CSE 326: Data Structures and Algorithms
EOQ Wrap-up and Review

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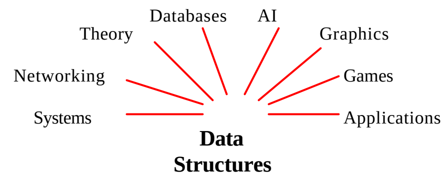
Why (did we) study data structures?

Clever ways to organize information in order to enable efficient computation



Why (did we) study algorithms?

Clever ways to solve problems in a *structured* and *efficient* manner

Ways to measure *structure*:
- Proofs of correctness
- Intuition

Ways to measure *complexity*:
- Worst case
- Expected case
- Average case
- Amortized over a series of (presumably representative) runs
- Best case (occasionally useful)

Apocalyptic Laptop

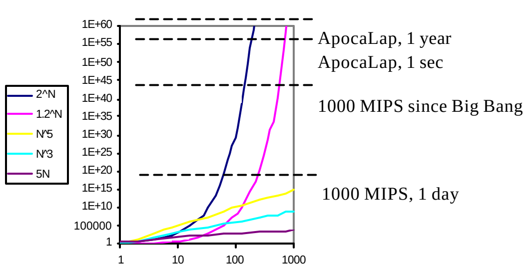
Seth Lloyd, a physicist at the Massachusetts Institute of Technology, has calculated how to make PCs almost unimaginably faster--if you don't mind working on a black hole.

Lloyd has used the laws of thermodynamics, information, relativity, and quantum mechanics to figure out the ultimate physical limits on the speed of a computer…

Lloyd's ultimate laptop would convert all of its 1-kilogram mass into energy via Einstein's famous equation $E = mc^2$, thus turning itself into a billion-degree blob of plasma. "This would present a packaging problem," Lloyd admits … The computer would be capable of performing 10^{51} operations per second.

- Charles Seife, Science Magazine, Vol289, No 5484, Sep 1 2000, pp. 1447-1448

Big Bang



Why (did we) take CSE 326?

- Learn some of the fundamental data structures and algorithms in computer science
  - And understand their tradeoffs!
- Learn to see and solve problems abstractly
  - Be able to see the intrinsic problem behind real-world scenarios, or vice versa, be able to realize an abstract solution in the real world
  - Data structures are your problem-solving building blocks!
- Learn to analyze and improve algorithms
  - Prove correctness
  - Gauge and improve time complexity
- Become modestly skilled with the UNIX operating system
- Appreciate that all languages are not created equal...

Some Data Structures, Algorithms, and Techniques We Covered

- List ADT
  - Stack ADT
  - Queue ADT
- Collection/Set ADT
- Dictionary/Map ADT
- Priority Queue ADT
- Disjoint Sets ADT
- Graph ADT

- Asymptotic analysis techniques
- Comparison-based sorting algorithms
- Shortest-path algorithms
- Minimum-spanning tree algorithms
- Randomization techniques
- “Greedy” algorithmic techniques
- Divide and Conquer techniques
- Dynamic programming techniques

Why So Many Data Structures?

Ideal data structure:

“fast”, “elegant”, memory efficient

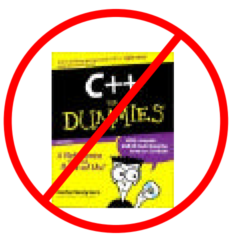
Generates tensions:

- time *vs.* space
- performance *vs.* elegance
- generality *vs.* simplicity
- one operation’s performance *vs.* another’s

The study of data structures is the study of tradeoffs. That’s why we have so many of them!

Are we convinced yet?

Mastery of this material separates you from …



Final Review: What you need to know

- Basic Math
  - Logs, exponents, summation of series
  - Proof by induction

$$\sum_{i=1}^{N} i = \frac{N(N+1)}{2}$$

$$\sum_{i=0}^{N} A^i = \frac{A^{N+1}-1}{A-1}$$

- Asymptotic Analysis
  - Big-oh, Theta and Omega
  - Know the definitions and how to show f(N) is big-O/Theta/Omega of (g(N))
  - How to estimate Running Time of code fragments
    - *E.g.* nested “for” loops
- Recurrence Relations
  - Deriving recurrence relation for run time of a recursive function

Final Review: What you need to know

- Lists, Stacks, Queues

Final Review: What you need to know

- (Binary) Search Trees

Final Review: What you need to know

- Hashing

Final Review: What you need to know

- Priority Queues

Final Review: What you need to know

- Sorting Algorithms

Final Review: What you need to know

- Graph Algorithms

Final Review: What you need to know

- Algorithm Design Techniques

Final Review: What you need to know

- Disjoint Sets

- Multi-dimensional search structures

Top Four Things to Know in Computer Science*

3) Ask not what you can do to an object; ask what an object can do to itself

2) $1 + 2 + \ldots + n = n(n+1) / 2$

1) The answer is "it depends"

0) $2^{10} = 1024$

** By Owen Astrachan, of Duke University*
Courtesy of Steve Wolfman