Final note on Hashing

Which collision resolution strategy is better?
- if #records is large,
- if need a fast speed,

What data structures can hash tables replace for ?

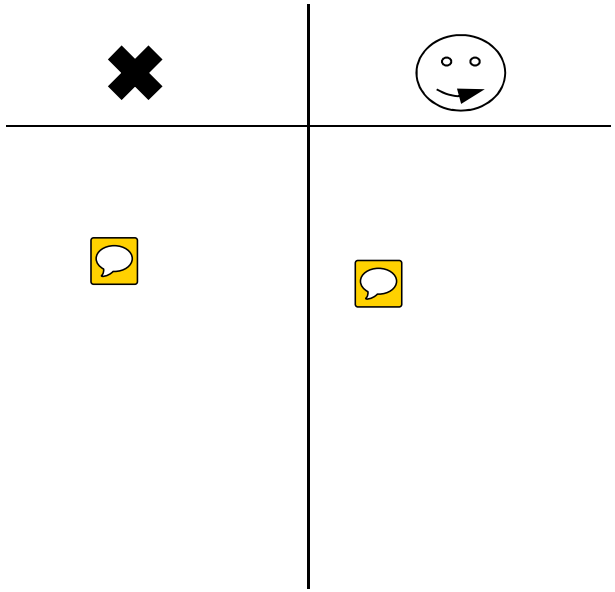
There is a (useful ?) constraint on Key space for binary search tree (BST) that hashing does not have: _____

Then, why do we talk about balanced BST if hashing is so powerful ?

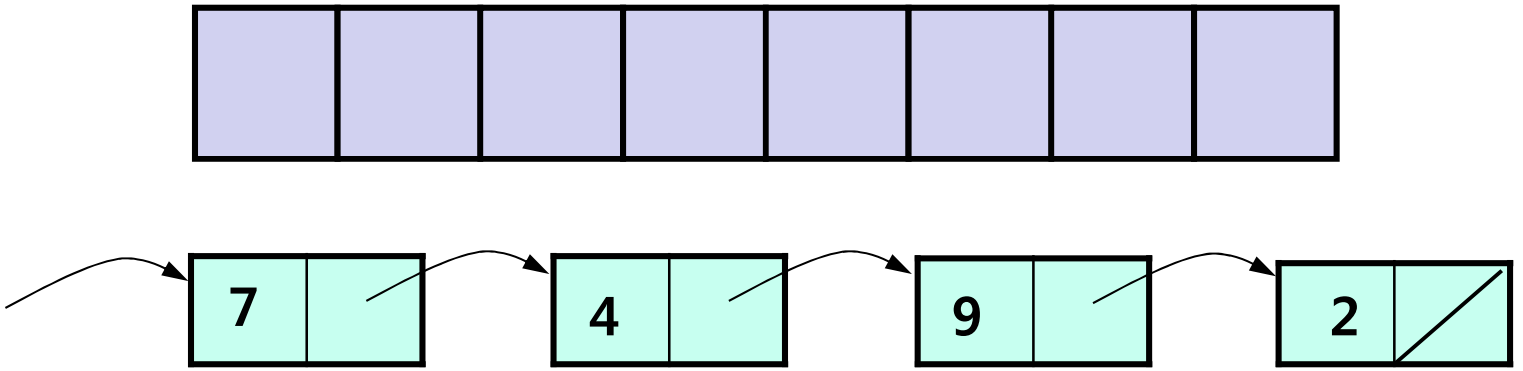
Now, new topic: one very interesting Data structure ....

