UNIT - 07

Data Warehouse

→ Provide tool for business executives to systematically organize, understand and use their data to make strategic decisions.

Key features of data warehouse (Imp. ***)

1) Subject oriented : It is organized around major subjects such as customer, supplier, product and sale.
2) Integrated : Data warehouse is constructed by integrating multiple heterogeneous sources such as flat files
3) Time variant : Data are stored to provide info. from a historical perspective (past 5 to 10 years).
4) Non volatile : Data warehouse is a physically separate store of data transformed from application data found in the operational environment.

Difference b/w operational DB systems and Data warehouse

- OLTP → cover day to day operations. (Online transaction Processing)
  e.g., Banking, inventory, purchasing.
- DW → Data analysis and decision making. (OLAP)

Feature	OLTP	OLAP
1) characteristic :	Operation processing	Information processing
2) Orientation	Transaction	Analysis
3) User	Clerk, DBA, DB professional	Knowledge worker e.g., manager, executive, analyst
4) Function	Day to day operations	Long term information requirements.
5) DB design	ER based ↓ Entity-Relation	star or snowflake, subject oriented
6) Access	Read and Write	Mostly Read
7) No. of records accessed	10 (tens)	Millions

a) No. of users	1000	100
b) DB size	100MB to 9B	100 GB to 7TB
c) Data storage	stores current data	stores historical data

23/4/2023

Multidimensional Data Model

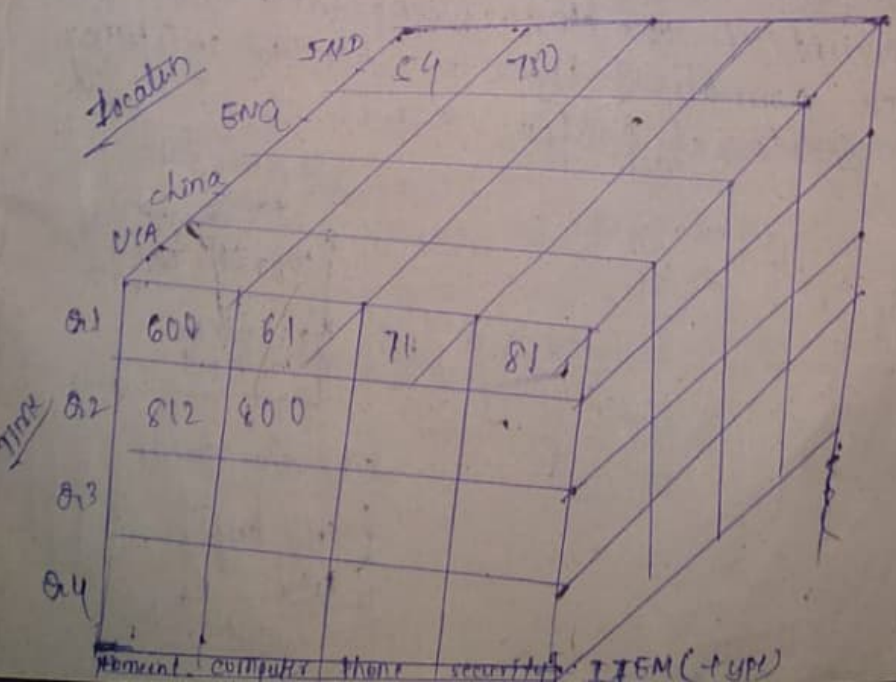
→ Views data in form of data cube
→ Data cube - Data to be modelled and viewed in multiple dimensions
→ Defined by dimensions & facts
eg) Dimensions → time, item, branch
Facts → Dollars sold, units sold

2D view of sales data

Location USA

	item (type)			
time	home ent.	Computer	phone	security
Q1	605	825	14	400
Q2				
Q3				
Q4				

