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CS61BL – Tutoring Section 9

Hashing, Priority queues and Heaps

- Quick Review
- Quiz Review (Optional)
- Worksheet

Resources:

- www.cs61bl.org/su20/resources

YOU COMPLETED MT2

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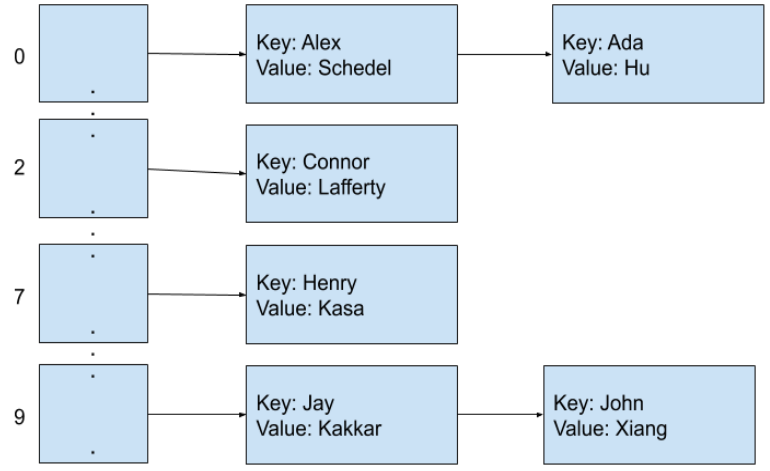
Hashing

- **Objective:** Data structure that supports Θ(1) runtime for adding and lookup.
- **Idea:** Combine the best of both worlds (Arrays + LinkedLists)
- **Hash Functions:**
  - ***Valid:***
    - *Determinism:* Same items (.equals()), same code
    - *Consistency:* Every time you call hash function on same item it produces the same code
  - ***Good***
    - *Uniform spreading and quick computation*
- **Memory Efficiency:**
  - Resizing when too crowded (Imagine: LinkedList)
  - $load\ factor = \frac{size}{array.length}$



Priority queues

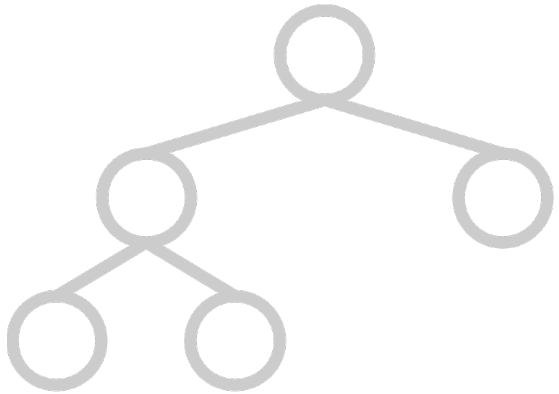
- **Objective:** Data Structure that processes based on priority
- **Variants:**
  - MaxPriorityQueue (Emergency Room)
  - MinPriorityQueue (Refrigerator)
- Each item in the PQ is in the form (Item, priority)
- **Functions:**
  - **Insert(item, priorityvalue)**
  - **Peek() –** Returns item to be popped off next
  - **Poll() –** Pops off item

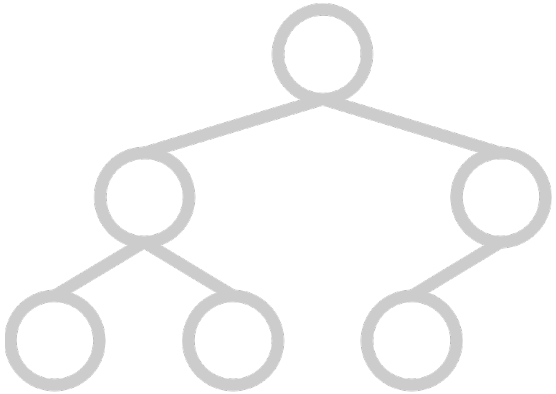
Heaps (Max/Min)

- **Objective:** Basically an implementation of a priority queue but more efficient in the form of a tree
- **NOTE: HEAPS ARE NOT BINARY SEARCH TREES**
- **Representation:** Complete Trees (i.e. completely filled, last row needs to be filled from left to right)
- **Implementation:** Array starting at i = 1. Left child = 2i; Right child = 2i+1 for all i in N.
- **Insertion:** Add item to bottom; Recursively check if item is smaller/larger than parent. If so, iterate until root or terminate.
- **Deletion:** Swap bottom item with root; Recursively check if item is smaller/larger than kid. If so, iterate until root or terminate.

