2019-05-08 Final Exam Review

Wednesday, May 8, 2019 2:53 PM

CS 212 Practice Final

Name:_____

The Rules (if this were a real exam)

- Closed book.
- Closed note.
- Closed neighbor. Merely ***Looking*** at the work of others is cheating and carries all of the normal consequences.
- Calculators are allowed.
- Neatness counts. If I can't read it, you won't get credit.
- Use of a calculator is allowed, anything else electronic is not.
- Be sure to show your work.

Identities

$$y = \log_a x \iff a^y = x \ \ (a, x > 0, a \neq 1)$$

$$\log_a 1 = 0$$

$$\log_a a = 1$$

$$\log_a (mn) = \log_a m + \log_a n$$

$$\log_a \frac{m}{n} = \log_a m - \log_a n$$

$$\log_a m^n = n \cdot \log_a m$$

$$\log_a m = \log_b m \cdot \log_a b$$

$$\log_a m = \frac{\log_b m}{\log_b a}$$

$$\log_a b = \frac{a}{\log_b a}$$

$$\log_a x = \frac{\ln a}{\ln x}$$

$$\sum_{i=1}^{n} i = \frac{n(n+1)}{2}.$$

$$\sum_{i=1}^{n} i^2 = \frac{2n^3 + 3n^2 + n}{6} = \frac{n(2n+1)(n+1)}{6}.$$

$$\sum_{i=1}^{\log n} n = n \log n.$$

$$\sum_{i=0}^{\infty} a^i = \frac{1}{1-a} \text{ for } 0 < a < 1.$$

$$\sum_{i=0}^{n} a^i = \frac{a^{n+1} - 1}{a - 1} \text{ for } a \neq 1.$$

$$\sum_{i=1}^{n} \frac{1}{2^i} = 1 - \frac{1}{2^n},$$

$$\sum_{i=0}^{n} 2^i = 2^{n+1} - 1.$$

$$\sum_{i=0}^{\log n} 2^i = 2^{\log n + 1} - 1 = 2n - 1.$$

Note

The final exam is cumulative. The questions on this handout only include new topics since the last exam. For a complete representation of what will be on the final exam, consult both handouts.

1. [2] Use the master method to solve the following recurrence:
$T(n) = 2T\left(\frac{n}{3}\right) + n$

$n^{\log_3 2}$ $\quad af(n/b) \leq cf(n)$

$2\left(\frac{n}{3}\right) \leq cn$

$\Theta(n)$ $\quad 2/3$ ✓

2. [2] Use the master method to solve the following recurrence:
$T(n) = 4T\left(\frac{n}{2}\right) + \mathrm{n}^2$

$n^{\log_2 4} = n^2$

$n^{\log_b a} \log n = \Theta(n^2 \log n)$

case 2

3. [2] Use the master method to solve the following recurrence:
$T(n) = 2T\left(\frac{n}{2}\right) + 1$

case 1

$n^{\log_2 2} = n^1 \quad \Theta(n)$

> 1

4. [2] Use the master method to solve the following recurrence:
$T(n) = 4T\left(\frac{n}{2}\right) + \mathrm{n}^2$

5. [3] Use the Levenshtein algorithm to compute the distance matrix for the strings "PENCIL" and "PAPER"

		P	**E**	**N**	**C**	**I**	**L**
	0	1	2	3	4	5	6
P	1	0	1	2	3	4	5
A	2	1	1	2	3	4	5

	0	1	2	3	4	5	6
P	1	0	1	2	3	4	5
A	2	1	1	2	3	4	5
P	3	2	2	2	3	4	5
E	4	3	2	3	3	4	5
R	5	4	3	3	4	4	5

P	E	N	C	I	L
=	~	~	~	+	~
P	A	P	E		R

6. [3] Use the Needleman-Wunch algorithm (Gap = -2, Match = 1, Mismatch = -1) to compute the distance matrix for the strings "PENCIL" and "PAPER". Draw arrows as a shorthand to represent the direction matrix.

		P	E	N	C	I	L
	0	-2	-4	-6	-8	-10	-12
P	-2	1	-1	-3	-5	-7	-9
A	-4	-1	0	-2	-4	-6	-8
P	-6	-3	-2	-1	-3	-5	-7
E	-8	-5	-2	-3	-2	-4	-6
R	-10	-7	-4	-3	-4	-3	-5

P	E	N	C	I	L
P	A	P	E	R	-

http://experiments.mostafa.io/public/needleman-wunsch/

Programming Problems

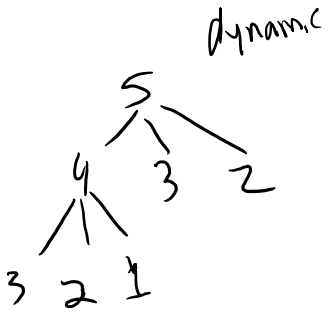
This exam will have one or more programming problems. Here is an example below:

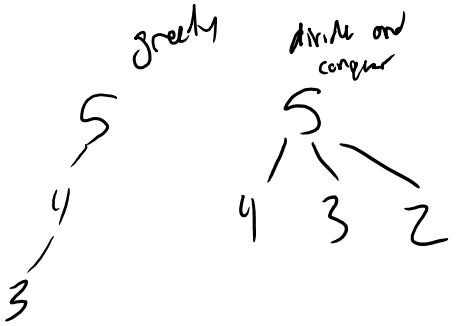
7. [5] A child is running up a staircase with N steps and can hop either 1, 2, or 3 steps at a time. Write a function to determine the number of possible ways that the child can run up the stairs.

```
NumStairs(n):
   if n == 1:
      return 1
   if n == 2:
      return 2
   if n == 3:
      return 4
   return NumStairs(n - 1) + numStairs(n - 2) + numStairs(n - 3)
```

What data structure would be used to house our mem?
HT<int, int>

Recursion tree for when N = 5





Algorithm Proposal

You will be given a scenario and must propose an algorithm that could be applied to the problem. For example,

8. You are developing a multiplayer matchmaking client for your team-based shooter.

Stable roommates (all same type of player)

Algorithm Identification

Lastly, you must be able to identify each algorithm as greedy, dynamic, or divide and conquer.

E.g. Dijkstra's Algorithm -> greedy
Rod cutting -> dynamic
Merge sort -> divide and conquer