This new offering will examine the relevance of modern theoretical computer science to traditional questions in philosophy, and conversely, what philosophy can contribute to theoretical computer science. Topics include: the status of the Church-Turing Thesis and its modern polynomial-time variants; quantum computing and the interpretation of quantum mechanics; complexity aspects of the strong-AI and free-will debates; complexity aspects of Darwinian evolution; the claim that “computation is physical”; the analog/digital distinction in computer science and physics; Kolmogorov complexity and the foundations of probability; computational learning theory and the problem of induction; bounded rationality and common knowledge; new notions of proof (probabilistic, interactive, zero-knowledge, quantum) and the nature of mathematical knowledge. Intended for graduate students and advanced undergraduates in computer science, philosophy, mathematics, and physics. Participation and discussion are an essential part of the course.

**Prerequisites:** Previous coursework in either computability and complexity theory (such as 6.045 or 6.840) or analytic philosophy (such as 24.09)


**Required Books:**
- David Deutsch, *The Beginning of Infinity*
- Roger Penrose, *The Emperor’s New Mind*

**Supplemental Books:**
- David Deutsch, *The Fabric of Reality*
- Christos Papadimitriou, *Computational Complexity*
- Christos Papadimitriou, *Turing (A Novel About Computation)*
- Roger Penrose, *Shadows of the Mind*
- Michael Sipser, *Introduction to the Theory of Computation*
Supplemental Lecture Notes:
Scott Aaronson, Quantum Computing Since Democritus
Scott Aaronson, Great Ideas In Theoretical Computer Science

Requirements. Grading will be on the following basis.
25% class reaction essays
20% book/paper reaction essay
15% class participation
40% final project

Class Reaction Essays. Instead of traditional scribe notes, we’re going to try something new for this class. After every class, every student will be asked to write roughly 2 paragraphs summarizing and responding to some point discussed in the class, mentioning questions, points of disagreement, etc. These “reaction essays” should be posted on the class wiki, which is publicly accessible from the 6.893 Stellar site. The reaction essays will be due one week after the class in question (i.e., before the next class).

Book/Paper Reaction Essay—due Wednesday, October 26. This will be a ~4-page-long essay responding to any book or paper relevant to the course material. (Including, but not limited to, any of the books or papers that are on the official reading list.)

Final Project—due Wednesday, December 14. The final project will be to do something original related to the course: for example, examine the role of computational complexity considerations for some philosophical issue (which might or might not be an issue that we discussed in the course!), or undertake a research project in theoretical computer science with a strong conceptual or philosophical component. As in many advanced graduate courses, the hope is that at least some of the projects will evolve into publishable research papers. Many possible project ideas will be discussed as the semester progresses. Students are strongly encouraged to do their final projects in groups of 2 or 3, although individual projects are also acceptable. The final output will be a term paper, as well as a ~15-minute presentation on the last day of class.

Psets. Right now, there are no plans for psets. However, we “reserve the right” to issue a pset later in the semester, if it becomes clear that one will be helpful!

Syllabus (extremely tentative).

Sep. 7: Intro, Church-Turing and Extended Church-Turing Theses
WPSACC Sections 1-3
Turing, “On Computable Numbers”
Edmonds, “Paths, Trees, and Flowers” (Section 2)
Penrose’s ENM, Chapter 2
(Readings are “after the fact,” for students who don’t yet know this material)

Sep. 14: Complexity issues in the Turing Test and Chinese Room
WPSACC Section 4
Turing, “Computing Machinery and Intelligence”
Shieber, “The Turing Test As Interactive Proof”
Levesque, “Is It Enough To Get the Behaviour Right?”
Parberry, “Knowledge, Understanding, and Computational Complexity”

Sep. 21: Human mathematical insight and NP-complete problems / Penrose’s views
WPSACC Section 4
Aaronson, “NP-complete Problems and Physical Reality”

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Sipser, “The History and Status of the P versus NP Question”
Penrose’s ENM, Chapters 1 and 4
Deutsch’s BoI, Chapter 7

Sep. 28: Syntax and semantics / knowledge and the problem of logical omniscience
WPSCACC Sections 5-6
Chalmers, “Does A Rock Implement Every Finite-State Automaton?”
Stalnaker, “The Problem of Logical Omniscience I”

Oct. 5: PAC-learning and the problem of induction
WPSCACC Section 7
Valiant, “A Theory of the Learnable”
De Wolf, “Philosophical Applications of Computational Learning Theory”

Oct. 12: Kolmogorov complexity and the foundations of probability
De Wolf, “Philosophical Applications of Computational Learning Theory”
Schmidhuber, “A Computer Scientist’s View of Life, the Universe, and Everything”

Oct. 19: Quantum computing and the Many-Worlds Interpretation
WPSCACC Section 8
Penrose’s ENM, Chapter 6
Aaronson, Quantum Computing Since Democritus Lectures 9 and 10
Bernstein and Vazirani, “Quantum Complexity Theory”
Deutsch, “Quantum theory, the Church-Turing Principle, and the universal quantum computer”
Deutsch’s BoI, Chapters 11 and 12

Oct. 26: New notions of mathematical proof / mathematical definiteness
WPSCACC Section 9
Shieber, “The Turing Test As Interactive Proof”
Deutsch’s BoI, Chapter 8

Nov. 2: Complexity and time; closed timelike curves
WPSCACC Section 10
Penrose’s ENM, Chapter 7
Deutsch, “Quantum mechanics near closed timelike lines”
Aaronson and Watrous, “Closed timelike curves make quantum and classical computing equivalent”

Nov. 9: Economics and bounded rationality
WPSCACC Section 11
Papadimitriou, “Algorithms, Games, and the Internet”

Other readings TBD

Nov. 16: Digital versus analog / “Is the universe a computer?”
Aaronson, “NP-complete Problems and Physical Reality”
Bostrom, “Are you living in a computer simulation?”

Nov. 23: Class cancelled because of Thanksgiving?
(Another possibility: special bonus class on complexity and Darwinian evolution)

Nov. 30: TCS issues in the free will vs. determinism debate
Aaronson, "Prediction, Quantum Mechanics, and Free Will” (to appear)
Penrose’s ENM, Chapters 9 and 10

Dec. 7: Discussion of Deutsch’s "The Beginning of Infinity" / other misc. topics
Deutsch’s BoI

Dec. 14: Student project presentations