3D view of sales data

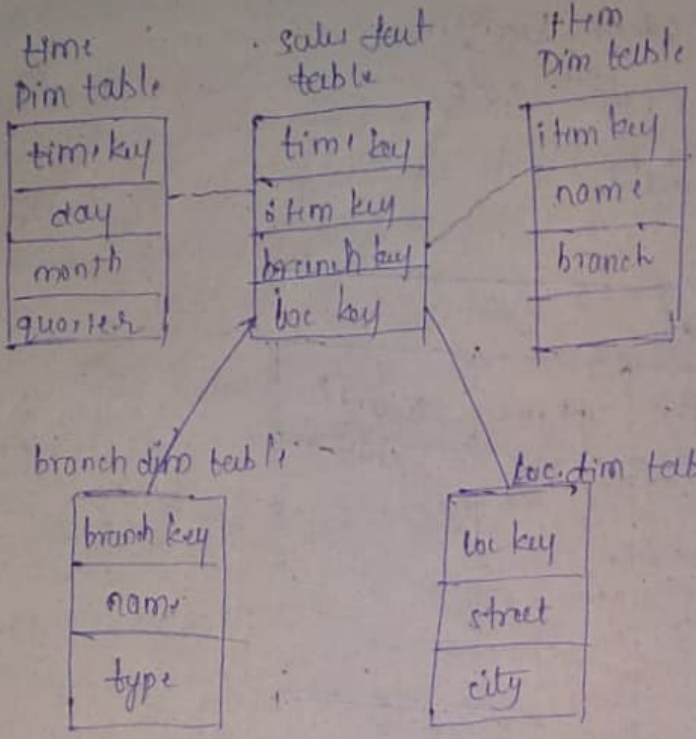


star, snowflake and fact constellations.

Schema for multidimensional DB (10-15 M 01)

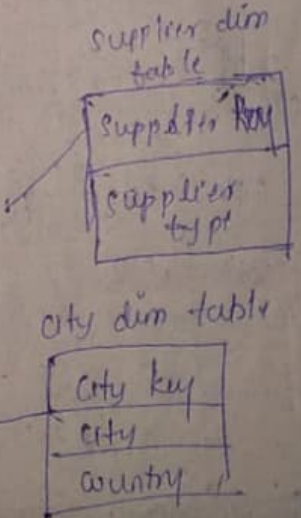
1) star schema of Datawarehouse for sales

→ Def²: The Data warehouse contains a large central table (fact table) containing the bulk of data, with no redundancy, a set of smaller attendant table (Dimension table) one for each dimension. (Many dim table one fact table)



2) Snowflake Schema

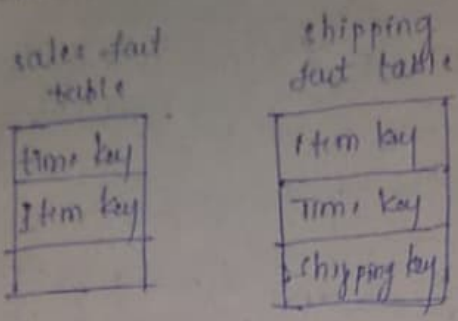
It is the variant of the star schema table where some dim tables are normalized thus by further splitting the data into additional tables.



3) Fact constellation schema

It requires multiple fact tables to share dimension tables. This kind of schema can be viewed as collection of stars hence it is called as galaxy schema or fact constellation schema

(Many fact table one dim table)



Examples for defining star, snowflake and fact constellation schema

→ SQL based DM query language - DMQL
→ DW defined using 2 language primitives
- one for cube def
- one for dimension def

Syntax
Define cube <cube name> <dimension list>: <measure list>
Define dimension <dimension name> as (<attribute list>)

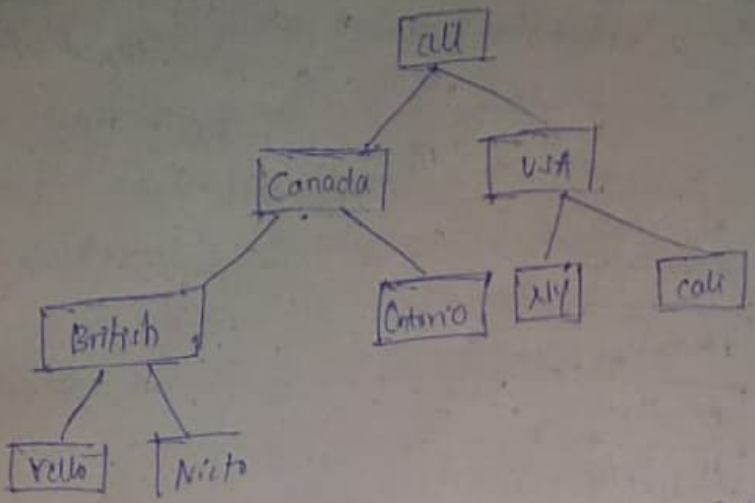
e.g.; star schema.

