

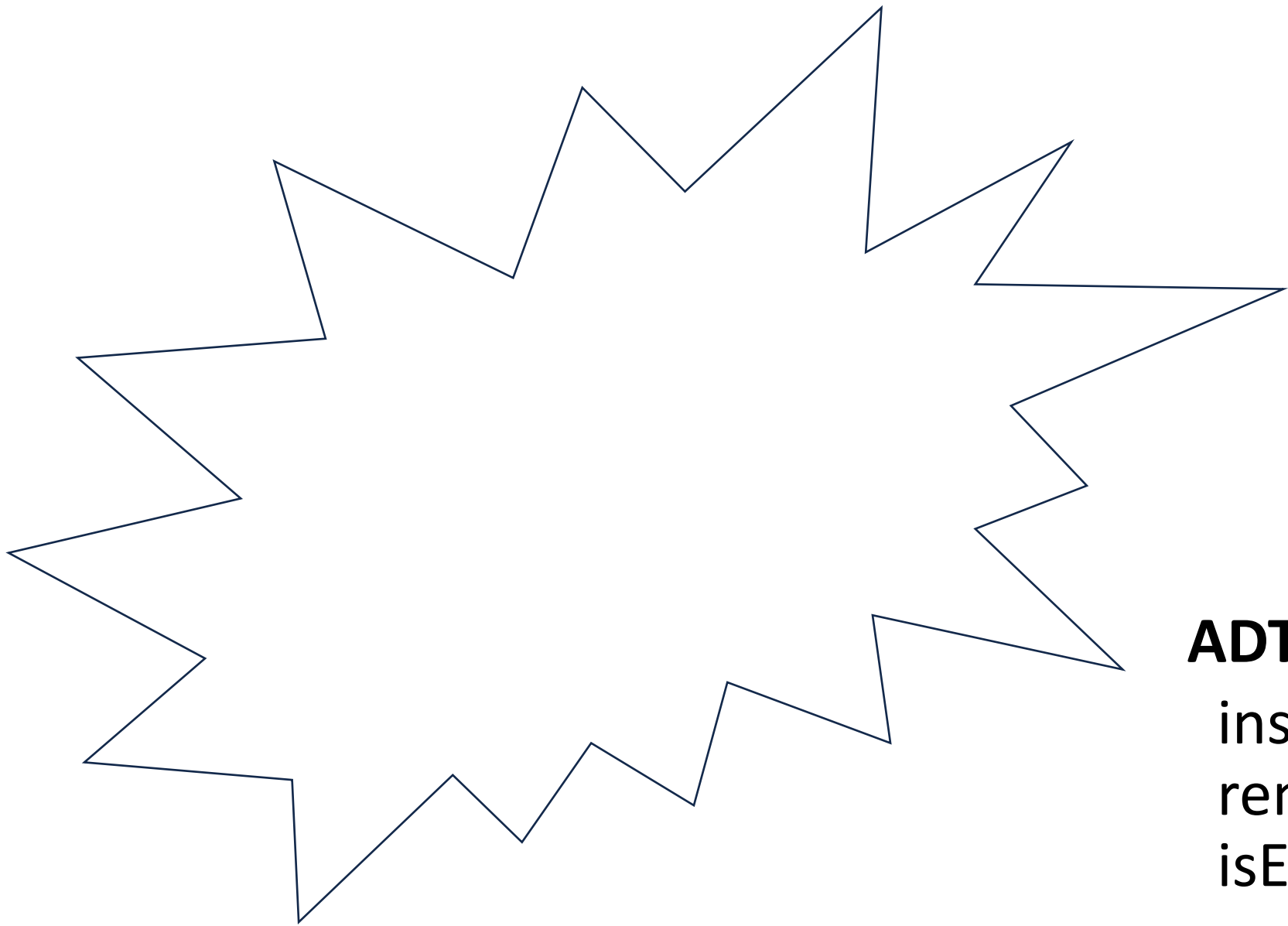


CS 225

Data Structures

Nov. 3 – Heaps
Wade Fagen-Ulmschneider

Secret, Mystery Data Structure



ADT:

- insert
- remove
- isEmpty

Priority Queue Implementation

insert	removeMin
$O(n)$	$O(n)$
$O(1)$	$O(n)$
$O(\lg(n))$	$O(1)$
$O(\lg(n))$	$O(1)$



unsorted



sorted



CS 225's Final Exam

Exam Details:

CBTF Exam, 3 Hours Long

Theory (MCQ) and Programming Questions

When you finish your exam, you're done with CS 225! :)

Signup Process:

CS 225 Exam will run **Thursday, Dec. 14 - Monday, Dec. 18**

(including both Saturday and Sunday)

You can sign up for your slot **right now!**

Share Your #cs225 work!

