CS2040C Semester 2 2018/2019
Data Structures and Algorithms

Tutorial 05 - More Binary Heap, Midtest Review

For Week 07

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1 Introduction and Objective

Welcome back from recess week =). I hope that you are (a bit) fresher now.

In this tutorial, we will first resume our discussion on Binary Heap data structure (we reuse `https://visualgo.net/en/heap` again) and ADT Priority Queue, especially on its two extra operations.

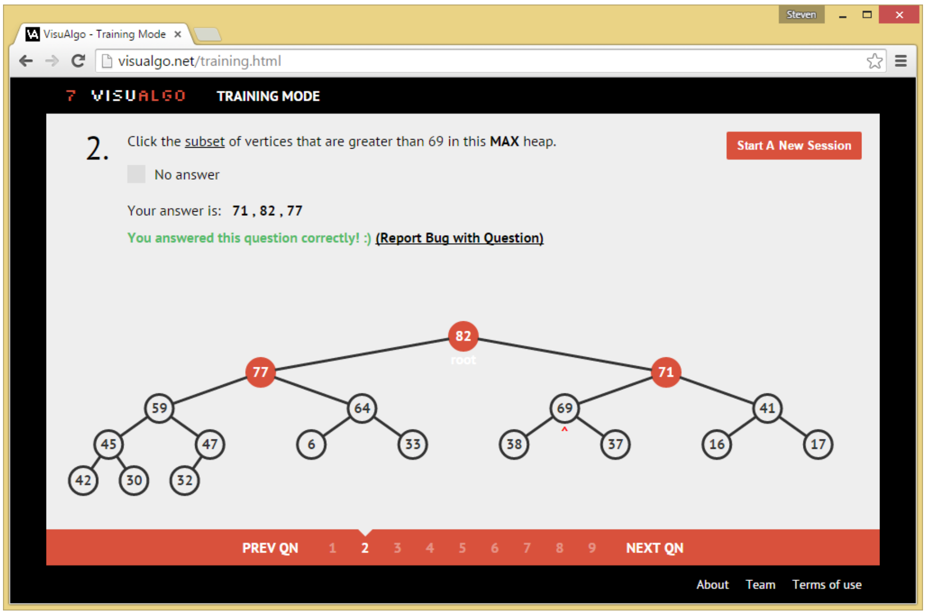
Finally, we will use the remaining time (we will try to make it a habit to end tutorial by 45m sharp) to return your Midterm Test script and to discuss some common mistakes that were found during grading. Steven will upload the updated midterm test modal answer file with full statistics after the last tutorial 05 has been conducted.

2 Tutorial 05 Questions

More Binary Heap Stuffs

Q1). Give an algorithm to find all vertices that have value $> x$ in a max heap of size n.
Your algorithm must run in $O(k)$ time where k is the number of vertices in the output.
Key lesson: This is a new algorithm analysis type for most of you as the time complexity of the algorithm does not depends on the input size n but rather the output size k :O...
Note that this question has also been integrated in VisuAlgo Online Quiz, so it may appear in future Online Quizzes :).

Q2). The *second* largest element in a max heap with more than two elements (to simplify this question, you can assume that all elements are unique) is always one of the children of the root. Is this true? If yes, show a simple proof. Otherwise, show a counter example.
Note that this kind of (simple) proof may appear in future CS2040/C written tests, so please refresh



2. Click the subset of vertices that are greater than 69 in this **MAX** heap.

□ No answer

Your answer is: 71 , 82 , 77

You answered this question correctly! :) (Report Bug with Question)

Figure 1: Also automated :)

your CS1231 (if you have taken that module) or just concentrate on how the tutor will answer this kind of question.

More ADT PQ Operations

Q3). There are two interesting features of Binary Heap data structure that are not available in C++ STL `priority_queue` and Java `PriorityQueue` yet: `Increase/Decrease/UpdateKey(old_v, new_v)` and `DeleteKey(v)` where `v` is not necessarily the max element. These two operations are not yet included in VisuAlgo (the hidden slide `https://visualgo.net/en/heap?slide=3-1`).

Q3a). Given `https://www.comp.nus.edu.sg/~stevenha/cs2040c/demos/BinaryHeapDemo.cpp` (that is a Binary Max Heap), what should we modify/add so that we can implement `DecreaseKey(old_v, new_lower_v)`?

Q3b). Given `https://www.comp.nus.edu.sg/~stevenha/cs2040c/demos/BinaryHeapDemo.cpp` (that is a Binary Max Heap), what should we modify/add so that we can implement `DeleteKey(v)` where `v` is not necessarily the max element?

Midterm Test Debrief

The tutor will spend the last few minutes up to 45m of this tutorial time to return your script and discuss some common mistakes.