define cube sales_star [time, item, branch, location]:
dollars_sold = sum (sales_in_dollars), units_sold = count(*)
define dimension time as (time_key, day, month, year)
" " item as (item_key, name, brand)
" " branch as (branch_key, item)

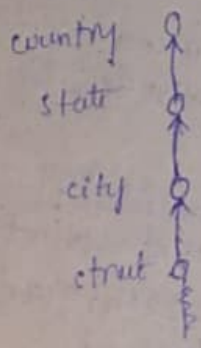
e.g.; snowflake schema:

define cube sales_star [time, item, branch, location, supplier]
define dimension location as (location_key, street, city (city_key), country)
define dimension item as (item_key, name, type, supplier (supplier type)

Concept Hierarchy

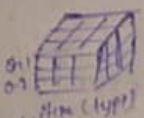


def²: Concept hierarchy defines a sequence of mappings from a set of low level concepts to higher level. The mappings form a concept hierarchy for the dimension location mapping a set of low level concepts (cities) to higher level concepts (countries)

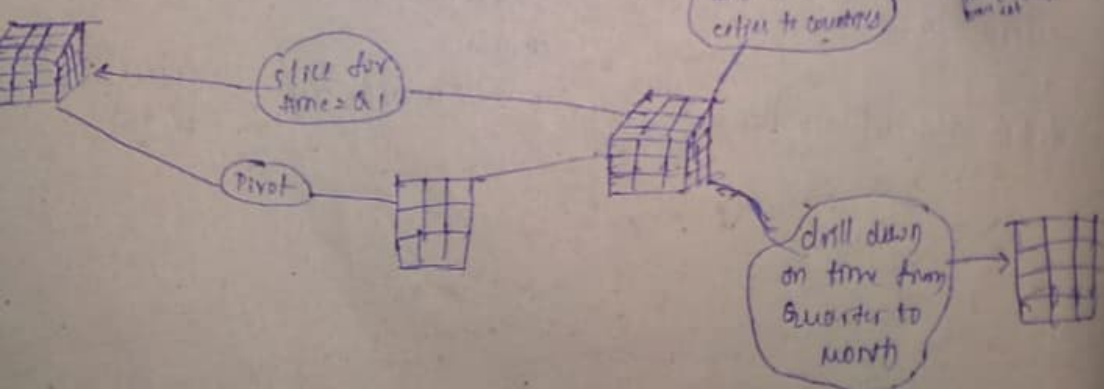


07/12/2023

OLAP operation in multidimensional data model



dice for
location =
and time = Q1 ∨ Q2 and item = home ent"



Roll up operation : climbing up a concept hierarchy for a dimension.
e.g. street city state country

Drill down : stepping down a concept hierarchy for a dimension.
e.g. month week day

slice operation : Performs selection on 1 D of the given cub
e.g. time = Q1

Dice operation : defines subcube by performing a selection on two or more dimensions.

Pivot : It provides an alternative presentation of data.
e.g. Row → columns or columns → rows.

Datawarehouse Architecture
→ steps for design and construction of DW
- what does DW provide for business analysis
1) Presents relevant ~~information~~ information.
2) Enhances business productivity.
3) Customer relationship management
4) Cost Reduction

4 different views regarding the design of data warehou
1) Top-down view : Allows the selection of relevant info necessary for the DW.
2) Data source view : The info being captured, stored and managed by operational systems.
3) Data warehouse view : includes fact and dimension tab
4) Business query view : The viewpoint of the end use

Database Design Process steps

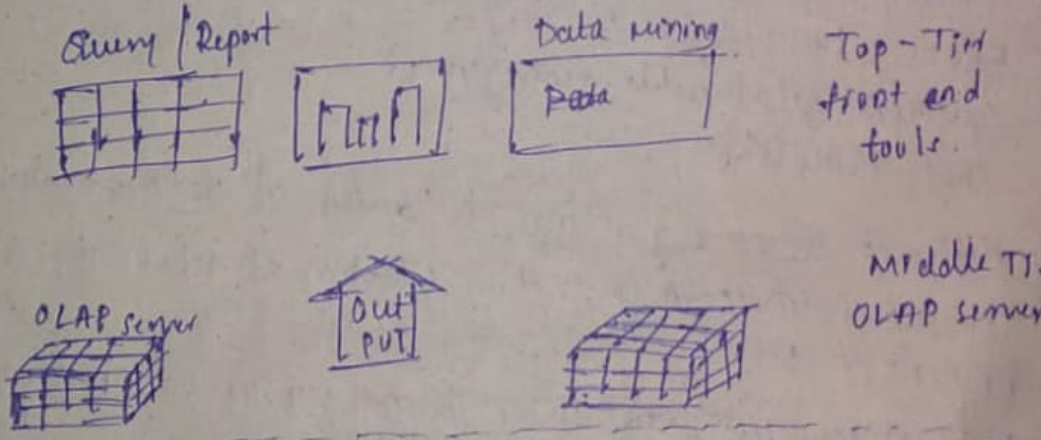
1) Choose a business process to be modeled e.g., orders, shipments, sales.
2) Choose grain of the ~~result~~ business process (e.g., Individual transaction)
3) Choose the dimensions.
4) Choose the measures for each fact table record.

