# CSM 61B Fall 2020 — Heaps and Hashing

Mentoring 9: October 19-23, 2020

## 1 Min-Heapify This

1.1 In general, there are 4 ways to heapify. Which 2 ways actually work?

- Level order, bubbling up
- Level order, bubbling down
- Reverse level order, bubbling up
- Reverse level order, bubbling down

1.2 Are the values in an array-based min-heap sorted in ascending order?

1.3 Is an array that is sorted in descending order also a max-oriented heap?

## 2 K Largest Items

2.1 The largest item in a heap must appear in position 1, and the second largest must appear in position 2 or 3. Give the list of positions in a heap where the $k$th largest can appear for $k \in \{2, 3, 4\}$. Assume values are distinct.

## 3 Ls for LinkedLists

3.1 (a) In the worst case, how long does it take to index into a linked list?

(b) In the worst case, how long does it take to index into an array?

(c) In the worst case, how long does it take to insert into a linked list?

(d) Assuming there's space, how long does it take to put a element in an array?

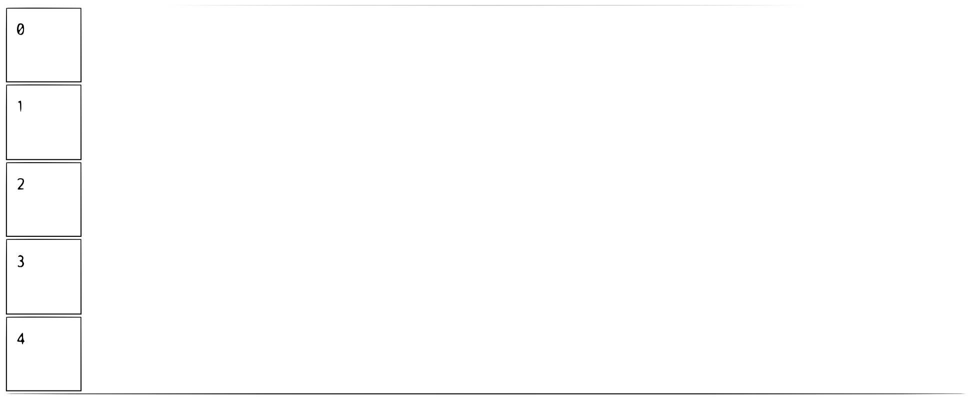
(e) What if we assume there is no more space in the array?

(f) Given what we know about linked lists and arrays, how could we build a data structure with efficient access and efficient insertion?

## 4 Hashing Practice

4.1 (a) Draw the diagram that results from the following operations on a Java `HashMap`. `Integer::hashCode` returns the integer's value.

```
put(3, "monument");
put(8, "shrine");
put(3, "worker");
put(5, "granary");
put(13, "worker");
```



(b) Suppose a resize occurs, doubling the array to size 10. What changes?

## 5 Hash Codes

There is a problem with each `hashCode()` method below (correctness, distribution, efficiency). Assume there are no problems with the correctness of `equals()`.

5.1
```
class Person {
    Long id;
    String name;
    Integer age;
    public int hashCode() {
        return id.hashCode() + name.hashCode() + age.hashCode();
    }
    public boolean equals(Object o) {
        Person p = (Person) o;
        return p.id == id;
    }
}
```

5.2
```
class Phonebook {
    List<Human> humans;
    public int hashCode() {
        int h = 0;
        for (Human human : humans) {
            // Assume Human::hashcode is correct
            h = (h + human.hashCode()) % 509;
        }
        return h;
    }
    public boolean equals(Object o) {
        Phonebook p = (Phonebook) o;
        return p.humans.equals(humans);
    }
}
```

5.3
```
class PokeTime {
    int startTime;
    int duration;
    public int getCurrentTime() {
        // Gets the current system clock time
    }
    public int hashCode() {
        return 1021 * (startTime + 1021 * duration + getCurrentTime());
    }
    public boolean equals(Object o) {
        PokeTime p = (PokeTime) o;
        return p.startTime == startTime && p.duration == duration;
    }
}
```