ADT of 

- insert (no constraint)
- remove (constraining to )
- getSize

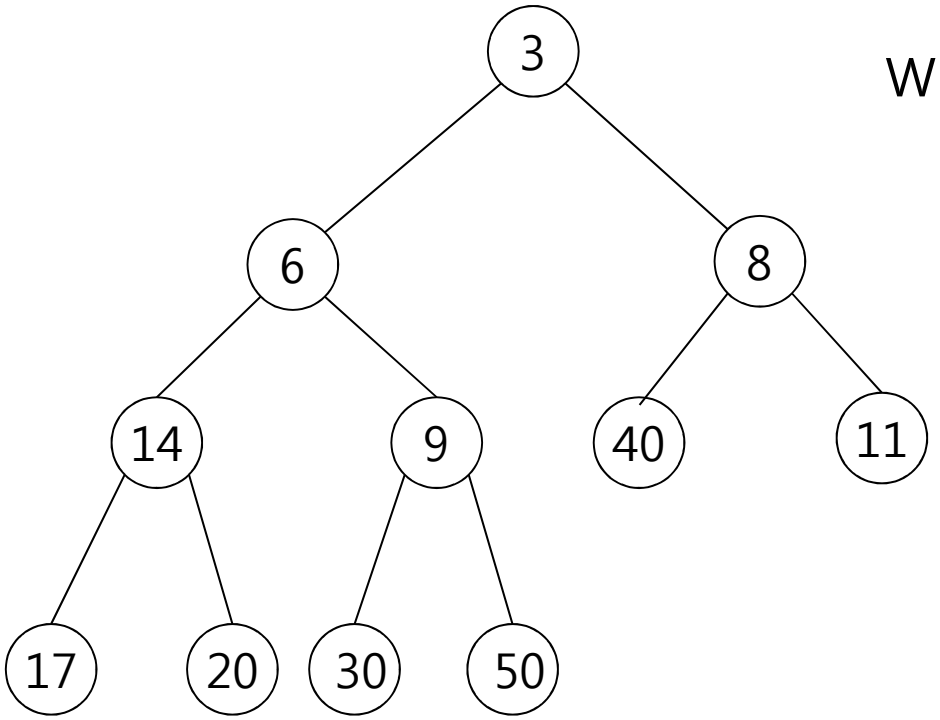


Time complexity so far



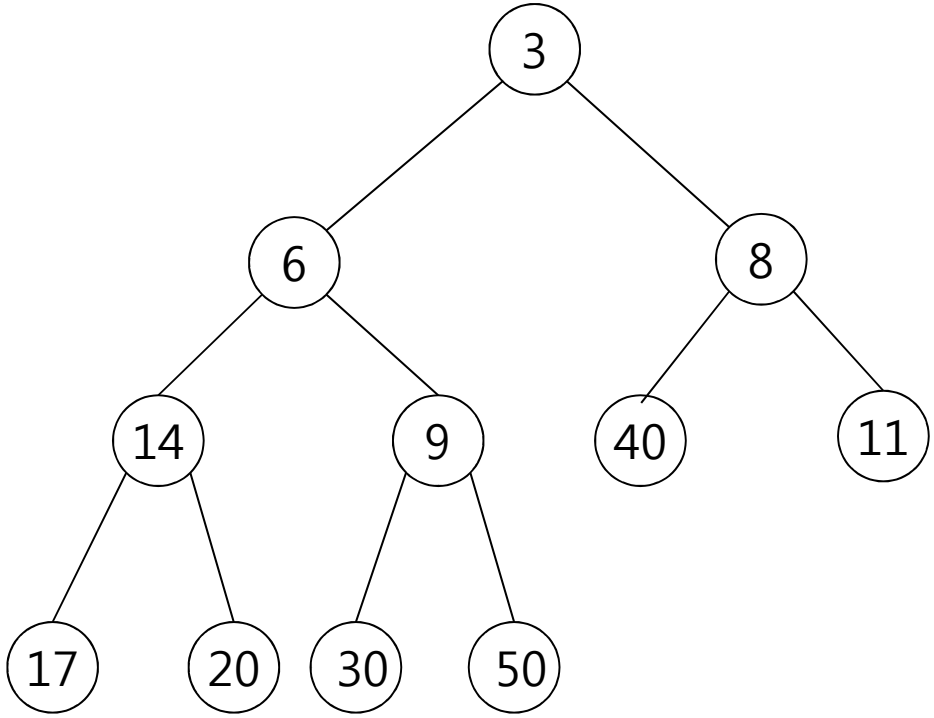
	(Unsorted)		(Sorted)	
	Array	List	Array	List
insert	O(n)	O(1)	O(log n)	O(log n)
removeMin	O(n)	O(n)	O(1)	O(1)

