# CS 2150 Exam 2

## Name

You MUST write your e-mail ID on **EACH** page and bubble in your userid at the bottom of this first page. And put your name on the top of this page, too.

If you are still writing when "pens down" is called, your exam will be ripped up and not graded – even if you are still writing to fill in the bubble form. So please do that first. Sorry to have to be strict on this!

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There are 6 pages to this exam. Once the exam starts, please make sure you have all the pages. Questions are worth different amounts of points.

#### If you do not bubble in this first page properly, you will not receive credit for the exam!

This exam is CLOSED text book, closed-notes, closed-calculator, closed-cell phone, closed-computer, closed-neighbor, etc. Questions are worth different amounts, so be sure to look over all the questions and plan your time accordingly. Please sign the honor pledge below.

> You step in the stream, But the water has moved on. This page is not here.

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#### Page 2: Trees

1. [3 points] Why is it the case that you must do at most one rotation (either single or double) to fix the *entire* AVL tree after an insert or removal?

2. [6 points] What are the rules for red-black trees?

3. [3 points] Why does a vector run in  $\Theta(1)$  amortized time?

### Page 3: Hash tables

4. [4 points] What are the big-Theta running times for the three primary operations on a hash table (insert(), remove(), and find()) using a probing collision resolution strategy? Briefly, why?

5. [8 points] For the four collision resolution strategies that we studied in class, give one advantage and one disadvantage of each. If it's not clear what the advantage or disadvantage means, then provide a brief explanation. Note that you cannot use the same fact for two answers: for example, if an advantage of A is that it faster than B, you cannot also claim that a disadvantage of B is that it is slower than A.

#### Page 4: x86

6. [6 points] Explain how a buffer overflow attack works with the C calling convention. While we are looking for a brief answer, it should be detailed enough to explain the vulnerability (where the weakness is) and how it is exploited (how to use this for an attack).

7. [3 points] Why must parameters be pushed on in reverse order? In your explanation, also describe what would happen if they were pushed on in forward order.

8. [3 points] What are all the parts of an activation record?

### Page 5: Proofs

9. [6 points] Prove that the maximum number of nodes in a binary tree of height *h* is  $2^{h+1} - 1$ .

10. [6 points] Given that  $f(n) = 3n^2 + 7x - 3$ , prove that  $f(n) \in \Theta(n^2)$ . Note that this is big-Theta, not big-Oh.

#### Page 6: Miscellaneous

11. [3 points] List 6 Emacs keyboard shortcuts, and briefly explain what they do.

12. [3 points] Can a pointer have a negative value? Why or why not?

13. [3 points] What is the purpose of cache memory? Briefly, how does it achieve this purpose?

14. [3 points] There are four UNIX pipes: <, >, >>, and |. Briefly explain what each one does.