COMP 102: Computers and Computing
Lecture 27: Conclusion

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Today's plan

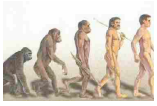
- Part I: Computers & Mind
- Part II: Future of computing
- Part III: Final exam

Computers vs. Minds

- Dead
- Deterministic
- Machines
- Simple (in theory)
  (only bits and bytes)
- Complex (in reality)
- Can process lots of data very fast

- Alive
- Have free will
- Creative
- Complex
  (brains & thoughts)
- Simple (neurons)
- Intelligent

A continuum or a qualitative jump?





How to study the relation between computers and minds?

- What is essentially human? How do we differ from animals and machines? *Intelligence*.
- What are criteria for intelligence?

  1. External: Behavior
     a) neurons,
     b) thinking processes,
     c) interaction with the world.

  2. Internal: Consciousness

Alan Turing (1912-1954)

- Developed a theoretical model of computation: Turing Machines (1936)
- Showed that some problems, like the *Halting Problem*, are not computable!
- At Bletchey Park during WWII, worked on cryptography.
- Worked on developing first computers in England.
- How can we study intelligence?

"Computing Machinery and Intelligence" (1950)

- How to assess the intelligence of a machine?
- The Turing Test:
  - Assume there is an Interrogator (human) and a Responder (human or machine).
  - The Interrogator has a conversation (via typed messages) with the Responder for 5 minutes, and then has to guess whether the Responder is a human or machine.
  - The machine passes the test if it fools the interrogator 30% of the time.
- Turing's prediction: by 2000, a computer with 10^9 units of memory could be programmed well enough to pass the test.
- Not quite. But some interrogators have been fooled!
  - Winner of 2009 Loebner Price: "Do-Much-More" *www.worldsbestchatbot.com/Competition_Transcripts*
  - See also this article: *www.theatlantic.com/magazine/print/1969/12/mind-vs-machine/8386/*

What to make of the Turing test?

- Test is still relevant today.
  - Recent version: *Twuring – The Twitter Turing Test*
- However:
  - AI researchers have spend little effort on the Turing test.
  - Turing test is not *reproducible* or amenable to *mathematical analysis*.
  - More important to study underlying principles of intelligence than trying to duplicate human intelligence.
- Thought: Quest for "artificial flight" succeeded when we stopped trying to imitate birds, and started learning about aerodynamics.

Turing's conclusion

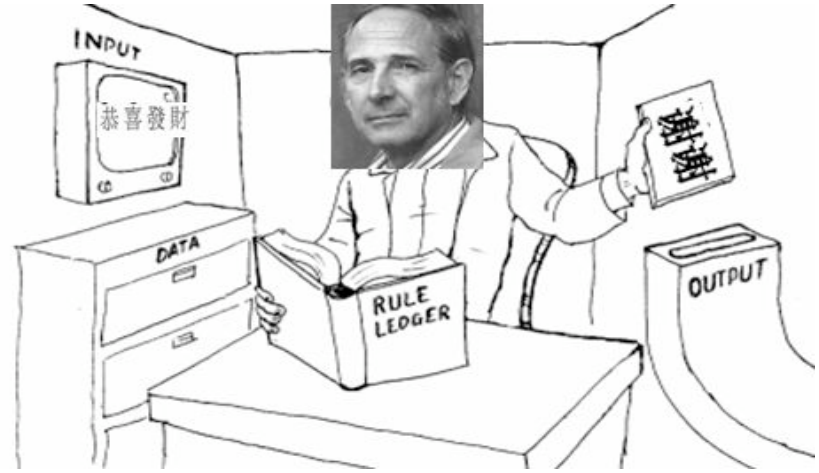
"We may hope that machines will eventually compete with men in all purely intellectual fields. […] Many people think that a very abstract activity, like playing chess, would be best. It can also be maintained that it is best to provide the machine with the best sense organs that money can buy, and then teach it to understand and speak English. […] Again I do not know what the right answer is, but I think both approaches should be tried. We can only see a short distance ahead, but we can see plenty there that needs to be done."

John Searle (1980): "Minds, Brains, and Programs"

- ***Chinese Room Argument*** to show that a symbol processing machine can never attain "understanding," "intentionality," or have a "mind," no matter how 'intelligently' it behaves.

- Now, focus on internal criteria and their relation to external ones.

The Chinese Room



Conclusion: Might behave intelligently, but isn't!

