How to Get Into Graduate School in the USA: A Lecture and Workshop

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October 21, 2008

Acknowledgments

- **Phil Agre, UCLA**
  Advice for Undergraduates Considering Graduate School
  http://polaris.gseis.ucla.edu/pagre/grad-school.html

- **William B. Thompson, University of Utah**
  Applying to Graduate School in Computer Science
  http://www.cs.utah.edu/~thompson/Graduate_School_in_CS.html

Autonomous Vehicle Navigation

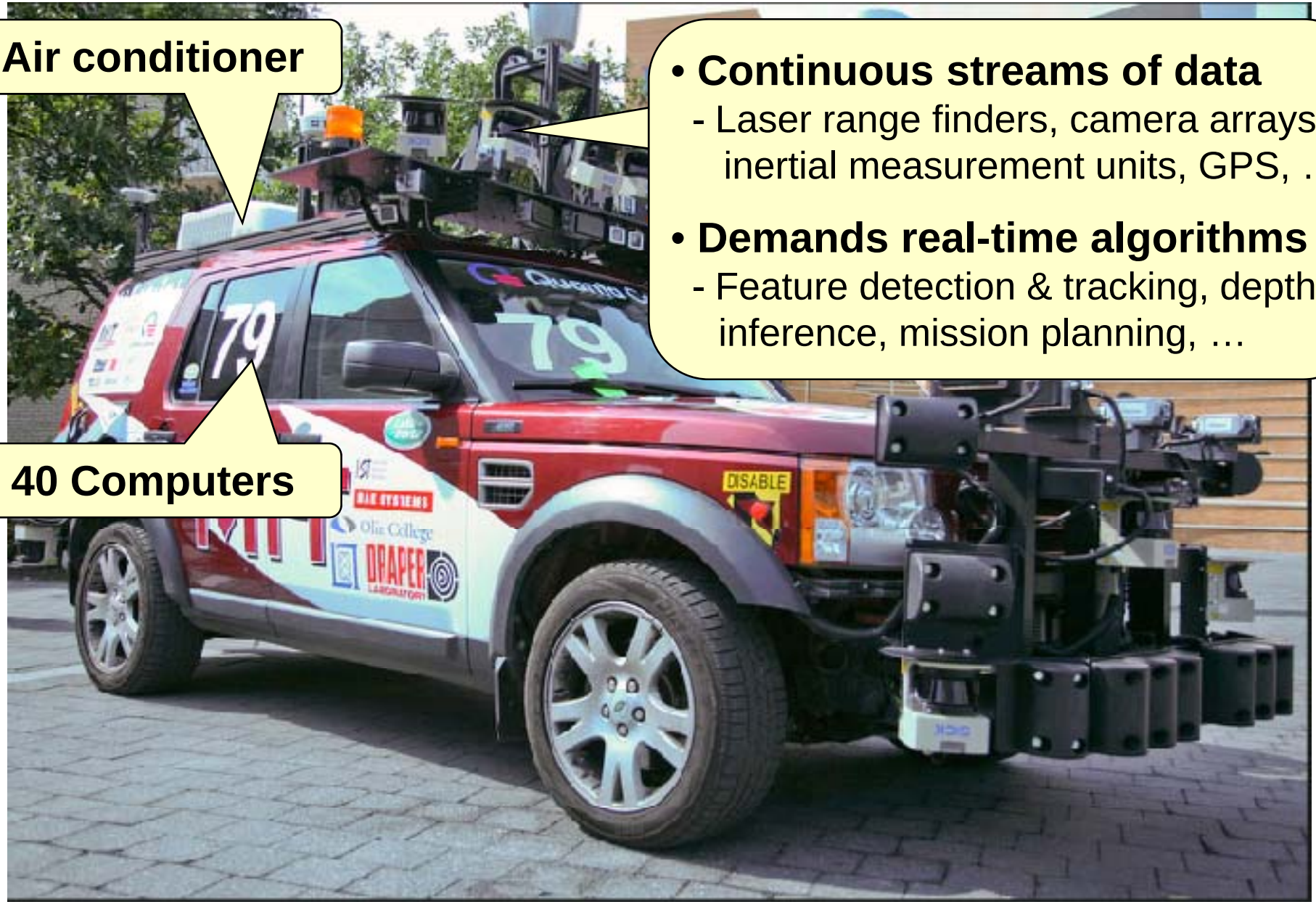
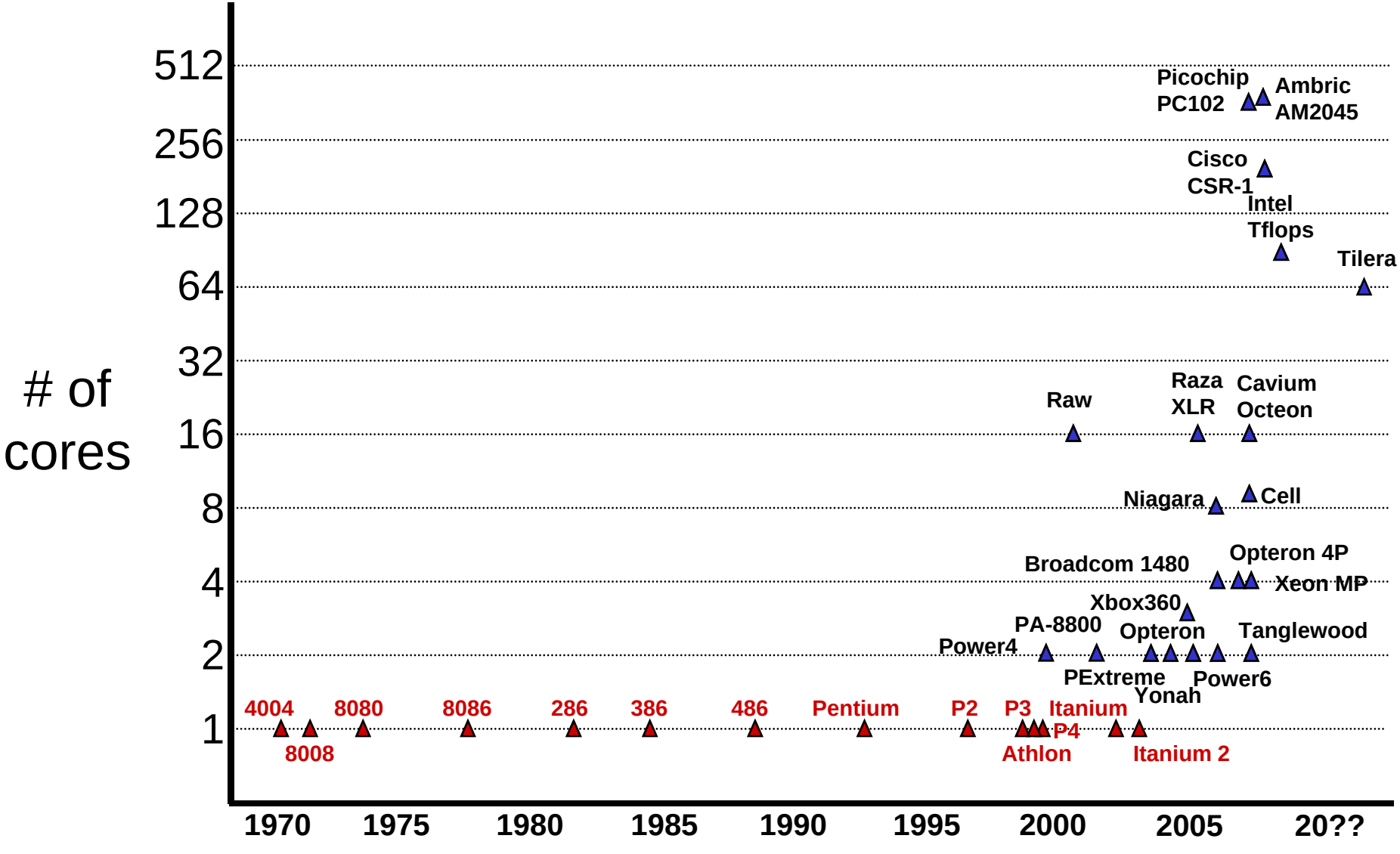


