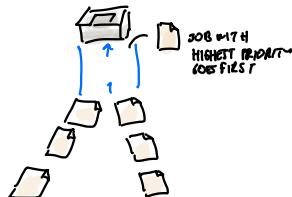


# PRIORITY QUEUE

MANY APPLICATIONS REQUIRE THAT WE PROCESS RECORDS WITH KEYS IN ORDER, BUT NOT NECESSARILY IN FULL SORTED ORDER.

OFTEN WE COLLECT A SET OF ITEMS AND PROCESS THE ONE WITH MINIMUM VALUE (OR MAXIMUM VALUE)

- JOBS SENT TO PRINTER



- OS JOB SCHEDULER

⇒ WE USE **PRIORITY QUEUE** DATA STRUCTURE

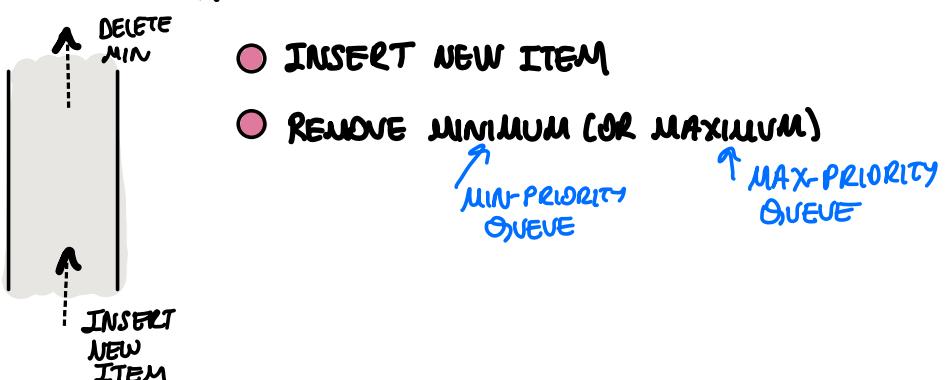
## DEFINITION

A PRIORITY QUEUE IS A DATA STRUCTURE (ADT) THAT SUPPORTS TWO BASIC OPERATIONS

→ ABSTRACT

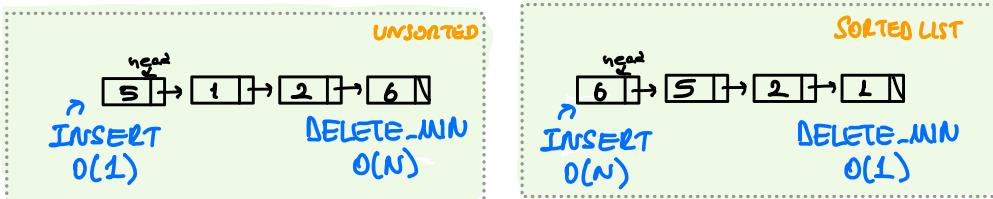
- INSERT NEW ITEM

- REMOVE MINIMUM (OR MAXIMUM)



## IMPLEMENTATIONS OF PRIORITY QUEUE

### A SIMPLE LINKED LIST



### A BINARY SEARCH TREE:



NEED TO STORE LINKS

BST SUPPORTS A LOT OF OPERATIONS THAT ARE NOT REQUIRED!

### AN ARRAY: BINARY HEAP

DOES NOT REQUIRE LINKS AND WILL SUPPORT BOTH OPERATIONS IN  $O(\log N)$  WORST CASE

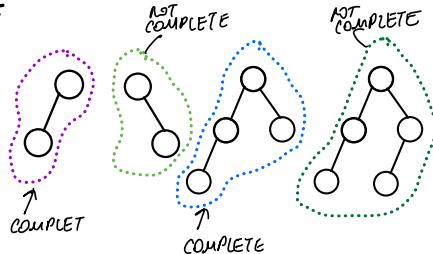
# BINARY HEAP



## STRUCTURE PROPERTY

→ A HEAP IS A COMPLETE TREE

A TREE THAT IS  
COMPLETELY FILLED  
WITH A POSSIBLE  
EXCEPTION OF  
THE BOTTOM LEVEL  
WHICH IS FILLED  
FROM LEFT TO  
RIGHT

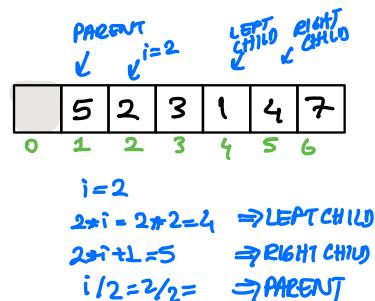
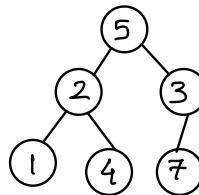


→ HEIGHT OF A COMPLETE TREE IS  $O(\log N)$

→ FOR ANY ELEMENT IN ARRAY POSITION  $i$ :

LEFT CHILD  $\rightarrow 2i$   
RIGHT CHILD  $\rightarrow 2i+1$   
PARENT  $\rightarrow i/2$

A COMPLETE  
BINARY TREE  
AND ITS ARRAY  
IMPLEMENTATION

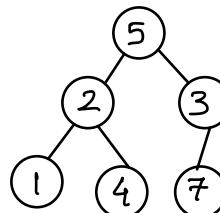
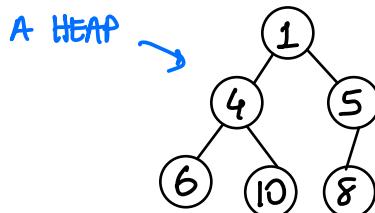


## ORDERING PROPERTY

IN A HEAP, FOR EVERY NODE  $X$  WITH PARENT  $P$ , THE KEY IN  $P$  IS SMALLER THAN OR EQUAL TO THE KEY IN  $X$ .

