NETWORKING, CLOUD COMPUTING, AND COURSE OVERVIEW

George Porter
Apr 2, 2018

ATTRIBUTION

• These slides are released under an Attribution-NonCommercial-ShareAlike 3.0 Unported (CC BY-NC-SA 3.0) Creative Commons license
• 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 = Product Recommendations

Data + Spotify = Custom Stations

Data + Amazon = Personalized Search
DATA-DRIVEN, PER-USER CUSTOMIZATION

Data + Amazon.com = Product Recommendations

App 1
App 2
App 3
App ...
App ...

DATACENTERS: THE HOME OF ALL THIS COMPUTING AND STORAGE

Microsoft
Google
Facebook
MASSIVE NETWORKED INFRASTRUCTURE

- To build:
  - Google spends about $3B per year
  - Microsoft spent $15B in total
- To operate:
  - 1-2% of global energy consumption\(^1\)
  - 91 billion kWh (34 500-MW coal-fired power plants)\(^2\)
- By 2020\(^2\):
  - 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


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 123 VS. 124

• 123: Networking
  • Theory of how the network works
  • Routing protocols, congestion control theory, switching and forwarding
  • “Up to layer 4”

• 124: Networked services
  • How to program networked software
  • Socket programming, RPC, DNS, protocol design and implementation, consensus and consistency, security, TLS, ...
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?
Outline

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

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 (but free PDF online)

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

PROGRAMMING LANGUAGES

• 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
124 TEACHING ASSISTANTS

• Kunal Kashilkar
• Vasudev Patel
• Siddarth Ravichandran
• Varun Syal
• Discussions: M 4-5, M 5-6
• Small(er) group meeting to work through examples, ask questions, seek out help on the projects/homeworks, etc.

WEEKLY LECTURES

• 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

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

No devices in first few rows

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

• Five homeworks (23%)
• In-class projects (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