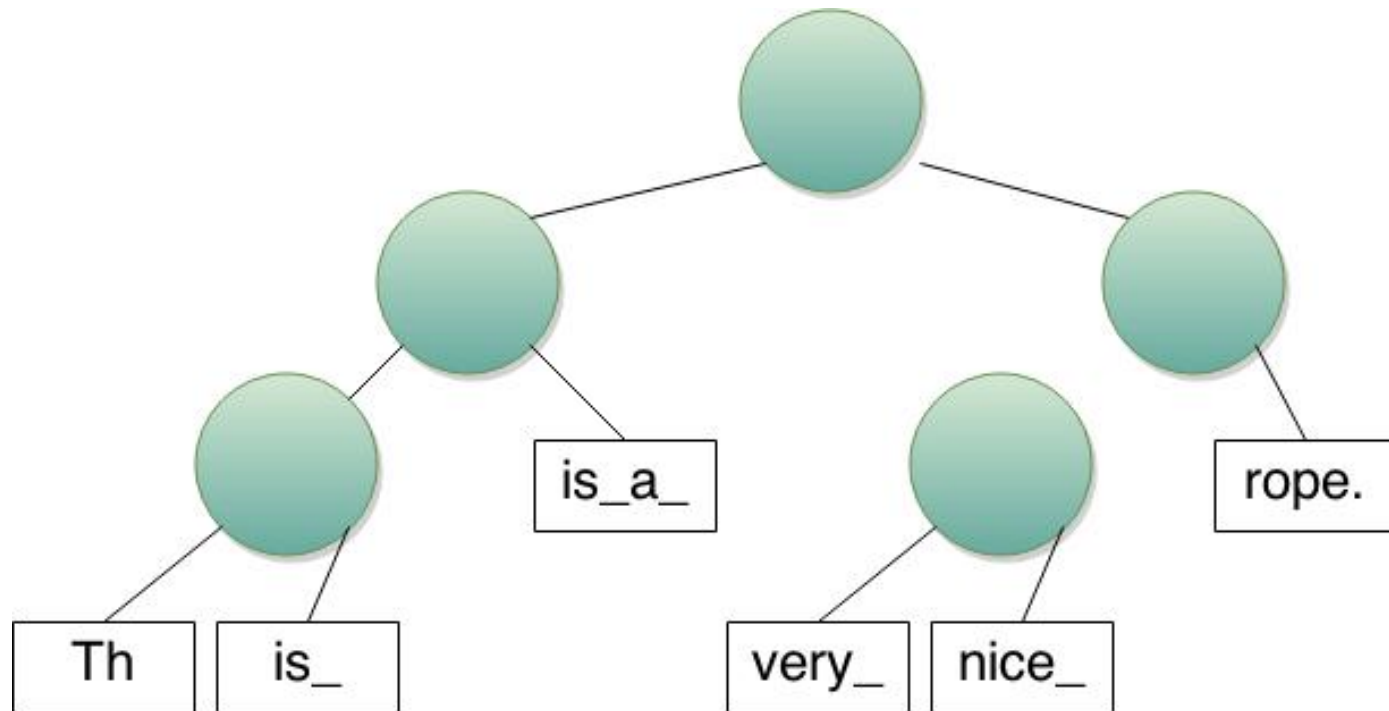


Rope - Data Structure Exercises

Nicholas Elliot

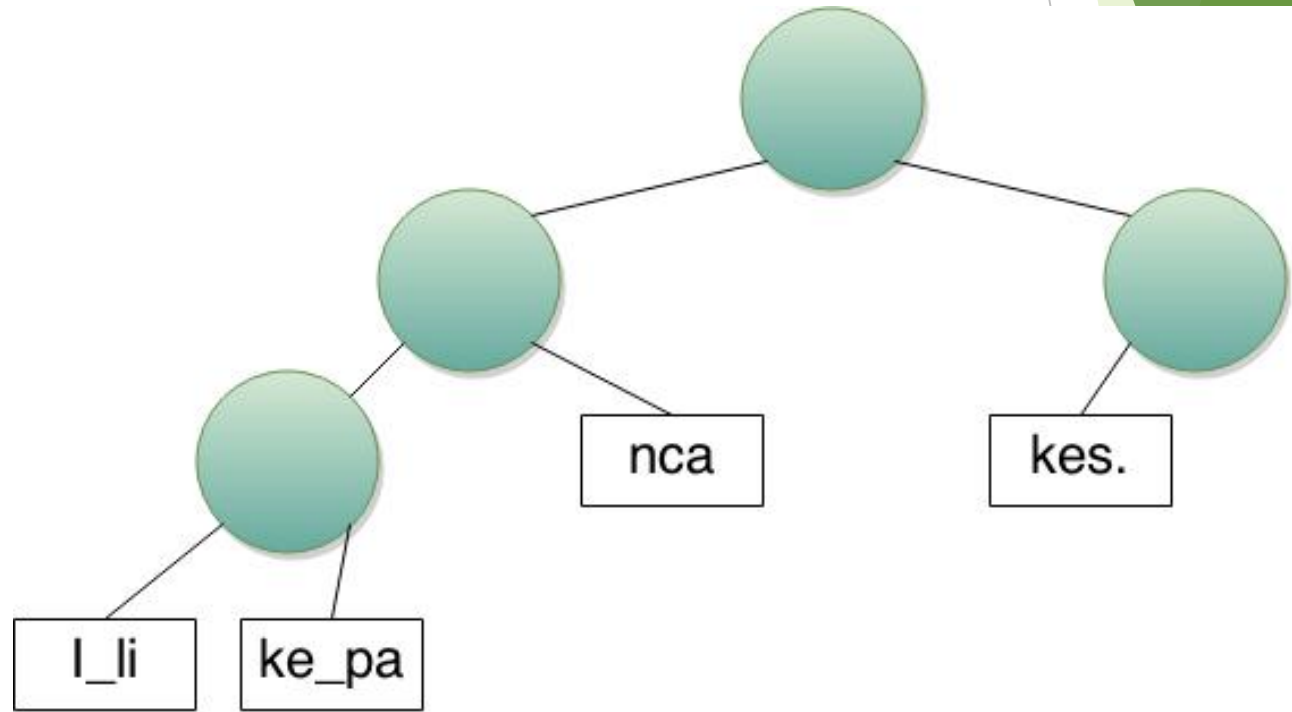
Rope

- ▶ A rope is a data structure that is meant to store a large string.
- ▶ When a large string is stored in a rope, it is divided into smaller “fragment” strings.
- ▶ Storing a large string in this way makes storage and manipulation more efficient.



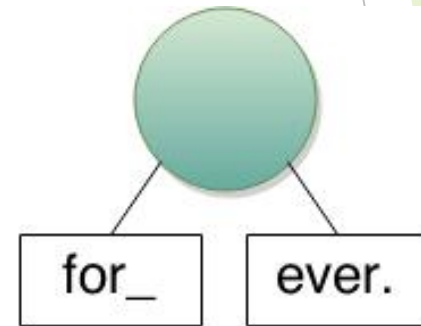
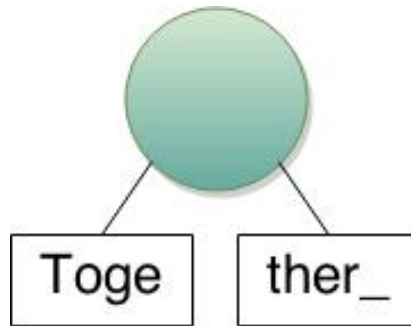
Weight

- ▶ Each node has a weight value equal to the length of its string plus the sum of all leaf nodes' weight in its left subtree.
- ▶ YOU: Label each node with its weight



