CS 173, Fall 2015
Examlet 11, Part B

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Discussion: **Thursday 2 3 4 5 Friday 9 10 11 12 1 2**

(6 points) Your partner has implemented the function Merge(A,B), which merges two sorted linked lists of integers. Using Merge, fill in the missing parts of this implementation of Mergesort.

Mergesort($L = (a_1, a_2, \ldots, a_n)$) \\\\ input is a linked list L containing n integers

p = floor(n/2)

(9 points) Check the (single) box that best characterizes each item.

$T(1) = d$
$T(n) = 4T(n/2) + n$

$\Theta(n)$ ☐	$\Theta(n \log n)$ ☐	$\Theta(n^2)$ ☐
$\Theta(n^{\log_3 2})$ ☐	$\Theta(n^{\log_2 3})$ ☐	$\Theta(2^n)$ ☐

The Towers of Hanoi puzzle can be solved in polynomial time.

proven true ☐ proven false ☐ not known ☐

Merging two sorted lists

$\Theta(\log n)$ ☐	$\Theta(n)$ ☐
$\Theta(n \log n)$ ☐	$\Theta(n^2)$ ☐

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(15 points) Check the (single) box that best characterizes each item.

$T(1) = d$
$T(n) = 2T(n-1) + c$

$\Theta(n)$ ☐ $\Theta(n^2)$ ☐ $\Theta(n \log n)$ ☐ $\Theta(2^n)$ ☐

Circuit satisfiability can be solved in polynomial time.

proven true ☐ proven false ☐ not known ☐

The running time of the Towers of Hanoi solver

$\Theta(\log n)$ ☐ $\Theta(n \log n)$ ☐ $\Theta(n^2)$ ☐ $\Theta(2^n)$ ☐

$T(1) = d$
$T(n) = T(n-1) + c$

$\Theta(n)$ ☐ $\Theta(n^2)$ ☐ $\Theta(n \log n)$ ☐ $\Theta(2^n)$ ☐

The running time of Karatsuba's algorithm is recursively defined by $T(1) = d$ and $T(n) =$

$2T(n/2) + cn$ ☐ $3T(n/2) + cn$ ☐

$4T(n/2) + cn$ ☐ $4T(n/2) + c$ ☐

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(15 points) Check the (single) box that best characterizes each item.

Karatsuba's integer multiplication algorithm

$\Theta(n^2)$ ☐ $\Theta(n^3)$ ☐ $\Theta(n \log n)$ ☐

$\Theta(n^{log_2 3})$ ☐ $\Theta(n^{log_3 2})$ ☐ $\Theta(2^n)$ ☐

The running time of binary search is recursively defined by $T(1) = d$ and $T(n) =$

$T(n/2) + c$ ☐ $T(n/2) + cn$ ☐

$2T(n/2) + c$ ☐ $2T(n/2) + cn$ ☐

If a yes/no problem is in NP, a "yes" answer always has a succinct justification.

true ☐ false ☐ not known ☐

Algorithm A takes n^5 time. On one input, A takes x time. How long will it take if I double the input size?

$2x$ ☐ $5x$ ☐ $32x$ ☐ x^5 ☐

Problems in class P (as in P vs. NP) require exponential time

never ☐ sometimes ☐

always ☐ not known ☐

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(15 points) Check the (single) box that best characterizes each item.

The running time of the Towers of Hanoi solver is recursively defined by $T(1) = d$ and $T(n) =$

$2T(n-1)+c$ ☐ $2T(n-1)+cn$ ☐

$2T(n/2)+c$ ☐ $2T(n/2)+cn$ ☐

If a yes/no problem is in co-NP, a "no" answer always has a succinct justification.

true ☐ false ☐ not known ☐

The running time of the Towers of Hanoi solver

$\Theta(\log n)$ ☐ $\Theta(n \log n)$ ☐ $\Theta(n^2)$ ☐ $\Theta(2^n)$ ☐

Algorithm A takes 2^n time. On one input, A takes x time. How long will it take if I double the input size?

$2x$ ☐ 2^x ☐ x^2 ☐

Finding the chromatic number of a graph with n nodes requires $\Theta(2^n)$ time.

proven true ☐ proven false ☐

not known ☐

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(6 points) Fill in the missing bits of this recursive algorithm for returning the location of a number k in a sorted list of numbers $a_p, a_2, ..., a_q$.

search(p,q,k) \\ assume $p \leq q$

$m := \lfloor (p+q)/2 \rfloor$

if $k = a_m$ then return m

else if $(k < a_m)$ and $p < m$ then

else if $(k > a_m)$ and $q > m$ then

else return -1 \\ i.e. error, not found

(9 points) Check the (single) box that best characterizes each item.

It takes exponential time to determine whether a propositional logic expression can be made true by picking the right true/false values for its propositional variables (e.g. p, q, r).

proven true ☐ proven false ☐

not known ☐

The running time of mergesort is $O(n^3)$. True ☐ False ☐

$n^{log_2 3}$ grows faster than n^2 ☐ slower than n^2 ☐ at the same rate as n^2 ☐

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(6 points) Fill in the missing bits of the recursive algorithm for solving the Towers of Hanoi puzzle.

hanoi(A,B,C: pegs, $d_1, d_2 \dots d_n$: disks) \\ move n disks from peg A to peg B

if ($n = 1$) move d_1 from A to B

else

move d_n from A to B

(9 points) Check the (single) box that best characterizes each item.

Determining whether a graph with n edges is connected.

polynomial ☐ exponential ☐ in NP ☐

The running time of mergesort is recursively defined by $T(1) = d$ and $T(n) =$

$2T(n-1) + c$ ☐ $2T(n-1) + cn$ ☐

$2T(n/2) + c$ ☐ $2T(n/2) + cn$ ☐

The running time of binary search

$\Theta(\log n)$ ☐ $\Theta(n)$ ☐ $\Theta(n \log n)$ ☐ $\Theta(n^2)$ ☐