On Facebook/Twitter/Instagram:

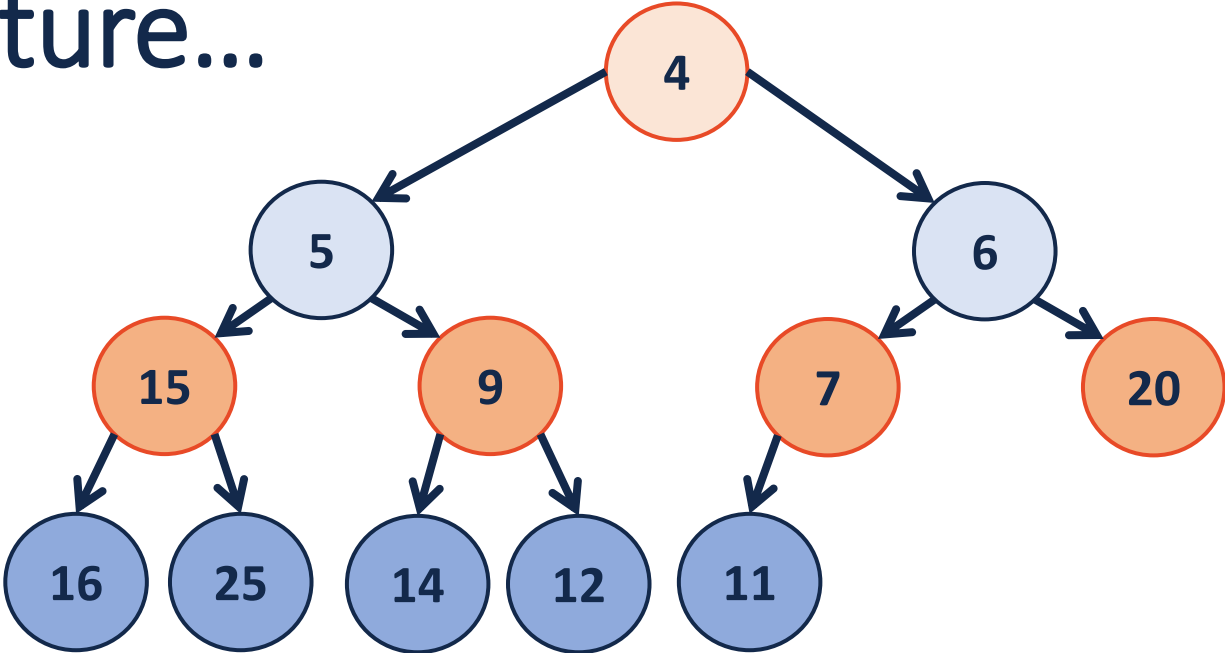
#cs225

...I'll search this tag every few days and like/heart your work!

On Piazza:

See pinned post: “MP5: Mosaic Sharing”

