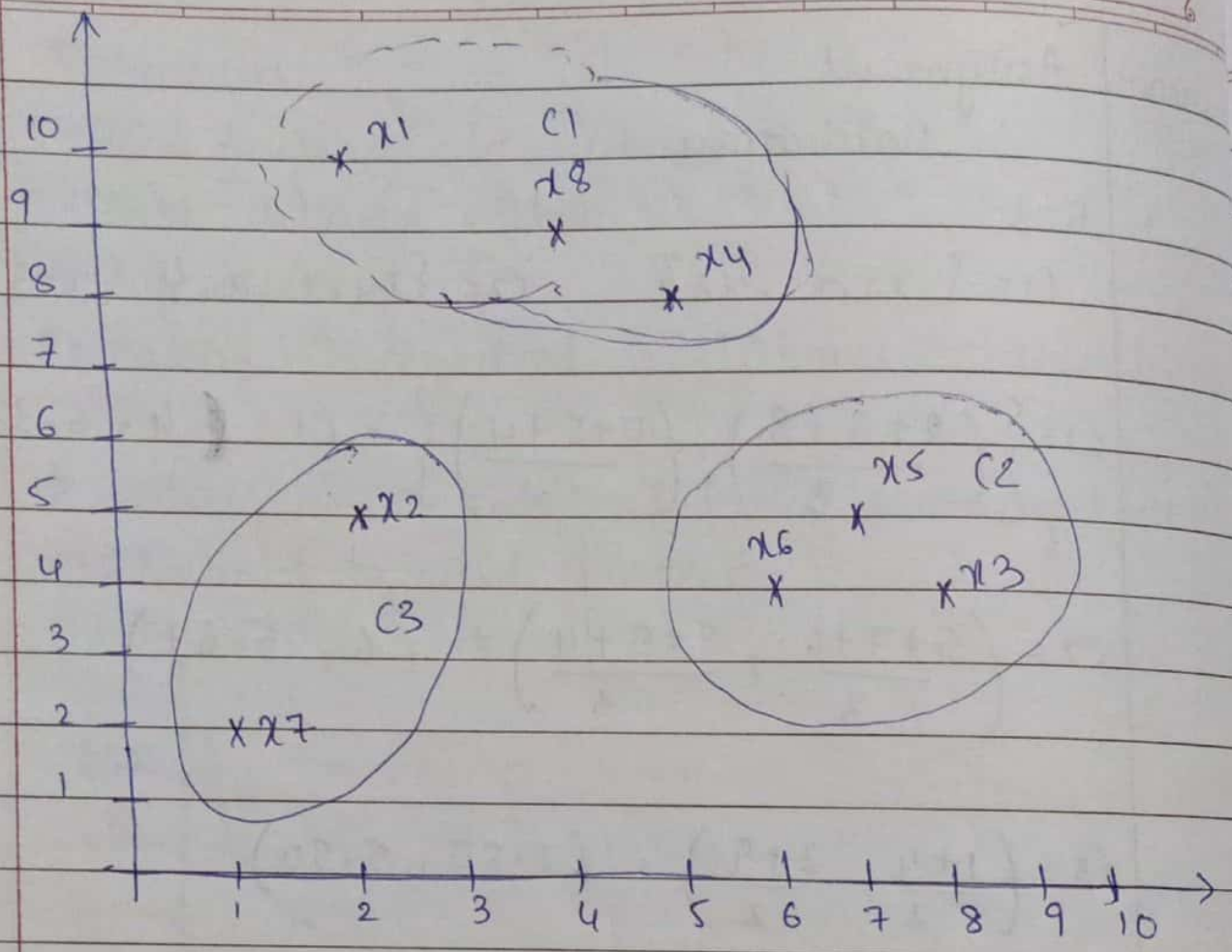

$C_1, x_6 = |4-6| + |6.33-4| = 4.33$

$C_1, x_7 = |4-1| + |6.33-2| = 7.33$

$C_1, x_8 = |4-4| + |6.33-9| = 2.67$

$C_2, x_1 = |6-2| + |5.67-10| = 8.33$

$C_2, x_2 = |6-2| + |5.67-5| = 4.67$

$C_2, x_3 = |6-8| + |5.67-4| = 3.67$

$C_2, x_4 = |6-5| + |5.67-8| = 3.33$

$C_2, x_5 = |6-7| + |5.67-3| = 1.67$

$C_2, x_6 = |6-6| + |5.67-4| = 1.67$

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$C_2, x_7 = |6 - 1| + |5.67 - 2| = 8.67$

