Carnegie Mellon University

The Computer Science Ph.D. Program

Frank Pfenning
Director of Graduate Programs
(thanks to Jeannette Wing!)

Open House
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What Does it Mean to Get a Ph.D. at CMU?

• To learn to how to do high-quality research
  – Opportunity to explore new territory with an expert guide
  – Transition from
    • Problems with answers in the back of the book
  – To
    • Problems where you don’t know whether there is an answer
    • Areas where asking the right question is difficult

• To make a long-term investment in your future
  – To prepare for a career in technical leadership
    • Industry or academia
    • Set directions that others follow
Congratulations! You Are a Select Group

• We admitted 70 students. (676 applied.)
  – We want all of you here!

• Threshold is set by capacity
  – We rejected many qualified applicants.
  – We want to ensure quality advising for each of you.
  – We provide financial support for each of you.
What’s so Special About CMU?

Artists Conception of the Gates Center for Computer Science
Distinguishing Principles of Our Ph.D. Program

• **Research** is a high priority activity.
  – Research from Day 1.
  – Interdisciplinary, collaborative, hands-on

• **Students choose their advisors based on mutual research interests, not funding.**
  – Learn by apprenticeship.
  – Peer-to-peer, not client-server interaction.

• **Admitted students are expected to finish.**
  – No further hurdles: no MS requirement, no qualifying exams.
  – Historically, ~75% finish.

• **The Ph.D. Program is flexible.**
  – We treat students as individuals.
Components of the Program

- **Getting Started**
  - Admissions, Open House (you are here)
  - Immigration Course (IC)
  - Getting an advisor

- **Course Work**
  - 5 Area Courses
  - 3 Elective Courses (or V-unit!)

- **Other Activities**
  - 2 Teaching Assignments
  - Skills: oral and written communication

- **Research**
  - Directed Research
  - Thesis Proposal
  - Thesis
A Student’s Life Pictorially
Immigration Course

- Two weeks in the fall to see entire range of research and educational activities
- Overall understanding of research and culture of CSD
- Students and faculty get to know each other
Getting an Advisor

• Policies
  – Any **SCS** faculty member can be your advisor
    • Not just those in CSD
  – Some non-SCS faculty also have advising privileges
    • ECE, Biology, Business
  – Can change advisors due to shifting interests & research styles

• “Handshake”: Matching students with advisors
  – Near end of September, everyone assigned advisor
  – Based on mutual interest of faculty and students
    • We work hard to make matches that are desirable for both students and faculty
Courses

• 8 Courses Required
  – 5 for breadth, spanning range of computer science
  – 3 for depth in specific area or breadth within and beyond computer science
  – Not all courses are courses

• Features
  – Typically completed in first two years
    • At 50% time effort
  – Most courses are targeted to Ph.D. students
    • Intense, thought-provoking
Five Area Star Courses

- **Algorithms and Complexity**
  * Algorithms
  * Complexity Theory

- **Artificial Intelligence**
  * Advanced AI Concepts
  * Machine Learning

- **Computer Systems**
  * Computer Architecture
  * Optimizing Compilers for Modern Architecture

- **Programming Languages**
  * Type Systems for Programming Languages
  * Programming Language Semantics

- **Software Systems**
  * Advanced Operating Systems and Distributed Systems
  * Networking
  * Database Management Systems
Other Educational Activities

- **Teaching**
  - Two semesters
  - Serve as integral part of our very successful undergraduate program
  - Being a TA is a learning process, not a financial necessity

- **Skills Requirements**
  - Writing
  - Speaking
Black Friday

- Progress of every student evaluated twice a year
  - By entire CS faculty
  - Progress through program
  - What kind of work is he/she doing

- Benefit for students
  - Uniform calibration of students across program
  - Review of advisor as well as the student
  - Cooperative effort to have all students succeed
Financial Support