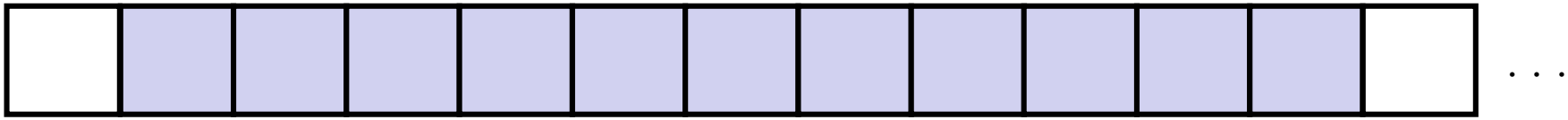
One implementation option …



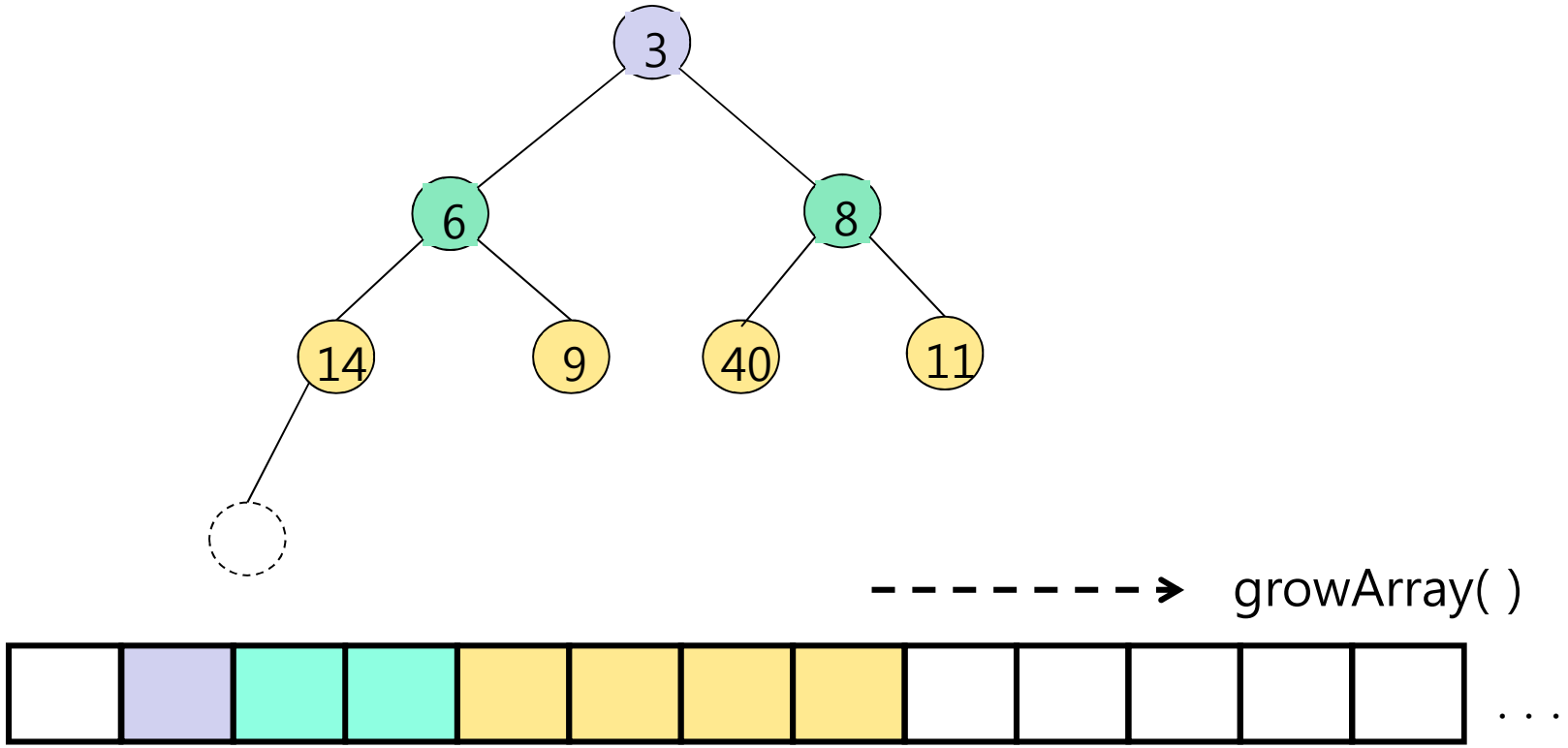
What characteristics do this tree have?

