ECSE 420 Parallel Computing

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Parallel Computing & World History

- Computers: human invention –a "general purpose" tool
- Parallelism – obvious right from the start
  - Even before computers existed
    - E.g.: pyramids in ancient Egypt
- A Necessity! Especially in High-Performance Computing (HPC)
- Right now: not postponed to future
  - M. Flynn: "Future is parallel" (circa 1996)

Parallelism in World History

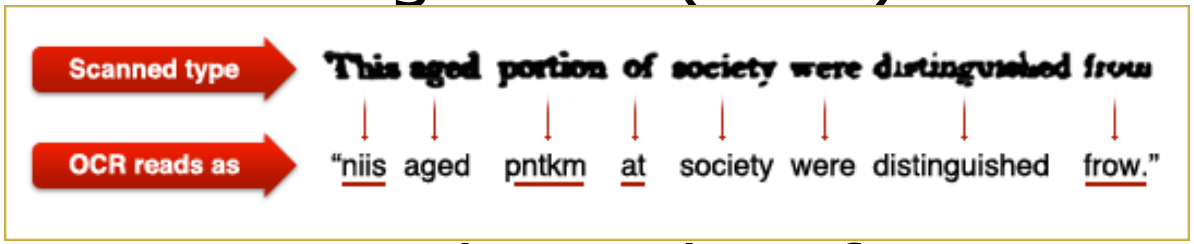
- End of feudal era:
  - Pipelining applied by craftsmen
- Spread of automobiles:
  - Synchronized production line at Ford
- Quantity -> quality concept in Hegel's philosophy:
  - Marx and followers, revolutions, upheavals
- Internet, open source, Google, …,

Parallelism in Nature

- Think of insects, microbes, viruses, plants, …,
  - Quantity -> quality concept at work again
- First objective: survival of the species
- More subtle objectives: getting work done
  - Look at ants, bees, pack of wolves, whales
- Regardless whether large or small
  - Animals, plants, other forms of life benefit by exploiting their strength in numbers

Parallelism and Beings: Farfetched

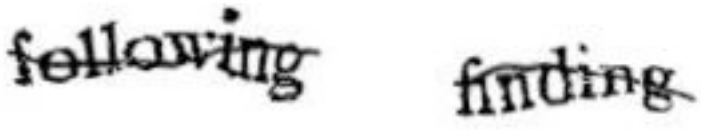
- Ongoing harvesting of human computation (free of charge!)
  - Digital archiving of NYT, word literature, radio
- Optical character recognition (OCR): ~90% accuracy



- Human typists: ~95%, but takes forever, expensive
- Good alternative?

CAPTCHA! to the Rescue

- CAPTCHA!: Completely Automated Public Turing test to tell Computers and Humans Apart



- Humans can recognize distorted text
- Great role in protecting from spam, protecting registrations
  - authorizing joining e-mail accounts, discussion groups, …

Underground Beating CAPTCHA!

- Include captcha's at entrance to porn sites
  - Free workforce
  - Limited in scope
- Hiring human readers - sweatshops
  - Costs money
  - IP detection issue
  - Time to react

Doing Useful Work for Free: reCAPTCHA

- OCR: humans better than machines
- Place scanned text as captcha's
- Two words at least: known + unknown

- Known captcha sweatshops get whole paragraph to type
- NYT done, others moving fast

Human-Machine Cooperation

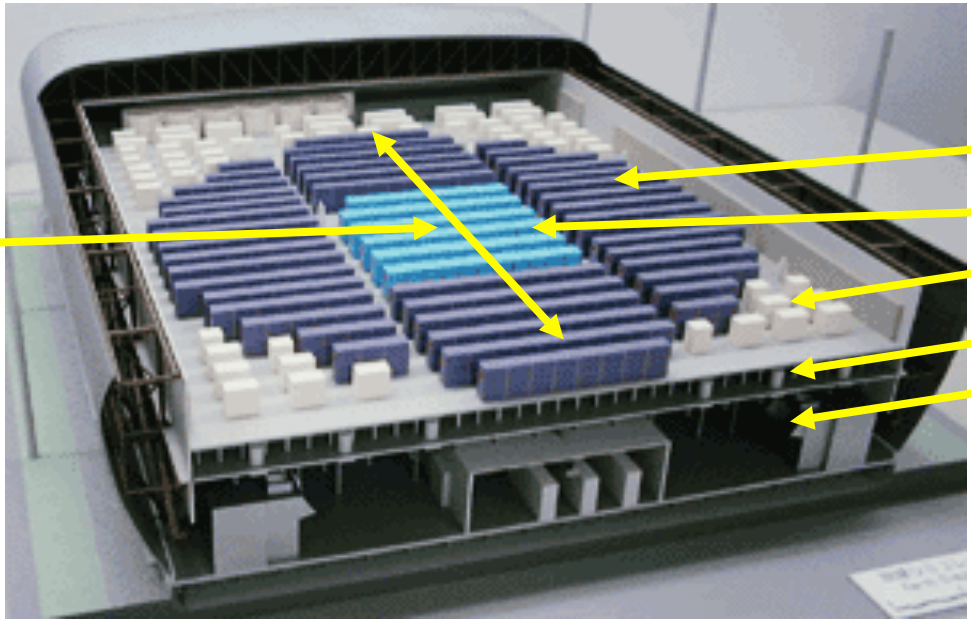
- DARPA Challenge:
  - Locate 10 red weather balloons released in continental USA in ~1 week
- DARPA already knows where balloons are
  - Wants to know how to muster Internet and social networking for ambitious tasks

Parallel Computing: Goals

- Pulling together compute resources to solve challenging computing tasks
- Keeping execution correctness while doing above (w.d.a.)
- Keeping productive w.d.a.
- Keeping electric distribution alive w.d.a.
- Having sufficient cooling w.d.a.
- Keeping existing computer room w.d.a. or
- Having enough money for sustaining the above

Case in Point: Earth Simulator

35.86 Tflop/s (#4), Footprint — 34,000 ft^2 (4 tennis courts x 3 floors)
10.0 MW!



Crossbar Interconnection Network
83000 Copper Cables
1800 Miles of Cable
http://www.es.jamstec.go.jp/esc/eng/index.html

⟺

High Interprocessor Latency
(11 in = 1ns)

Parallel Computing Disciplines

- Architecture
- Operating Systems
- Programming Languages
- Compilers
- Programming techniques
- Algorithms (conceptual)
- Important application types
  - Databases, numerical linear algebra, modeling, intelligence (both meanings), CAD, visualization
- Opportunistic parallelism exploitation
  - SETI, spam generators, all SW on multiple-core PCs
- Remember: parallel/concurrent computing is a necessity