ELE/COS 583: Great Moments in Computing (Spring 2009)

Instructors:
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Where to find stuff:
Course materials available on blackboard.princeton.edu

Where and When:
Mondays and Wednesdays, 11:00 AM – 12:20 PM, Friend 112

Course Description:
This course will cover pivotal developments in computing, including hardware, software, and theory. Material will be covered by reading seminal papers, patents and descriptions of highly-influential architectures. Emphasis will be on developing deep understandings of the discoveries and inventions that brought computer systems to where they are today. Discussion-oriented class will focus on in-depth analysis of readings. Final project or paper required.

Note: The papers you will read, while seminal, are not, well, *introductory*. You should expect to have difficulty understanding some, or even many, of them (as do your instructors). You therefore will not be expected to master these readings, but rather to make your best effort. Our hope is that class discussion will help you to better understand the parts that may be difficult.

Course Grading Overview:
Participation in class discussions: 50%
Written responses to per-paper questions: 25%
Paper/project: 25%

The Four Disclaimers:
(shamelessly adapted from NPR's "Whad'ya Know" http://www.notmuch.com)

1) There have been more than great moments in computing than we can fit in one semester, so nobody is claiming completeness.
2) Careful examination of the list would no doubt reveal subtle, shameless biases towards topics closest to the instructors' areas of expertise and interest.
3) Strong feelings that some favorite seminal papers have been left out may be addressed in one's final project. Weak feelings too.
4) Anyone who doesn't like these disclaimers can get their own darn "Great Moments" class!

Class participation and response papers
This course uses a discussion, not lecture, format. Each class will cover particular subjects from the assigned reading; particular issues for discussion will be posed in a handout distributed the previous week (and usually available on the course homepage).

Students will be expected to have carefully read the relevant assigned readings and to have prepared responses to, and analyses of, any assigned questions or topics. Some of these will require a brief written response; your written responses (1 or 2 pages) are due no later than the

beginning of the class to which they pertain. Twenty-five percent of the course grade will come from response papers, but we will discard the worst two. (Late written responses won't be accepted.)

The quality and quantity of student participation in class discussions is worth 50% of the course grade. Participation grades will reflect the quality of the student's preparation and analysis as well as the student's contribution to the process of discussion: making connections with other students' remarks, raising overlooked issues, asking good questions, making good summaries. Note that effective participation requires a great deal more listening than speaking, and in particular requires careful listening *to other students*, and not just to the instructors.

Course Project Description:
Your final project will be a cogent, well-supported two-part essay regarding great moments to be added or deleted from this course. In particular, Part 1 is to pick one paper from *before you were born* and argue why it should be included in next year's version of the course. (Part of your case may be a claim that some paper included this year didn't really deserve to be.) In Part 2, you will select a published work from *after you started college (undergrad)* and argue why it will become influential enough in the future to warrant inclusion when *your children are taking this class*.

Project Phases (Tentative dates)

- Topic proposal, due around April 1.
- First draft or outline (to be returned with instructor's feedback) due around April 22
- Final paper due (in both pdf and hardcopy) May 12 (Dean's Date)

More details on the final paper will be forthcoming in the second half of the semester.

Great Moments: Approximate Syllabus and Reading Assignments

Week	Dates	Monday	Wednesday
1	Feb 2, 4	Class Overview	Foundations of Digital Logic [Boole, 1854] [Shannon, 1938]
2	Feb 9, 11	Artificial Intelligence [Turing, 1950] [Searle, 1980]	Early Architectures [Wilkes, 1951] [Burks *et al*. 1946]
3	Feb 16, 18	Ethernet [Metcalfe and Boggs, 1976]	Architecture vs. Implementation [Amdahl, 1964] [Tomasulo, 1967]
4	Feb 23, 25	Computability [Turing, 1936]	Caches and Virtual Memory [Wilkes, 1965] [Kilburn, *et al*., 1962]
5	Mar 2, 4	Human-Computer Interaction [Sutherland, 1963]	Dawn of Transistors [Bardeen, 1950, 1956] [Bardeen & Brattain, 1948]
6	Mar 9, 11	Computational Complexity [Cook, 1971] [Karp, 1972]	Dawn of Parallelism: Cray-1 and Illiac IV [Russell, 1978] [Burroughs, 1972]
Mar 16, 18		No Class: Spring break	

7	Mar 23, 25	Invention of the Mouse [Engelbart, 1970]	Integrated Circuits and the first Microprocessor [Kilby 1964, 2000] [Faggin *et al*., 1996]
8	Mar 30, Apr 1	Google [Page *et al*., 1998]	Network Protocols [Cerf & Kahn, 1974] (VOTE FOR WILDCARD)
9	Apr 6, 8	UNIX [Ritchie & Thompson, 1974]	Video Games: Past and Present [Baer, 1973] [Brand, 1972] [Graetz, 1981]
10	Apr 13, 15	Compilers [Hopper, 1952] [Backus, *et al*., 1957]	Moore's Law and its Future [Moore, 1965] [Moore, 2003]
11	Apr 20, 22	Public-Key Cryptography [Diffie & Hellman, 1976]	RSA Encryption [Rivest *et al*., 1978]
12	Apr 27, 29	Wildcard	Back to the Future [Bush, 1945]

Reading List

[Amdahl, *et al*. 1964] G. M. Amdahl, G. A. Blaauw, and F. P. Brooks, Jr. Architecture of the IBM System/360. *IBM Journal of R & D*, vol. 8, no. 2 (April 1964), pp. 87-101.