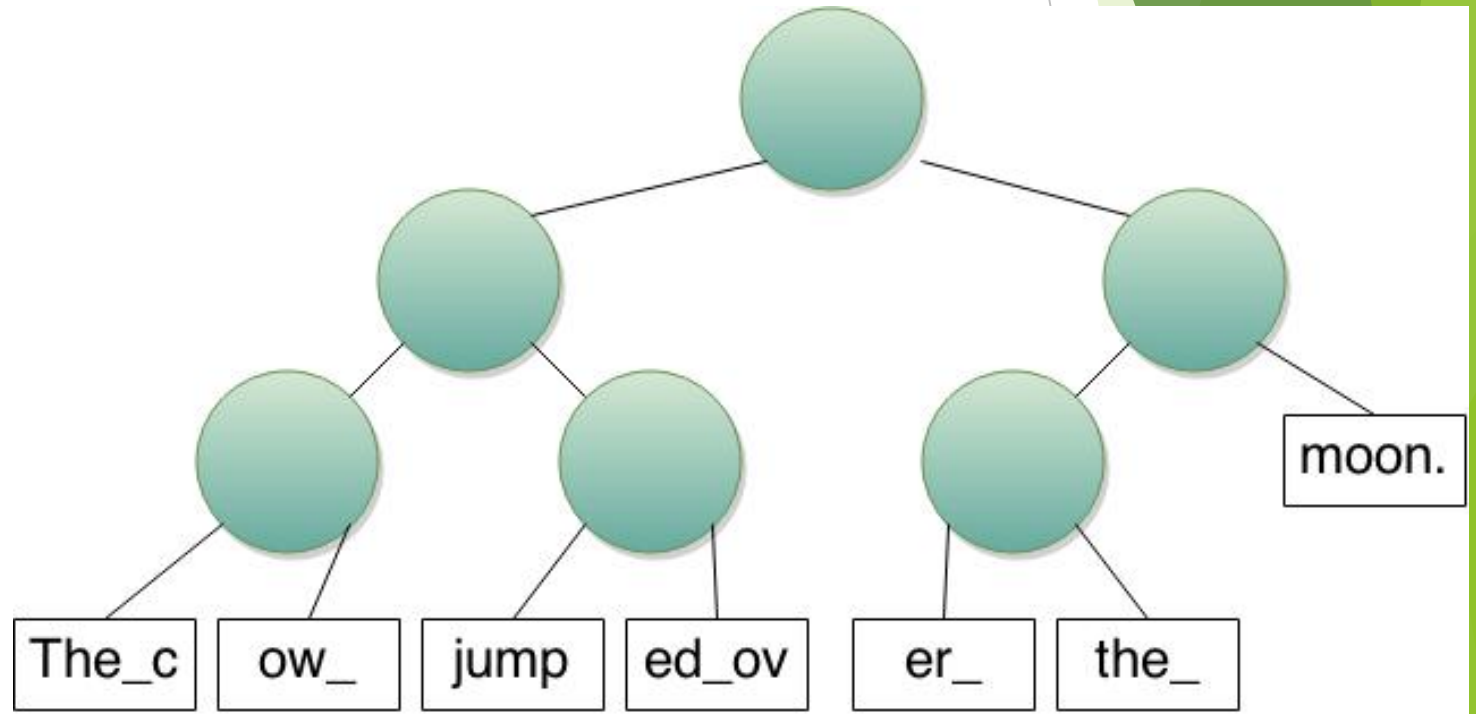
Concatenate – $O(\log n)$

- ▶ $\text{Concat}(S_1, S_2)$: concatenate two ropes, S_1 and S_2 , into a single rope.
- ▶ A concatenation can be performed simply by creating a new root node with $left = S_1$ and $right = S_2$
- ▶ YOU: Concat these two separate ropes into a single rope.