THUS, THE MINIMUM ELEMENT IS ALWAYS AT THE ROOT

DELETE-MIN  $\Rightarrow O(1)$

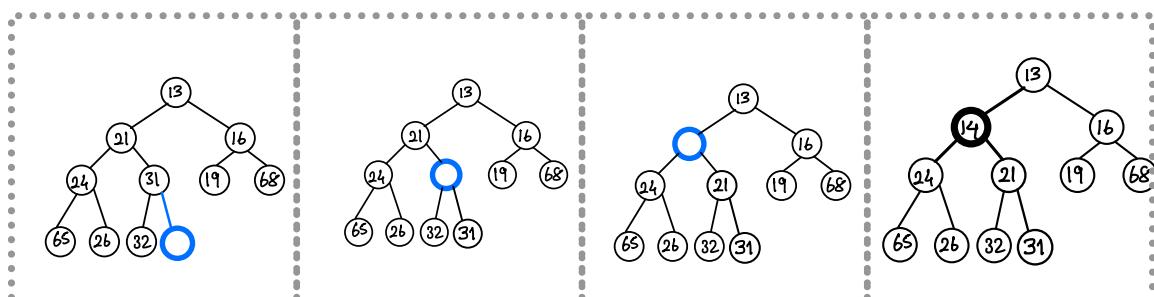
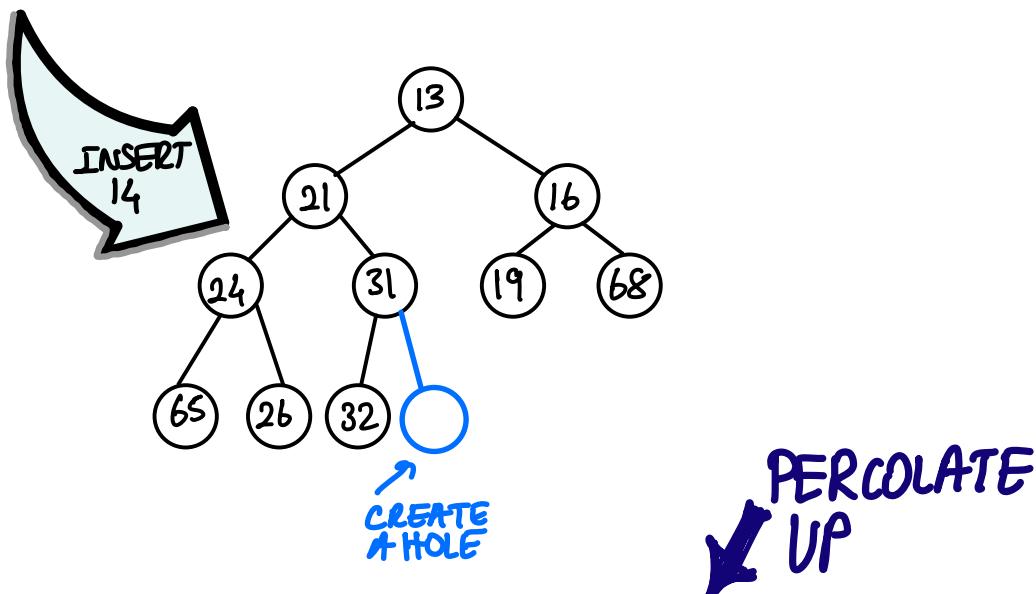


← NOT A  
HEAP

## BASIC HEAP OPERATIONS : INSERT

TO INSERT AN ELEMENT X INTO THE HEAP:

- CREATE A HOLE IN THE NEXT AVAILABLE LOCATION
  - IF X CAN BE PLACED THERE WITHOUT VIOLATING THE HEAP PROPERTY, THEN WE DO SO AND ARE DONE.
  - OTHERWISE
    - BUBBLE UP THE HOLE TOWARD THE ROOT BY SLIDING THE ELEMENT IN THE HOLE'S PARENT DOWN
    - WE CONTINUE THIS UNTIL X CAN BE PLACED IN THE HOLE
- ← CALLED PERCOLATE UP

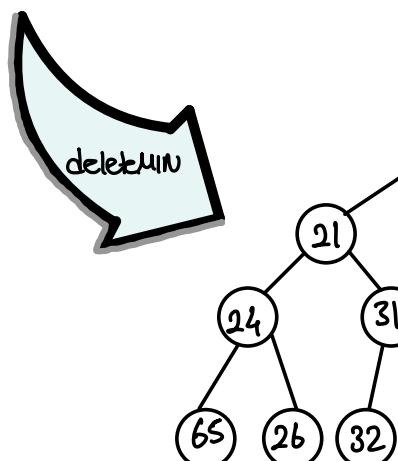


## BASIC HEAP OPERATIONS: DELETE MIN

- deletemin is handled in a similar manner as insertion
- REMOVE THE MINIMUM; A HOLE IS CREATED AT THE ROOT
- THE LAST ELEMENT X MUST MOVE SOMEWHERE IN THE HEAP

PERCOLATE  
DOWN

- IF X CAN BE PLACED IN THE HOLE THEN WE ARE DONE
- OTHERWISE
  - WE SLIDE THE SMALLER OF THE HOLE'S CHILDREN INTO THE HOLE, thus pushing the hole one level down.
  - REPEAT UNTIL X CAN BE PLACED IN THE HOLE.



PERCOLATE  
DOWN

