Concurrent Object Oriented Languages

CSE 6490A

wiki.cse.yorku.ca/course/6490A

Instructor

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Overview

- concurrent algorithms
- concurrent programming in Java
- measuring performance of concurrent Java code
- verification of concurrent Java code

- searching the literature
  guest lecture by librarian Jacqueline Kreller-Vanderkooy
- writing
  guest lecture by Susan Visser (Publishing Program Manager, IBM)
- presenting

Evaluation

- 3 assignments (20% each)
- 3 presentations (5% each)
- paper (15%)
- participation (10%)

Assignments

1. Find a nontrivial (concurrent) algorithm in the literature.
2. Implement your algorithm in Java.
3. Measure the performance of your implementation.
   You will get access to Intel's Multicore Testing Lab.

For each assignment, you are expected to write a report.

Presentations

Present your assignments.

Paper

- Combine your assignments into a paper
- of 15 pages
- using LaTeX
- in Springer's Lecture Notes in Computer Science format.

Participation

For example,

- contributions to the wiki
- contributions to the forum
- discussion in class
- questions after presentations
- be on time
- ...

Academic honesty

"If you put your name on something, then it is your work, unless you explicitly say that it is not."

Examples of academic dishonesty include copying text, diagrams, code, etc. without providing a reference, in your assignments and presentations.
Read http://secretariat-policies.info.yorku.ca/policies/academic-honesty-senate-policy-on/ for more details. Also read http://www.yorku.ca/spark/academic_integrity/.

Concurrency

In which systems/applications do you find concurrency today?

- operating systems
- data bases
- graphical user interfaces
- Internet applications

Concurrency

In which systems/applications will you find concurrency in the near future?

- Everywhere?

Concurrency

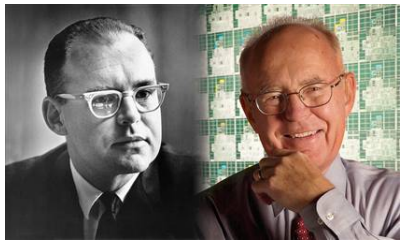
> *"Concurrency has long been touted as the "next big thing" and "the way of the future," but for the past 30 years, mainstream software development has been able to ignore it. Our parallel future has finally arrived: new machines will be parallel machines, and this will require major changes in the way we develop software."*

Herb Sutter and James Larus. Software and the Concurrency Revolution. *Queue*, 3(7):54-62, September 2005.

Moore's Law

> *"The complexity for minimum component costs has increased at a rate of roughly a factor of two per year. Certainly over the short term this rate can be expected to continue, if not to increase. Over the longer term, the rate of increase is a bit more uncertain, although there is no reason to believe it will not remain nearly constant for at least 10 years."*

Gordon E. Moore. Cramming more components onto integrated circuits. *Electronics*, 38(8), April 1965.



source: www.rentoid.com

Carver Mead dubbed this Moore's Law.