MinHeap : insert( )





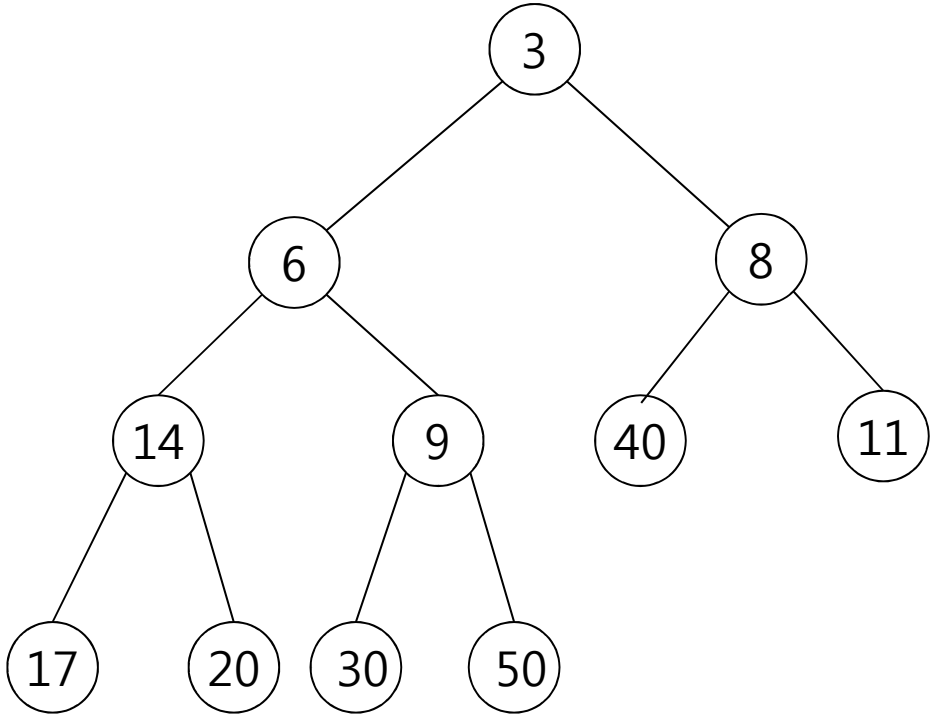
```
template <class T>
void Heap<T>::insert(const T & key) {
      if (size==capacity) growArray();
      size++;
      items[size] = key;
      heapifyUp(size);
}
```

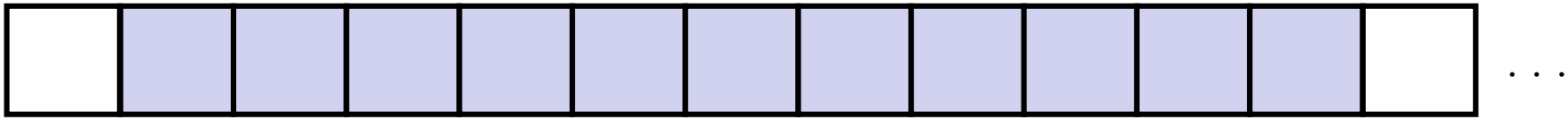


```
template <class T>
void Heap<T>::insert(const T & key) {
      if (size==capacity) growArray();
      size++;
      items[size] = key;
      heapifyUp(size);
}
```

```
template <class T>
void Heap<T>::heapifyUp(int idx) {
     if (idx > _____) {
          if (items[idx] ___ items[parent(idx)]) {
               swap(_____ , _____);
               heapifyUp(_____);
          }
    }
}
```

MinHeap : removeMin( )



