36

Illinois Institute of Technology Computer Science

Second Exam

CS 331 — Programming Languages
Fall 2013
Friday, November 1, 2013 15:15–16:30

This is a **closed book** and **closed notes** exam.
You are **not** allowed to use calculators or computers during this exam.
Do **ALL** problems in this booklet. Read each question very carefully.
You may detach pages, but **you must return all pages of this exam.**

Name	
IIT Email	

Stacks and Queues

Question 1) (6 points) What are the three queue operations? What are their time complexitites?

Question 2) (6 points) What are the three stack operations? What are their time complexitites?

Question 3) (6 points) Consider the following code:

```
(defrecord Stack [data size])
```

The element `data` is a standard Clojure persistent singly-linked list. Write the function `(pop stk)` that pops an element off this stack. Return the new stack, not the element.

Question 4) (6 points)
What do the terms FIFO and LIFO stand for?

Question 5) (6 points)
Suppose you have a queue implemented by a mutable linked list (with a last pointer). The list contains the data `(2 3 5 8)`. What does the list look like after a dequeue?

Question 6) (6 points)
Suppose you have a queue implemented by two persistent linked lists. The front list has data `(8 6 7)` and the back list has data `(5 3 0)`. What do these lists look like after enqueuing the number 42?

Doubly Linked Lists

Question 7) (6 points) Consider the following record definition:

```
(defrecord DList [sentinel size])
(defrecord DNode [prev data next])
```

Suppose you also have standard setters and getters (i.e., `getPrev`, `setPrev!`, etc.) for all of these fields.[1] Write the code for `(insert-last xx elt)`, where `xx` is the list and `elt` is the new item. Your code can return anything you want.

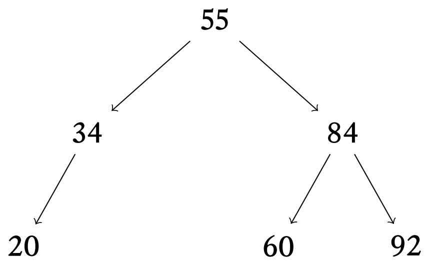
```
(defn insert-last [xx elt]
  (let [last (-> xx getSentinel getPrev)]
    (do ;; you take it from here...
```

Question 8) (6 points) Doubly linked lists are pretty much always mutable. Why is that?

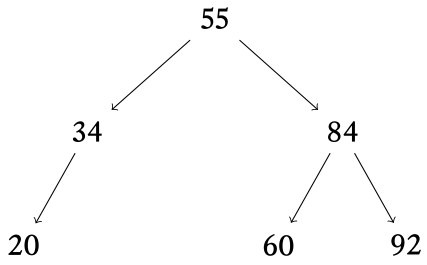
[1] One reason for assuming this is that you won't need to use atom operations to answer this. You may use them anyway if you prefer.

Binary Search Trees

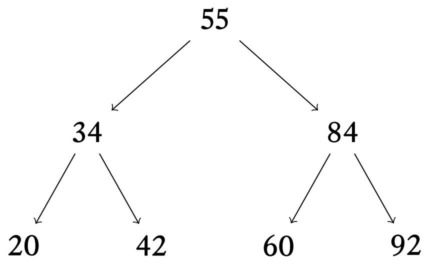
Question 9) (6 points)
Add the elements 33 and 57 to the following tree. You may redraw it or modify the original.



Question 10) (6 points)
Delete the elements 34 and 60 from the following tree. You may redraw it or modify the original.



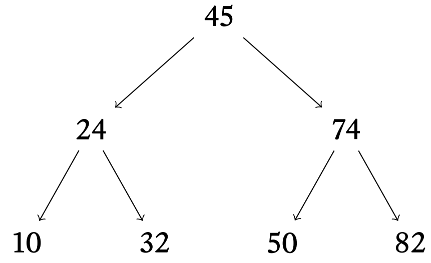
Question 11) (6 points)
Delete the elements 55 from the following tree. You may use the predecessor or the successor.



Question 12) (6 points)
There is a situation in which binary search trees perform very poorly. What is that situation?

Traversals

Give the traversals for the following tree:



Preorder

Inorder

Postorder

Level Order

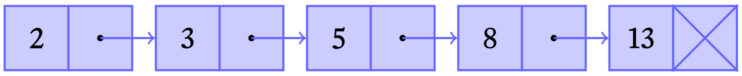
Question 13) (6 points)
What advantage does a breadth-first search have over a depth-first search?

Locality

Question 14) (6 points)

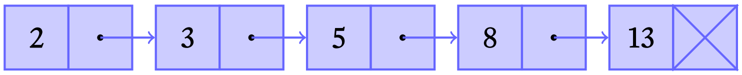
What is temporal locality? How can we code data-structures to take advantage of it?

Question 15) (6 points) Consider this list.



Suppose we now find the 5 node. Show the effect of using the *move-to-front* heuristic.

Question 16) (6 points) Consider this list.



Suppose we now find the 5 node. Show the effect of using the *swap* heuristic.

Meta Questions Name (optional):

These questions are optional, and do not count toward your grade. Don't spend any time on them unless you are already finished with the exam. This page will be separated from the exam, so the data will be anonymous unless you put your name on it.

- How do you think you did just now? What percentage would you estimate to be your score?
- The purpose of this course is to enable you to become an expert at data structures. What is one area in which this course is accomplishing its purpose? Give examples if you can.
- What is an improvement that could be made that would allow the course to accomplish its purpose even better?
- What is one strength as a student you have developed or improved since the last midterm?
- What is one thing you could do to improve your role as a student for the rest of the course?