Data Structures & Algorithms

Overview

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Slides are Reformatted From Lecture Note of Algorithms Course by Robert Sedgewick, Princeton University, Fall, 2008.

Course Overview

- outline
- why study algorithms?
- resources (books)

Course Overview

- Programming and problem solving with applications.
- Algorithm: method for solving a problem.
- Data structure: method to store information.

Topic	Data Structures and Algorithms
data types	stack, queue, list, union-find, priority queue
sorting	quicksort, mergesort, heapsort, radix sorts
searching	hash table, BST, red-black tree, B-tree
graphs	BFS, DFS, Prim, Kruskal, Dijkstra
strings	KMP, Rabin-Karp, TST, Huffman, LZW
geometry	Graham scan, k-d tree, Voronoi diagram

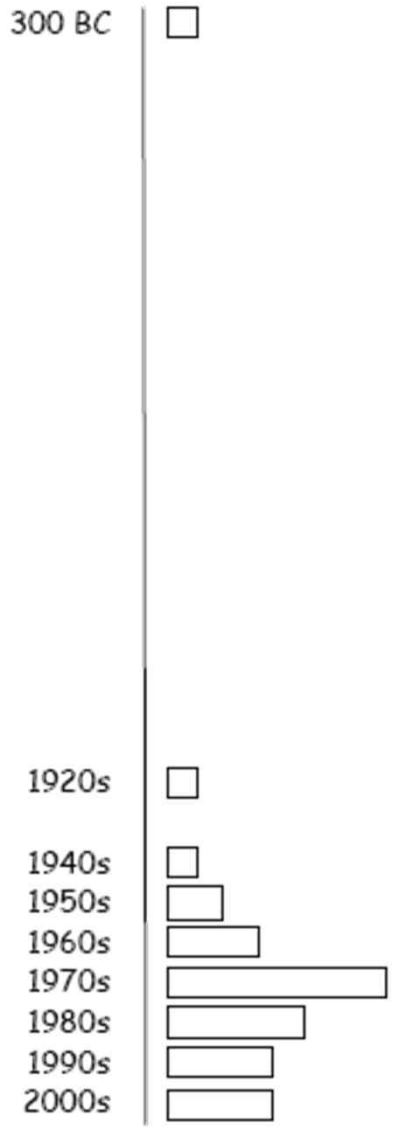
Why study algorithms?

- Their impact is broad and far-reaching

  - Internet. Web search, packet routing, distributed file sharing.
  - Biology. Human genome project, protein folding.
  - Computers. Circuit layout, file system, compilers.
  - Computer graphics. Movies, video games, virtual reality.
  - Security. Cell phones, e-commerce, voting machines.
  - Multimedia. CD player, DVD, MP3, JPG, DivX, HDTV.
  - Transportation. Airline crew scheduling, map routing.
  - Physics. N-body simulation, particle collision simulation.

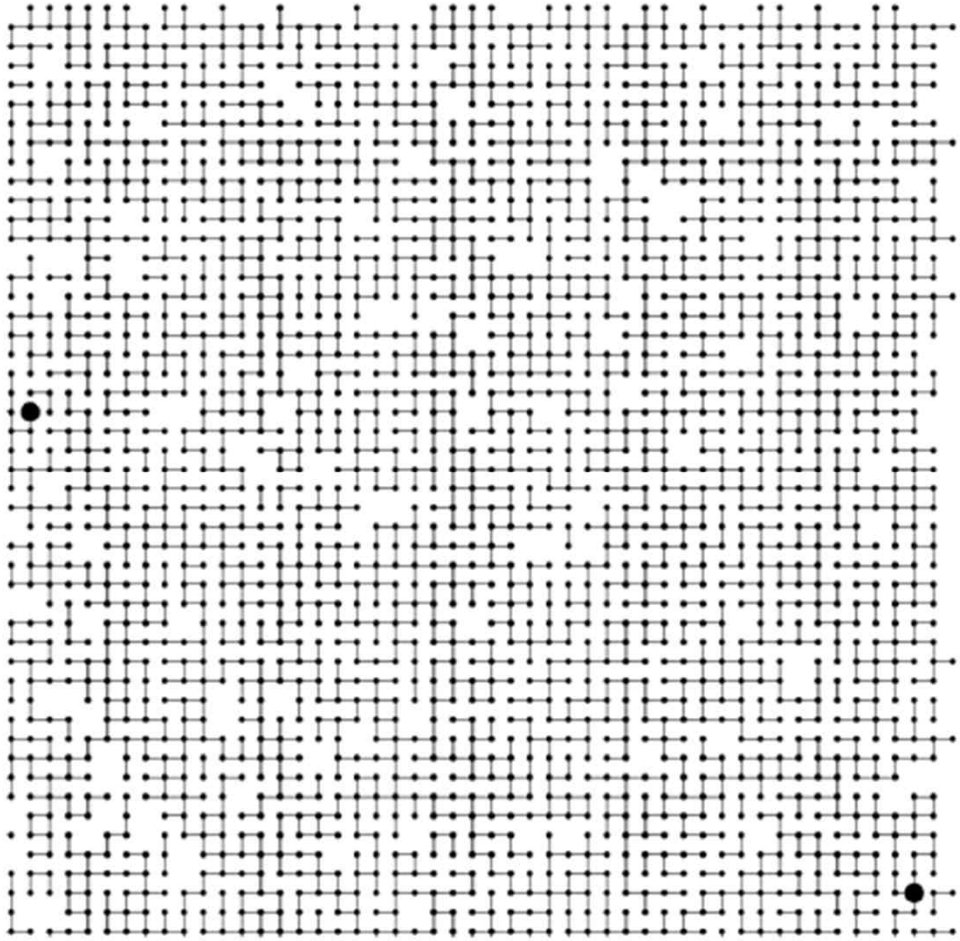
Why study algorithms?

