CS 245: Minds, Brains, & Machines 11-28-08
Neil Stillings

Assignment 6: Due Friday, Dec. 12

Instructions:

- **Submit hard copy to Neil's mailbox in the CS office by 4:30 pm.**
- **To receive a passing evaluation you must answer at least 4 of the 5 questions. To demonstrate a more comprehensive mastery of the course material, you should answer all five questions.**
- **Note that there are options embedded in some of the questions.**
- **Each question should require 2-4 pages to answer. The minimum length for a decent job is around 10-12 pages. An excellent job might require something more like 14-17 pages.**
- **Appended to the assignment, you will find the *Lombardi* and *Lee* challenge questions. These are optional, but those who complete either one will be appropriately rewarded.**
- **This is a complex assignment. You should work on it over several days, for several hours each day. You should write your own answers to the questions. However, discussion with fellow students and with the course TA's is encouraged.**

Questions:

1. Answer part a. or part b. *[For extra credit answer both a. & b.]*

    a. In different ways the papers by Santi & Grodzinsky, Rizzolatti & Arbib, and Smith & Jonides all concern the function of Broca's area.

        i. Summarize the hypotheses that are investigated in these three papers, with particular attention to Broca's area.
        ii. Discuss how these hypotheses are related to each other. In what ways do they conflict with each other, and in what ways might they be made compatible with each other.
        iii. What overall view do you think is best supported by the evidence and makes the most sense in terms of how language must have evolved?

        [Note that Smith & Jonides's paper directly addresses Boca's area and nearby areas on pp. 1657-59. Be clear in general, however, about the larger picture that is sketched in their paper. Rizzolatti & Arbib's paper also discusses Broca's area within a larger context. Santi & Grodzinski's paper can be seen as posing a specific challenge to some interpretations of the main hypotheses in the other two papers.]

    b. Hauser, Chomsky, & Fitch (HCF) present a view of the evolution of language that is challenged by Pinker and Jackendoff (PJ).

        i. Summarize the difference between the two theories. *[PJ pp. 201-205 are a good start here.]*

ii. Outline PJ's argument against HCF *(pp. 217-218 provides a summary).* Pick two sections from among PJ's sections 2.1 through 2.6 and describe the disagreement in detail.
iii. How do HCF answer PJ? Are their answers effective? Explain.

[Note: In the supplemental readings at the end of the syllabus, you will see posted HCF's reply to PJ, and PJ's reply to HCF's reply.]

2. Intuitively, we think of paying attention to something as selecting it for processing and as processing it differentially in some way relative to other things. Winkowski and Knudsen (WK) present evidence for a neural mechanism in the barn owl that partly implements this intuition.

   a. Explain the mechanism that they investigate.
   b. Explain how it functions as an attentional mechanism.
   c. Explain how their work fits into Posner's theory of attention, which we looked at early in the course.
   d. *[Optional]* Explain Figure 2, part *e* of WK in detail.

3. One theme in this course has been a contrast between automatic and controlled processes. It could be argued that the connectionist approach to cognition is better suited to modeling automatic processes than controlled processes. *[The PDP Approach to Semantic Cognition, by McClelland and Rogers, is the primary source for this question. Andy Clark's paper, AI and the Many Faces of Reason, is also potentially very helpful in answering the question.]*

   a. Using the paper by McClelland and Rogers, give a version of this argument, explaining why connectionism might offer a good explanation of automatic processes and have difficulty explaining controlled processes.
   b. In their last two sections *PDP and theory theory* and *The role of causal information,* McClelland and Rogers might be seen to be taking the first steps to toward applying the PDP approach to controlled processes. Discuss how much progress they have made here and how far they have to go, in terms of the human ability to think in terms of theories and causes.
   c. *[Optional]* Explain the relationship between parts a. and b. of Figure 4 in the McClelland and Rogers paper. In part a. what happens between epochs 250, 750, and 2500 and why is it significant? How does part b. show us clearly what happens over training epochs?

4. Assume that the cognitive neuroscience approach to the mind/brain will ultimately prove to be correct. This would mean that the capacities of the mind/brain can be exhaustively characterized as computations that are implemented physically in the brain. This suggests to many people the possibility that a mind comparable to the human mind could be fabricated out of non-biological materials. In his paper *The relationship between matter and life*, Rodney Brooks both celebrates the achievements of AI/Alife and admits that AI/Alife is a failure in terms of duplicating biological cognitive/behavioral capacities:

> "… neither AI nor Alife has produced artefacts that could be confused with a living organism for more than an instant. AI just does not seem as present or aware as even a simple animal and Alife cannot match the complexities of the simplest forms of life (p. 409)."

In their papers Brooks and Andy Clark outline many resources that AI currently has available that were not fully anticipated by Turing. Assuming the correctness of cognitive neuroscience, where do you think AI has fallen short so far? Even if we assume the correctness of the cognitive neuroscience approach to biological minds, is there a good argument that AI/Alife will never succeed? *[Note that on pp. 410-411 of his Matter & Life paper, Brooks provides at least the beginnings of a roadmap for answering this question. Clark's paper can also be seen as parsing the problem rather neatly.]*

5. Answer part a. or part b. For extra credit answer both a. and b.

   a. Briefly restate the core points of Horgan's *Critique of the knowledge argument (pp. 149-152 of his paper)* and Churchland's *The persistent equivocation* (*pp. 67-71 of his paper)*. Comment on the similarities and differences between the two arguments.
   b. In his paper Churchland argues (1) that knowledge by acquaintance (including qualia and skilled "knowing how") and knowledge by description can be distinct (see e.g. the golf example beginning at the bottom of p.68) and (2) that scientific knowledge (the ultimate in knowledge by description we might say) can change our qualitative experiences (Part 4, pp. 74-76). Can he have it both ways? Are you convinced by his argument that scientific knowledge can deeply affect our qualia? Explain your view.

Optional *Lombardi* and *Lee* challenges for major extra credit:

I. For a Vince Lombardi Memorial Certificate in the Fundamentals of Cognitive Science:

Name and briefly describe 50 key ideas, concepts, or findings that you were exposed to in this course.

and/or

II. For a Peggy Lee memorial *I know a little bit* of cognitive science award:

Use 50 terms from cognitive science in a poem or song.