$C_2, x_8 = |6 - 4| + |5.67 - 9| = 5.33$

$C_3, x_1 = |2.5 - 2| + |5.5 - 10| = 5$

$C_3, x_2 = |2.5 - 2| + |5.5 - 5| = 1$

$C_3, x_3 = |2.5 - 8| + |5.5 - 4| = 7$

$C_3, x_4 = |2.5 - 5| + |5.5 - 8| = 5$

$C_3, x_5 = |2.5 - 7| + |5.5 - 5| = 5$

$C_3, x_6 = |2.5 - 6| + |5.5 - 4| = 5$

$C_3, x_7 = |2.5 - 1| + |5.5 - 2| = 5$

$C_3, x_8 = |2.5 - 4| + |5.5 - 9| = 5$

Iteration 2

$C_1 = \{x_4, x_8\}$

$C_2 = \{x_3, x_5, x_6\}$

$C_3 = \{x_1, x_2, x_7\}$

$$C_1 = \left(\frac{5+4}{2}, \frac{8+9}{2}\right) = (4.50, 8.5)$$

$$C_2 = \left(\frac{8+7+6}{3}, \frac{4+5+4}{3}\right) = (7, 4.33)$$

$$C_3 = \left(\frac{2+2+1}{3}, \frac{10+5+2}{3}\right) = (1.67, 5.67)$$

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	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
C1	4	6	8	1	6	6	10	1
C2	10.67	5.67	1.33	5.67	0.67	1.33	8.33	7.67
C3	4.66	1	8	5.66	6	6	4.34	5.34
Clusters	C1	C3	C2	C1	C2	C2	C3	C1

$C_1, x_1 = |4.5 - 2| + |8.5 - 10| = 4$

$C_1, x_2 = |4.5 - 2| + |8.5 - 5| = 6$

$C_1, x_3 = |4.5 - 8| + |8.5 - 4| = 8$

$C_1, x_4 = |4.5 - 5| + |8.5 - 8| = 1$

$C_1, x_5 = |4.5 - 7| + |8.5 - 5| = 6$

$C_1, x_6 = |4.5 - 6| + |8.5 - 4| = 6$

$C_1, x_7 = |4.5 - 1| + |8.5 - 2| = 10$

$C_1, x_8 = |4.5 - 4| + |8.5 - 9| = 1$

$C_2, x_1 = |7 - 2| + |4.33 - 10| = 10.67$

$C_2, x_2 = |7 - 2| + |4.33 - 5| = 5.67$

$C_2, x_3 = |7 - 8| + |4.33 - 4| = 1.33$

$C_2, x_4 = |7 - 5| + |4.33 - 8| = 5.67$

$C_2, x_5 = |7 - 7| + |4.33 - 5| = 0.67$

$C_2, x_6 = |7 - 6| + |4.33 - 4| = 1.33$

$C_2, x_7 = |7 - 1| + |4.33 - 2| = 8.33$

$C_2, x_8 = |7 - 4| + |4.33 - 9| = 7.67$

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0.33 4.33

$C3,x_1 = |4.67 - 2| + |5.67 - 10| = 4.66$

$C3,x_2 = |4.67 - 2| + |5.67 - 5| = 1$

$C3,x_3 = |4.67 - 8| + |5.67 - 4| = 8$

$C3,x_4 = |1.67 - 5| + |5.67 - 8| = 5.66$ (6.33, 3.33)

$C3,x_5 = |1.67 - 7| + |5.67 - 5| = 6$

$C3,x_6 = |1.67 - 6| + |5.67 - 4| = 6.$ (4.33)

$C3,x_7 = |1.67 - 1| + |5.67 - 2| = 4.34$

$C3,x_8 = |1.67 - 11| + |5.67 - 9| = 5.66$ (2.33, 3.33)

Iteration 3 $C1 = (x_1, x_4, x_8)$ $C2 = (x_3, x_5, x_6)$ $C3 = (x_2, x_7)$

$C1 = (2+5+4/3, 10+8+9/3)$

$C2 = (8+7+6/3, 4+5+4/3)$

$C3 = (2+1/2, 5+2/2)$

$C1 = (3.67, 9)$

$C2 = (7, 4.33)$

$C3 = (1.5, 3.5)$

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
C1	2.67	5.67	9.33	2.33	7.33	7.33	9.67	0.33
C2	10.67	5.67	1.33	5.67	0.67	1.33	8.33	7.67
C3	7	2	7	8	7	5	2	8
Cluster	C1	C3	C2	C1	C2	C2	C3	C1

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$C_1,x_1 = 3.67 - 2 + 9 - 10 = 2.67$

