CSCI 136: Data Structures and Advanced Programming Lecture 32 Heaps	Topics Heaps
Instructor: Dan Barowy Williams	
Your to-dos	Announcements
 Read before Wed: Review readings from <i>Bailey</i>. Lab 10 (partner lab), due Tuesday 5/10 by 10pm. 	 Senior thesis presentations in Wege auditorium: Monday, May 16, 10am-noon Monday, May 16, 1:30-3pm Ward prize presentations for best class project in Wege auditorium: Tuesday, May 17, 2:30-4pm

Announcements

- 1. Final exam: Sunday, May 22, 9:30am in TPL 205.
- 2. Note that all of the **practice quiz solutions** are on the course website.

Announcements

- 1. Student course surveys, in class, Wednesday, 5/11.
 - a. Please bring laptop/tablet to fill out survey.

2. Final exam review session, in class, Friday 5/13.

Practice Activity (+ cookies)

Activity: connectedness

boolean connected():

How might I compute this using fundamental ops?

(adjacent, vertices, incident, degree, neighbors)



(note that graph is undirected)



































Priority Queue

A **priority queue** is an abstract data type that returns the elements in **priority order**. Under priority ordering, an element **e** with a higher priority (an integer) is returned before all elements **L** having lower priority, even if that **e** was enqueued after all **L**. When any two elements have **equal priority**, they are returned in **first-in**, **first-out order** (i.e., in the order in which they were enqueued).











Priority Queue: Operations insert: inserts an element with a given priority value. Ensures that the next element of the queue is in priority order. Like enqueue.



Priority Queue: Operations

find-max: returns the next element with a highest priority value. Like **peek**, does not modify the queue.



Priority Queue: Operations

extract: removes and returns the next element with a maximum priority value. Like **dequeue**.



Priority Queue

How to implement?

Vector: find-max: O(1) insert: O(n) extract: O(n) BinarySearchTree: find-max: O(n) insert: O(n) extract: O(n)

Heap: find-max: O(1) insert: O(log n) extract: O(log n)



Max Heap

A max heap is a tree-based data structure that returns its elements in priority order. A heap maintains the max heap property: for any given node n, if p is a parent node of n, then the key of p is \geq to the key of n.

A max heap is a tree whose root is the maximum element and whose subtrees are, themselves, heaps. Is this a binary search tree?



No. Nodes do not obey binary search property.





















The **swapping procedure** performed on **extract** is often referred to as **heap-down** or **percolate-down**.

Recap & Next Class

Today:

Priority queues

Heaps

Next class:

Dijkstra's algorithm