Name: _____

Exercise C6/D0, 4/1/05

Complexity (Data-Size Scalability)

During the first half of Module D, we will be discussing the third subarea of the traditional Theory of Computation, the efficiency of an algorithm with respect to the input size (data-size scalability). For example, you must remember that while a naive sorting algorithm would run in $O(n^2)$, "quick sort" runs in $O(n \log n)$. You must be familiar with this subject to some extent from other courses, most notably, Advanced Algorithms. So, try to bring in whatever you know and expand on it. As in Module C, I often notice that students' understanding of this area varies greatly. As we proceed, try to exchange what you know with other students and the instructor so that we all learn through the process.

Task: Write a concise essay about algorithm efficiency with respect to the input size (of course, for a decidable problem/subproblem), referring to (i) your problem from Exercise 00 and (ii) your mini research question(s) from earlier exercises or different one(s) from the list (below). In addition to discussing these problems in their entirety, you must also consider possible subproblems.

Note: If possible, it would be good to provide a precise asymptotic analysis, e.g., the *O* notation (or its variants). However, if you are not comfortable doing so, try your best to describe (1) how the algorithm performance depends on the input data size and (2) the difficulty you are having with asymptotic analysis. In any case, you may want to review the materials in Advanced Algorithms.

List of sample research questions from Exercise A6/B0

1. Can **organizational dynamics** be modeled as an algorithm?
2. Can **evolution** be modeled as an algorithm?
3. Can **ecology** be modeled as an algorithm?
4. Can **human development** be modeled as a computer?
5. Can our **minds** be modeled as a computer?
6. Can **vision** be modeled as an algorithm?
7. Can **learning** be modeled as an algorithm?
8. What would be the minimal mechanism to process **human language**?
9. Can the entire situation of an arbitrary **game** be modeled as an algorithm?
10. Would "perfect" **user modeling**, e.g., for web search, be possible?
11. Would "perfect" **computer security** be possible?
12. Can the entire process of **software engineering** be modeled computationally?
13. Can **computer networks** be modeled as a single computer?
14. Could **biology** be reduced to physics?
15. Could some computer generate real (not pseudo) **random numbers**?
16. Would it be possible to decide whether the given numbers are **random**?
17. Would **randomization** affect computability and/or complexity?
18. Would **parallelism** affect computability and/or complexity?
19. Would **artificial neural network** be more powerful than TMs?
20. Would **cellular automata** be more powerful than TMs?
21. Would the use of **analog** (or fuzzy) values affect computability?
22. Would relativistic, quantum, or some other **modern-physics**-based computation surpass TMs?

23. Can all the cases of **on-line algorithms** be simulated by off-line computation? [On-line algorithms would obtain inputs as the time progress. Off-line computation would provide all the possibilities as input at once. Cf. function-to-relation conversion used to fold the output within the input]
24. Would **oracle computing** affect computability? [Oracle computing: A TM with the capability to ask questions to another mechanism]
25. Would **persistent TM** be able to compute more than the standard TM? [Persistent TM: Multiple sessions of TM operation with some memory between them]
26. Would **accelerating** a TM give more power?
27. Would slight **error tolerance** affect any aspect of the Theory of Computation?
28. What would be the ability of a finite automaton with a **queue**?
29. What would be the effect of "**constant**" (as in complexity analysis) in practice?
30. Can any **mathematical function** be represented computationally?
31. What exactly are **power sets** doing to the Theory of Computation?
32. Is what you can do in **logic** the same as what you can do with computation?
33. If you have a research question of **your own**, please consult the instructor first.

Survey: Time spent between classes: _____

// End