$C_1,x_2 = 11 - 2 + 9 - 5 = 5.67$

$C_1,x_3 = 11 - 8 + 9 - 4 = 9.33$

$C_1,x_4 = 3.67 - 5 + 9 - 8 = 2.33$

$C_1,x_5 = 3.67 - 7 + 9 - 5 = 7.33$

$C_1,x_6 = 3.67 - 6 + 9 - 4 = 7.33$

$C_1,x_7 = 3.67 - 1 + 9 - 2 = 9.67$

$C_1,x_8 = 3.67 - 4 + 9 - 9 = 0.33$

$C_2,x_1 = 7 - 2 + 4.33 - 10 = 10.67$

$C_2,x_2 = 7 - 2 + 4.33 - 5 = 5.67$

$C_2,x_3 = 7 - 8 + 4.33 - 4 = 1.33$

$C_2,x_4 = 7 - 5 + 4.33 - 8 = 5.67$

$C_2,x_5 = 7 - 7 + 4.33 - 5 = 0.67$

$C_2,x_6 = 7 - 6 + 4.33 - 4 = 1.33$

$C_2,x_7 = 7 - 1 + 4.33 - 2 = 8.33$

$C_2,x_8 = 7 - 4 + 4.33 - 9 = 7.67$

$C_3,x_1 = 1.5 - 2 + 3.5 - 10 = 7$

$C_3,x_2 = 1.5 - 2 + 3.5 - 5 = 2$

$C_3,x_3 = 1.5 - 8 + 3.5 - 4 = 7$

$C_3,x_4 = 1.5 - 5 + 3.5 - 8 = 8$

$C_3,x_5 = 1.5 - 7 + 3.5 - 5 = 7$

$C_3,x_6 = 1.5 - 6 + 3.5 - 4 = 5$

$C_3,x_7 = 1.5 - 1 + 3.5 - 2 = 2$

$C_3,x_8 = 1.5 - 4 + 3.5 - 9 = 8$

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Let no. of clusters = $\sqrt{\frac{n}{2}}$

Each cluster has = $\sqrt{2n}$ points

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Krishna

Ch-P (HP)

	x	y
⑦ P_1	1	2
P_2	1.5	1.5
P_3	2	1.5
P_4	5	1.5
P_5	4.5	2
P_6	2.5	7
P_7	3	6.5

d = Manhatan

$d(P_1P_2) = |1-1.5| + |2-1.5| = 1$

$d(P_1P_3) = 1 + 0.5 = 1.5$

$d(P_1P_4) = 4 + 0.5 = 4.5$

$d(P_1P_5) = 3.5 + 0 = 3.5$

$d(P_1P_6) = 1.5 + 5 = 6.5$

$d(P_1P_7) = 2 + 4.5 = 6.5$

$d(P_2P_3) = 0.5$

$d(P_2P_4) = 3.5$

$d(P_2P_5) = 3 + 0.5 = 3.5$

$d(P_2P_6) = 1 + 5.5 = 6.5$

$d(P_2P_7) = 1.5 + 5 = 6.5$

$d(P_3P_4) = 3 + 0 = 3$

$d(P_3P_5) = 2.5 + 0.5 = 3$

$d(P_3P_6) = 0.5 + 5.5 = 6$

$d(P_3P_7) = 1 + 5 = 6$

$d(P_4P_5) = 0.5 + 0.5 = 1$

$d(P_4P_6) = 2.5 + 5.5 = 8$

$d(P_4P_7) = 2 + 5 = 7$

$d(P_5P_6) = 2 + 5 = 7$

$d(P_5P_7) = 1.5 + 4.5 = 6$

$d(P_6P_7) = 0.5 + 0.5 = 1$

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Single linkage

	P_1	P_2	P_3	P_4	P_5	P_6	P_7
P_1	0						
P_2	1	0					
P_3	1.5	0.5	0				
P_4	4.5	3.5	3	0			
P_5	3.5	3.5	3	1	0		
P_6	6.5	6.5	6	8	7	0	
P_7	6.5	6.5	6	7	6	1	0

P_3P_2 → New cluster

	P_1P_2	P_2P_3	P_4	P_5	P_6	P_7
P_1P_2	0					
P_2P_3	1	0				
P_4	4.5	3	0			
P_5	3.5	3	1	0		
P_6	6.5	6	8	7	0	
P_7	6.5	6	7	6	1	0

$P_1P_2P_3$ → New cluster

	$P_1P_2P_3$	P_4	P_5	P_6	P_7
$P_1P_2P_3$	0				
P_4	3	0			
P_5	3	1	0		
P_6	6	8	7	0	
P_7	6	7	6	1	0

P_4P_5 → New

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	$P_1P_2P_3$	P_4P_5	P_6	P_7
$P_1P_2P_3$	0			
P_4P_5	3	0		
P_6	6	7	0	
P_7	6	6	(1)	0

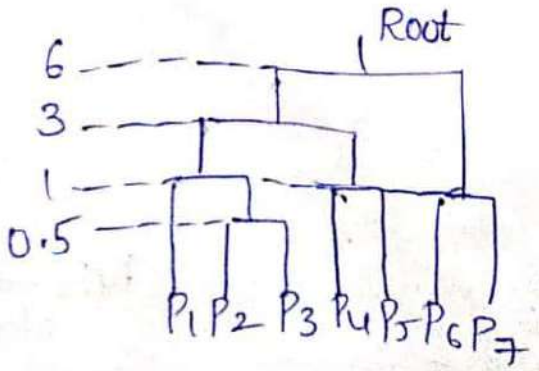
$P_6P_7 \rightarrow$ NIC

	$P_1P_2P_3$	P_4P_5	P_6P_7
$P_1P_2P_3$	0		
P_4P_5	(3)	0	
P_6P_7	6	6	0

$P_1P_2P_3P_4P_5 \rightarrow$ N-C

	$P_1P_2P_3P_4P_5$	P_6P_7
$P_1P_2P_3P_4P_5$	0	
P_6P_7	(6)	0

$P_1P_2P_3P_4P_5P_6P_7 \rightarrow$ One cluster



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Complete linkage (max dist)