- We provide financial support while you are in good standing in the program.
- How does this work?
  - Mostly paid out of faculty research grants
    - Your advisor has a vested interest in your success!
  - External fellowships
    - Solicited by student
      - NSF, etc. We will supplement.
    - Through department
      - Intel, Microsoft, IBM, ...
  - Departmental funds
    - While you are teaching
    - Special cases
      - Advisor has funding gap
      - Faculty just starting up
Computing at Carnegie Mellon

CMU

School of Computer Science

Fine Arts Design Drama
Social Sciences Psychology Philosophy Statistics
Entertainment Technology Center

Science Biology Math
Human Computer Interaction
Learning and Discovery
Languages Technology

Computer Science

Engineering Mechanical Electrical
Robotics

Business Public Policy
Software Engineering Institute

Software Engineering

Supercomputing
Medical

Pitt
School of Computer Science

• People
  – 190 faculty
  – 200+ courses offered
  – 370 doctoral students in 7 Ph.D. programs
  – 300 masters students in 10 MS programs
  – 540 bachelors students in 1 BS program

• Units
  – **Computer Science Department**
  – Center for Automated Learning and Discovery
  – Robotics Institute
  – Human-Computer Interaction Institute
  – Institute for Software Research, International
  – Languages Technology Institute

• CSD
  – 80 faculty
  – 160 Ph.D. students
  – 157 staff
Our Ph.D. Programs

- Ph.D. in Computation, Organizations and Society
- Ph.D. in Computational and Statistical Learning
  - Ph.D. in Computational and Statistical Learning (Neural Basis of Cognition)
- Ph.D. in Computer Science
  - Ph.D. in Computer Science (Algorithms, Combinatorics, and Optimization)
  - Ph.D. in Computer Science (Neural Basis of Cognition)
  - Ph.D. in Computer Science (Pure and Applied Logic)
- Ph.D. in Human-Computer Interaction
- Ph.D. in Language and Information Technologies
- Ph.D. in Robotics
  - Ph.D. in Robotics (Neural Basis of Cognition)
  - M.D./Ph.D. in Robotics
- Ph.D. in Software Engineering

- Interdisciplinary Ph.D. Program (self-defined)
  - ISRI
  - CALD
    - CALD & CNBC
  - CSD
    - CSD & Math & GSIA
    - CSD & CNBC
    - CSD & Math & Phil
  - HClI
  - LTI
  - Robo
    - Robo & CNBC
    - Robo & Pitt
  - ISRI
  - SCS
Research Paradigms in CSD

• Theory
  – Formulate underlying principles
  – Create mathematical basis
  – The principle and its applicability is the end product

• System Building
  – Construct medium to large scale systems
  – Evaluate and measure
  – The artifact is the end product

• AI
  – Attempt to mimic human thought process
  – Display of intelligence is the end product

• Crosscutting research and projects
Your Research Career at CMU

We support many different styles according to student, advisor, and research area.

- **Initial**
  - Actively participate in research right from beginning
  - Often part of multi-student project
- **Transition**
  - Develop own ideas and research agenda
  - Write papers, attend conferences, etc.
- **Thesis**
  - PhD proposal (typically in 4th year)
  - Research (usually ~2 years)
  - Defense: Present to committee & public
Interdisciplinary Work

• Value
  – Push frontiers by seeking new problems and finding new approaches to old problems

• Traditional strength for all of Carnegie Mellon
  – History of expanding boundaries of computer science through interdisciplinary collaboration
    • robotics, psychology, language technology, data mining, ...
  – Environment where people with different backgrounds work together
Collaboration: How We Encourage It

• Mixing office space: among student/faculty & among disciplines
• ~25% of students have joint advisors
• Advising by faculty from other parts of university
  – Rest of SCS
  – ECE, Biology, ...