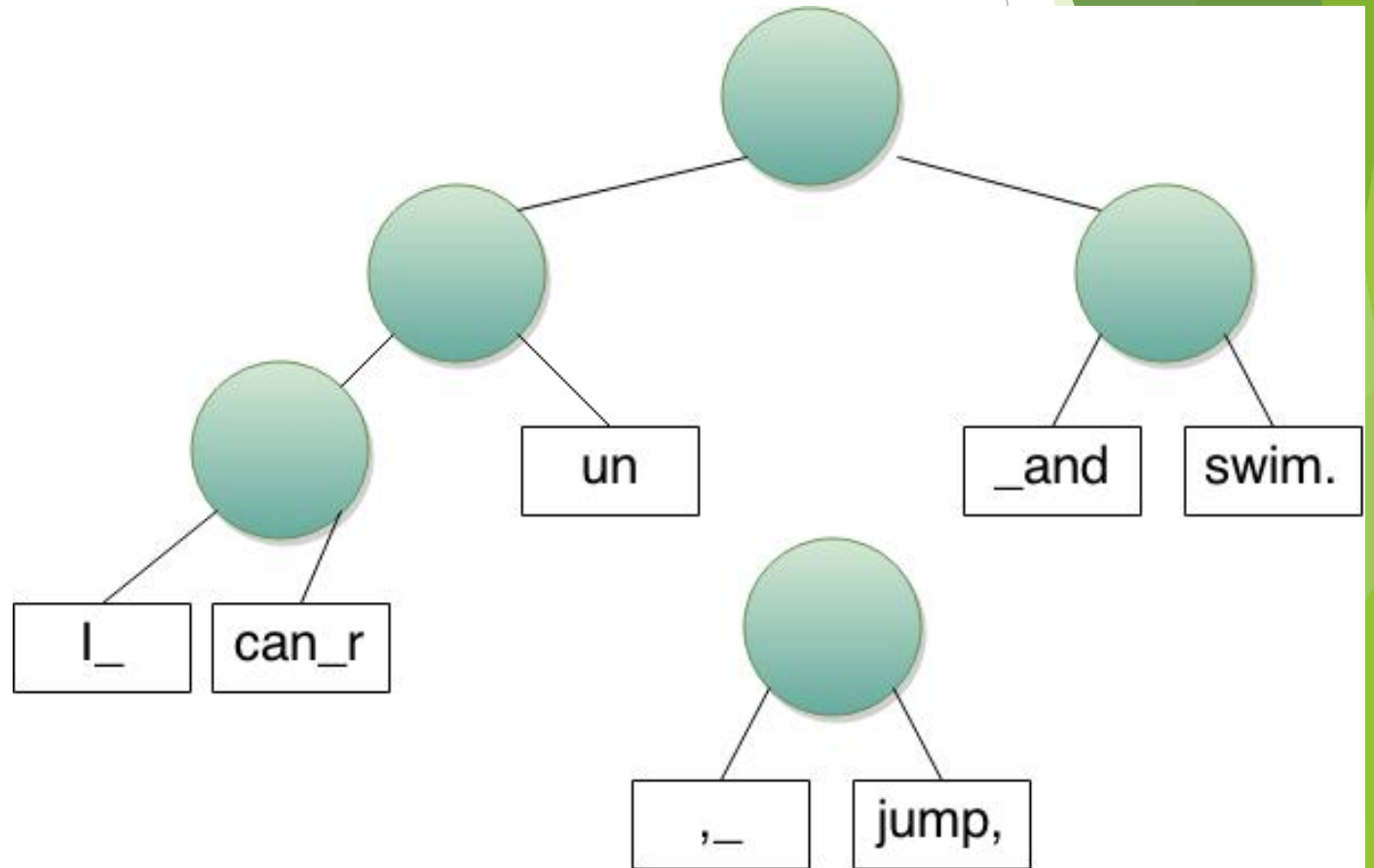
Split – $O(\log n)$

- ▶ Split (i): split the rope into two new strings S1 and S2
- ▶ There are two cases that must be dealt with:
 1. The split point is at the end of a string (i.e. after the last character of a leaf node)
 2. The split point is in the middle of a string.
- ▶ **YOU: Perform split(15)**
 - ▶ Redraw the rope to compensate for the case 2.
 - ▶ Then, draw a line through the rope, across the branches to be removed.