	P_1	P_2P_3	P_4	P_5	P_6	P_7
P_1	0					
P_2P_3	1.5	0				
P_4	4.5	3.5	0			
P_5	3.5	3.5	(1)	0		
P_6	6.5	6.5	8	7	0	
P_7	6.5	6.5	7	6	1	0

$P_4P_5 \rightarrow N.C$

	P_1	P_2P_3	P_4P_5	P_6	P_7
P_1	0				
P_2P_3	1.5	0			
P_4P_5	4.5	3.5	0		
P_6	6.5	6.5	8	0	
P_7	6.5	6.5	7	(1)	0

$P_6P_7 \rightarrow NC$

	P_1	P_2P_3	P_4P_5	P_6P_7
P_1	0			
P_2P_3	(1.5)	0		
P_4P_5	4.5	3.5	0	
P_6P_7	6.5	6.5	8	0

$P_1P_2P_3 \rightarrow N.C$

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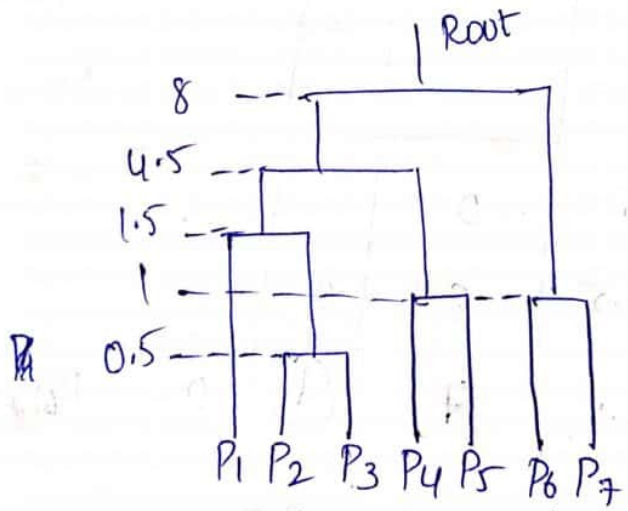
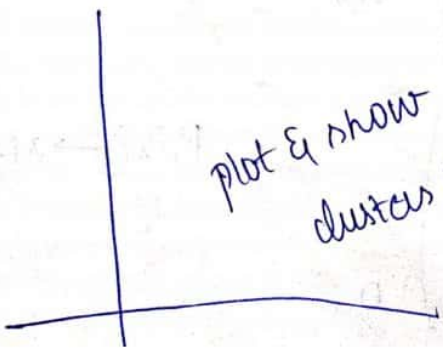
	$P_1P_2P_3$	P_4P_5	P_6P_7
$P_1P_2P_3$	0		
P_4P_5	(4.5)	0	
P_6P_7	6.5	8	0

$P_1P_2P_3P_4P_5 \rightarrow N.C$

	$P_1P_2P_3P_4P_5$	P_6P_7
$P_1P_2P_3P_4P_5$	0	
P_6P_7	(8)	0

$P_1P_2P_3P_4P_5P_6P_7 \rightarrow N.C$





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Avg linkage

	P_1	P_2P_3	P_4	P_5	P_6	P_7
P_1	0					
P_2P_3	$=1.25$ $\frac{1.5+1}{2}$	0				
P_4	4.5	3.25	0			
P_5	3.5	3.25	(1)	0		
P_6	6.5	6.25	8.	7	0	
P_7	6.5	6.25	7	6	1	0

$P_4P_5 \rightarrow NC$

	P_1	P_2P_3	P_4P_5	P_6	P_7
P_1	0				
P_2P_3	1.25	0			
P_4P_5	4	3.25	0		
P_6	6.5	6.25	7.5	0	
P_7	6.5	6.25	6.5	(1)	0

$P_6P_7 \rightarrow NC$

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	P_1	P_2P_3	P_4P_5	P_6P_7
P_1	0			
P_2P_3	1.25	0		
P_4P_5	4	3.25	0	
P_6P_7	6.5	6.25	7	0

$P_1P_2P_3 \rightarrow N.C$

	$P_1P_2P_3$	P_4P_5	P_6P_7
$P_1P_2P_3$	0		
P_4P_5	3.625	0	
P_6P_7	6.375	7	0

$P_1P_2P_3P_4P_5 \longrightarrow N.C$

	$P_1P_2P_3P_4P_5$	P_6P_7
$P_1P_2P_3P_4P_5$	0	
P_6P_7	6.6875	0

$P_1P_2P_3P_4P_5P_6P_7$
$\downarrow N.C$

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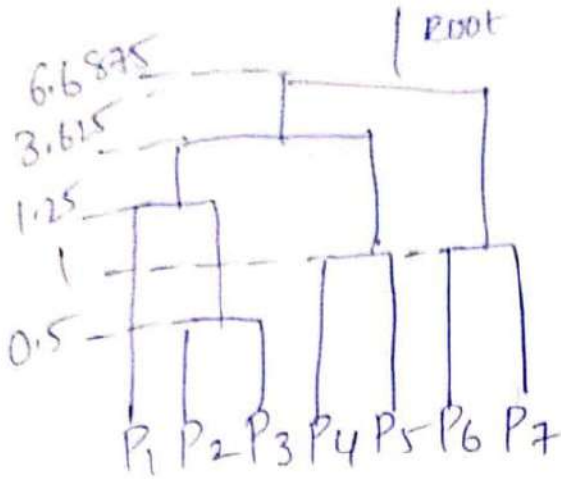


↳ dendogram

(5) with paramaters as Minpts = 6, ε = 0.1 > Noise = 5%

clusters = 4

" " " Minpts = 8, ε = 0.1 (const) > Noise will increase

No. of clusters will ~~decrease increase~~ decrease.