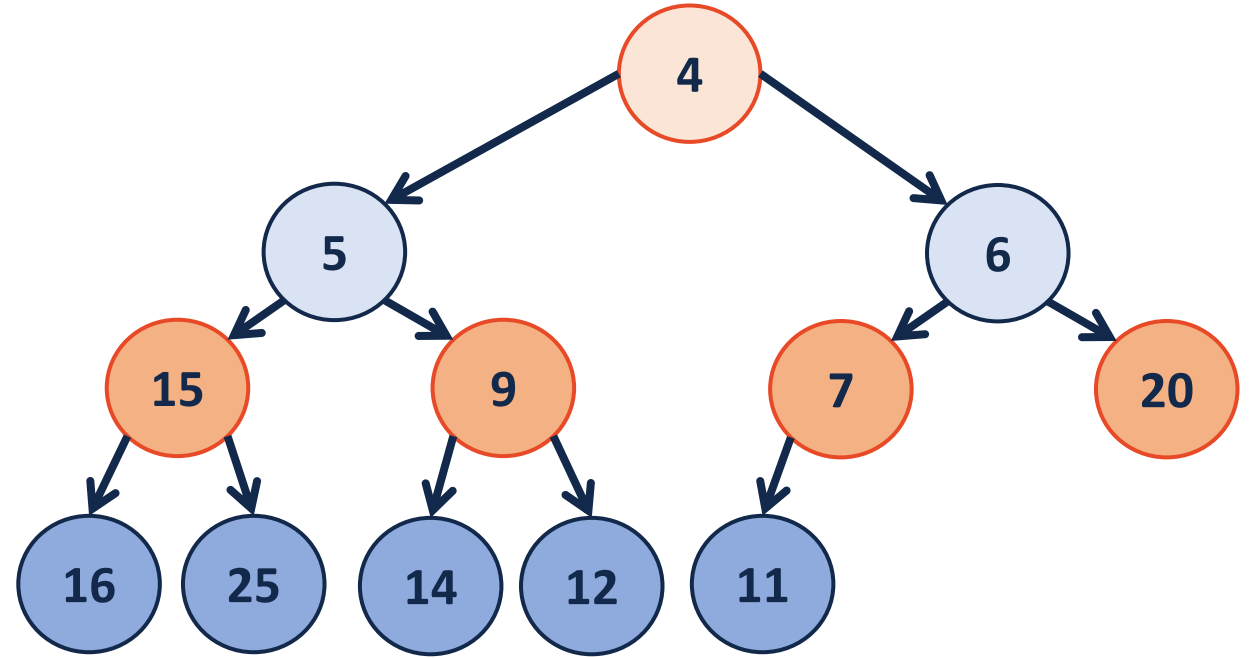
Another possibly structure...



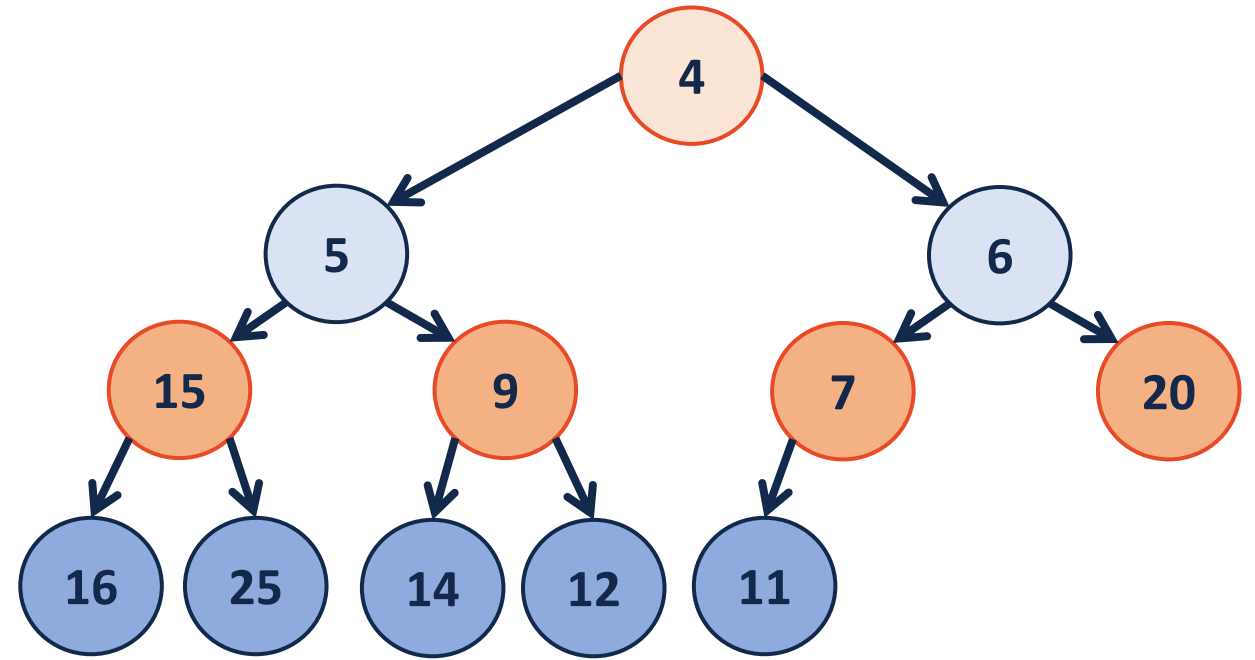
(min)Heap

A complete binary tree T is a min-heap if:

- $T = \{\}$ or
- $T = \{r, T_L, T_R\}$, where r is less than the roots of $\{T_L, T_R\}$ and $\{T_L, T_R\}$ are min-heaps.

