CS 492
Why Should You Do Research and a Thesis?

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Agenda

- External Recognition
- Career Opportunities
- the PhD
- Skills

Why? External Recognition

- Looks great on your CV/Resume
- You need it to graduate with the specialization!
- These are the **least important**
- They should not be your ***sole*** motivators

Star Student Syndrome

- Research is **not** about perfect grades, deans list, looking good on paper
- Though in many cases these things correlate

So Why Then?

- This is the door to *graduate school*, more specifically **PhD**
- *But why do a PhD?*

Perhaps You Want:

- Independence
- Flexibility
- Impact
- to work at the cutting edge
- Creative Outlet
- Deep Thinking
- Life-long Learning

Maybe Less Important to You

- $$$
- Building products
- Business issues, customers
- Regular 9-5 schedule
- Tasks being handed to you
- *Note*: these all have merits!

Careers in CS Research

- We'll have a whole lecture on this, but briefly
  - Research Scientist in **Industry**

Microsoft Research
IBM Research
intel labs
NOKIA Bell Labs
SRI International
facebook research
NVIDIA
Adobe
NEC Laboratories America
Relentless passion for innovation
Google Research
ORACLE for Research
CRAY RESEARCH, INC.
Mitsubishi Research Institute
vmware RESEARCH

Careers in CS Research

- We'll have a whole lecture on this, but briefly
  - Research Scientist in **Gov't**

OAK RIDGE National Laboratory

Pacific Northwest NATIONAL LABORATORY

BROOKHAVEN NATIONAL LABORATORY

Sandia National Laboratories

Argonne NATIONAL LABORATORY

Fermilab

Lawrence Livermore National Laboratory

BERKELEY LAB
Bringing Science Solutions to the World

Los Alamos NATIONAL LABORATORY EST. 1943

NIST National Institute of Standards and Technology U.S. Department of Commerce

NATIONAL SECURITY AGENCY UNITED STATES OF AMERICA

NASA

U.S. DEPARTMENT OF ENERGY
Office of Science

NSF

NERSC

TACC TEXAS ADVANCED COMPUTING CENTER

SDSC SAN DIEGO SUPERCOMPUTER CENTER

DEPARTMENT OF DEFENSE UNITED STATES OF AMERICA

CENTRAL INTELLIGENCE AGENCY UNITED STATES OF AMERICA

DEVCOM ARMY RESEARCH LABORATORY

NREL NATIONAL RENEWABLE ENERGY LABORATORY

ILLINOIS INSTITUTE OF TECHNOLOGY

Careers in CS Research

- We'll have a whole lecture on this, but briefly
  - Research Scientist at a **Startup**

Careers in CS Research

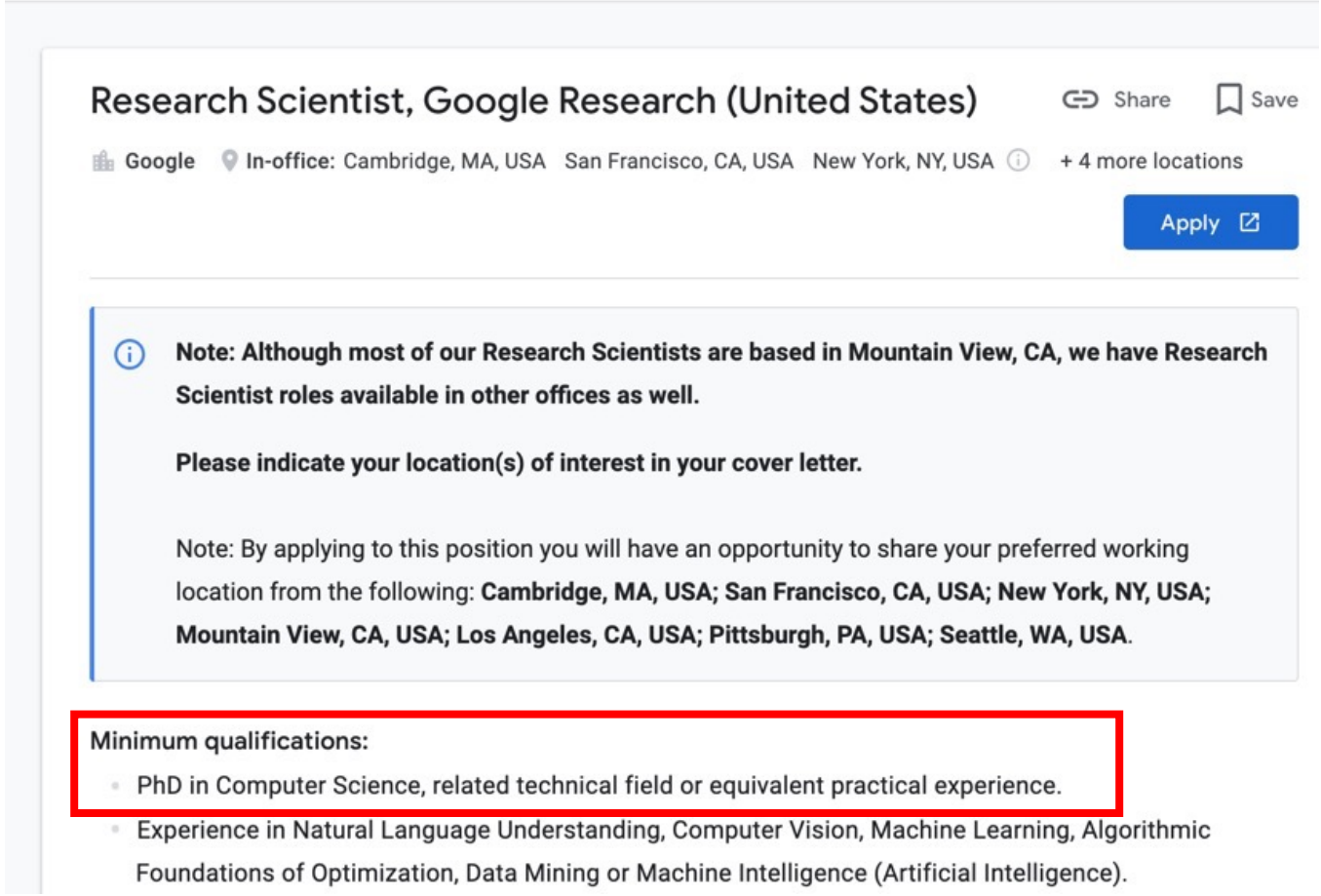
- We'll have a whole lecture on this, but briefly
  - **Academia**: research + teaching