Comment

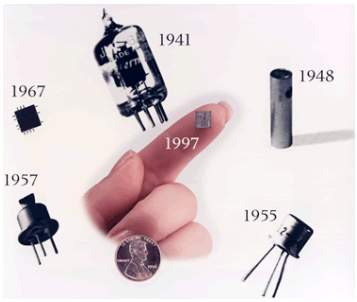
Different criteria for intelligence

1. External: Behavior
   a) neurons,
   b) thinking processes,
   c) interaction with the world.

2. Internal: Consciousness, intentionality

The evolution of computers

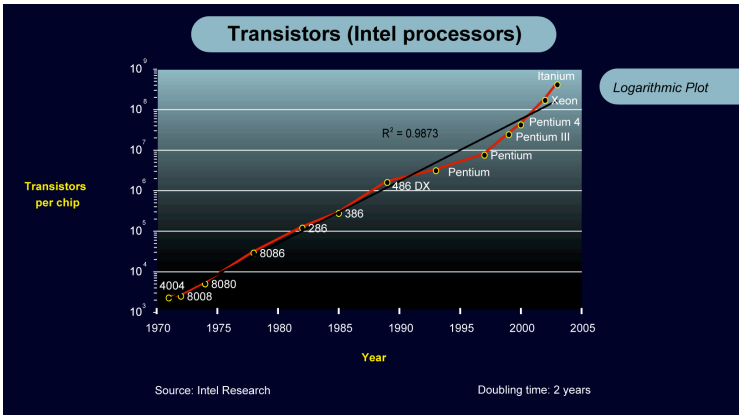
- From early computers with vacuum tubes to modern machines with millions of transistors.



What's next?

Moore's Law

Prediction by Gordon Moore, co-founder of Intel, that computer chips (processors, memory, etc.) double their complexity every 12-24 months at near constant cost.



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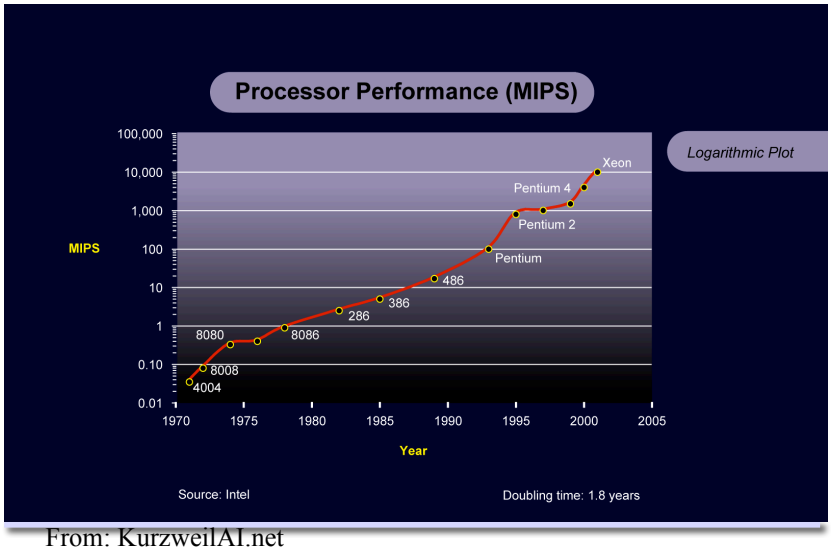
Processor Performance



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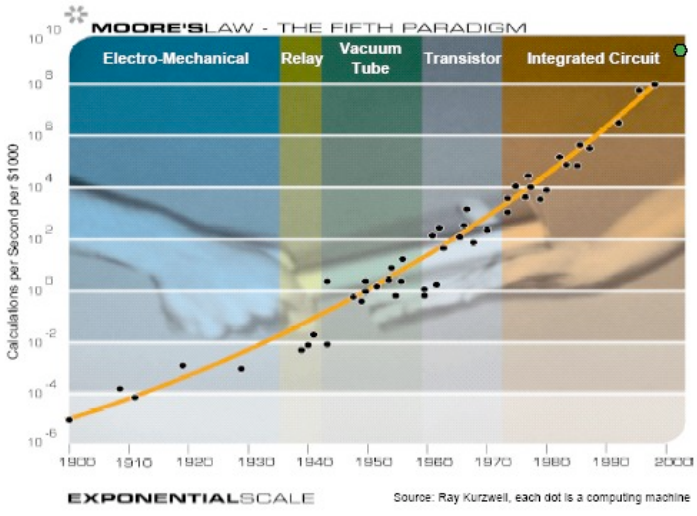
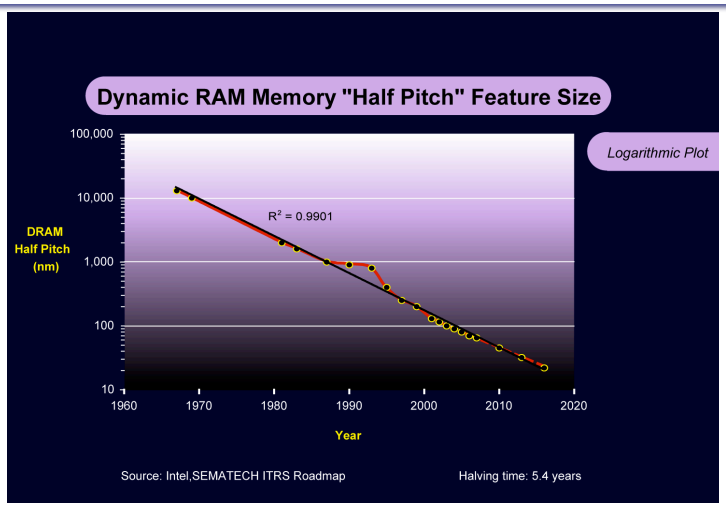
Ray Kurzweil's Generalized Moore Law