20/12/2023

Process of Database Design

→ Top down approach - design of planning.
→ Botton-up approach - experiment and prototypes.
→ Combined approach.
→ Software engg → planning requirement study, problem analysis, warehouse design, Data integration and testing, deployment.

Three-Tier DW Architecture (8-10 M) ***



* Bottom tier is almost a relational DB where the data extracted from the tier in order to create a data ware-house.
* 'Middle tier' is implemented using relational OLAP and multidimensional OLAP.
* Top tier contains reporting tools, analysis tools and data mining tools.

Enterprise Data warehouse and data mart

→ Collects all of the information about subjects spanning the entire organization.

Data Mart: It contains information specific to an organiza-tion business unit.

Types of OLAP servers

1) Relational OLAP server
2) Multidimensional OLAP server
3) Hybrid OLAP server.

1) Relational OLAP server
→ Application based on relational DBMS. It can handle large amount of info., it has greater scalability; and it's performance is slow or low.

2) Multidimensional OLAP serv
Application based on multidimensional DBMS. It has fast info. retrival, performance complex calculation and limited info. it can handle.
→ Through indexing info. can be retrieved.

3) Hybrid OLAP server
→ It is combination of both relational and multidimen-sional OLAP server.

Datawarehouse Implimentation

21/12/2021

Compute cube operator and its implimentation

→ Compute cube → Aggregate over all subset of dimensions.

e.g., 3 dimensions - city, item, year and Sales-in-dollars as measures

$2^3 = 8$ Possible groupby {city, item, year}, {city, item}, {city, year}, {item, year}, {city}, {item}, {year}, {}

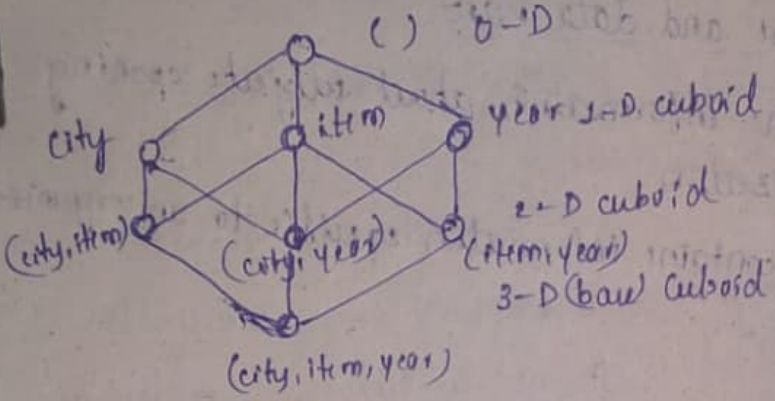


Fig. 3D Database

Datawarehouse Backend Tools and utilities.

1. Data extraction
2. Data cleaning
3. Data Transformation
4. Load
5. Refresh → All the updation to the data has to be done

UNIT-04

CLUSTERING

Imp *** Q-1 (a).

→ Cluster is a collection of data objects that are similar to one another within the same cluster and dissimilar in other cluster.

→ It is widely used in numerous applications like image processing, pattern recognition, data analysis, market research.

→ Clustering is an example of unsupervised learning.

* Unsupervised learning do not rely on predefined classes and class labeled training examples.

* Supervised → Predefined sets or classes.

Requirements of clustering

1. Scalability
2. Ability to deal with different types of attributes.
3. Minimal requirements for domain knowledge to determine input parameters.
4. Ability to deal with noisy data.
5. High dimensionality.
6. Constraints based clustering.
7. Interpretability and usability.

