HEAP DATA STRUCTURE

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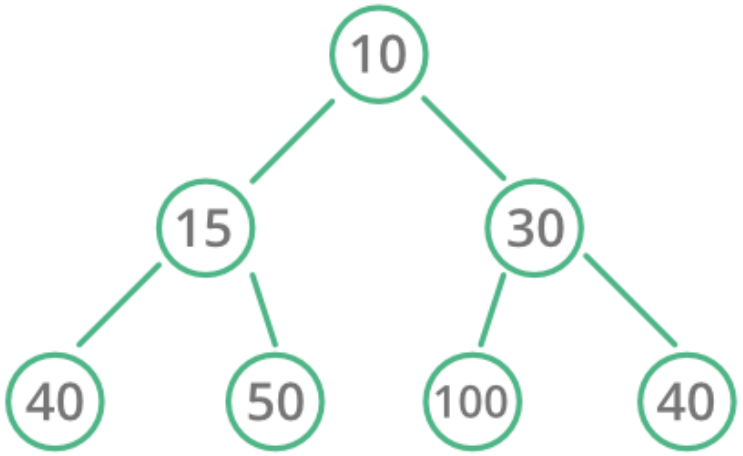
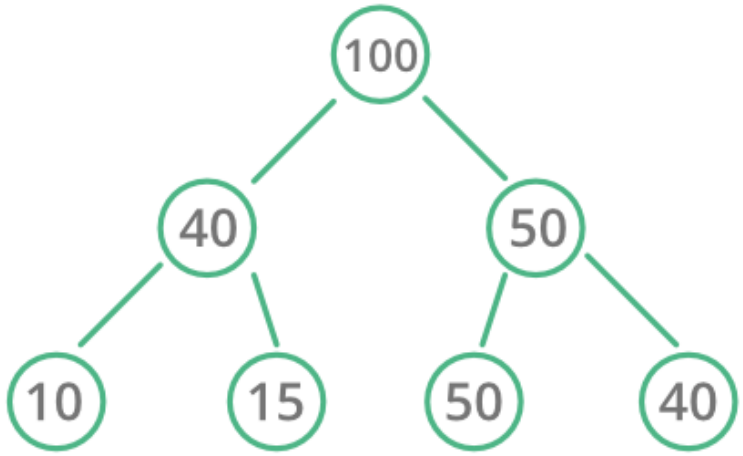
- A heap is a complete binary tree that satisfies the heap property.
  - For each node, the value of its children is (less than or equal) to its own value.
- Max Heap
  - The root node contains the maximum value.
  - For each node C, the value of its parent P is greater than or equal to its own value.
- Min Heap
  - The root node contains the minimum value.
  - For each node C, the value of its parent P is less than or equal to its own value.

Heap Data Structure

Heap is not a sorted structure.



Min Heap



Max Heap

https://www.geeksforgeeks.org/heap-data-structure/

HEAP OPERATIONS

- heapify: Rearrange the heap in order to maintain the heap property
- insert: Add a new key to the heap
- extract: Delete the root node and return its value
- buildHeap: Build a heap from the given array

APPLICATIONS OF HEAP DATA STRUCTURE

- Priority Queues
- Heap Sort
- Graph Algorithms (e.g. Dijkstra's algorithm and Prim's algorithm)
  - Finding the shortest paths
  - Minimum spanning trees

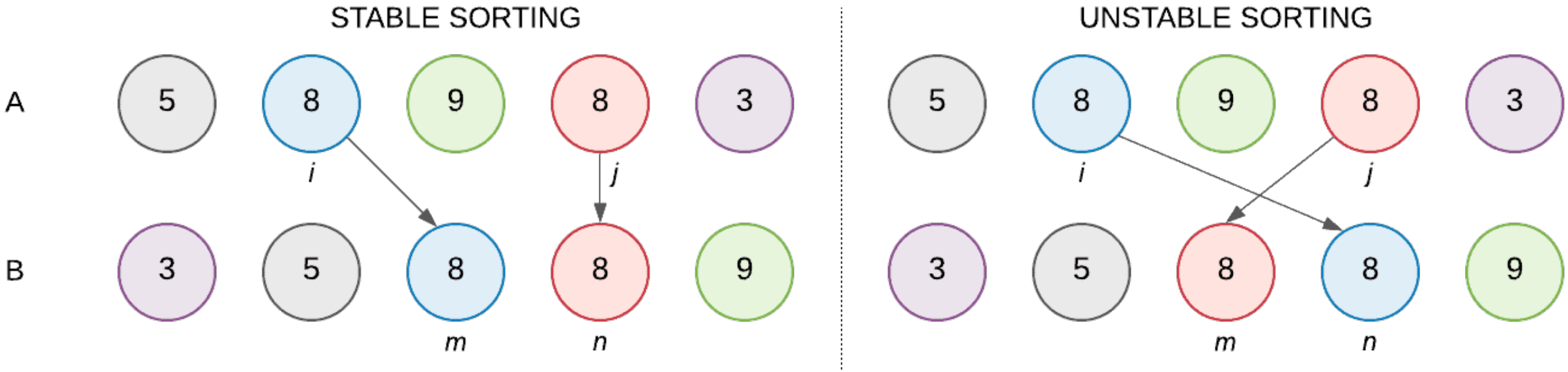
PRIORITY QUEUE

- An abstract data type
- Each element in a priority queue is associated with a priority.
- A queue whose elements are arranged based on their priorities.
  - Elements with higher priority are retrieved before elements with lower priority.

HEAPSORT

- Heapsort is similar to selection sort *i.e.*, repeated choosing the largest item and moving it to the end of the array.
- It utilizes the heap data structure in sorting.
- It is an in-place but unstable sorting algorithm
  - The order of elements of equal keys is not preserved after sorting.

STABLE VS. UNSTABLE SORTING



HEAPSORT ALGORITHM

- Steps:
  1. Transform the array into a binary tree.
  2. Convert the binary tree into a max heap.
  3. Swap the root node (largest element) with the last node in the heap.
  4. Heapify to maintain the heap property.
  5. Repeat step 3 and 4 until there is no element left in the heap.