Name: _____

Exercise D6 (Module D Comprehensive Exercise), 4/22/05

Note: This exercise is announced in advance so that we can think about it through this module. The due date of this exercise is the date of Module D Evaluation Workshop.

Part 1: Mini Research

One of the main goals of this course is to be able to see real-world problems in a principled way assisted by the concepts and tools in the Theory of Computation. To practice making such a connection between problems (concrete) and the Theory (abstract), you will spend part of your out-of-class time to conduct mini research. You will identify your own research question which is related to a practical problem of your interest, and respond to it using the skills gained in this (and possibly other) courses. Your research question can be *related* to your initial problem and/or earlier mini research questions, or can be an entirely new one. If you choose a related question, avoid repeating what you have already found and/or written; that is, if you continue on an earlier topic, you must have *something new* (and must explicitly state what is new). If you want to work on a borderline/questionable case, consult the instructor. Some parts of module D take-home exercises will guide you through the process of completing this comprehensive exercise: e.g., Exercise D2 asks for the choice of your research question and Exercise D3 asks for an outline of the paper.

Task 1: Write a mini research paper. In your paper, address the following points:

- Clearly identify your research question early in the paper (if necessary, provide some background information to introduce the question)
- Clearly identify the cost/significance of the research question (this can be done by connecting your research question with a practical problem)
- Organize your paper so that the paper responds to the research question *applying the concepts/techniques discussed in this course*, at a level reasonable for the available time and your capacity
    - It would be ideal if you can refer to all three subareas of the traditional Theory of Computation. If this is not possible, try to include as many Theory topics as possible.
    - While it would be great if you can offer a "solution" to your research question, you should be content if you describe your attempt to solve it.
- Conclude the paper with a punch-line statement of your response (and if you were unable to offer a solution, state the information necessary to solve or complete your research)
- Consider to have multiple sections (Introduction, middle section(s), and Conclusion). However, there are no other formatting or length requirements.

Note: Recall that paper writing (as well as coding) can be seen as a context-free activity (if you cannot remember, make sure to understand this by discussing with other students or the instructor). When you organize your paper, try to apply this concept.

Task 2: Prepare for a five-minute, informal presentation (to take place during Module D Evaluation Workshop). You can (but not required to) use PowerPoint slides (no more than several slides) if the file is accessible without logging into your Novell account (e.g., stored in

your public HTML folder on a floppy diskette). Attach to this exercise the printout of your presentation materials, if any (preferably, in the format with multiple slides per page).

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 algorithm**s 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.

Part 2: Evaluation Form and Supporting Notes

Review the evaluation procedure. Then, complete your evaluation form and supporting notes. Bring them to the evaluation workshop (hard copy). Print them well in advance so that you can avoid potential problems, e.g., not being able to print just before the evaluation.

Survey: Time spent between after Unit D6 before the evaluation workshop: _____

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