Name: ______________________

Exercise D4, 4/15/05

Reading: MacLennan

While we have been studying the traditional, TM-based Theory of Computation as a useful tool for analyzing practical problems, we also encountered its limitations at various points. In order to broaden our view, we will read a paper by B.J. MacLennan, who is very critical about TM-based models of computation.

Reference: MacLennan, B. J. 2003. Transcending Turing Computability. *Minds and Machines* 13(1):3-22. [also see others in the course reference list; MacLennan's web site: http://www.cs.utk.edu/~mclennan/]

Task 1: Read the paper carefully. Try to relate the author's argument with what you learned in this course.

Task 2: Concisely write up your response to the following questions. In doing so, try to apply your analysis to your own mini research paper.

1. What is the main research question of the paper?
2. What is the significance of the research question?
3. Does the paper respond to the research question well?
4. Is the paper organized well?
5. Summarize the author's criticism of the traditional Theory of Computation *in the order of importance* (as you understand).
6. Try to criticize the author's position/arguments. If you cannot do this, explain why.
7. How would the author's criticism about the traditional Theory of Computation affect your analyses of your own problems and/or your choice of the mini research problems that have been done so far, *focusing on computability and (time) complexity*?
8. [Optional] What would the author mean by "pitfalls of learning"? (in the middle of p. 19)
9. [Optional] Discuss whether you would analyze yourself in terms of a Turing machine or a natural computation, referring to the arguments in the paper and relevant properties of yours.
10. [Optional] The author does not directly discuss one subarea, formal languages/automata (except the TM). Speculate what the author would say about the Chomsky hierarchy.
11. [Optional] Speculate on how to define the "power" of natural computation. (in the middle of p. 19)

Be prepared to *discuss* your response in class (no need to prepare for a formal presentation).

Survey: Time spent between classes: ______________

Supplemental notes for the reading

- Effective (p. 4): Roughly, well-defined, step-by-step (e.g., algorithm = effective procedure that terminates)

- Calculus (p. 4): In logic, calculus refers to basically symbol manipulation (i.e., syntax, which is contrasted with semantics or meaning).
- Phenomenological (p. 5): One of the main methods of the phenomenological investigation is to suspend presuppositions (Stewart and Mickunas, 1990).
- Schema (sg.)/schemata (pl.) (p. 6): As an example, $X + Y = Y + X$ is a rule schema, which can be instantiated with various values for X and Y.
- Semantic vs. pragmatic effect (p. 8): While semantics normally refers to context-independent part of the meaning of a statement, pragmatics is about how to use symbols in context.
- Generative grammar (p. 8): Basically the same as our use of "grammar" in this course. That is, a grammar is supposed to accept/generate strings.
- Competence/performance (p. 8): These were introduced by Chomsky, and are widely used. Analogous (but not identical) contrasts have been noted by other people as well: e.g., langue/parole by Saussure, I-language/E-language by late Chomsky.
- Tarski (p. 8): The main figure who proposed the "truth-conditional" approach to interpretation of logical statements.
- Löwenheim-Skolem Paradox (p. 10): Here is an example used in my section of Discrete Structures. Mathematicians try to specify the set of natural numbers using a set of statements in first-order logic. However, when they feel they are successful, the specification also specifies unintended structures as well. That is, all the structures of the form NZ*, where N represents natural numbers, Z represents integers, and '*' represents the Kleene closure, i.e., any number of integers attached after natural numbers can still satisfy the specification. A result like this can only be obtained if we carefully relate the syntax (form) and the semantics (content) of a logical system (as done in model theory, part of formal logic). This suggests that there may be a lot of loose ends to formal specification.
- Satisfice (p. 12): "To accept a choice or judgment as one that is good enough, one that satisfies." Herbert Simon is a Nobel laureate (Economics), who is also considered as a pioneer in AI.
- Foreground/background (p. 14): Cf. people's interpretation of the "vase-face illusion."
- Emergent phenomenon (p. 16): One of the main properties of a complex system. Such a phenomenon, which is often unpredictable, may emerge as a result of the interaction among (possibly relatively simple) components.
- Pragmatics/semantics/syntax (p. 17): Pragmatics deals with how language (or other means) is *used* in context. Semantics primarily deals with a *context-independent part of the meaning* of a sentence. Syntax deals with the (recursive) *structure* of a sentence.
- Nekker cube (p. 17): Best to see the image (do a web search). The switching of your perception can be analyzed in terms of "catastrophe theory" (a non-technical intro in, e.g., Gottman, et al. "Mathematics of Marriage"). This type of observation is often used in support of "holistic" position to cognition, cf. "reductionistic" or "analytical" position.

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