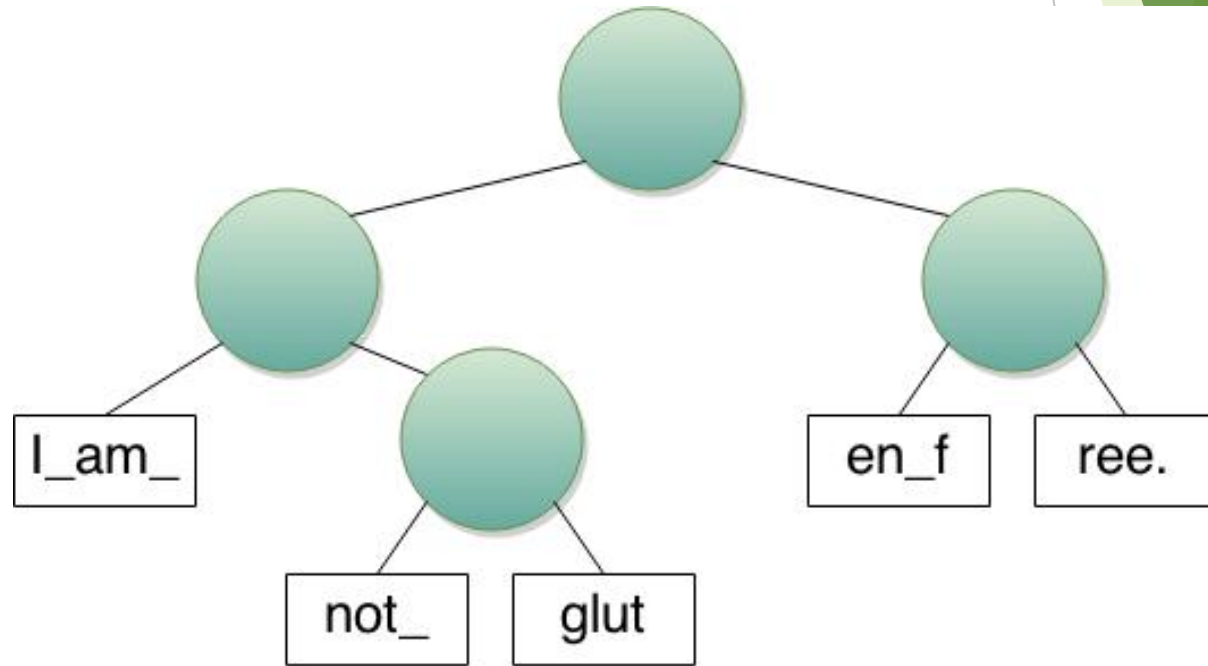
Insert - $O(\log n)$

- ▶ `Insert(i, S)`: insert string S at position i.
- ▶ Operation can be completed by:
 - ▶ `Split()`
 - ▶ `Concat()`
 - ▶ `Concat()`
- ▶ YOU: `Insert(9, ",_jump,")`



Delete - $O(\log n)$

- ▶ Delete(i, j): delete the substring at indices i to j Rope to form a new Rope.
- ▶ Operation can be complete by:
 - ▶ Split()
 - ▶ Split()
 - ▶ Concat()
- ▶ YOU: Delete(5, 9)



Performance

| Operation | Rope | String |
|---------------------------|-------------|--------|
| Build | $O(n)$ | $O(n)$ |
| Iterate over e/ character | $O(n)$ | $O(n)$ |
| Index | $O(\log n)$ | $O(1)$ |
| Concatenate | $O(\log n)$ | $O(n)$ |
| Split | $O(\log n)$ | $O(1)$ |
| Insert | $O(\log n)$ | $O(n)$ |
| Delete | $O(\log n)$ | $O(n)$ |