***

Types of data in cluster analysis

1. Interval scaled variable → 200-300
2. Binary variable → 0 or 1
3. Nominal variable → map color (Representing more than one state)
4. Ordinal → Assistant, Associate, professor (order / sequence)

03/09/20

Categories of clustering methods

1) Partitioning method
   - → DB of n objects, k partitions of data
   - → $k \leq n$
   - → classify data into k groups
     1) Each group must contain atleast one object
     2) Each object must belong to exactly one group.
   - → Uses iterative relocation technique methods
     1) k-means
     2) k-medoid

2) Hierarchical Method
   - → Hierarchical decomposition of given set of data objects
   - → Methods
     1) Agglomerative → Bottom-up
     2) Divisive → Top-down

3) Density Based Method
   - → It is based on density, it continuous growing the given cluster as long as the density exceeds some threshold.

4) Grid Based Method
   - → It quantise the object space into finite no. of cells that form a grid structure. All the clustering operations are performed on grid structure.

Partitioning Method (10 M) ***

→ $K \leq n$

→ K-means Algorithm

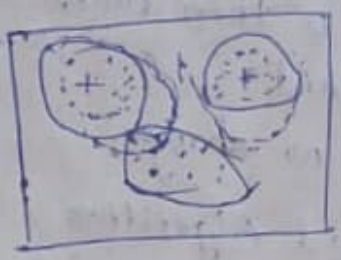
I/P : no. of clusters k, n objects.

O/P : set of k clusters.

Method

1) Arbitrarily choose k objects as initial cluster centers.
2) Repeat
3) (re) assign each object to cluster to which the object is most similar based on mean value of the object in the cluster.
4) Update the cluster mean.
5) Until no change.

K = 3



How k-means algorithm works :

→ First it randomly selects k of the objects, each of which initially represents cluster means or cluster centre.

→ For each of the remaining objects an object is assigned to a cluster to which it is most similar based on the distance btw object and cluster mean.

then computes the new mean for each cluster. This process iterates until all the objects are in one of the k cluster.

K-medoid Algorithm

I/P : No. of k clusters, n objects

O/P : set of k cluster.

Method:

1) Arbitrarily choose k objects as initial medoid.
2) Repeat
3) Assign each remaining object to cluster with nearest medoid.
4) Randomly select non medoid object O_{random}
5) Compute total cost, s of swapping O_j with O_{random}
6) If $s < 0$ then swap to form new set of k medoid
7) Until no change.

k-Medoid Algorithm : (8M) ***

		x	y	k_1	k_2	cost
$k_1 = m_1$	①	8	2	0	c	0
	②	3	5	8	2	2
	③	4	7	9	3	3
	④	8	4	2	4	2
$k_2 = m_2$	⑤	5	5	6	0	0
						7

Manhattan distance

→ $|x_2 - x_1| + |y_2 - y_1|$

$= |5-3| + |5-2| = 3+3 = 6$.

→ $|3-8| + |5-2| = 5+3 = 8$

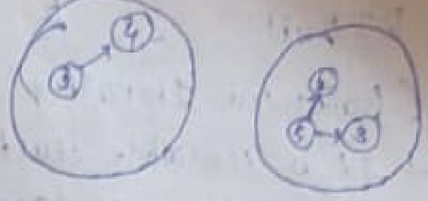
→ $|3-5| + |5-5| = 2$

→ $|4-8| + |7-2| = 4+5 = 9$

→ $|4-5| + |7-5| = 1+2 = 3$

→ $|8-8| + |4-2| = 2$

→ $|8-5| + |4-5| = 3+1 = 4$

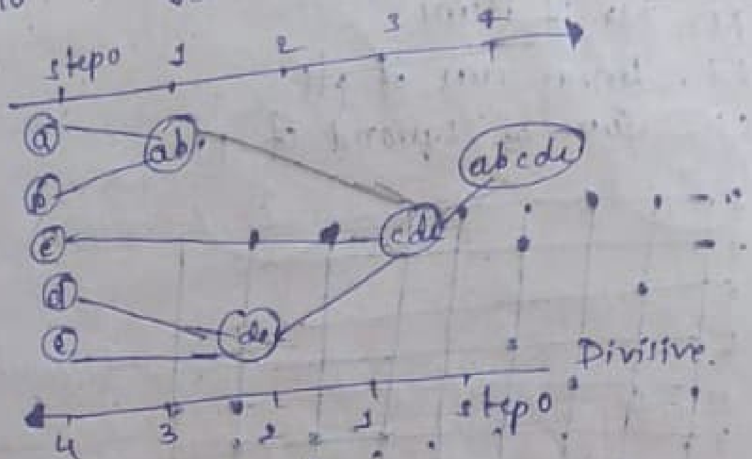


04/01/2024

Hierarchical Method (*** Imp)

→ Works by grouping data objects into tree of clusters.

