CSE332: Data Abstractions

Lecture 26: Course Victory Lap

Dan Grossman

Spring 2012

Today

- Rest-of-course logistics: exam, etc.
- Review of main course themes
- Some thoughts on “data structures and threads” together
- Some time for questions and discussion
- Course evaluations
  - Thoughtful and constructive feedback deeply appreciated
  - (Including what you liked)

Final Exam

As also indicated on the web page:

- Next Tuesday, 2:30-4:20
- Intention is to test a subset of the topics in sorting, graphs, parallelism, concurrency, amortization
  - In other words, "stuff not covered by the midterm"
  - But as always the course topics build on earlier ones, especially algorithm analysis
- May need to read and write Java, among other things

Grading Schedule

Needs grading:

- Homework 8 [Stanley]
- Project 3 [Tyler]
- Final exam [Dan]

Will let you know when grading is done

- Encourage you to pick up your homework, exam
- But Dan will be out of town June 9-20
  - Exams at department front desk during this time?

Victory Lap

A victory lap is an extra trip around the track

- By the exhausted victors (that's us) ☺

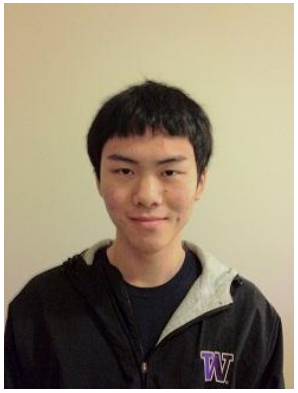
Review course goals

- Slides from Lecture 1
- What makes CSE332 special

Thank you!

Big thank-you to your TAs

- Section covers essential software topics and complements lecture: indispensable in my opinion
- *Lots* of grading in CSE332: “free response” and “open design” better for students, harder for TAs



Thank you!

And huge thank you to all of **you**

- Great attitude
- *Extraordinarily good class attendance and questions*
- Occasionally laughed at stuff ☺

Now five slides, completely unedited, from Lecture 1

- Hopefully they make more sense now
- Hopefully we succeeded

Data Structures + Threads

- About 70% of the course is a "classic data-structures course"
  - Timeless, essential stuff
  - Core data structures and algorithms that underlie most software
  - How to analyze algorithms

- Plus a serious first treatment of programming with *multiple threads*
  - For *parallelism*: Use multiple processors to finish sooner
  - For *concurrency*: Correct access to shared resources
  - Will make many connections to the classic material

What is 332 is about

- Deeply understand the basic structures used in all software
  - Understand the data structures and their trade-offs
  - Rigorously analyze the algorithms that use them (math!)
  - Learn how to pick “the right thing for the job”

- Experience the purposes and headaches of multithreading

- Practice design, analysis, and implementation
  - The elegant interplay of “theory” and “engineering” at the core of computer science

Goals

- Be able to make good design choices as a developer, project manager, etc.
  - Reason in terms of the general abstractions that come up in all non-trivial software (and many non-software) systems
- Be able to justify and communicate your design decisions

Dan's take:

3 years from now this course will seem like it was a waste of your time because you can't imagine not "just knowing" every main concept in it

- Key abstractions computer scientists and engineers use almost every day
- A big piece of what separates us from others

Data structures

(Often highly *non-obvious*) ways to organize information to enable *efficient* computation over that information

- Key goal over the next week is introducing asymptotic analysis to *precisely* and *generally* describe efficient use of time and space

A data structure supports certain *operations*, each with a:

- Meaning: what does the operation do/return
- Performance: how efficient is the operation

Examples:

- ***List*** with operations **`insert`** and **`delete`**
- ***Stack*** with operations **`push`** and **`pop`**

Trade-offs

A data structure strives to provide many useful, efficient operations

But there are unavoidable trade-offs:

- Time vs. space
- One operation more efficient if another less efficient
- Generality vs. simplicity vs. performance

That is why there are many data structures and educated CSEers internalize their main trade-offs and techniques

- And recognize logarithmic < linear < quadratic < exponential

Now thoughts on teaching parallelism and concurrency in this class

- Something I have vigorously advocated personally
- And it seems to be working

Background

- "Old" data structures course taught more data structures and algorithms
  - Splay trees, leftist heaps, skew heaps, disjoint-set, network flow, …

- Threads are way more important than they used to be

- "Data structures" is not what most faculty would think of for the "best place to fit it"…

The fit

Hopefully it did not seem to odd to you, because:

- Work, span, Amdahl's Law are about asymptotics
- Fork-join is great for divide-and-conquer
- Sequential cutoffs are like quicksort/insertion-sort cutoffs
- ADTs need critical sections
- Queues motivate passive waiting
- … (several more examples)

Other main thesis: emphasize parallelism vs. concurrency distinction

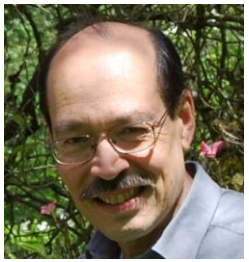
  - Not always widely appreciated
  - Often mixed in practice

Seems to work

- CSE332 instructors at UW








- Parts of materials picked up by 8 other schools so far
  - So please keep reporting typos, especially in reading notes

- A paper at SIGCSE2012 (main CS Education Conference)

Introducing Parallelism and Concurrency in the Data Structures Course

Dan Grossman Ruth E. Anderson
Dept. of Computer Science & Engineering
University of Washington
Seattle, WA, USA
djg@cs.washington.edu rea@cs.washington.edu

ABSTRACT
We report on our experience integrating a three-week introduction to multithreading in a required data structures course for second-year computer science majors. We emphasize the near term, many institutions may find it equally unrealistic to, on the one hand, modify many courses so that multithreading pervades the curriculum or, on the other hand, add an entire required course. Instead, our approach has been to use *part* of a

Last slide

What do you think was good about 332?

What could be improved?

And:

Don't be a stranger: let me know how the rest of your time in CSE (and beyond!) goes… I really do like to know