Photo compliments of the MIT DARPA Grand Challenge Team, http://grandchallenge.mit.edu/

The Multicore Revolution



The Multicore Revolution

Hardware was responsible for improving performance

# of cores

512
256
128
64
32
16
8
4
2
1

1970 1975 1980 1985 1990 1995 2000 2005 20??

4004 8008 8080 8086 286 386 486 Pentium P2 P3 P4 Athlon Itanium Itanium 2

Picochip PC102
Ambric AM2045
Cisco CSR-1
Intel Tflops
Tilera
Raw
Raza XLR
Cavium Octeon
Niagara
Cell
Broadcom 1480
Opteron 4P
Xeon MP
Xbox360
PA-8800
Opteron
Tanglewood
Power4
PExtreme
Yonah
Power6

The Multicore Revolution

Now, performance burden falls on programmers

# of cores

512
256
128
64
32
16
8
4
2
1

4004
8008
8080
8086
286
386
486
Pentium
P2
P3
Itanium
P4
Athlon
Itanium 2
Picochip PC102
Ambric AM2045
Cisco CSR-1
Intel Tflops
Tilera
Raw
Raza XLR
Cavium Octeon
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Broadcom 1480
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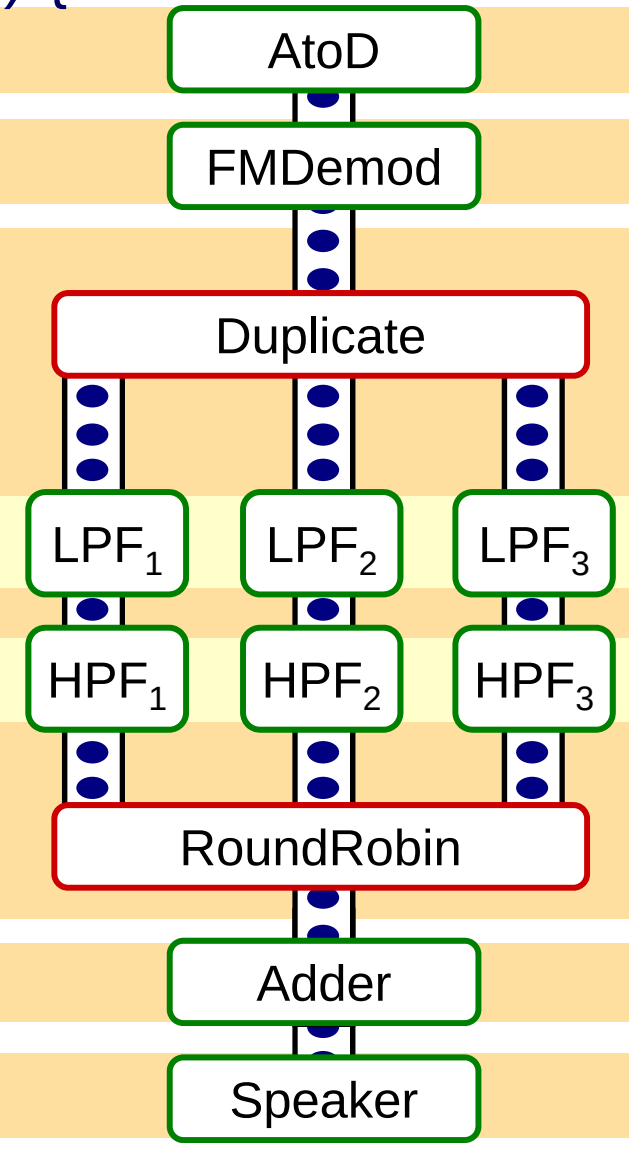
Yonah

1970
1975
1980
1985
1990
1995
2000
2005
20??