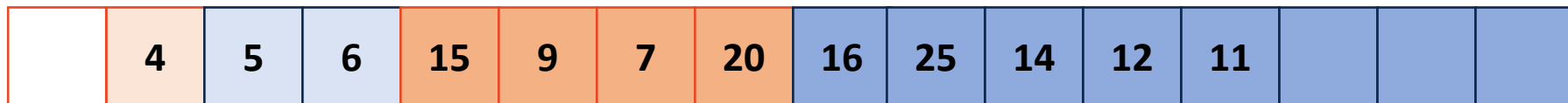
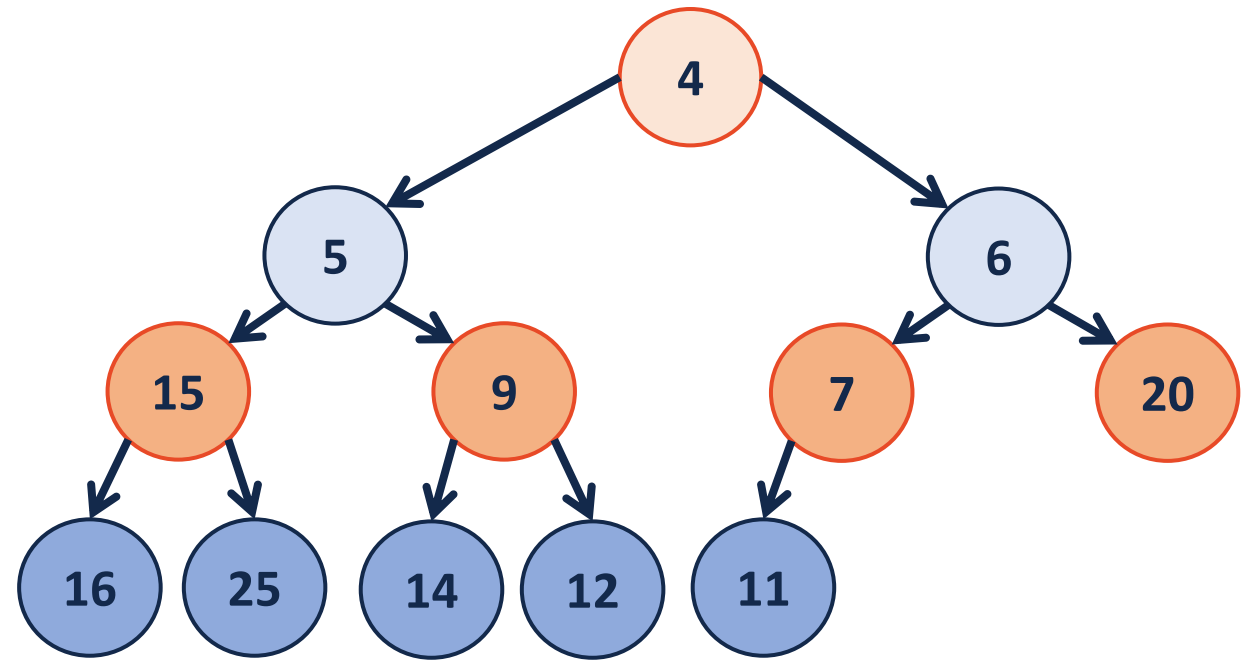


