Graduate Studies in Computer Science & Engineering

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Reasons to Consider Grad School

- You want to have an impact on the way software and computer systems are built and used.
  - novel applications
  - transformational technologies (cell phones, youtube, google, WWW)

- You want a leadership position
  - MS: technical manager
  - PhD: CTO, Chief Scientist

- You love ideas and want to understand computer science more deeply.

- You want to be a professor and teach computer science to others.

- You want to be a researcher and advance the frontiers of computer science or other fields
Careers with MS

• Senior Software Engineer -- design and implement the key components of a system.
• Technical lead -- design technical approaches to solving problems. Designing new products and services.
• Technical project manager -- lead a team of people to produce a product.
• Technical Program Manager (Microsoft concept) -- primary designer of the user experience for a product. Author and owner of the specification. Coordinate the design and engineering; user studies.
• Technical editor/Technical writer
• Teacher (K-12 or Community College)
• CEO (combined with experience; MBA)
Careers with PhD

• Management
  – Technical Project Manager/Program Manager
  – VP of Engineering
  – Chief Technical Officer
  – Chief Scientist
  – CEO

• Research
  – Professor
  – Industrial Researcher (MSR; Google; Yahoo; HP; Intel; top accounting firms; FICO (formerly Fair Isaac); internet security firms)
  – Defense Industry contract research organizations (SRI International, ISI, BBN, Boeing, Lockheed-Martin, BAE, etc.)
  – Consultant

• Research Management
  – Grant Program Manager (NSF, DARPA, Private Foundations)
  – In-house researcher at VC firm (not entry level)
Preparing for MS Programs

- Rigorous Course Work
  - Communications skills
- Engineering-oriented Senior Project
- Engineering internship
- Tool mastery
  - IDEs, Java, C++, C#, Matlab, R
  - Frameworks
  - Scripting languages
  - Version control and issue tracking
  - Databases
- Read industry magazines and blogs
Typical MS Program Content

• Approx. 10 courses (12 months of coursework)
  – 3 courses in your focus area
  – Remaining courses distributed across topic areas
    • Theoretical Computer Science: CS 515-517, CS 52X
    • Artificial Intelligence: CS 53X
    • Computer Systems: CS 57X, CS 54X, ECE 57X
    • Programming Languages: CS 58X
    • Software Engineering: CS 56X
    • Computer Vision and Graphics: CS 55X
    • An area approved by the committee

• MS Thesis vs. Project vs. Course-Only (M. Eng.)
Preparing for PhD Programs

• Rigorous Course Work
• Broad Course Work
• Research-oriented Senior Project
• Research internship
• Read the literature
Rigorous Course Work

- Computer science research = idea +
  experiments +
  mathematical analysis

- Take as much math as you can
  - Linear algebra, numerical linear algebra
  - Optimization (linear programming, convex optimization, non-linear optimization)
  - Probability and statistics (probability theory, theory of statistics)
  - Discrete math, graph theory, abstract algebra
  - Theoretical Computer Science
Broad Course Work

• Computer science solves other peoples’ problems. It is extremely valuable to know the vocabulary:
  – biology
  – ecology
  – chemistry
  – medicine
  – physics
  – psychology
  – business (advertising, marketing, economics)
Examples of fields I’ve worked in

- **Bio-engineering**
  - Computational Optimization of Microbial Fuel Cells
- **Ecology**
  - Conservation design for endangered species
- **Forest Fire Response**
- **Fire and Emergency Response**
- **Games**
  - Real-Time Strategy Games
  - Worlds best computer Klondike Solitaire player
- **Computer Security**
  - Insider threat detection
  - Advanced persistent threat detection
  - Controlling botnets for proactive security
- **Computer Vision**
  - Sports Video Analysis
  - General Visual Activity Recognition
- **Human-Computer Interaction**
- **Adaptive Network Protocols**
- **Software Engineering**
  - Intelligent Automated Software Testing
  - Adaptive Programming Languages
- **Power Systems**
  - Control of power grids under stress conditions
- **among others …..**
Research-Oriented Senior Project

