NETWORKING, CLOUD COMPUTING, AND COURSE OVERVIEW

George Porter
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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
4. Network terminology

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)
  - Performant (runs fast)
  - 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 = Product Recommendations
DATA-DRIVEN, PER-USER CUSTOMIZATION + ML

Product Recommendations

App 1
App 2
App 3
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
  • 91 billion kWh (34 500-MW coal-fired power plants)
  • By 2020: (less than a year from now!)
    • 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

THE NETWORK HAS SEEN RAPID GROWTH


Web Created

Google's 1st cluster

Facebook
HOW TO BUILD SUCH LARGE SYSTEMS?

• Systems...
  • Built on top of abstractions...
• Built on software...
• Built on hardware...

THE IMPORTANCE OF SCALE

• Network abstractions 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

CSE 123: Computer Networks
- How the Internet works
- How to route packets through multiple networks
- How to deliver a reliable, in-order byte stream over unreliable packet delivery
- Resource sharing
- Network-level errors

124: Networked services
- How to program networked software
- Programming abstractions:
  - Socket programming
  - RPC
  - Message passing
- Protocol design and implementation
- Consensus and consistency
- Security, TLS, ...
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
- Google Q&A
- Each other!

CLASS MEETINGS (M/W/F)

- Overview of material, work through examples/demos
- To help you do what you need to do for your projects/homeworks
- **Be involved**--don’t expect 45 minute speeches!
  - Engagement is good:
    - Being unengaged saps energy from your peers and me
    - 10am isn’t too bad...
• All free, available online via course webpage

PROGRAMMING LANGUAGE: 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
124 TEACHING ASSISTANTS

- Aashi Jain
- Kunal Kashilikan
- Siddarth Ravichandran
- Discussion: Fri 12-1pm
  - Small(er) group meeting to work through examples, ask questions, seek out help on the projects/homeworks, etc.
  - Midterm will be given during a discussion midway into the term

WEEKLY LECTURES

- Electronic device policy: None allowed in first few rows (ok in back)

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

No devices in first few rows

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

- Assignments (60%)
  - Three major programming projects
  - Smaller written homeworks
- Mid-term (15%)
- Final (25%)

PROJECTS

- Build your own web server
- Build a cloud-based file storage system patterned off of how Dropbox works
  - Geodistributed across the globe
  - Have it keep working even when portions crash/fail
AMAZON CLOUD SERVICES

• 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

• Groups of 1 or 2
• 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!
    • Short story about using online resources at a real company
• Examples of OK resources
  • C++ API docs, Library documentation

PIAZZA

Piazza’s business model is based on selling your data to 3rd parties
PIAZZA GOOGLE Q&A

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NETWORK TERMINOLOGY

- Some network terms
  - Cloud
  - Hosts
  - Switches
  - Internetwork
  - Router/gateway
  - Host-to-host connectivity
  - Address
  - Routing
  - Unicast/broadcast/multicast

(a) A switched network
(b) Interconnection of networks
NETWORK TERMINOLOGY

- Some common terminology
  - Scale
  - Link
  - Nodes
  - Point-to-point
  - Multiple access
  - Switched Network
  - Packet, message
  - Store-and-forward

(a) Point-to-point
(b) Multiple access

RESOURCE SHARING

- Resource: links and nodes
- How to share a link?
  - Multiplexing
  - De-multiplexing
  - Queuing
QUESTIONS? COMMENTS?

Consult the course web page for this week’s readings