(min)Heap



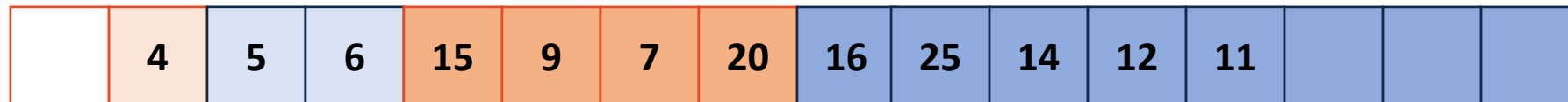
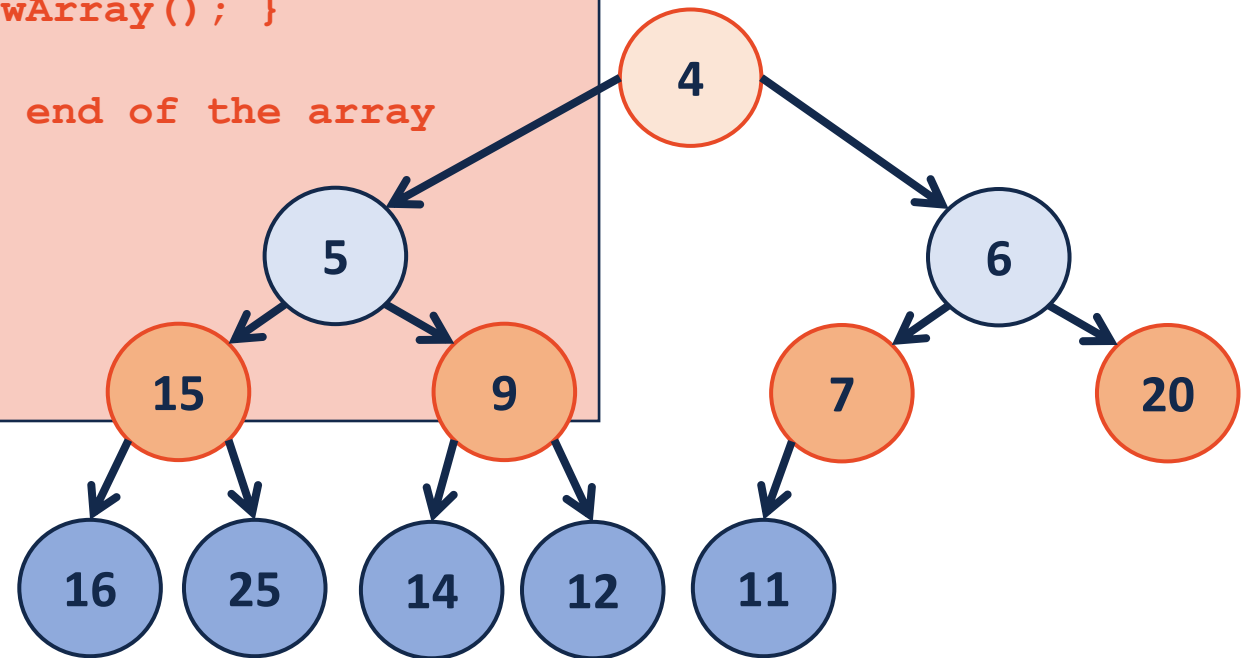
4	5	6	15	9	7	20	16	25	14	12	11			
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insert