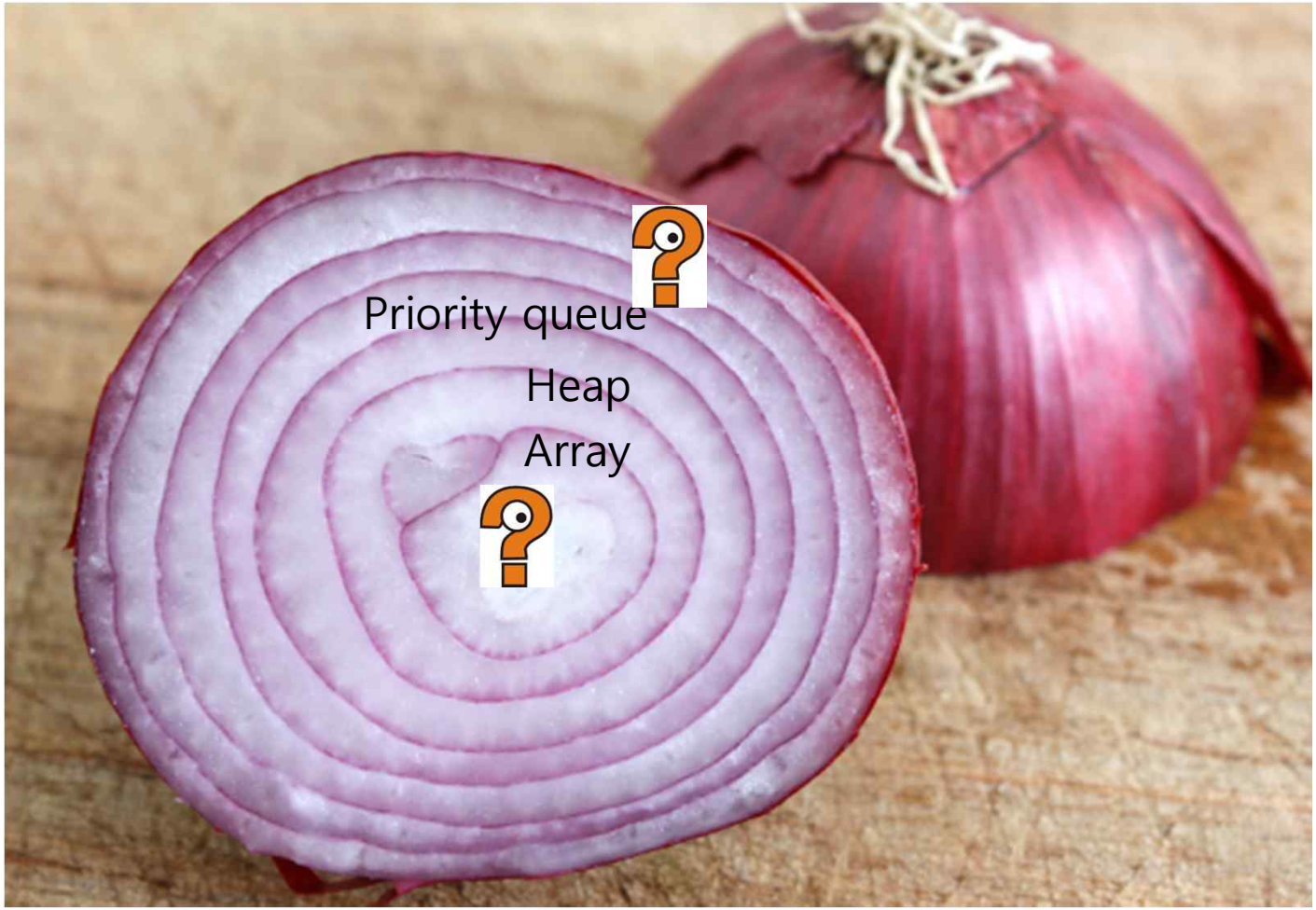


```
template <class T>
T Heap<T>::removeMin(){
      T minVal = items[1];
      items[1] = items[size];
      size--;
      heapifyDown(1);
      return minVal;
}
```