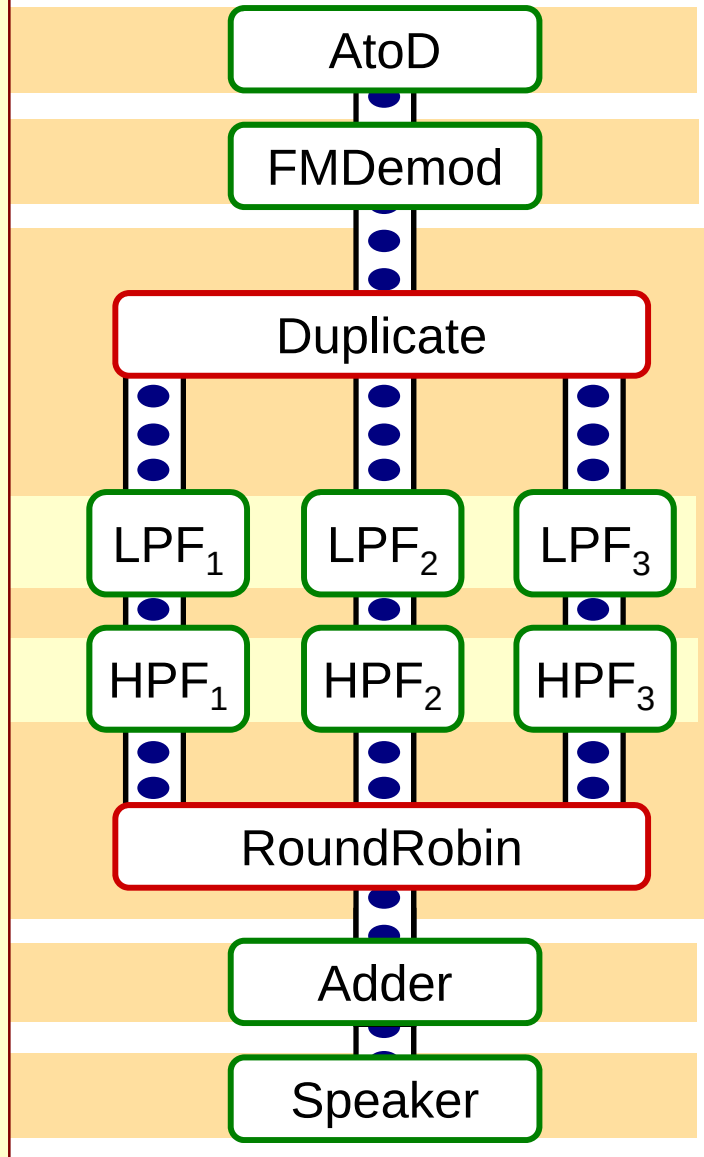
The StreamIt Language

```
void->void pipeline FMRadio(int N, float lo, float hi) {
  add AtoD();
  add FMDemod();
  add splitjoin {
    split duplicate;
    for (int i=0; i<N; i++) {
      add pipeline {
        add LowPassFilter(lo + i*(hi - lo)/N);
        add HighPassFilter(lo + i*(hi - lo)/N);
      }
    }
    join roundrobin();
  }
  add Adder();
  add Speaker();
}
```



The StreamIt Language

- **Applications**
  - DES and Serpent [PLDI 05]
  - MPEG-2 [IPDPS 06]
  - SAR, DSP benchmarks, JPEG, …
- **Programmability**
  - StreamIt Language (CC 02)
  - Teleport Messaging (PPOPP 05)
  - Programming Environment in Eclipse (P-PHEC 05)
- **Domain Specific Optimizations**
  - Linear Analysis and Optimization (PLDI 03)
  - Optimizations for bit streaming (PLDI 05)
  - Linear State Space Analysis (CASES 05)
- **Automatic Parallelization for Multicores**
  - Compiling for Communication-Exposed Architectures (ASPLOS 02 & 06, dasCMP 07)
  - Phased Scheduling (LCTES 03)
  - Cache Aware Optimization (LCTES 05)
  - Load-Balanced Rendering (Graphics Hardware 05)
- **Migrating Legacy Code to a Stream Representation**
  - Using a Dynamic Analysis (MICRO 07)



What is “Graduate School”?