→ Divided into → Agglomerative & Divisive Hierarchical clustering.



Agglomerative Hierarchical clustering :
This is bottom-up strategy starts by placing each object in it's own cluster and then merges these atomic clusters into Larger & Larger clusters until all the objects are in single cluster.

Divisive Hierarchical clustering :
This is top-down approach it starts with all objects in one cluster. It subdivides the cluster into smaller & smaller pieces until each object forms a cluster on it's own.

(Balanced Iterative Reducing & Clustering using Hierar
→ It is scalable clustering.
→ Works for very large dataset.
→ Only one scan of data is necessary.
→ Clustering is based on CF (Clustering Feature).
→ CF Tree → stores the cluster features.
→ cluster of data pts is represented by triple of numbers (N, LS, SS)

N = No. of items
LS = Linear sum of pts.
SS = Sum of squared of pts.

e.g.;

e.g.; CF

CF = (N, LS, SS)
N = No. of data pts
$LS = \sum_{i=1}^{N} X_i$ $SS = \sum_{i=1}^{N} X_i^2$

(3,4) (2,6) (4,5) (4,7) (3,8)

N = 5

LS = 3 + 2 + 4 + 4 + 3 = 16
= 4 + 6 + 5 + 7 + 8 = 30

SS = $3^2 + 2^2 + 4^2 + 4^2 + 3^2 = 54$
$4^2 + 6^2 + 5^2 + 7^2 + 8^2 = 190$

(6,2) (7,3) (8,3) (8,4)

5) N = 4

CF = (N, LS, SS)

LS = 6+7+8+8 = 29

2+3+3+4 = 12

SS = $6^2+7^2+8^2+8^2 = 213$.

$2^2+3^2+3^2+4^2 = 38$

CF = (4,

Basic algorithm of BIRCH: ~~phase 1~~

Phase 1: Load the data into memory.

phase 2: Condense data - resize the data set by building smaller cluster feature (CF) tree.

phase 3: Global clustering - It uses existing clustering algorithm on CF entries.

phase 4: cluster refining.

Chameleon: Hierarchical clustering using dynamic modelling

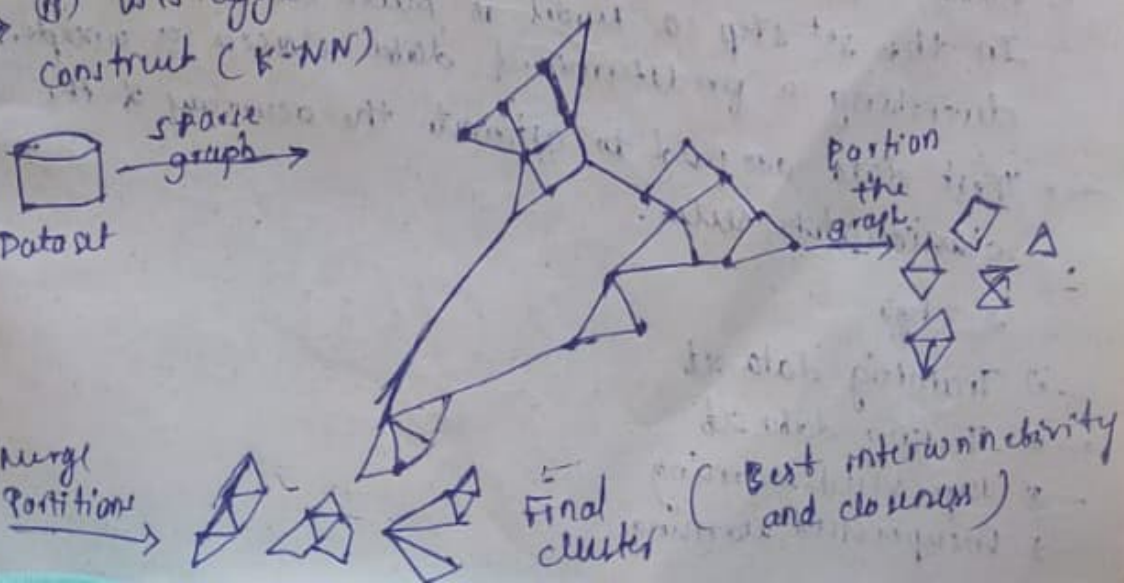
→ Two clusters are merged → if interconnecting & closeness blw 2 clusters are high.