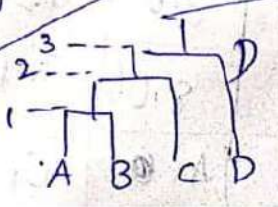
(3) single

AB → NC

	A	B	C	D
A	0			
B	(1)	0		
C	4	2	0	
D	5	6	3	0

	A B	C	D
AB	0		
C	(2)	0	
D	5	3	0

	ABC	D
ABL	0	
D	(3)	0



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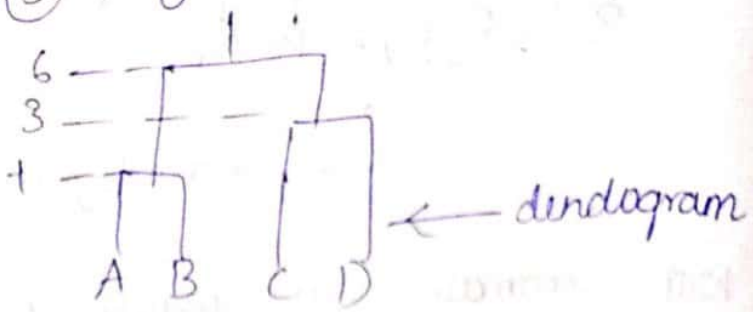
Complete

	AB	C	D
AB	0		
C	4	0	
D	6	(3)	0

⇒

	AB	CD
AB	0	
CD	(6)	0



(2) $A_1(2,10)$
$A_2(2,5)$
$A_3(8,4)$
$B_1(5,8)$
$B_2(7,5)$
$B_3(6,4)$
$C_1(1,2)$
$C_2(4,9)$

Distance M:- Euclidian

New clusters { $A_1(2,10)$, $B_1(5,8)$, $C_1(1,2)$ } are initial clusters centres of each clus

K-Means ?

Round-1

	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2
A_1	0	5	8.48	3.6	7.07	7.21	8.06	2
B_1	3.6	4.24	5	0	3.60	4.123	7.2	1
C_1	8.06	3.16	7.28	7.21	6.7	5.39	0	7
	A_1	C_1	B_1	B_1	B_1	B_1	C_1	C_1

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Lets calculate distances to update distance Matrix

$d(A_1, A_1) = 0$

$d(A_1, A_2) = \sqrt{0^2 + 5^2} = 5$

$d(A_1, A_3) = \sqrt{6^2 + 6^2} = 8.48$

$d(A_1, B_1) = \sqrt{3^2 + 2^2} = 3.60$

$d(A_1, B_2) = \sqrt{5^2 + 5^2} = 7.07$

$d(A_1, B_3) = \sqrt{4^2 + 6^2} = 7.21$

$d(A_1, C_1) = \sqrt{1^2 + 8^2} = 8.06$

$d(A_1, C_2) = \sqrt{2^2 + 1^2} = 2.23$

~~$d(A_1, C_3) = \sqrt{\quad}$~~

$d(B_1, A_1) = 3.6$

$d(B_1, A_2) = \sqrt{3^2 + 3^2} = 4.24$, $d(B_1, A_3) = \sqrt{3^2 + 4^2} = 5$

$d(B_1, B_1) = 0$

$d(B_1, B_2) = \sqrt{2^2 + 3^2} = 3.60$

$d(B_1, B_3) = \sqrt{1^2 + 4^2} = 4.123$

$d(B_1, B_1, C_1) = \sqrt{4^2 + 6^2} = 7.21$

$d(B_1, C_2) = \sqrt{1^2 + 1^2} = 1.41$

$d(C_1, A_1) = 8.06$

$d(C_1, A_2) = \sqrt{1^2 + 3^2} = 3.16$

$d(C_1, A_3) = \sqrt{7^2 + 2^2} = 7.28$

$d(C_1, B_1) = 7.21$

$d(C_1, B_2) = \sqrt{6^2 + 3^2} = 6.7$

$d(C_1, C_1) = 0$, $d(C_1, B_3) = \sqrt{5^2 + 2^2} = 5.39$

$d(C_1, C_2) = \sqrt{3^2 + 7^2} = 7.61$

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(a) After first round = New clusters are

