Name: Ayush Jain
SAP ID: 60004200132
Div: B
Computer Engineering

AA - Assignment 1

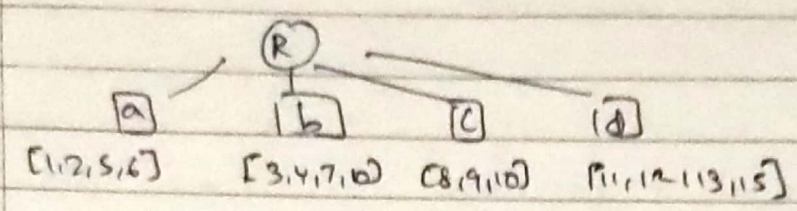
Q 1) Discuss need of R Tree and demonstrate its working?

→ 1) R trees is an advanced height balanced Tree Data Structure that is widely used in production for spatial problems.
2) Spatial data can be defined as any data that points to specific location on earth.
3) This data is stored in database and common operations for any database are storing data and performing all sort of queries among them.
4) Although there are many indexing based mechanism such as B-trees and ISAM index, they won't work well with multi-dimensional data.

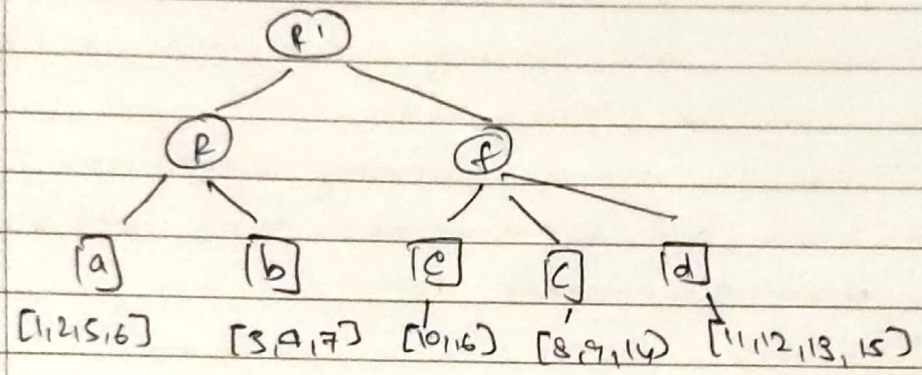
Working of R-Tree:

1) Insertion:
- Traverse the R-tree top-down, starting from root to each node.
- If there is a node where directory rectangle contains the D be inserted there search subtree.
- If more than one node satisfy this, choose the one with smallest area.
- Repeat with a leaf node is reached.
- If the leaf node is not full, an empty is inserted else
split the leaf node.
- Update the directory rectangles of ancestor nodes if necessary.

Insert object is , M=2 , m=1



Insert 16, M=2 , m=1



Q. 2) Explain Edmonds-Karp and max flow min cut Algorithm with suitable example?

→ 1) It is used to find max flow in a flow n/w and is an implementation of ford-fulkerson method.

2) Difference between Edmond-Karp and Ford-Fulkerson algo is that the selection of augmenting path is defined in Edmond Karp.

3) Edmond Karp algorithm:

Begin

Initialize flow s to 0

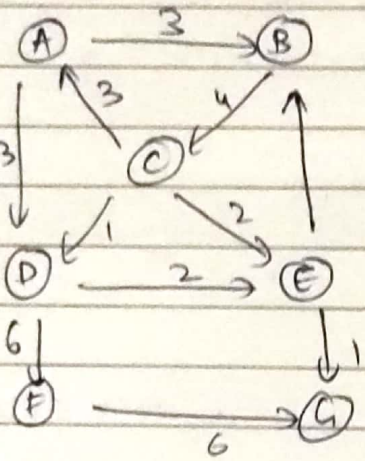
While there exists an augmenting path P0 the residual network as du

Choose the shortest augmenting path
Augment flow f along P
Return flow.

End.

9) Time complexity of Algorithm is $O(V(E^2))$

5) Example:



Step 1.

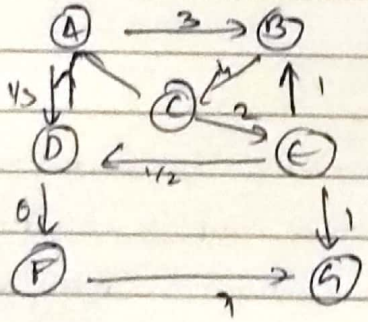
A B C D E F G

Parent map
B→A D→A
C→B E→D
F→D G→E

Visited Set
A B C G
E F C

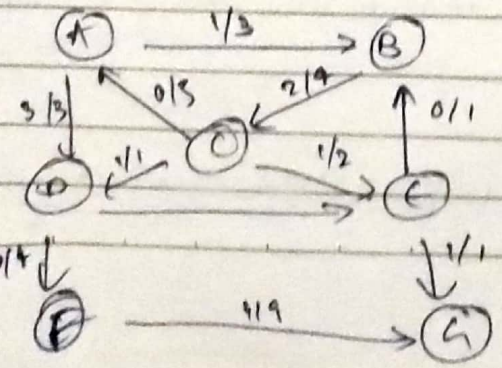
By BFS, Augmenting Path
$A \xrightarrow{3} D \xrightarrow{2} E \xrightarrow{1} G \Rightarrow 1$

Step 2:



Next BFS path would be,
$A \xrightarrow{2} D \xrightarrow{6} F \xrightarrow{1} G \Rightarrow 2$

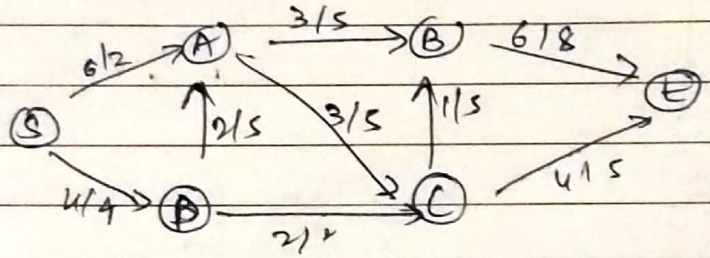
∴ Final Graph:



∴ max. flow = 1+2+1+1 = 5

Max flow Min Cut theorem

- A s-t cut is a portion of the vertices of flow network into 2-sets, such one set including source s and other one contains t. The capacity of s-t cut is defined as sum of capacities of from source to sink.
- The max flow is bounded by maximum cut capacity. Max flow min cut states that capacity of maximum flow has to be equal to the capacity of minimum cut.



In the above diagram, capacity of cut is $5+3+2=10$.

Q. 3) Explain Weighted Non-Bipartite matching with suitable examples.

→ 1) Weighted non-bipartite matching is a mathematical problem that includes fixed the optimal matching b/w two set of nodes (where the nodes may be non-bipartite i.e. there may be edges b/w nodes with the same set.

2) The goal of this problem is to assign weights to each edge and find the maximum weight matching b/w ~~two~~ set of node.

3) For example:

Consider a group of n people who need to be paired

up for a competition. Each person has a skill level, and the goal is to pair up people with complement skills to maximize the total skill level of the pairs. Let the set of people be denoted by A and their response skills levels by $w_1, w_2, w_3 \ldots w_n$. The weights of the edges between any two people can be calculated as the absolute difference in their skill levels of person i and person j are w_i and w_j. Now suppose that the people are divided into 2-groups - male and Female.

- This is the bi-partite matching problem. However if we want to allow pairing blw people of some gender, we need to solve a non-bipartite matching problem.