• Try to solve a problem relevant to some faculty member
  – get a letter of reference
  – maybe get a publication
Research Internship

• Formal NSF Research Experiences for Undergraduates
  – paid research experience (hourly)
  – formal summer programs, advertised on web and at NSF (http://www.nsf.gov/crssprgm/reu/reu_search.cfm)

• Informal research experience
  – paid research experience with a faculty member
  – unpaid, but for course credit

• Often results in publications and good letters of reference
  – some OSU REUs are now famous professors
Read the Literature

• Identify hot topics by looking at CS conferences
  – each area in CS research has a few high-quality conferences
  – look at the topics of invited speakers
  – look at the topics of associated tutorials and workshops

• Read papers and see who is doing good work
  – who is helping define the problem?
  – who is doing the rigorous experiments?
  – who is able to apply the best mathematical tools?
  – who is doing a good job of training grad students?
    • students giving talks, winning “best paper” awards
    • students getting good jobs (read department web pages)

• Attend Research Seminars at your campus
  – typically weekly seminars by visitors
  – job talks during recruiting season (January-March)
Example Hot Topics

• Artificial Intelligence: recent workshops
  – AI for Cities
  – AI for Assistive Technologies and Smart Environments
  – Computational Sustainability
  – Computer Poker and Imperfect Information

• Software Engineering: recent workshops
  – Workshop on Automation of Software Testing
  – Principles of Engineering Service-Oriented and Cloud Systems
  – Workshop on Complex Faults and Failures in Large Software Systems

• HCI: recent workshops
  – Beyond Personal Information: Designing for Experiences with Data
  – Designing Smart Home Technologies that Evolve with Users
  – End-User Development in the Internet of Things Era
Applying to Grad School

• Choose good programs.
  – Find out what exams are required
  – GRE general test (CS subject test?)
• Choose your 3 letter writers carefully
• Write a good statement of purpose (get feedback from faculty members)
• Apply for NSF Fellowship (Senior Year)
  – Get advice from faculty member about likelihood of success
  – Deadline: around November 15 (see www.nsfgrfp.org)
• Other (more specialized) fellowships:
  – NDSEG (National Defense Science and Engineering Graduate Fellowship) (ndseg.asee.org/)
  – DOE Office of Science Graduate Fellowship (emphasizes supercomputing) (www.scied.science.doe.gov/SCGF.html)
Life in Grad School

• It’s Fun!

• Someone else pays!
  – Graduate Teaching Assistantship
    • grading, recitation sections, fill-in lectures
  – Graduate Research Assistantship
    • software development, algorithm design, experimentation, writing
  – Covers tuition
  – Provides stipend (e.g., $1900 per month; NSF Fellowships are $2500 per month)

• Conferences are fun!
Choosing an Advisor

- Works on important problems
- Can teach you key techniques
  - algorithmic, mathematical, methodological, software tools
- Is easy to work with
- Has the time to work with you
- Has a good team of students who help each other
- Can help you get good job interviews
- Has funding
Grad School Activities

- Research
  - Choosing a good problem
    - Reading
    - Exploratory Experiments ("Formative User Studies")
  - Developing and pursuing alternative approaches to solving it
    - Constructing and proving theorems
    - Designing algorithms
    - Developing software tools, languages
    - Building prototype systems
    - User studies
    - Comparative benchmarking
  - Writing papers, attending conferences, giving talks
- Internships at research labs
- Research visits to other groups
- Collaborations with other researchers
- Coursework: a means to an end
- Programming: a means to an end
# PhD Schedule

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Qualifying Exam  Prelim / Proposal  Thesis Defense
Other Resources

• How to be a successful grad student:
  – www.cs.cmu.edu/afs/cs.cmu.edu/user/mleone/web/how-to.html