A A_1 → $A1_1$

B B_1 → $A_3, B_1, B_2 B_3, C_2$

C C_1 → A_2, C_1

$A = (2, 10)$

$B = \left(\frac{8+5+7+6+4}{5}, \frac{4+8+5+4+9}{5}\right)$

$= (6, 6)$

$C = \left(\frac{2+1}{2}, \frac{5+2}{2}\right) = (1.5, 3.5)$

Round-2

	A_1	B_2	A_3	B_1	B_2	B_3	C_1	C_2
A_1	0							
B A_2								
C A_3								

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$d(A_1, B_1)$ -

$d(A_1, A_3)$ -

$d(A_1 B_1)$ -

$d(A_1 B_2)$ -

$d(A_1 B_3)$ -

$d(A_1, C_1)$ -

$d(A_1, C_2)$ -

$d(B_1, A_1)$ -

$d(B_1 A_2)$ -

$d(B_1, A_3)$ -

$d(B_1, B_1)$ -

$d(B_1, B_2)$ -

$d(B_1 B_3)$ -

$d(B_1 C_1) =$

$d(B_1, C_2) =$

$d(C_1 A_1)$ -

$d(C_1 A_2)$ -

$d(C_1, A_3)$ -

$d(C_{s1}, B_1)$ -

$d(C_1, B_2)$ -

$d(C_1 B_3)$ -

$d(C_1 C_1)$ -

$d(C_1 C_2)$ -

calculate distance & update distance matrix if last & this centroids DP are same stop

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Chapter-3 (LP)

(4)

A	B	class label
0	1	C1
0	0	C2
1	1	C1
0	1	C1
1	0	C1
0	0	C2
1	1	C1
0	0	C2
1	0	C1
1	0	C2

$C_1 = 6 \quad C_2 = 4$

Total = 10

A:

	A=0	A=1
C1	2	4
C2	3	1
	5	5

B:

	B=0	B=1
C1	2	4
C2	4	0
	6	4

(a) Gain using Gini Index

The overall gini index before splitting is

$G_{orig} = 1 - ((0.6)^2 + (0.4)^2)$

$= 0.48$

The gain in the Gini index after splitting on A is

A: $G_{A=0} = 1 - \left(\frac{2}{5}\right)^2 - \left(\frac{3}{5}\right)^2 \Rightarrow 1 - 0.16 - 0.36 = 0.48$

$G_{A=1} = 1 - \left(\frac{4}{5}\right)^2 - \left(\frac{1}{5}\right)^2 \Rightarrow 1 - 0.64 - 0.04 = 0.32$

B: $G_{B=0} = 1 - (2/6)^2 - (4/6)^2 = 1 - 0.11 - 0.44 = 0.44$

$G_{B=1} = 1 - (4/4)^2 - 0 \Rightarrow 0$

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corresponding gain$_A$ is $G_{orig} - \left(\frac{5}{10}\right) G_{A=0} - \frac{5}{10} G_{A=1}$

$\Rightarrow 0.48 - 0.5(0.48) - 0.5(0.32)$

$\Rightarrow 0.08$ //

$Gain_B = 0.48 - (6/10)(0.44) - (4/10)(0)$

$= 0.48 - (0.6)(0.44)$

$= 0.216$ //

As gain for B is more we chose B attribute to split the node.

(b) Entropy before split is E_{orig}

$E_{orig} = -0.6 \log_2(0.6) - 0.4 \log_2(0.4)$

$= -0.6(-0.736) - 0.4(-1.32)$

$= 0.4416 + 0.528$

$= 0.9696$

Info gain after splitting A is

$E_{A=0} = -\frac{2}{5} \log_2\left(\frac{2}{5}\right) - \frac{3}{5} \log_2\left(\frac{3}{5}\right)$

$\Rightarrow -0.4(-1.32) - (0.6)(-0.736)$

$\Rightarrow 0.9696$

$E_{A=1} = -\frac{4}{5} \log_2\left(\frac{4}{5}\right) - \left(\frac{1}{5}\right) \log_2\left(\frac{1}{5}\right)$

$= -(0.8)(-0.32) - (0.2)(-2.32) = 0.1512$

$= 0.72$

$\Delta_A = 0.9696 - 5/10(0.9696) - (5/10)(0.72)$

$\Rightarrow 0.1248$

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For B

$G_{B=0} \Rightarrow -\frac{2}{6}\log_2\left(\frac{2}{6}\right) - \frac{4}{6}\log_2\left(\frac{4}{6}\right)$

$\Rightarrow (-0.33)(-1.59) - (0.6)(-0.58)$

$\Rightarrow 0.8727$

$G_{B=1}$

$\Rightarrow \frac{-4}{4}\log_2(4/4)$

$\Rightarrow 0$ //

$\Delta_B = 0.9696 - \left(\frac{6}{10}\right)(0.8727) - \left(\frac{4}{10}\right)(0)$

$\Rightarrow 0.44598$

∴ B is choosen as first attribute to split as B has more Δ (gain) value than A

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(3)

class	Prob	TP	FP	TN	FN	TPR	FPR
P	0.95	1	0	5	4	0.2	0
N	0.85	1	1	4	4	0.2	0.2
P	0.78	2	1	4	3	0.4	0.2
P	0.66	3	1	4	2	0.6	0.2
N	0.60	3	2	3	2	0.6	0.4
P	0.55	4	2	3	1	0.8	0.4
N	0.53	4	3	2	1	0.8	0.6
N	0.52	4	4	1	1	0.8	0.8
N	0.51	4	5	0	1	0.8	1
P	0.40	5	5	0	0	1	1