- Old roots, new opportunities
  - Study of algorithms dates at least to Euclid
  - Some important algorithms were discovered by undergraduates!



Why study algorithms?

- To be able solve problems that could not otherwise be addressed
  - Example: Network connectivity
    - ✓ [stay tuned]



Why study algorithms?

- For intellectual stimulation
  - For me, great algorithms are the poetry of computation. Just like verse, they can be terse, allusive, dense, and even mysterious. But once unlocked, they cast a brilliant new light on some aspect of computing. – Francis Sullivan
  - An algorithm must be seen to be believed. - D. E. Knuth

Why study algorithms?

- They may unlock the secrets of life and of the universe.
  - Computational models are replacing mathematical models in scientific enquiry.

$$E = mc^2$$

$$F = ma \qquad F = \frac{Gm_1m_2}{r^2}$$

$$\left[-\frac{\hbar^2}{2m}\nabla^2 + V(r)\right]\Psi(r) = E\,\Psi(r)$$

20th century science
(formula based)

```
for (double t = 0.0; true; t = t + dt)
   for (int i = 0; i < N; i++)
   {
      bodies[i].resetForce();
      for (int j = 0; j < N; j++)
         if (i != j)
            bodies[i].addForce(bodies[j]);
   }
```

21st century science
(algorithm based)

  - Algorithms: a common language for nature, human, and computer

- Avi Widgerson

Why study algorithms?

- For fun and profit

Nintendo

Adobe

Google

D E Shaw & Co

Morgan Stanley

Microsoft

YAHOO!

PIXAR

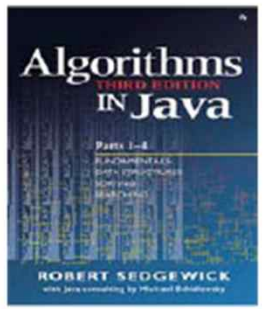
Why study algorithms?

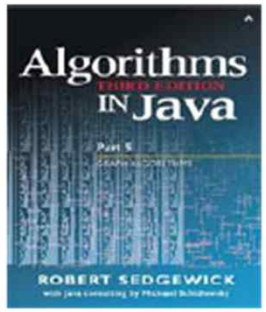
- Their impact is broad and far-reaching
- Old roots, new opportunities
- To be able to solve problems that could not otherwise be addressed
- For intellectual stimulation
- They may unlock the secrets of life and of the universe
- For fun and profit

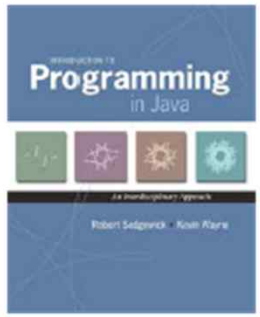
- Anything else?

Resources (books)

- Algorithms in Java, 3rd edition
  - Parts 1-4. [sorting, searching]
  - Part 5. [graph algorithms]
- Introduction to Programming in Java
  - basic programming model
  - elementary AofA and data structures
- Algorithms in Pascal(!)/C/C++, 2nd edition
  - strings
  - elementary geometric algorithms







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