• Attitudes
  – Willingness to share credit with others
  – Respect for ideas of others
Example

• In 1999/2000 I advised 4 graduating Ph.D. students
  – Roberto Virga, Department of Mathematics
    • Postdoc at Princeton, now back in Italy
  – Carsten Schürmann, Department of Computer Science
    • Assistant Professor, Yale, moving to ITU Copenhagen
  – Alberto Momigliano, Department of Philosophy
    • Research Fellow, University of Edinburgh
  – Gerald Penn, Language Technologies Institute
    • Assistant Professor, University of Toronto
    • Winner of E.W.Beth Dissertation Award in Computational Linguistics

• 3 Schools (SCS, MCS, H&SS), 4 Departments
Profile #1: Jonathan Shewchuk

• Life History
  – B.Sc. in Physics and CS 1990, Simon Fraser
  – Ph.D. 1997, CMU
  – Now on faculty at Berkeley

• Research
  – Efficient generation of high-quality meshes
    • Sophisticated algorithms
    • Hard to get all of the details right
  – Triangle Program
    • In regular use worldwide

• Collaboration
  – Algorithms: Gary Miller
  – Systems: Dave O’Hallaron
  – Application: Ground modeling project in Civil Engineering
Profile #2: Rob Miller

- **Life History**
  - S.B. and M.Eng 1995, MIT
  - Ph.D. 2002, CMU
  - Now on faculty at MIT

- **Research**
  - Combines programmable architectures, machine learning, and effective visualizations and interaction techniques to produce powerful, usable user interfaces

- **Research Style**
  - Produce new style of user interface
  - Evaluate with user studies
Profile #3: Monica Lam

- **Life History**
  - B.S. Univ. of British Columbia, 1980
  - CMU PhD, 1987
  - Now Full Professor at Stanford

- **Research**
  - Compiler infrastructure for locality optimizations and interprocedural parallelization
  - Program analysis for finding bugs

- **Research Style**
  - Compilation techniques for improving the performance and reliability of programs
Living in Pittsburgh

- Big enough to be interesting
- Small enough to be livable
Lifestyle Issues

- **Housing**
  - Affordable housing within walking (and DSL) distance
    - Shadyside, Squirrel Hill
  - Some graduate students buy their own houses

- **Things to Do**
  - Interesting restaurants, places to go
    - Shadyside, Strip District, South Side
  - Good cultural activities
    - Museums, Symphony, Renaissance & Baroque, Dance
  - Easy reach of outdoor recreation
    - Biking, hiking, skiing, white water

- **Advice**
  - Talk to current students. You’ll find they like the academic and social environment
Why You Should Get a Ph.D. at CMU

• Breadth of opportunities
  – Interpret “Computer Science” in the broadest terms
  – World class research in many disciplines

• Unique environment
  – Close student/advisor relationship
  – Collaboration and breadth are encouraged
  – Funding issues are not a concern for students
Distinguishing Characteristic of Our Environment

- **Reasonable Person Principle**
  - Assume that others around you are competent and reasonable
    - Smart
    - Ethical
    - Concerned for welfare of others and of organization
  - You are obligated to be reasonable as well
Some Questions You Should Ask

- **Programmatic**
  - What steps must I take before I qualify as a Ph.D. student?

- **Financial**
  - What happens when my first-year fellowship runs out?
  - What happens if my advisor’s research contract gets cancelled?

- **Research**
  - How often do advisors typically meet with students?
  - What is the student/advisor ratio?
  - Is it common to work with students from different areas and having different advisors?
Resources: Reading Material

- The Ph.D. Document
- The Faculty Research Guide
- Web pages
  - SCS  http://www.cs.cmu.edu/scs/scs.html
  - CSD  http://www.cs.cmu.edu/csd/csd.html
  - PhD  http://www.cs.cmu.edu/csd/phd.html
Resources: People

- Sharon Burks
  - Associate Department Head
  - sharon.burks@cs.cmu.edu

- Frank Pfenning
  - Director of Graduate Programs, CSD
  - fp@cs.cmu.edu

- Jeannette Wing
  - Department Head, CSD
  - wing@cs.cmu.edu

- Randy Bryant
  - Dean, SCS
  - randy.bryant@cs.cmu.edu

- Martha Clarke
  - Graduate Admissions

- All students and other faculty and staff