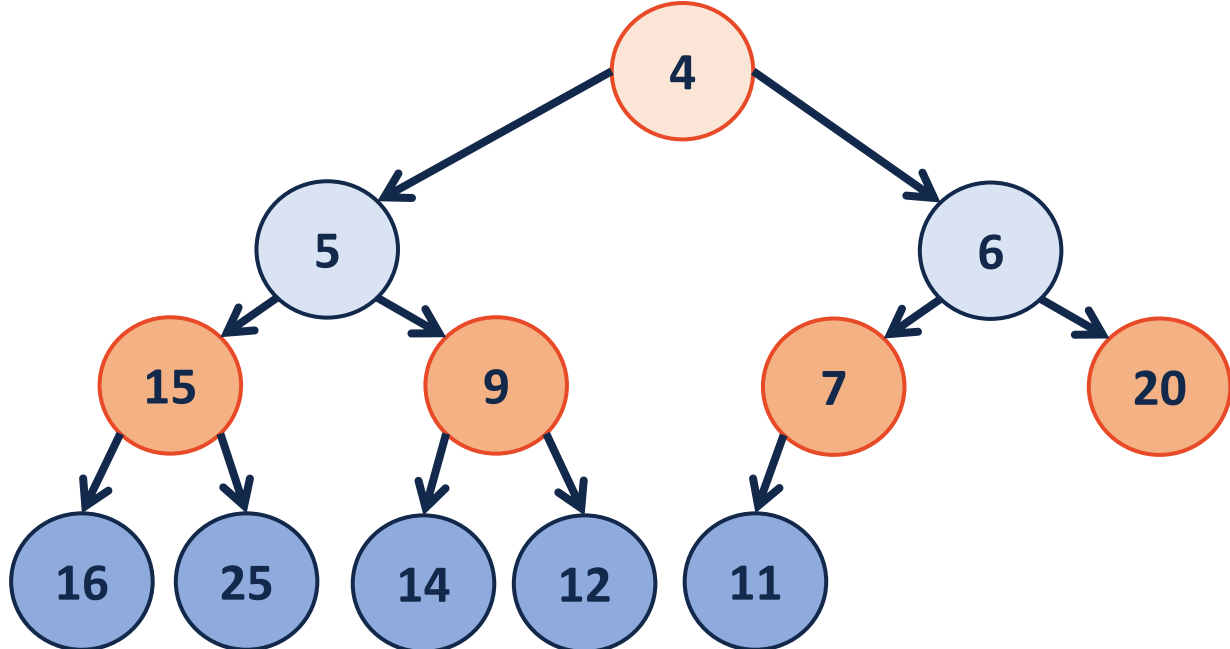


insert

```
1 template <class T>
2 void Heap<T>::_insert(const T & key) {
3     // Check to ensure there's space to insert an element
4     // ...if not, grow the array
5     if ( size_ == capacity_ ) { _growArray(); }
6
7     // Insert the new element at the end of the array
8     item_[++size] = key;
9
10    // Restore the heap property
11    _heapifyUp(size);
12 }
```



growArray

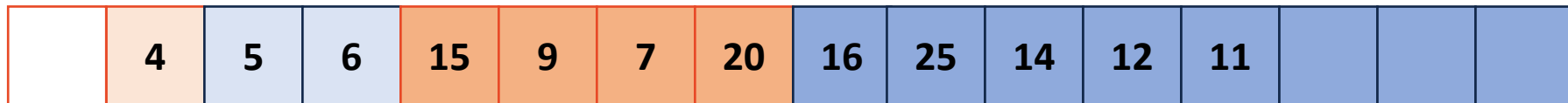
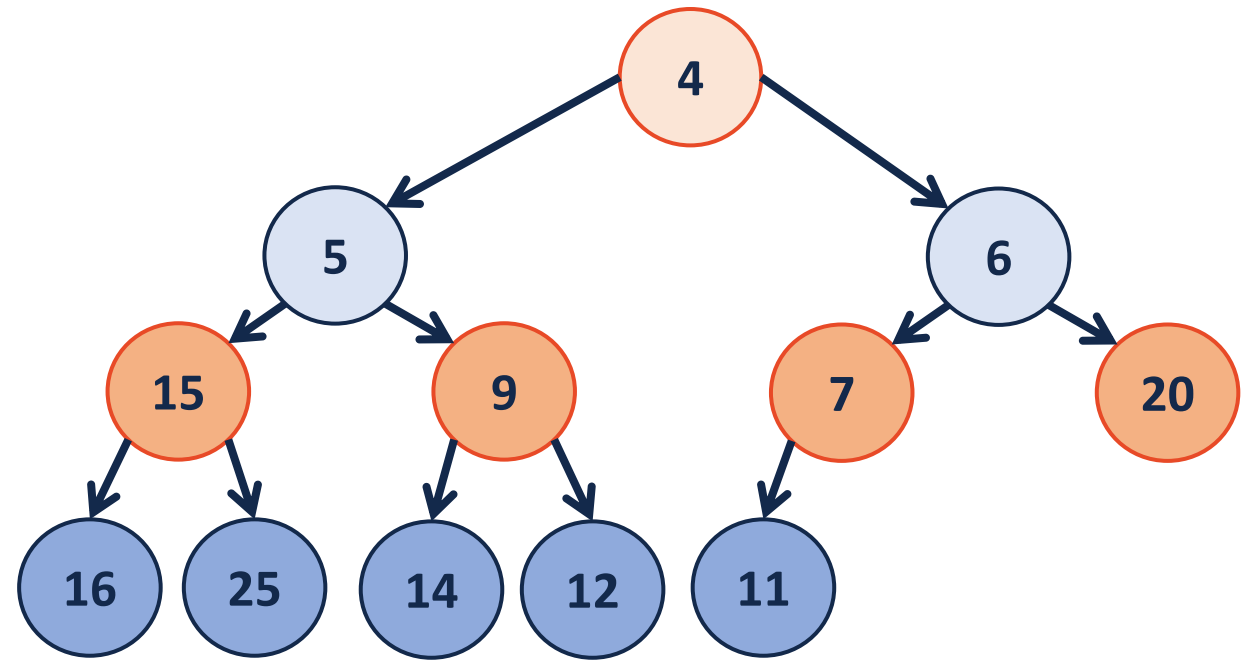


insert - heapifyUp

```
1  template <class T>
2  void Heap<T>::_insert(const T & key) {
3      // Check to ensure there's space to insert an element
4      // ...if not, grow the array
5      if ( size_ == capacity_ ) { _growArray(); }
6
7      // Insert the new element at the end of the array
8      item_[++size] = key;
9
10     // Restore the heap property
11     _heapifyUp(size);
12 }
```