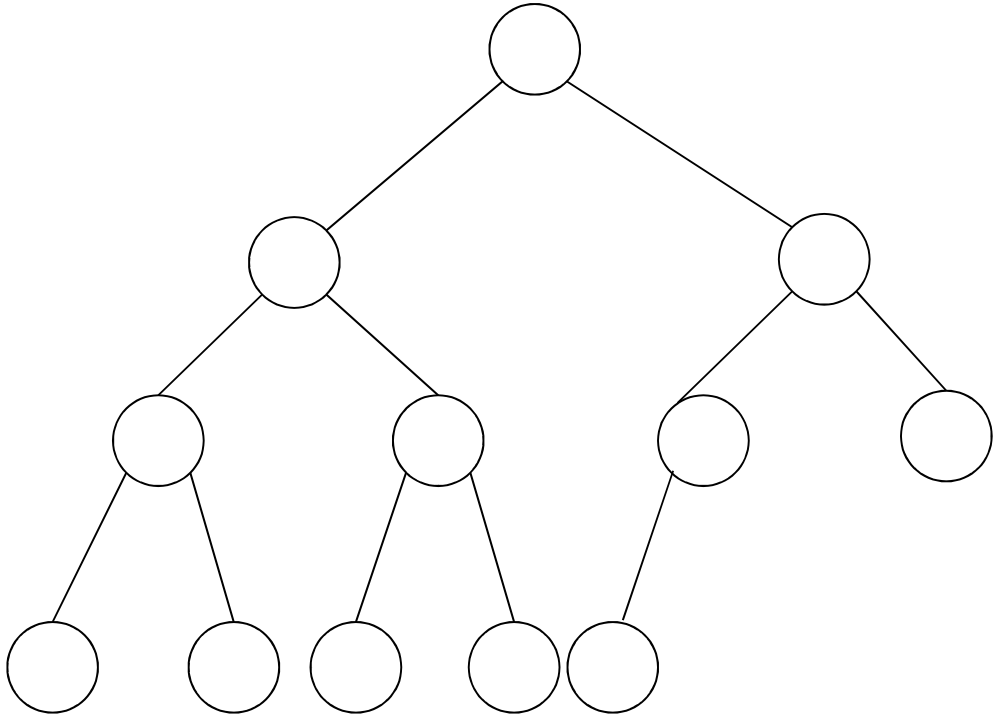
```
template <class T>
void Heap<T>::heapifyDown(int idx) {
     if (hasAChild(idx)) {
          minChildIdx = minChild(idx);
          if (items[idx] ____ items[minChildIdx]) {
               swap(_____ , _____);
               _____;


}}
```

So far, where we are, and where will go ?

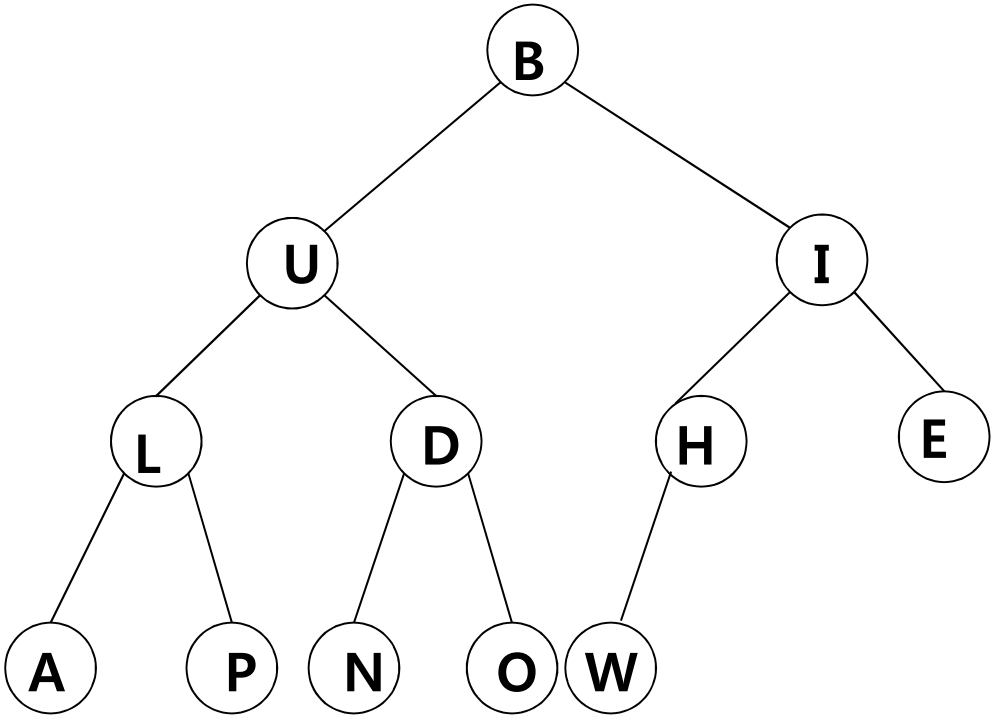


MinHeap : buildHeap( )



	B	U	I	L	D	H	E	A	P	N	O	W

MinHeap : buildHeap( ) – 3 choices




```
template <class T>
void Heap<T>::buildHeap() {
    for (int i=parent(size); i > 0; i--)
        heapifyDown(i);
}
```

```
template <class T>
void Heap<T>::buildHeap() {
      for (int i=2; i <= size; i++)
            heapifyUp(i);
}
```

	B	U	I	L	B	H	E	A	P	N	O	W

Sort the array