CS80—Senior Seminar
Discussion Questions—Penrose Chapters 9 & 10

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Fall 2000

These are a few questions for thought and discussion.

1. What is the relationship between attention and consciousness? Is consciousness without attention possible? How about *vice versa*? Why does Penrose find the cerebellum more automaton-like than the cerebrum? What is the relationship between consciousness and algorithmic behavior, both in Penrose's apparent perspective in this context and from the perspective of being able to capture thought processes by recording one's state of mind?

2. The promise of Quantum Computing is the possibility of realizing non-deterministic machines—computers with unbounded parallelism (since the quantum computer could be in many states simultaneously). What is the relationship between non-determinism (in which the next state is not fully determined by the current state) and unbounded parallelism? Is finitely bounded parallelism (as in current parallel computers) sufficient? Is unbounded parallelism sufficient to solve the halting problem?

3. Why is it important to Penrose's arguments to have the collapse of superposed quantum states (operation **R**) be driven by a mechanism other than observation?

4. What is the relationship between consciousness and intelligence? (How did we get from questions of artificial intelligence to questions of artificial consciousness?) Once again, how does Penrose's insistence that consciousness is necessary for intelligence fit with Turing's ideas about capturing thought processes by recording one's state of mind? with intuitive notions of intelligent behavior? On Page 409 Penrose dismisses philosophical reflection as evolutionary baggage (although mathematical reflection seems to distinguish intelligent thought from the merely algorithmic). Is it possible that consciousness is also evolutionary baggage? So what evolutionary advantages does Penrose find for either consciousness or intelligence?

5. In the Section *The non=algorithmic nature of mathematical insight* Penrose makes an argument for the existence of Gödel sentences for the totality of mathematical reasoning. This seems to be based on the idea that there is a single system of mathematical reasoning that is approximated in all mathematical argumentation. Must the system of reasoning used in the communication of mathematical results be complete? What sort of problem (in terms of formal logic) arises in the process of being convinced by a proof? Is this necessarily undecidable?

6. So what is the punch line? Where does Penrose find hope for non-algorithmic behavior in the brain? How does this proposal fit with what we know about Quantum Computing? How does it fit with Penrose's belief that one must be conscious of behavior for it to be intelligent?