→ 2 parameters → Interconnectivity & closeness.

→ Graph based & a two phase algo. (uses graph partitioning algorithm.

→ (ii) It is agglomerative hierarchical clustering algo.

Construct (K-NN)



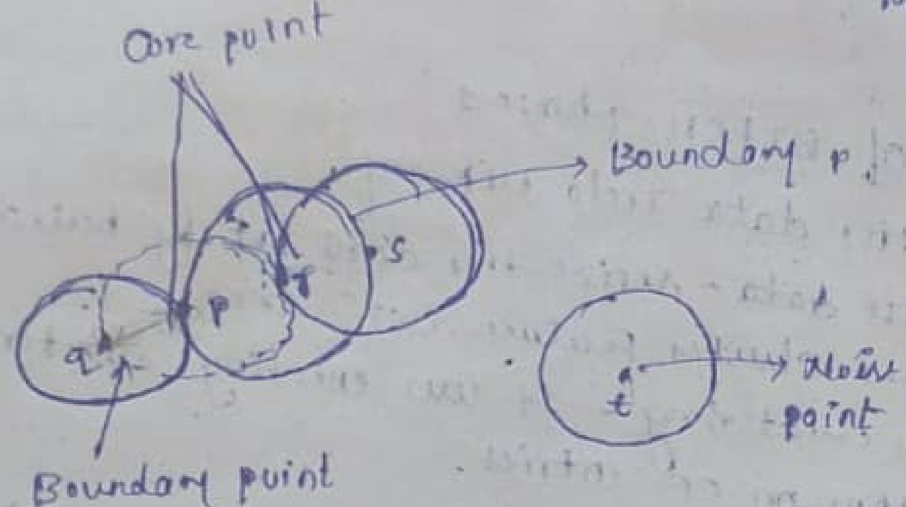
DBSCAN (*** 7-8 marks). 05/01/20..

(Density Based Spatial Clustering of Application with Noise).

→ forms clustering based on density.

→ Eps
Minpts = 3] → 2 I/P parameters.

Minpts → Minimum pts.



→ Directly density reachable must be neighbour of core pt
so q is directly density reachable from pt p.

→ p & r are core pts → satisfies Minpts = 3

→ s & q → Boundary pt → should be neighbour of any core point. t is noise point.

Classification and Prediction

→ Data classification is a 2 step process.
In the 1st step a model is built describing a predetermined data classes or concepts.
describing a predetermined data classes or concepts. the accuracy of the

→ Test data are used to estimate the accuracy of the classification rules.