Moore's Law

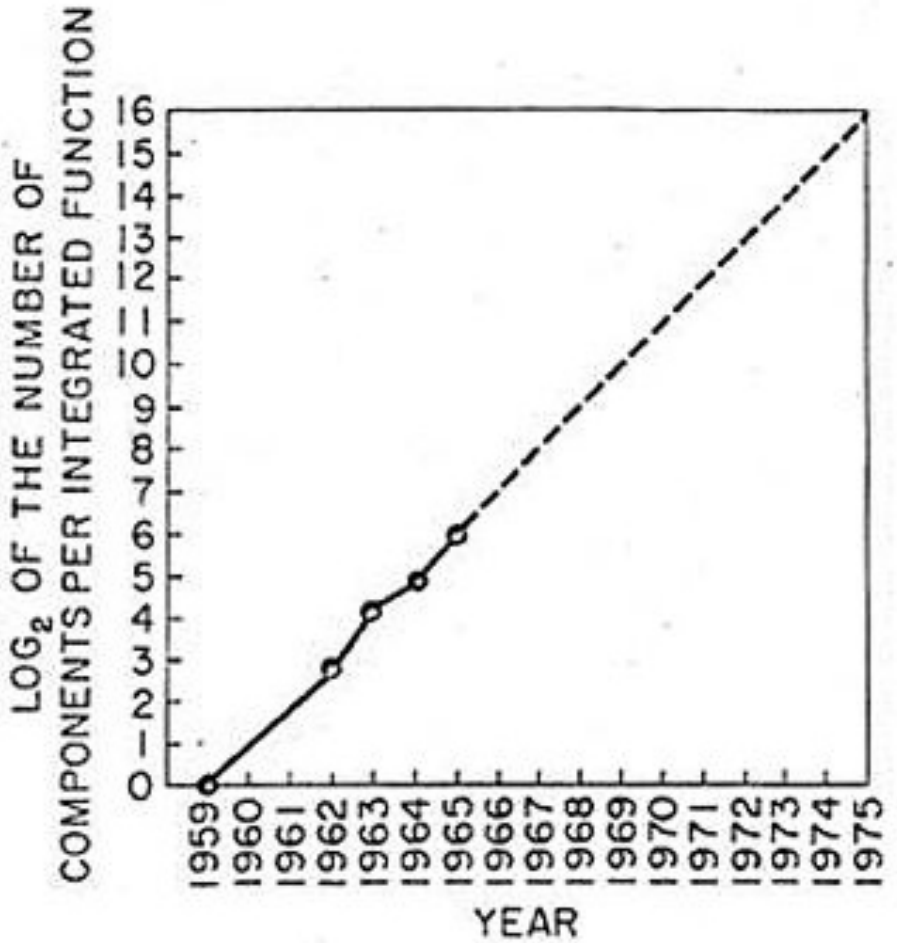


Fig. 2 Number of components per integrated function for minimum cost per component extrapolated vs time.

