Assignment 1

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TYBtech Comps B

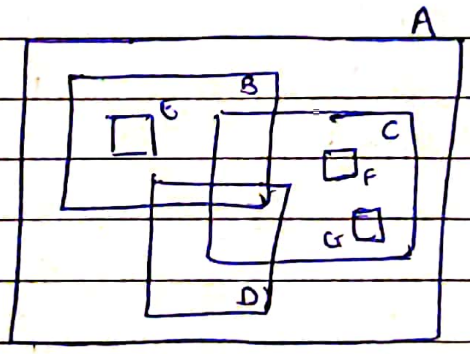
Q1 Discuss the need of R tree and demonstrate its working.

→ R-tree is a tree data structure used for storing spatial data indexes in an efficient manner. R-trees are highly useful for spatial data queries and storage.

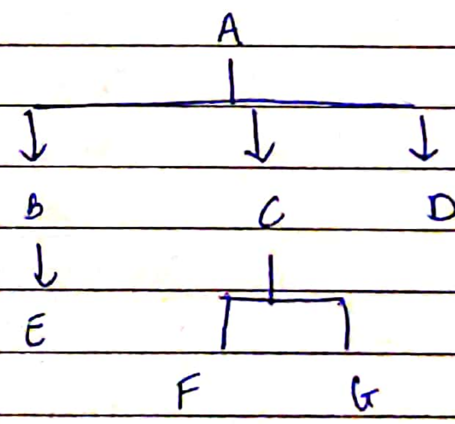
Some of the real life applications are given below:

- Indexing multi-dimensional information
- Handling geospatial co-ordinates
- Implementation of virtual maps.
- Handling game data.

Example



R-tree Representation



So here each MBR's represents the smallest rectangular region that contains a group of spatial objects such as points, lines or polygons.

Q2 Explain weighted Non-Bipartite Matching with eg.

→ Weighted non-bipartite matching is a technique used in graph theory to find optimal pairing between elements in a graph, considering both connections & associated weights. Unlike bipartite matching, which restricts elements to 2 distinct groups, non-bipartite matching allows elements to connect freely within the graph.

Real world applications
1) Resource Allocation
2) Scheduling.

Eg. Suppose we have a gap of cities with distance between them, and we want to pair with them up to minimize the total distance travelled by connecting them with roads.

City A :	City B (10)	city C (15)	city D (20)
City B	City A (10)	city C (25)	city D (30)
" C	City A (15)	city B (25)	city D (35)
D	city A (20)	city B (10)	city C (35)

A with B (10)
C with D (35

This pairing would result in a total distance of 45 units travelled.

Q3 Discuss the technique to find the closest pair of points.

→ We are given an array of n points in the plane and the problem is to find out the closest pair of points in an array. This problem arises

This in a no. of applications For Eg in air traffic control, you may want to monitor planes they come too close together, since this may indicate a possible collision.

The Brute force solution is $O(n^2)$ compute the distance between each pair & return the smallest we can calculate the smallest distance in $O(n \log n)$ Divide & conquer algorithm.

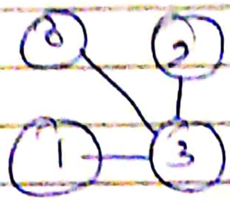
1) sort the points by their x coordinates
2) Divide set of pt into 2 equal sized subsets by median x - coordinate.
3) Recursively find the closest pair in the left & right subsets.
4) Determine the minimum distance and b/n the closest pair of points found in left & right subsets
5) Construct a strip of point whose x-coordinate is within the units of the median x-coordinate
6) Sort the strip by their y-coordinate.
7) Compare each point in the strip with next 7 point
8) The overall time complexity of this algo is $O(n \log n)$

4 Explain vertex cover problem as an approximation problem.

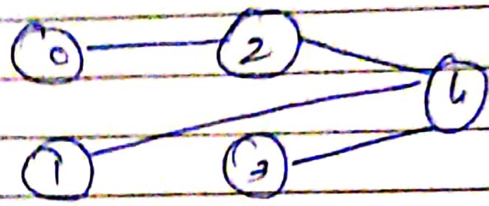
A vertex cover of an undirected graph is a subset of its vertices such that for every edge (u, v) of the graph, either 'u' or 'v' is in the vertex cover. Although the name is vertex

the set covers all edges of the given graph.
The following are some examples:

Minimum vertex cover is empty



Minimum vertex cover is 3



Minimum vector cover is {4,2} & {4,0}

Approximant Algorithm for vertex cover. 1)

1) Initialize the result as {}
2) Consider a set of all edges in given graph. Let the set be E.
3) Do following while E is not empty.
   a) Pick an arbitrary edge (u,v) from set E & add 'u' 'v'
   b) Remove all edges from E which are either incident on U or V.
4) Return result. 1)

5 1) K-server.

The k-server problem is a classical problem in computer science that deals with efficient management of server resources to handle requests from clients. In this problem there are k-server located at different points in the metric space such as a n/w or a graphical area.
This problem has important application in various areas including computer network & robotics & transportation logistics.

6 Discuss satisfiability (3 sat), reducibility required by NP completeness proof.

To prove that a problem is NP-complete, two main components are needed demonstrating that the problem belongs to the class NP and showing that it is NP hard, which is usually done through reduction from a known NP-complete problem.

1) NP membership: A problem that belong to the class NP if given a solution, it can be verified in polynomial time.

2) NP-hardness via reducibility - To show that 3sat is NP hard, we need to reduce a known NP-complete problem (such as Boolean satisfiability or SAT) to 3SAT.

The reduction typically involves breaking down each clause in SAT instance into clauses with exactly 3 literals which can be achieved through various techniques such as adding new variable or introducing additional clauses.