2 steps

→ Training data set

→ Testing data set

→ Supervised learning

→ Unsupervised learning

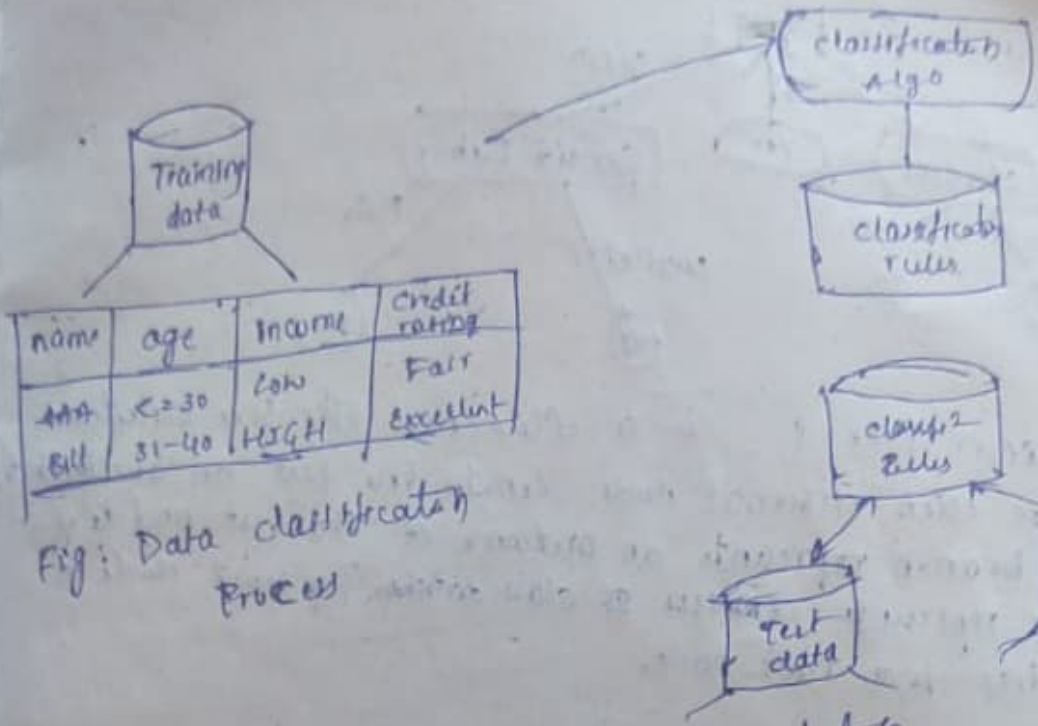


Fig: Data classification Process

Issues regarding classification and prediction.

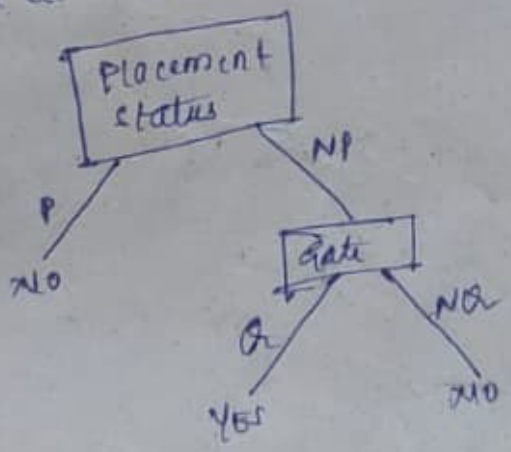
1) Data cleaning: Preprocessing of data to remove or reduce noise.

→ Relevance analysis.

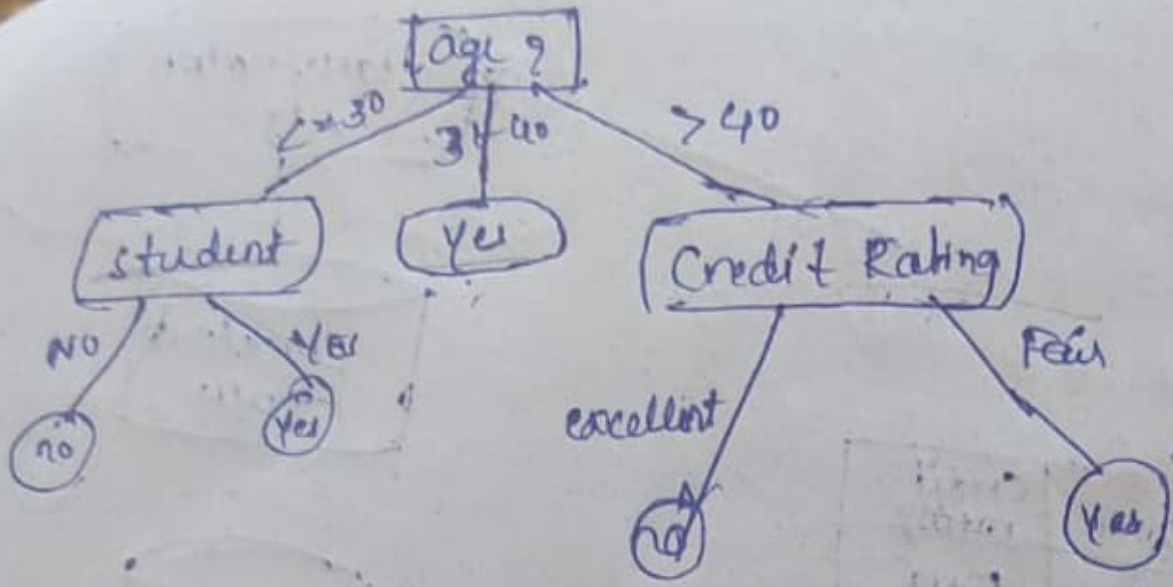
3) Data Transformation: Data can be generalized to higher level concepts.

Decision Tree Induction

→ To take a decision



playing football



Decision Tree : is a flow chart like tree structure where each internal node denotes the test on an attribute each branch represents an outcome of the test and leaf node represents classes or class distribution. Top most node in a tree is a root node.