Harry Mairson
Computer Science Department
Volen 257

Freshman Seminar (USEM 77a):
Where the idea of the computer came from

Short description for Bulletin:

Where did the idea of the computer come from? This course examines its cultural, non-engineering roots in philosophy, logic, and mathematics: algorithms, undecidability, games, mechanical intelligence and the mind, and precursor ideas of desktop publishing and Internet technology. Readings include historical documents as well as fiction. A willingness to think abstractly and mathematically is an informal prerequisite.

Long description for First Year Pamphlet:

Computers are the product of engineering and manufacture, but this course explores the mathematical and philosophical culture from which the idea of the computer emerged. Where did the idea of the computer come from, quite apart from the technology that put the laptop on your lap? How did anyone ever imagine thinking of or making such a thing? What visions of possibility presaged the development of later technology? In the course of trying to answer these questions, we will consider a "mathematical way of thinking" and how it lead to related ideas: algorithms, undecidability, games, rules and representations, the possibility of mechanical intelligence, and the precursor ideas of desktop publishing and Internet technology.

The course curriculum is a mixture of philosophy of mind, history, mathematics, and literature. It includes some "strictly" mathematical subjects (what an algorithm is, how Babbage's "difference engine" worked and what it has to do with calculus, Knuth's rediscovery of Conway's games and how they relate to the "birth" of numbers, Godel's and Turing's theorems), philosophy (Turing's original work on machine intelligence, and some of its descendants in cognitive science and philosophy), fiction (writing on mathematical possibility, games, and creativity in mathematics), and theatre (Hugh Whitmore's play about Turing, based on the biography by Andrew Hodges, and "The Day the Earth Stood Still"). This mixture of readings is intended to be mathematically stimulating to non-experts, philosophically challenging to anyone who has thought about minds and machines, and amusing to anyone looking for some enjoyable fiction.

The polymath John von Neumann once got into an argument with Presper Eckart, one of the first computer engineers, about how many vacuum tubes are needed to build an addition circuit---von Neumann said five, Eckert said ten. After a long argument, von Neumann said, "OK---five for the logic, five for the electronics." This course ignores the electronics, and looks at all the other stuff.

Course Goals:

The seminar develops and strengthens the basic skills of reading, writing, and discussing. Reading skills are focused primarily on scientific topics, written in a technical but non-expert layman's prose. Writing will consist of two short papers (3 to 5 pages) and one longer paper (10 to 15 pages), as well as paragraph "book review" evaluations of readings. We may read and analyze these papers towards the end of term in preparation of final drafts of them.

Course Requirements:

Readings, three papers (as described above), participation in and possibly leading of group discussions. There is not a lot of reading, but some of the more technical readings have to be consumed slowly and carefully.

Syllabus:

Week 1: Introduction. What is an algorithm?
Inflexible Logic (Russell Maloney)
The Stable Marriage Problem (Harry Mairson)
Charles Babbage's Difference Engine [class notes, and
`http://mycetes.pwp.blueyonder.co.uk/babbage/de1maths.htm`]

Weeks 2 and 3: Godel's theorem, and the impossibility of formally characterizing mathematical reasoning.
Godel's Proof (Ernest Nagel and James R. Newman)

Week 4: Undecidability, and the impossibility of mechanically characterizing mathematical reasoning.
Where the Power of the Computer Comes From (Joseph Weizenbaum)
Turing: a Natural Philosopher (Andrew Hodges)
Breaking the Code (Hugh Whitmore) [play and film]

Weeks 5 and 6: Cognitive science and the philosophy of mind.
Computing Machinery and Intelligence (Alan Turing)
Minds, Brains, and Science (John Searle)
Minds, Machines, and Godel (J. R. Lucas)

Week 7: Games and Learning Machines.
A Matchbox Game-Learning Machine (Martin Gardner)
The Royal Game (Stefan Zweig)

Week 8: Computers and Theology.
God and Golem (Norbert Wiener)
The Day the Earth Stood Still [film]

Weeks 9 and 10: Mathematical Thinking.
Surreal Numbers (Donald Knuth)
The Ideal Mathematician (Philip Davis and Reuben Hersh)
A Mathematician's Apology (G.H. Hardy and C.P. Snow)

Week 11: Visions of the Internet.
As We May Think (Vannevar Bush)
The Dream Machine: J.C.R. Licklider and the Revolution That Made Computing Personal (M. Mitchell Waldrop)

Weeks 12 and 13: Term paper presentations and workshops.