P=5 N=5

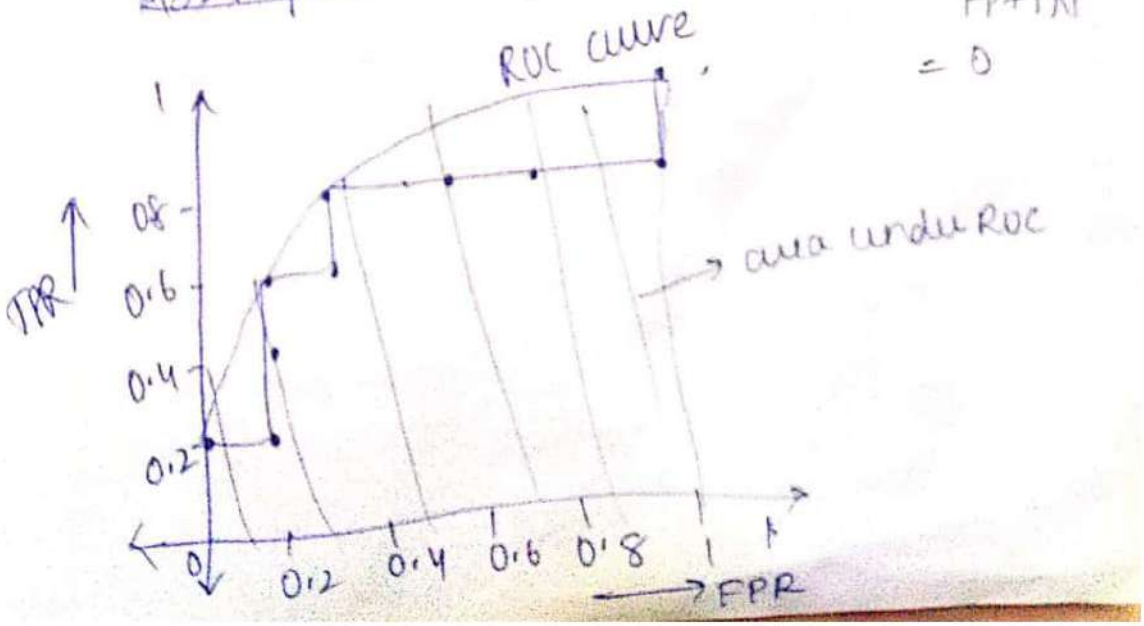
	P'	N'
P	TP 5 4 3 2 1	FN 0 1 2 3 4
N	FP 0 1 2 3 4	TN 0 1 2 3 4 5

$$TPR = \frac{TP}{TP+FN}$$

$$= 1/5 = 0.2$$

$$FPR = \frac{FP}{FP+TN}$$

$$= 0$$



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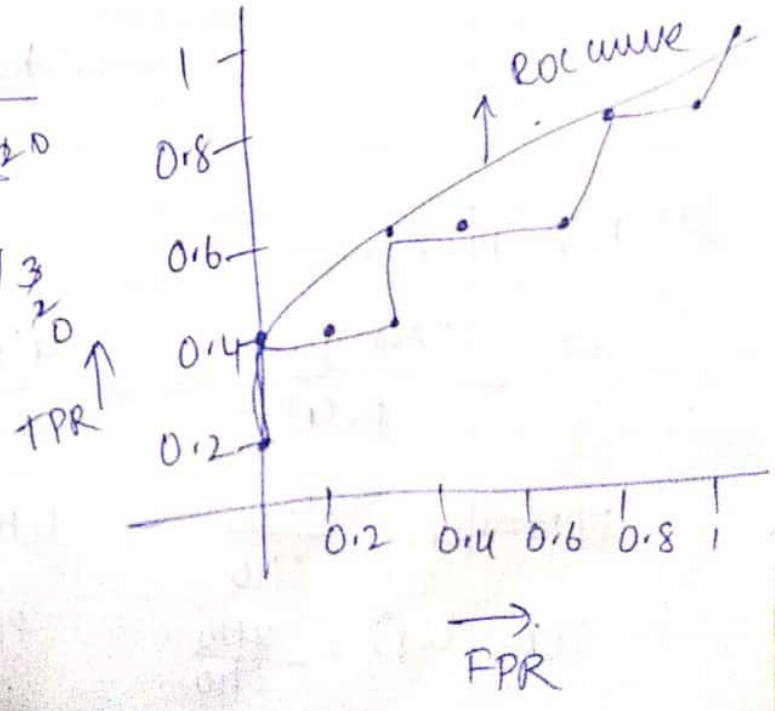
(5)

Class.	Prob	TP	FP	TN	FN	TPR	FPR
(P) +1	0.95	1	0	5	4	0.2	0
(P) +1	0.94	2	0	5	3	0.4	0
(N) -1	0.87	2	1	4	3	0.4	0.2
(N) -1	0.86	2	2	3	3	0.4	0.4
(P) +1	0.86	3	2	3	2	0.6	0.4
(N) -1	0.86	3	3	2	2	0.6	0.6
(N) -1	0.76	3	4	1	2	0.6	0.8
(P) +1	0.53	4	4	1	1	0.8	0.8
(N) -1	0.44	4	5	0	1	0.8	1
(P) +1	0.25	5	5	0	0	1	1