[Backus, *et al*., 1957] Backus, J. W., Beeber, R. J., Best, S., Goldberg, R., Haibt, L. M., Herrick, H. L., Nelson, R. A., Sayre, D., Sheridan, P. B., Stern, H., Ziller, I., Hughes, R. A., and Nutt. R. The FORTRAN Automatic Coding System. *Proc. WJCC*, Los Angeles, Feb. 1957, pp. 188-198.

[Baer, 1973] Baer, R. Television Gaming and Training Apparatus. U.S. Patent #3,728,480, issued 1973.

[Bardeen 1948] J. Bardeen and W. H. Brattain. The Transistor, A Semi-Conductor Triode. Phys. Rev. 74, 230 - 231 (1948)

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[Bardeen, 1956] Bardeen, J. Semiconductor research leading to the point contact transistor. Nobel Lecture, Dec. 1956.

[Barroso & Hoelzle, 2007] Barroso, L.A. and Hoelzle, U. The Case for Energy-Proportional Computing. IEEE Computer, Vol. 20, Issue 12, Dec. 2007, pp. 33-37.

[Boole, 1854] George Boole, *An investigation into the Laws of Thought, on Which are founded the Mathematical Theories of Logic and Probabilities*. 1854. Chapters 2 and 3.

[Brand, 1972] Stewart Brand. SPACEWAR: Fanatic Life and Symbolic Death Among the Computer Bums. Rolling Stone magazine. December 7, 1972.

[Burks *et al*. 1946] Arthur W. Burks, Herman H. Goldstine, and John von Neumann, "Preliminary discussion of the Logical Design of an Electronic Computing Instrument," report to U.S. Army Ordnance Dept, 1946.

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[Bush, 1945] Vannevar Bush, As We May Think. *Atlantic Monthly*, July 1945. http://www.theatlantic.com/unbound/flashbks/computer/bushf.htm

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[Cook, 1971] S. Cook, The complexity of theorem-proving procedures. *Proc. Third Annual ACM Symposium on Theory of Computing*. 1971. pp. 151 - 158 .

[Davis, *et al*. 2005] Davis, J.D., Laudon, J., and Olukotun, K. Maximizing CMP throughput with mediocre cores. *Proc. 14th Int. Conf. on Parallel Architecture and Compilation Techniques*, 2005, pp. 51-62.

[Diffie & Hellman 1976] W. Diffie and M.E. Hellman, New Directions in Cryptography, *IEEE Trans. on Information Theory*. Vol. IT-22, No. 6. Nov. 1976, pp. 644-654.

[Engelbart, 1970] Engelbart, D. X-Y Position Indicator for a Display System. US Patent #3,541,541, filed June 1967, issued Nov., 1970.

[Faggin *et al*., 1996] Faggin, F., Hoff, M.E., Mazor, S., and Shima, M. The history of the 4004. *IEEE Micro*, Vol 16, Issue 6, Dec. 1996, pp. 10-20.

[Graetz, 1981] J. Martin Graetz. The Origin of Spacewar. Creative Computing. 1981.

[Hopper, 1952] Hopper, G. M. The Education of a Computer. *Proc. ACM Conference*, Pittsburgh, 1952. Reprinted in *Annals of the History of Computing*, Vol. 9, Num. 3/4, 1988, pp. 271-281.

[Karp, 1972] Karp, R.M. Reducibility among combinatorial problems. R.E Miller and J.W. Thatcher, editors, *Complexity of Computer Computations*, 85-103, Plenum Press, NY, 1972.

[Kilburn, *et al*., 1962] Kilburn, T., Edwards, D. B. G., Lanigan, M. J., and Sumner, F. H. One-Level Storage System. *IRE Trans. Electronic Computers*, Vol. EC-11, Num. 2, April 1962.

[Kilby, 1964] Kilby, J. Miaturize Electronic Circuits. U.S. Patent #3,138,743, issued 1964.

[Kilby, 2000] Kilby, J. Turing potential into realities: the invention of the integrated circuit. Nobel Lecture, Dec. 2000.

[Kongetira, *et al*., 2005] Kongetira, P., Aingaran, K., and Olukotun, K. Niagara: a 32-way multithreaded Sparc processor. *IEEE Micro*, March/April 2005, pp. 21-29.

[Metcalfe and Boggs, 1976] R.M. Metcalfe and D. R. Boggs, Ethernet: Distributed packet switching for local computer networks. *Comm. ACM*. Vol. 19, Issue 7 (July 1976). pp: 395 – 404.

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[Page *et al*., 1998] Page, L., Brin, S, Motwani, R., and Winograd, T. The PageRank Citation Ranking: Bringing Order to the Web, Unpublished draft (!), 1998.

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[Ritchie and Thompson, 1974], B. Ritchie and K. Thompson. The UNIX Time-Sharing System. *Communications of the ACM*. Vol. 17, Issue 7 (July 1974). Pp. 365 – 375.

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[Wilkes, 1951] M. V. Wilkes. The best way to design an automatic calculating machine. *Manchester University Computer Inaugural Conference*, Manchester July 1951 pp 16-18. Reprinted as Wilkes and Stringer in Bell, Siewiorek and Newell.
Also: http://www.cl.cam.ac.uk/UoCCL/misc/EDSAC99/ (EDSAC page)

[Wilkes, 1965] M. V. Wilkes, Slave Memories and Dynamic Storage Allocation, *IEEE Trans*., vol. EC-14, no. 2, pp. 270-271, 1965.