- **People use the term to refer to different things:**
  - *Professional school*, such as law, medicine, education, etc.
  - *Master’s programs*, where the highest degree is an M.S.
  - *Doctoral programs*, where the highest degree is a Ph.D.
- **In this talk, we focus on doctoral programs**
- **However, in almost all doctoral programs, one obtains a Master’s degree en route to the Ph.D.**
  - Even if you think you might stop with a M.S., it is likely cheaper and higher quality to enroll in a Ph.D. program

Why Enter a Doctoral Program?

- **Because you want to do *research***
  - The primary goal of doctoral programs is to train researchers
  - You want to pursue scholarly subjects in great depth
  - You want to make fundamental contributions to a field
- **Because you want to *teach* at the college level**
  - A Ph.D. is required to be a professor at most universities
- **Reasons NOT to go to graduate school:**
  - You enjoy taking courses
  - You are in a hurry to get a real job
  - You are trying to improve your salary

Median salary amongst engineers (1999):	
Ph.D.	$93,000
M.S.	$74,000
B.S.	$67,000

Note:
A Master's degree may be a good financial investment

Graduate Student Lifestyle

- **Graduate school provides a very attractive lifestyle**
- **You have a large amount of freedom while in school**
  - Unlike classes, you can approach research at your own pace
  - You can usually work whatever hours are best for you
  - You can often work from home
  - Your vacation days are extremely flexible
  - You can work on projects not directly related to your degree
- **There is an extremely supportive community of peers and mentors**
  - Your fellow students share your background and interests
  - A good thesis advisor also serves as an all-around life coach
- **There is built-in support for international students**
- **If you publish papers, there are travel opportunities**
  - For me: India, Sri Lanka, South Korea, Hong Kong, France, Singapore, and >20 locations in the United States

Lifestyle Following Graduation

- **A research career often maintains much of the freedom of graduate school**
- **Compared to engineers with a B.S., those with a Ph.D.:**
  - Have more responsibility in group projects
  - Have more control over the direction of their work
  - Work on more open-ended problems
  - Are respected in the academic community
- **Any job that is available to you with a B.S. is also available with a Ph.D.**
  - There is nothing to lose (besides time, money) in grad. school
- **Graduate school also provides a unique platform for launching startup companies**
  - Companies like Google, Yahoo founded by grad. students

Paying for Graduate School

- **Good doctoral programs are usually *free* for almost everyone who attends. How?**
  1. Research assistanceship (RA)
  2. Teaching assistanceship (TA)
  3. Fellowship
- **If you apply to a Master's program rather than a Ph.D. program, it may be very expensive**
  - This is one reason to apply to Ph.D. programs

What is Required in a Ph.D. Program?

- **Class work**
- **Qualifying exams**
- **Master's thesis**
- **Research, research, and more research…**
- **Teaching assistanceship**
- **Ph.D. thesis**

What is Research?

- **Research is the process of creating new knowledge**
- **As opposed to product development, you focus on:**
  - Understanding the fundamentals
  - Developing the most general theory, framework, or approach
  - Exploring high-risk, high-reward ideas
  - Looking ahead 10 to 20 years, rather than 3-5 years
  - Publishing all results in open, peer-reviewed venues
- **In academia, research is often associated with:**
  - Working on whatever interests you most
  - Focusing on aesthetics, beauty, and learning for the sake of learning, rather than only focusing on immediate applications

“If we knew what we were doing, it wouldn’t be called research”

- Albert Einstein

Examples of Research

(third-party slides omitted from the online version of this presentation)

