Lecture 1: Introduction to Research

Basic Concepts

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Introduction to Research

This Class

- Mandatory: All Graduate students
- Learn about all research going on in the Department
- One faculty member per week
- We start with some basics
  - That I wish I knew
- Opportunity to learn about new results
- Opportunity to think of new ideas
- Opportunity to find a research advisor if you're looking
- Opportunity to meet other graduate students
- Welcome to the Computer Science Department (Graduate School)

What is Research

- Knowledge
  - Experience, tradition, authority
  - Deductive reasoning, mathematics, assumption to conclusion
  - Inductive reasoning, measurement, generalization
- Scientific method
  - Inductive reasoning
  - Hypothesis testing
  - Rigorous logging, analysis
  - Formal design, detailed execution

What is Computer Science

- Computer Science is quite new
- Roots in Logic and Mathematics (deductive)
- ...but also electrical engineering, physics (inductive)
- ...and technology, artifact design and development (creative, inductive)
- Research is not just the development of new knowledge
- We do not study a pre-existing universe
- Development-technology-evaluation cycle

What is Computer Science

- *"the systematic study of algorithmic processes that describe and transform information: their theory, analysis, design, efficiency, implementation, and application" (ACM 1989)*
- "the study of phenomena related to computers" (Newell, Perlis and Simon, 1967)
- *"the study of information structures" (ACM Curriculum, 1968)*
- "the study and management of complexity" (Dijkstra, 1969)
- *"the mechanization of abstraction" (Aho and Ullman, 1992)*

- Informatics, Computer Science

What is Computer Science Research

- Understand and discover properties of computation
- Design and build computer systems
- Understand and evaluate computer systems

- Scientific research: a process performed by a community
- Same for computer science
- People perform research
- Community effort

New knowledge in science

- Understand current knowledge, observations
- Formulate new hypothesis
- Test hypothesis, study evidence
  - Convince yourself
- Communicate findings
  - Peer review system
  - Convince community
- New knowledge: community knowledge

What are Papers

- Document describing results
- Teaches something new
- Contains evidence, to convince
- Communication tool

- In Computer Science
- Solves Problem
- System Design
- System Properties
- New Understanding
- (Relevant)

What are Conferences

- Scientific conferences: venues for communication
- Submit paper, review, publication
- Tools for building community knowledge
- In Computer Science: venues of dissemination, review
- Different than other fields (ad hoc)

What are Journals

- Older fields
- Communication by correspondence
- Regular publication cycles, no physical presence
- In Computer Science: room for more information
- Details, thorough review, multiple interactions

What are Technical Reports

- Libraries, Universities
- Timestamp
- More details, supporting information
- Failed attempts!

What is arxiv (and similar)

- Technical Report system based on Network of Libraries
- Old structure
- Online Repositories for Technical Reports
- Faster dissemination, Indexing
- Community feedback, relaxed review structure
- Complements rigid reviewing in Journals, even Conferences

What is ACM and IEEE

- Professional Associations
- Not just publishers
- Community knowledge
- Tools: libraries, conferences, journals, processes
- Accreditation!
  - https://www.sigplan.org/Resources/EmpiricalEvaluation/
  - https://www.acm.org/publications/policies/artifact-review-badging

Conference rankings

- Not all conferences and journals are equal
- Quality, competitiveness
- Community, target audience
- Authority
- First-tier: Everyone reads those
- Second-tier: Special interests, smaller targeted fields
- Third-tier: work in progress, early feedback, active communication
- Predatory!

Bibliographic Indexes

- Publication count
- Citation count
- h-index
  - At least N publications
  - At least N citations per publication
- h5-Index
  - In the last 5 years
- Impact Factor
  - Yearly average number of citations for recent articles
  - Journal Ranking
  - Conference Ranking
  - Per year calculation
- Erdős Number

Indexers, Rankings, Search Engines

- ACM: https://dl.acm.org
- IEEE: https://ieeexplore.ieee.org
- DBLP: https://dblp.org
- Web of Science: http://www.webofknowledge.com/
- Scopus: https://www.scopus.com
- Google Scholar: https://scholar.google.com
- Microsoft Academic: https://academic.microsoft.com

How to read a paper

- Read always as if reviewing
- Critical reading
- Are you convinced?
- What can you learn?
- Process, restate, summarize, note
- If you do it right, you get ideas and get distracted
  - That is good!
  - Note them down, refocus
  - That's why papers have margins
- http://www.cs.jhu.edu/%7Ejason/advice/how-to-read-a-paper.html
- http://www.eecs.harvard.edu/%7Emichaelm/postscripts/ReadPaper.pdf
- http://www.cs.columbia.edu/%7Ehgs/netbib/efficientReading.pdf

How to write a paper

- Keep in mind what you are trying to accomplish
- Teach something new
- Community knowledge
- Critical readers
- Technical Text != Work of Literature
- Become better reviewer, Become better author
- *This is not an exam!*
- https://www.microsoft.com/en-us/research/academic-program/write-great-research-paper/
- http://jmlr.csail.mit.edu/reviewing-papers/knuth_mathematical_writing.pdf

Areas of Computer Science

- ACM Special Interest Groups: https://www.acm.org/special-interest-groups/sigs-by-knowledge-area
- According to ACM/IEEE Curricula Guides: https://ieeecs-media.computer.org/assets/pdf/CS2013-final-report.pdf
  - AL - Algorithms and Complexity
  - AR - Architecture and Organization
  - CN - Computational Science
  - DS - Discrete Structures
  - GV - Graphics and Visualization
  - HCI - Human-Computer Interaction
  - IAS - Information Assurance and Security
  - IM - Information Management
  - IS - Intelligent Systems
  - NC - Networking and Communications
  - OS - Operating Systems
  - PBD - Platform-based Development
  - PD - Parallel and Distributed Computing
  - PL - Programming Languages
  - SDF - Software Development Fundamentals
  - SE - Software Engineering
  - SF - Systems Fundamentals
  - SP - Social Issues and Professional Practice

And some advice

- Keep the goal in mind
- Always know why you are doing something
- Use the classes, advisors, seminars, conferences
- Time management: planning, accept "good enough", understand trade-offs
- Communicate problems
- Sleep