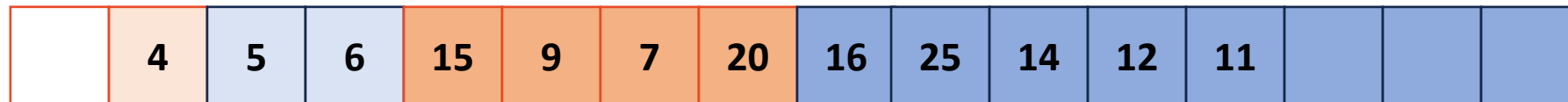
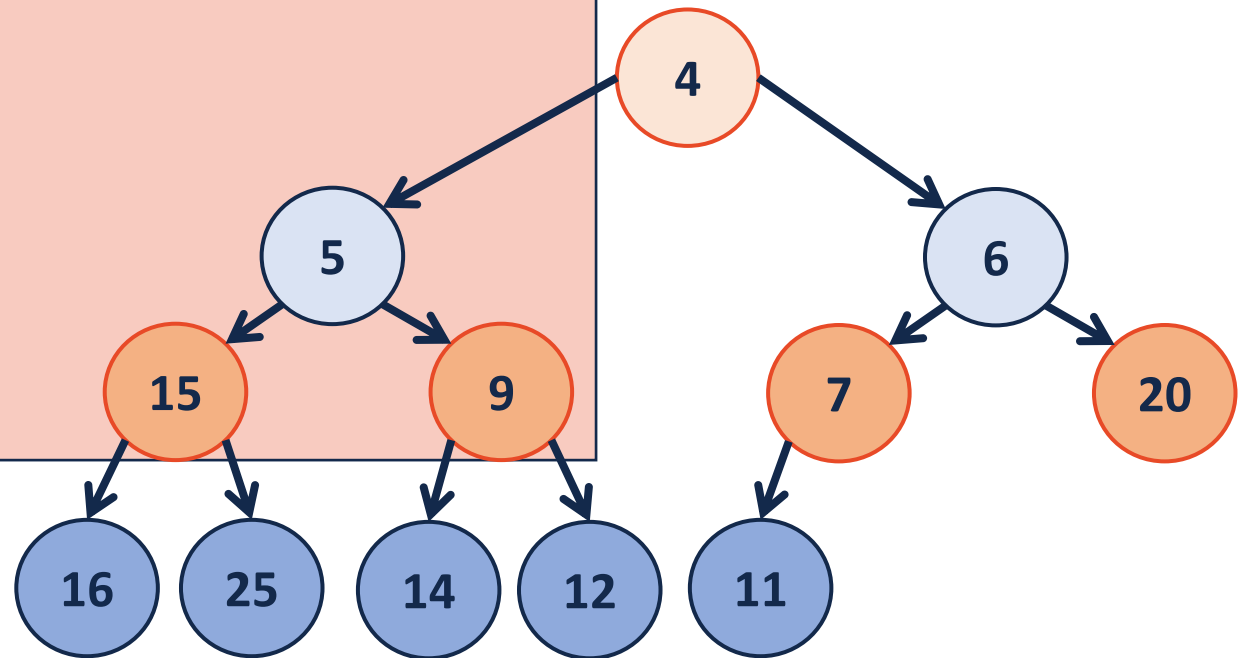
```
1  template <class T>
2  void Heap<T>::_heapifyUp( _____ ) {
3      if ( index > _____ ) {
4          if ( item_[index] < item_[ parent(index) ] ) {
5              std::swap( item_[index], item_[ parent(index) ] );
6              _heapifyUp( _____ );
7          }
8      }
9  }
```

removeMin



removeMin

```
1  template <class T>
2  void Heap<T>::_removeMin() {
3      // Swap with the last value
4      T minValue = item_[1];
5      item_[1] = item_[size_];
6      size--;
7
8      // Restore the heap property
9      heapifyDown();
10
11     // Return the minimum value
12     return minValue;
13 }
```

