2-3-4 Trees

This lesson is a brief introduction to 2-3-4 Trees. We will discuss its key features and take a look at its examples.

> **We'll cover the following** ∧
>
> - Introduction
> - Example

Introduction

2-3-4 is a search tree which is an advanced version of 2-3 Trees. This tree can accommodate more keys and hence more child nodes as compared to 2-3 Trees. 2-3-4 satisfies all the properties covered in 2-3 Trees along with some additional key features:

- Each internal node can contain at max three keys

- Each internal node can have at max four child nodes

- In case of three keys at an internal node namely *left*, *mid*, and *right* key, all the keys present at *LeftChild* node are smaller than the *left key*, which can be mathematically expressed as:

$$LeftChild.keys < LeftKey$$

- All the keys present at *LeftMidChild* node are smaller than the *mid key*, which can be mathematically expressed as:

$$LeftMidChild.keys < MidKey$$

- All the keys present at *RightMidChild* node are smaller than the *right key*, which can be mathematically expressed as:

$$RightMidChild.keys < RightKey$$

- Finally, all the keys present at *RightChild* node are greater than the *right key*, which can be mathematically expressed as:

$$RightChild.keys > RightKey$$

Example

Given below is an example of 2-3-4 Trees. The insertion/deletion is performed in the same way as we did in 2-3 Trees keeping just one fact in mind that here, nodes are allowed to have *three* keys at a time instead of two.

```
        29  55  75

14  26    30  35  40    58  60  70    80  89
```
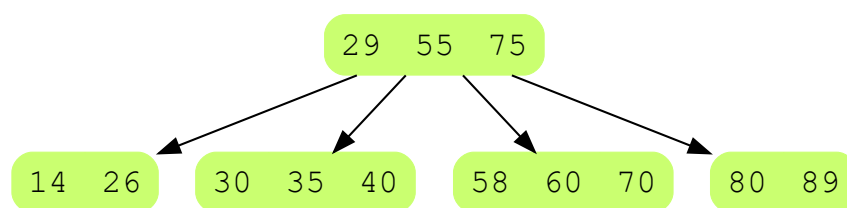
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