RAM Miniaturization



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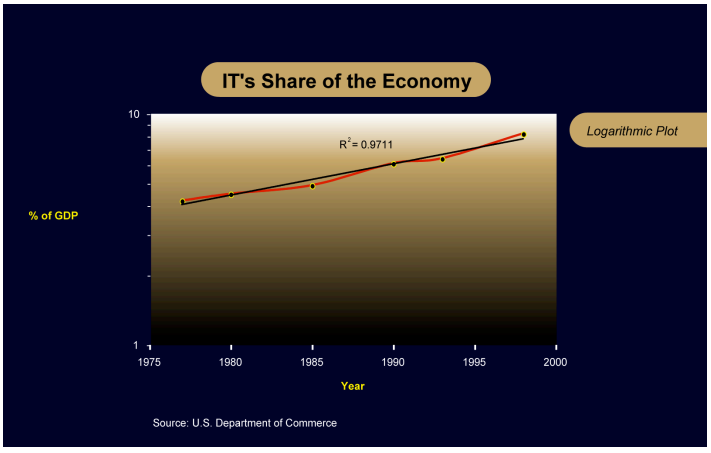
Impact on the Economy



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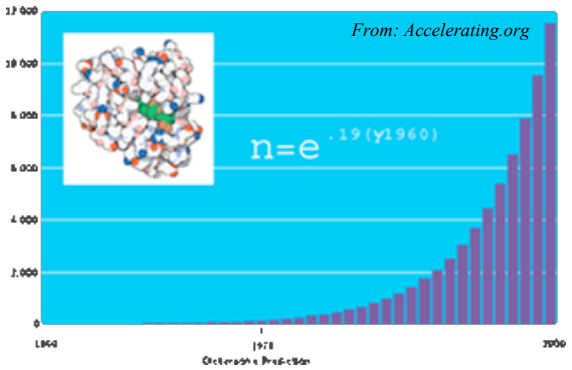
Impact on Scientific Questions

Richard Dickerson (1978) Cal Tech:

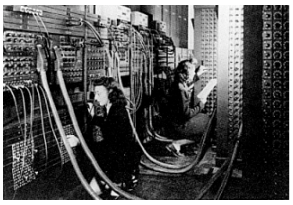
Protein crystal structure solutions grow according to n=exp(0.19y1960)



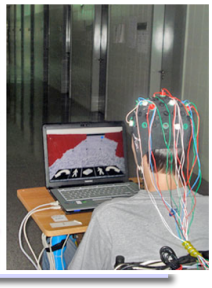
Dickerson's law predicted **14,201** solved crystal structures by 2002. The actual number (in online Protein Data Bank (PDB)) was **14,250**. Just 49 more.

The evolution of interfaces

- From room-sized machines to embedded machines.
- Human interfaces will improve, but not at the same rate as hardware.
- **Recent interfaces**: Smart touch, Language-based interfaces.
- **In the future**: Electronic paper, Neural interfaces.



http://www.vitodibari.com/en/polytechnic-university-milan-developed-lurch-brain-computer-interface-move-muscles.html



The evolution of software systems

From Babbage's Difference Engine…

to predicting weather patterns

beating word-class chess players

flying helicopters,

etc.

The evolution of the computing paradigm

- Change from current technological paradigm:
  - Quantum computing
  - Nanotechnology
  - DNA/biological computing

Take-home message

The details of the most fashionable hardware, software, programming language, interface, will change over time. But the fundamental concepts of computation covered in the course (and in many other CS courses) will persist.

Other courses of interest in CS

COMP-202: Introduction to Computing 1

- Introductory course in computer programming

COMP-250: Introduction to Computer Science

- Basic concepts (algorithms, data structures) for those who already know how to program.

COMP-230: Logic and Computability

- Propositional Logic, predicate calculus, Turing machines, unsolvable problems, completeness, Godel's theorem. No programming.

COMP-280: History and Philosophy of Computing

- Roots of computer science, relation to philosophy, mathematics and engineering. No programming.

COMP-364: Computer Tools for Life Sciences

- Basic concepts and tools for storing, retrieving, and analyzing large biological data sets (databases, numerical methods, images&movies).

Many CS programs available (major, minor, joint), either through Bachelor of Science, or Bachelor of Arts.

Exam preparation

What we covered in the course:

- History of CS
- Bits&bytes, boolean representations, finite state machines
- Programming, interpreting the program
- Arrays, trees, graphs, networks
- Algorithms, searching, sorting
- Data compression
- Computability, complexity
- Cryptography, constraint satisfaction
- AI, games, robotics
- Future of computing

What's on the exam? **Everything!** Except Lectures 24-26. **Same format as midterm.**

To prepare: Review course notes. Review homeworks, solution sets, midterm.

Office hours will continue next week. Additional help available by appt.

Final comments

- If you haven't done so, fill in online course evaluation form.
  - Only 12/42 response so far. **You can do better than that!** **It's really useful!**

Thank you!