

# CE205 Data Structures

## Week-10

Advanced Tree Data Structures (Binary Search Tree, AVL Tree, B Trees and derivations, Red-Black trees, Splay Trees and Augmented Data Structures, van Emde Boas Trees, Binomial and Minimax Trees ) and Comparisons.

Download [DOC](#), [SLIDE](#), [PPTX](#)



## Outline

- Trees
  - Binary Search Tree
    - Search and Insertion
    - Delete
    - BST over Hash Table
    - Construction and Conversions
    - Check Smallest/Largest Element

# Outline

- Trees
  - Red Black Tree and Threaded Binary Tree
  - AVL Trees
  - B Trees
    - Defitinion of B Trees
    - Basic operations on B tree
    - Deleting a key from a B tree
  - 2 3 4 Trees
  - 2 3 Trees
  - B+ Trees

## Outline

- Trees
  - R Trees
  - Red - Black Tree Datastructure
  - Splay Tree Datastructure
  - Augmenting Data Structures
    - Dynamic order statistics
    - How to augment a data structure

# Outline

- Trees
  - Interval trees
  - van Emde Boas Trees
    - Preliminary approaches
    - A recursive structure
    - The van Emde Boas tree
  - Binomial Trees
  - Comparison of Search Trees
  - Minimax Tree

## Binary Search Tree

- [http://www.btechsmartclass.com/data\\_structures/binary-search-tree.html](http://www.btechsmartclass.com/data_structures/binary-search-tree.html)
- <https://visualgo.net/en/bst?slide=1> (Select BINARY SEARCH TREE)
- <https://www.cs.usfca.edu/~galles/visualization/BST.html>
- Search and Insertion
- Delete

## BST over Hash Table

- <https://www.geeksforgeeks.org/advantages-of-bst-over-hash-table/?ref=lbp>
- Construction and Conversions
- Check Smallest/Largest Element

## Red Black Tree and Threaded Binary Tree

- <https://www.geeksforgeeks.org/threaded-binary-tree/>



## AVL Trees

- [http://www.btechsmartclass.com/data\\_structures/avl-trees.html](http://www.btechsmartclass.com/data_structures/avl-trees.html)
- <https://visualgo.net/en/bst> (Select AVL)
- <https://www.cs.usfca.edu/~galles/visualization/AVLtree.html>

## B Trees

- [http://www.btechsmartclass.com/data\\_structures/b-trees.html](http://www.btechsmartclass.com/data_structures/b-trees.html)
- <https://www.cs.usfca.edu/~galles/visualization/BTree.html>

## Defitinion of B Trees

- <https://www.geeksforgeeks.org/introduction-of-b-tree-2/>

## Basic operations on B tree

- <https://www.geeksforgeeks.org/insert-operation-in-b-tree/>
- <https://www.guru99.com/b-tree-example.html>

## Deleting a key from a B tree

- <https://www.geeksforgeeks.org/delete-operation-in-b-tree/>

## 2 3 4 Trees

- [https://en.wikipedia.org/wiki/2-3-4\\_tree](https://en.wikipedia.org/wiki/2-3-4_tree)

## 2 3 Trees

- [https://en.wikipedia.org/wiki/2-3\\_tree](https://en.wikipedia.org/wiki/2-3_tree)

## B+ Trees

- <https://www.geeksforgeeks.org/introduction-of-b-tree/>
- <https://www.cs.usfca.edu/~galles/visualization/BPlusTree.html>
- <https://www.geeksforgeeks.org/difference-between-b-tree-and-b-tree/?ref=rp>



## R Trees

- <https://www.geeksforgeeks.org/introduction-to-r-tree/?ref=rp>

## Red - Black Tree Datastructure

- [http://www.btechsmartclass.com/data\\_structures/red-black-trees.html](http://www.btechsmartclass.com/data_structures/red-black-trees.html)
- <https://www.geeksforgeeks.org/red-black-tree-set-1-introduction-2/?ref=rp>
- <https://www.geeksforgeeks.org/red-black-tree-set-2-insert/>
- <https://www.geeksforgeeks.org/red-black-tree-set-3-delete-2/>

## Splay Tree Datastructure

- [http://www.btechsmartclass.com/data\\_structures/splay-trees.html](http://www.btechsmartclass.com/data_structures/splay-trees.html)
- <https://www.geeksforgeeks.org/splay-tree-set-1-insert/?ref=rp>
- <https://www.geeksforgeeks.org/splay-tree-set-2-insert-delete/>
- <https://www.geeksforgeeks.org/splay-tree-set-3-delete/?ref=rp>

## Augmenting Data Structures

- [http://cs.bilkent.edu.tr/~ugur/teaching/cs502/material/cs502\\_2\\_ADS.pdf](http://cs.bilkent.edu.tr/~ugur/teaching/cs502/material/cs502_2_ADS.pdf)
- <https://iq.opengenus.org/augmented-data-structures/>
- <http://staff.ustc.edu.cn/~csl/graduate/algorithms/book6/chap15.htm>
- <http://www.facweb.iitkgp.ac.in/~sourav/Lecture-11.pdf>

## Dynamic order statistics

- <http://www.facweb.iitkgp.ac.in/~sourav/Lecture-11.pdf>

## How to augment a data structure

- <http://www.facweb.iitkgp.ac.in/~sourav/Lecture-11.pdf>

## Interval trees

- <https://www.geeksforgeeks.org/interval-tree/>

## van Emde Boas Trees

- <https://www.geeksforgeeks.org/van-emde-boas-tree-set-1-basics-and-construction/>
- <https://web.stanford.edu/class/archive/cs/cs166/cs166.1146/lectures/14/Small14.pdf>
- Preliminary approaches
- A recursive structure



## Binomial Trees

- <https://www.geeksforgeeks.org/binomial-heap-2/#:~:text=What is a Binomial Tree,as leftmost child or other.>

## Comparison of Search Trees

- [http://www.btechsmartclass.com/data\\_structures/comparison-of-search-trees.html](http://www.btechsmartclass.com/data_structures/comparison-of-search-trees.html)

## Minimax Tree

- <https://www.geeksforgeeks.org/minimax-algorithm-in-game-theory-set-1-introduction/>

*End – Of – Week – 10*