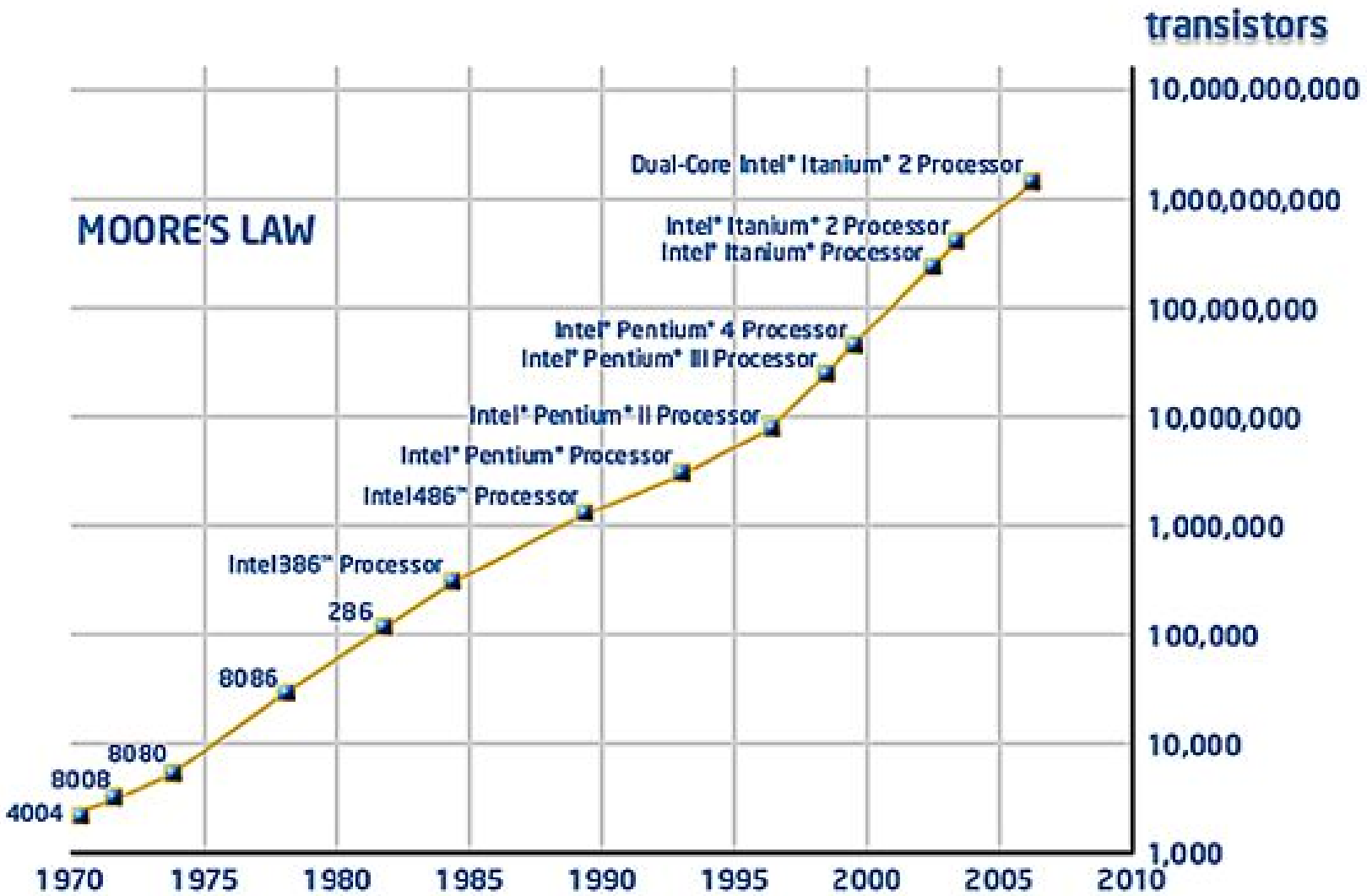
source: www.intel.com

Moore's Law

> *"So the original one was doubling every year in complexity now in 1975, I had to go back and revisit this... So then I changed it to looking forward, we'd only be doubling every couple of years..."*

Excerpts from a conversation with Gordon Moore (source: www.intel.com)

Moore's Law



source: www.intel.com

Moore's Law

This complexity (which doubled every two years) is strongly correlated with

- processor speed
- memory capacity

The End of Moore's Law?

> *"The combination of limited instruction parallelism suitable for superscalar issue, practical limits to pipelining, and a "power ceiling" limited by practical cooling limitations has limited future speed increases within conventional processor cores to the basic Moore's law improvement rate of the underlying transistors."*

Kunle Olukotun and Lance Hammond. The Future of Microprocessors. *Queue*, 3(7):26–29, September 2005.

Multicore CPUs

> *"Chip multicore processors implement two or more conventional superscalar processors together on a single die."*

Kunle Olukotun and Lance Hammond. The Future of Microprocessors. *Queue*, 3(7):26–29, September 2005.

The End of Moore's Law?

> *"While Moore's Law continues to hold, due to both intractable physical limitations and practical engineering considerations, that increasing density is no longer being spent on boosting clock rate, but rather on putting multiple CPU cores on a single CPU die. ... most code can (and should) achieve concurrency without explicit parallelism ..."*

Bryan Cantrill and Jeff Bonwick. Real-world concurrency. *Communications of the ACM*, 51(11):34-39, November 2008.

Multicore CPUs

- dual-core processor
  (AMD Phenom II X2 and Intel Core 2 Duo)
- quad-core processor
  (AMD Phenom II X4 and Intel Core 2 Quad)
- 8-core processor
  (Intel Xeon 7560 and Sun UltraSPARC T2)
- 15-core processor (Intel Xeon E7-2890)
- 16-core processor (AMD Opteron 6300)
- 61-core processor (Intel Xeon Phi)
- 80-core processor (Intel Teraflops Research Chip)

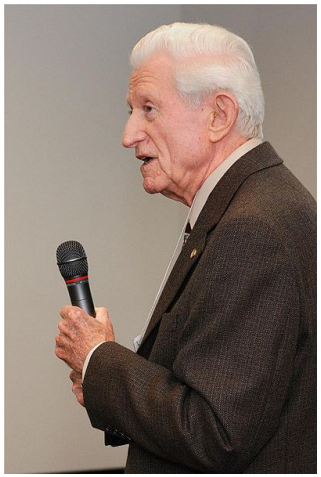
Multicore GPUs

- NVIDIA Tesla K40 (4992 cores)
- AMD FirePro W7100 (1792 cores)

Amdahl's Law

> *"... the effort expended on achieving high parallel processing rates is wasted unless it is accompanied by achievements in sequential processing rates of very nearly the same magnitude."*

Gene M. Amdahl. Validity of the single processor approach to achieving large scale computing capabilities. In *Proceedings of the AFIPS Joint Computer Conferences*, pages 483–485, Atlantic City, NJ, USA, April 1967. ACM.



source: Perry Kivolowitz

Concurrency is Hard

> *"But concurrency is hard. Not only are today's languages and tools inadequate to transform applications into parallel programs, but also it is difficult to find parallelism in mainstream applications, and—worst of all—concurrency requires programmers to think in a way humans find difficult."*

Herb Sutter and James Larus. Software and the Concurrency Revolution. *Queue*, 3(7):54-62, September 2005.

Concurrency is Hard

> *"Multicore architectures will (finally) bring parallel computing into the mainstream. To effectively exploit them, legions of programmers must emphasize concurrency."*
>
> *"Nontrivial software written with threads, semaphores, and mutexes are incomprehensible to humans and cannot and should not be trusted!"*

Edward A. Lee. Making Concurrency Mainstream. Presentation at the *17th International Conference on Concurrency Theory*, Bonn, Germany, August 27, 2006.