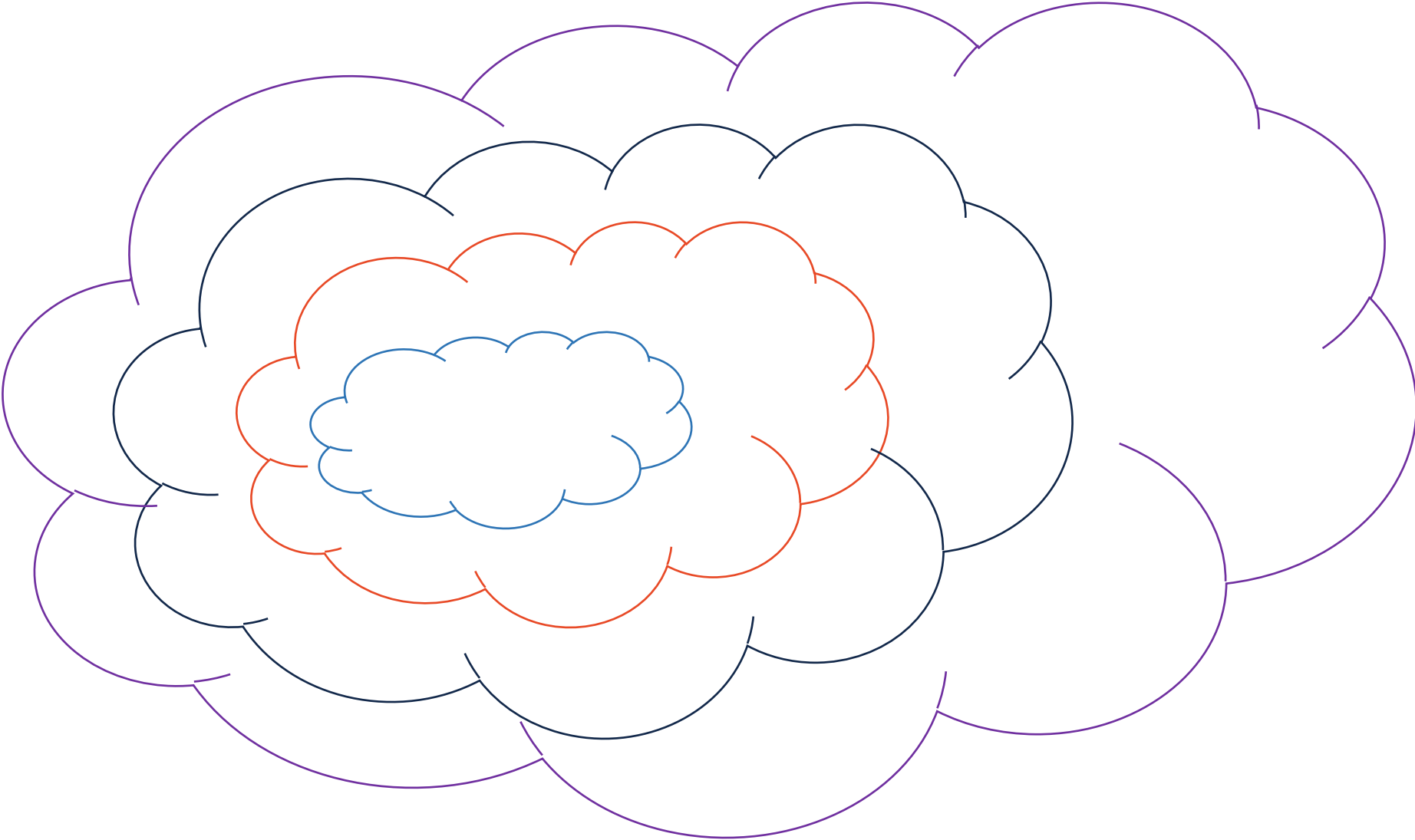


insert - heapifyUp

```
1  template <class T>
2  void Heap<T>::_removeMin() {
3      // Swap with the last value
4      T minValue = item_[1];
5      item_[1] = item_[size_];
6      size--;
7
8      // Restore the heap property
9      _heapifyDown();
10
11     // Return the minimum value
12     return minValue;
13 }
```

```
1  template <class T>
2  void Heap<T>::_heapifyDown(int index) {
3      if ( !_isLeaf(index) ) {
4          T minChildIndex = _minChild(index);
5          if ( item_[index] > item_[minChildIndex] ) {
6              std::swap( item_[index], item_[minChildIndex] );
7              _heapifyDown( minChildIndex );
8          }
9      }
10 }
```

Array Abstractions



CS 225 – Things To Be Doing

Register for CS 225's Final Exam!

Exam 8 (programming exam, MP4-like and AVL) is live!

More Info: <https://courses.engr.illinois.edu/cs225/fa2017/exams/>

MP5: kd-trees

Due Monday, Nov. 6 at 11:59pm

Lab: lab_hash released today

Due Sunday, Nov. 5 at 11:59pm

POTD

Every Monday-Friday – *Worth +1 Extra Credit /problem (up to +40 total)*