NETWORKING, CLOUD COMPUTING, AND COURSE OVERVIEW

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ATTRIBUTION

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• These slides incorporate material from:
  • Michael Freedman and Kyle Jamieson, Princeton University
Outline

1. Networking and cloud computing
2. Course overview
3. Open Q&A

COURSE OBJECTIVES

• Add networking support to software
  • Between two computers
  • Between computer and datacenter (“The Cloud”)

• Develop software that is:
  • Scalable (handles 100s of M to 1+ billion users)
  • Fault-tolerant (survives failures)
  • Evolvable (how to support different versions?)
  • Secure
OUR LIVES ARE (LARGELY) ONLINE!

NETWORKED SERVICES DRIVEN BY DATA

Data + Google = Personalized Search

Data + Spotify = Custom Stations

Data + Amazon.com = Product Recommendations
DATA-DRIVEN, PER-USER CUSTOMIZATION

Data + amazon.com = Product Recommendations

DATACENTERS: THE HOME OF ALL THIS COMPUTING AND STORAGE

Microsoft

Google

Facebook
Google 2012

Microsoft
MASSIVE NETWORKED INFRASTRUCTURE

- To build:
  - Google spends about $3B per year
  - Microsoft spent $15B in total

- To operate:
  - 1-2% of global energy consumption¹
  - 91 billion kWh (34 500-MW coal-fired power plants)²

- By 2020²:
  - 140 billion kWh (50 power plants)
  - $13 billion in electricity bills
  - 100 metric tons of carbon pollution per year

¹. LBNL, 2013
². NRDC report
THE NETWORK HAS SEEN RAPID GROWTH


Web Created

THE NETWORK HAS SEEN RAPID GROWTH


Web Created

Google's 1st cluster (15 years)

THE NETWORK HAS SEEN RAPID GROWTH


Web Created

Google's 1st cluster (15 years)

facebook (10 years)
THE IMPORTANCE OF SCALE

• Network primitives are designed to scale

• Techniques we learn are directly applicable to global-scale services like Google, Facebook, ...

• Your projects will be tested in small scale
  • Yet could scale immensely with minimal to no modifications

CSE 124 VS. 291

• Both cover topics related to designing, reasoning about, and building networked software/systems

• 124
  • Undergraduate course
  • Introduction to the topics

• 291
  • Graduate course
  • Deeper exposure to selected topics
  • Will read a number of primary research papers
WHY FOCUS ON CORRECTNESS?

SELF-DRIVING CARS
SMART CITIES AND SMART GRIDS

Smart, cleanly-powered grid
Interconnected grid with: 1. Distributed, regional, and central generation; 2. Hybrids (multiple means) of power generation at each scale; 3. Smart sensors in buildings for efficient use; 4. Smart technologies to designate critical areas during power losses; 5. New generation batteries and other storage technologies.


THE CHALLENGE OF NETWORKING

• Undergraduate program includes:
  • Algorithms
  • Programming languages
  • Architecture
  • Data structures
  • Etc...

• How does the network change each of these areas?
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RESOURCES

- Course web page
  - Linked off of www.cs.ucsd.edu/~gmporter
- Syllabus, schedule, and blog/updates
- Books
- TA discussion sections
- Class meetings
- Each other!
CLASS MEETINGS (M/W/F)

- Overview of material, work through examples/demos, small-group activities
- To help you do what you need to do for your projects/homeworks
- Occasional graded exercises in class
  - Based on “reasonable effort and preparedness” not strict correctness
- **Be involved**--don’t expect 45 minute speeches!
  - Engagement:
    - Being unengaged saps energy from your peers and me

BOOKS

- **Required**
  - TCP/IP Sockets in C
  - The Datacenter as a Computer
  - Required (but free PDF online)
- **Required**
  - Distributed Systems
  - Principles and Paradigms
- **Optional**
PROGRAMMING LANGUAGES

• Project 1: C/C++
  • Pluralsight online training (link on course page)
    • Usually quite expensive, but UCSD is covering the cost
  • Need: Functions, basic data structures, containers (Map, Vector/List, String)
  • Maybe: Classes, unit testing
  • Don’t need: Inheritance, metaprogramming, templates, advanced features, ...
  • Correctness, but also code quality

• Project 2: Java
  • Pluralsight online training (link on course page)
    • Usually quite expensive, but UCSD is covering the cost
  • We will be building our code using Maven
  • Fully working starter code will be provided
  • Correctness, but also code quality
291 TEACHING ASSISTANTS

• Yibo Guo
• Bhargav Sridharan

WEEKLY LECTURES

Devices permitted
(But no TV, movies, video, or games!)

No devices in first few rows

• Electronic device policy: None allowed in first few rows (ok in back)
• Except when we work on in-class projects
• Bring your laptop on in-class project days if you have one
• Or share with a partner

Picture courtesy http://tinyurl.com/znkuezc
291 ASSESSMENT

• Five homeworks (23%)
• In-class projects / paper reading quizzes (5%)
• Projects
  • Build a webserver (25%)
  • Build a Dropbox-like cloud storage app (27%)
• Final exam (20%)

HOMEWORK 1

• A networked calculator
• Is a “dry run” of the networking, framing, and parsing portions of your webserver
• Will be very useful as a big portion of your project 1 submission
• Can use the code in project 1
HOMEWORK 2

- Deploy your code on Amazon AWS to datacenters on five continents
  - Mumbai, India; Dublin Ireland; Sao Paulo Brazil; Seoul, Korea, San Diego, Calif.

COLLABORATION POLICY

- Homework 1 + Project 1
  - Groups of 1 or 2 (same group for both)
- Project 2
  - Groups of 1 or 2 (can be different from project 1)
- GradeScope
  - For homeworks and projects
  - Automatic grading of the project (a bit experimental)
- Can use GitHub:
  - For all assignments, if you use GitHub you must use private GitHub repos that we will provide to you
  - Do not post code online, on the web, in a public repo, on discussion forums, etc.
STACK OVERFLOW, GOOGLE, ETC...

• Be aware of Googling for answers
  • Isn’t that what “real” programmers do?
  • Nope!

• Examples of OK resources
  • Javadoc, C++ API docs

PIAZZA

• Will be available if you want to discuss topics from the course with fellow students

• Can ask questions about projects and homeworks, but...
  • We may choose to answer questions by updating the assignment specification on the web site to prevent the answers from being buried, and to prevent “notification overload”
QUESTIONS? COMMENTS?

For Wednesday:
• Reading due: Donahoo and Calvert, Chapters 1 and 5