How to Apply to Graduate School

- **Most schools require you to submit the following:**
  - GRE scores
  - TOEFL scores
  - Statement of Purpose
  - Grades Transcript
  - 3-4 letters of recommendation
  - Application fee
- **A Master's degree is NOT required to apply to a doctoral program!**

Application Timeline

- **Years in advance:**
  - Explore areas of interest
  - Develop relationships with professors who can write letters
- **By Nov 1, 2008:**
  - Take GRE and TOEFL
  - Identify schools of interest
  - Request recommendation letters from professors
- **By Dec 1, 2008: Prepare drafts of applications**
- **In Dec 2008 / Jan 2009: Submit applications**
- **In March 2009 / April 2009: Receive notifications**
- **In April 2009: Possibly visit schools of interest**
- **In September 2009: Start graduate school!**

Where to Apply

- **Factors to consider**
  - Ranking of program, versus strength of your application
  - Location
  - Size
  - Specific research groups and labs that interest you
- **Identifying an advisor**
  - Eventually, your relationship with your thesis advisor will likely be the most important aspect of graduate school
  - While difficult to assess from afar, you can identify people of interest by reading journals, conferences, and web sites
- **Sources of information:**
  - U.S. News ranking of graduate schools
  - CRA Foresythe List
  - National Research Council

Rankings I Will Share with You (U.S. News)

- **Chemical Engineering**
- **Civil Engineering**
- **Computer Science**
- **Electrical Engineering**
- **Engineering (Overall)**
- **Industrial Engineering**
- **Materials Engineering**
- **Mathematics**
- **Mechanical Engineering**
- **Nuclear Engineering**

How to Get Accepted

- **If possible, the *best thing you can do* is to perform research as an undergraduate and to publish it**
  - Graduate schools are making a big investment when they accept you. If they know you are capable of research, and that you enjoy it, then they are much more likely to take you.
  - If you can publish your research, the venue provides a national or international measure of your quality as a candidate
    - Google “CS Conference Ranking” for best CS conferences
- **How to perform research?**
  - Ask faculty members if you can assist them with research
  - Continue class projects in new and interesting directions after the class has ended
  - Read journal and conference papers and look for open problems that you can pursue as an independent project

How to Get Accepted (II): Letters of Recommendation

- **Letters of reference are extremely important**
- **It is important to start developing your relationship with your letter writers as soon as possible – possibly years in advance!**
  - Try to get involved as a research assistant
  - Ask questions in class
  - Pursue projects outside of class
  - Take leadership in academic and extracurricular activities
- **When requesting a letter, give as much information as possible**
  - Provide the letter writer with your complete application
  - Possibly draft a few paragraphs describing your strengths and highlighting the outstanding parts of your application

How to Get Accepted (III): Statement of Purpose

- **Graduate schools require a "statement of purpose"**
- **This statement is intended to ascertain:**
  - Your interest in a research career
  - Your prior research experience
  - Your understanding of a viable research question
- **The statement will be read by experts in your field**
  - It is worthwhile to read some conference and journal papers to understand the terminology used
  - Upon entering graduate school, you will not be required to pursue the directions proposed in this statement. Write something that is as scholarly and interesting as possible.
- **Ask professors for feedback, and revise several times**
- **I will send out several samples from MIT grad. students**

How to Get Accepted (IV): Targeting Specific Schools

- **Many applicants write form letters to professors at schools they are applying to**
  - This does NOT help! It is likely to annoy professors.
- **However, it can sometimes be helpful to contact professors with feedback on their research**
  - Example: ***carefully*** read the latest paper from a professor's research group, and send the author your thoughts and comments
    - Aim for creative and constructive feedback
    - Try to think of things the researchers might have missed
  - If the researcher replies, you can later mention that you are applying for graduate school and would be interested in discussing further
  - If you make an excellent impression, this could possibly influence admission (if the professor is on the committee)

Working Session

- **The rest of this session will be in groups, and 1-on-1**
- **Goals:**
  - Get all questions answered about graduate school
  - Construct initial list of schools interested in applying to
- **We will move to the computer lab for Internet access**

Any Questions?