+ve (+1)

	P'	N'
P	TP 4 3 2 1	FN 4 3 2 0
N	FP 2 1 0 3 4 5	TN 5 4 3 2 0



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Krishna

Model Paper

3b)

	P'	N'	
P	100 (TP)	FN 40	= 140
N	60 (FP)	TN 300	= 360
	160	340	

$N = TP + FN + FP + TN$

$\Rightarrow 500$

a) $\text{Accuracy} = \frac{TP + TN}{N} = \frac{400}{500} = 0.8 \times 100 = 80\%$

b) $\text{Precision} = \frac{TP}{P'} = \frac{100}{160} = 0.625 = 62.5\%$

c) $\text{Recall} = \frac{TP}{P} = \frac{100}{140} = 0.714 = 71.42\%$

d) $\text{F1 score} = \frac{2 \times \text{Pre} \times \text{Recall}}{\text{Pre} + \text{Recall}}$

$= \frac{2 \times 0.625 \times 0.714}{0.625 * 0.714} = \frac{0.8925}{1.339} = 66.65\%$

3a) $P(A=1 | C=C_1)$

$\Rightarrow \frac{P(A=1 \text{ given } C_1)}{P(C_1)} = \frac{4/10}{6/10} = 0.66$

$P(B=1|C_1) = \frac{4/10}{6/10}$

$P(B=0|C_1) = \frac{2/10}{6/10}$

$P(A=1|C_2) = \frac{4/10}{4/10}$

$P(A=0|C_2) = \frac{3/10}{4/10}$

$P(B=1|C_2) = 0$

$P(B=0|C_2) = \frac{4/10}{4/10}$

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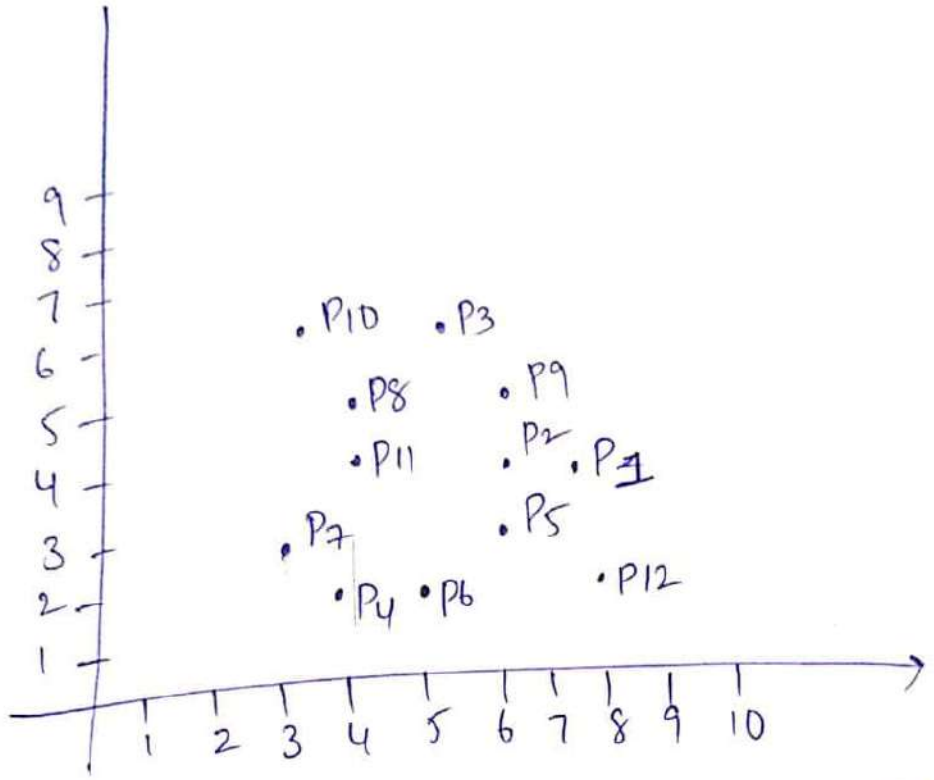
1b) R = 1.9 (ε)

Minpts = 4



$P_4(4,2)$ $P_6(5,2)$ $P_{12}(8,2)$ $P_7(3,3)$ $P_5(6,3)$ $P_1(7,4)$

$P_2(8,4)$ $P_{11}(4,4)$ $P_8(4,5)$ $P_9(6,5)$ $P_3(5,6)$

$P_{10}(3,6)$

Find distances then fill distance matrix And check for $\epsilon = 1.9$ & if mp = 4 then core else if min one pt mean border else noise

$d(P_1P_2)$

$d(P_1P_3)$

$d(P_1P_4)$

$d(P_1P_5)$

$d(P_1P_6)$

$d(P_1P_7)$

$d(P_1P_8)$

$d(P_1P_9)$ ---. done :c

Scanned with CamScanner