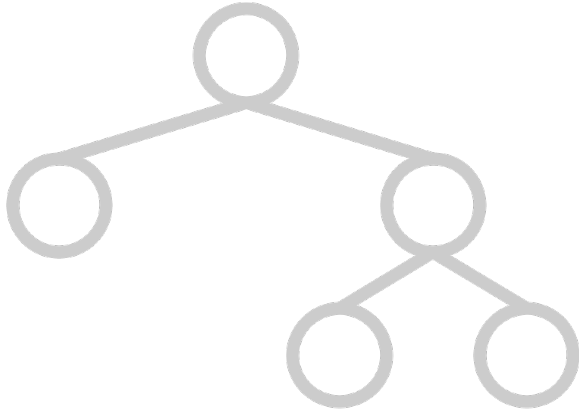
Completeness

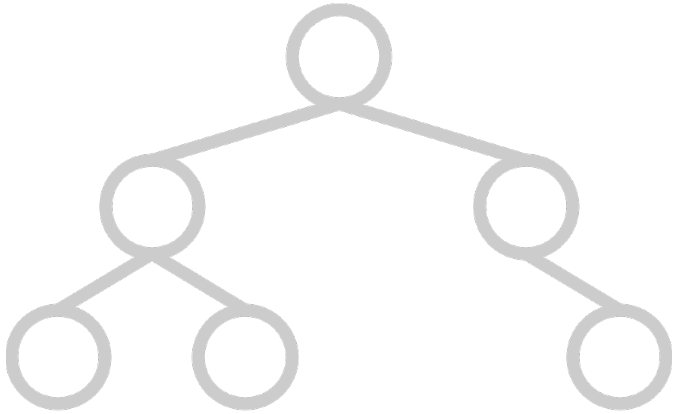
Complete





Incomplete





Quiz Q1.1: Hashing

Which ones are valid hashing functions?

```java
public class Course {
    public final int CCN;
    public final String instructor;
    public Student[] students;
    public int audited; //when the course was last audited
    public Course(int CCN, Student[] initial) {
        this.CCN = CCN;
        this.students = initial;
        this.instructor = "Matt";
    }
    //implementation
    public void audit() {
        this.audited = System.currentTimeMillis();
        //implementation
    }
    public void addStudent(Student s) {
        //implementation
    }
}
```

A)

```java
@Override
public int hashCode() {
    return CCN;  //Option A
}
```

B)

```java
@Override
public int hashCode() {
    return this.students.length;  //Option B
}
```

C)

```java
@Override
public int hashCode() {
    return this.audited; //Option C
}
```

D)

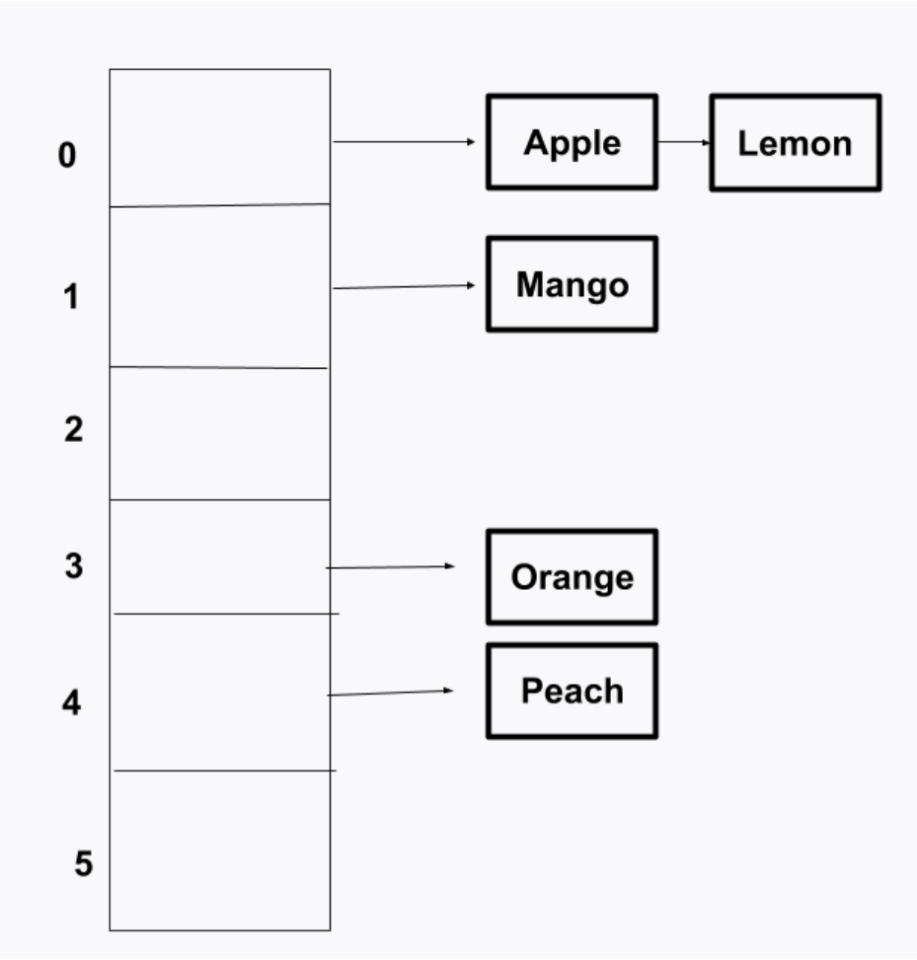
```java
@Override
public int hashCode() {
    return 5; //Option D
}
```

E)

```java
@Override
public int hashCode() {
    return getNumericValue(this.instructor.charAt(0)); //Option E
}
```

Quiz Q1.2: Hashing

If the load factor is 1.25, how many inserts can we make before resizing?



Monster Hashing Question is explained on video

Quiz Q2: Heaps

What is the left child of 4 and right child of 6?

We have the following heap, representing a Min PQ:
[-, 1, 4, 6, 7, 10, 12, 15, 16, 22, 34, 56, 71]
Here, `-` represents null.

MaxHeap: Peeking, polling and inserting. We only have access to a MinHeap. What do we do?