Careers in CS Research

- The Computing Research Association (CRA) is a great resource for understanding jobs in CS research
- For example, they maintain a list of labs that do CS research: https://cra.org/cra-wp/research-labs/
- Also stats on PhDs and research jobs

Careers in CS Research

- We'll have a whole lecture on this, but briefly
  - **These all require a PhD!**



Research Scientist, Google Research (United States)

Share Save

Google In-office: Cambridge, MA, USA San Francisco, CA, USA New York, NY, USA + 4 more locations

Apply

Note: Although most of our Research Scientists are based in Mountain View, CA, we have Research Scientist roles available in other offices as well.

Please indicate your location(s) of interest in your cover letter.

Note: By applying to this position you will have an opportunity to share your preferred working location from the following: **Cambridge, MA, USA; San Francisco, CA, USA; New York, NY, USA; Mountain View, CA, USA; Los Angeles, CA, USA; Pittsburgh, PA, USA; Seattle, WA, USA**.

Minimum qualifications:

- PhD in Computer Science, related technical field or equivalent practical experience.
- Experience in Natural Language Understanding, Computer Vision, Machine Learning, Algorithmic Foundations of Optimization, Data Mining or Machine Intelligence (Artificial Intelligence).

Sounds Good? Now what?

- If you *think* you want to pursue a research career, you should **try it out** before committing
- Competitive PhD programs are looking for research experience:
- For you that means you want to have accomplished something by middle of your final year!
  - So get started early!

Start Now

- Sit in the front of your classes and get to know your profs
- Talk to them about their research (office hours, after class)
  - Don’t be shy/afraid. They love doing this, even if they’re busy
- Start a research project early (talk to profs about your background and skills)
- Read papers, we’ll help you here (also see https://blog.acolyer.org/)

How do you get a leg up for PhD Apps?

- We'll have a whole lecture on this, but roughly in order
  - **Optimal**: You are first author on a good paper at a top venue and you have effusive recommendation letters from your profs. *This will get you in the door at the top schools (MIT, CMU, Stanford, UCBerkeley, etc)*
  - Next best thing: You are on the author list for ^
  - Next best thing: You are on the author list for a paper published *somewhere*, e.g. lesser conference or workshop paper
  - **Insufficient**: perfect grades

Research is a Deeply Formative Process

- Even if you don't end up doing research as a career, the skills are extremely valuable!

Skills You'll (need to) Develop

- Independent and creative thinking
- Time management
- Learning quickly and independently
- Digesting others' research and reading technical material (especially papers)
- Clear and accurate writing
- Clear communication and presentation
- Experiment design, engineering, math, statistics, modeling, measurement
- (CS) a lot of programming and scripting
- Clearly presenting and interpreting data

Independent Work

- You're used to structured classes:
  - Professors give you work to do, you do it
  - Answers to problems are typically known
- Research courses (491, 497) require independence:
  - You'll have to learn on your own (but prof will guide you)
  - How much you see your prof depends on you and the prof
  - You'll manage your own time
  - The answer won't be known! This can be scary…

Technical Skills

- You'll likely be working on or developing real codebases

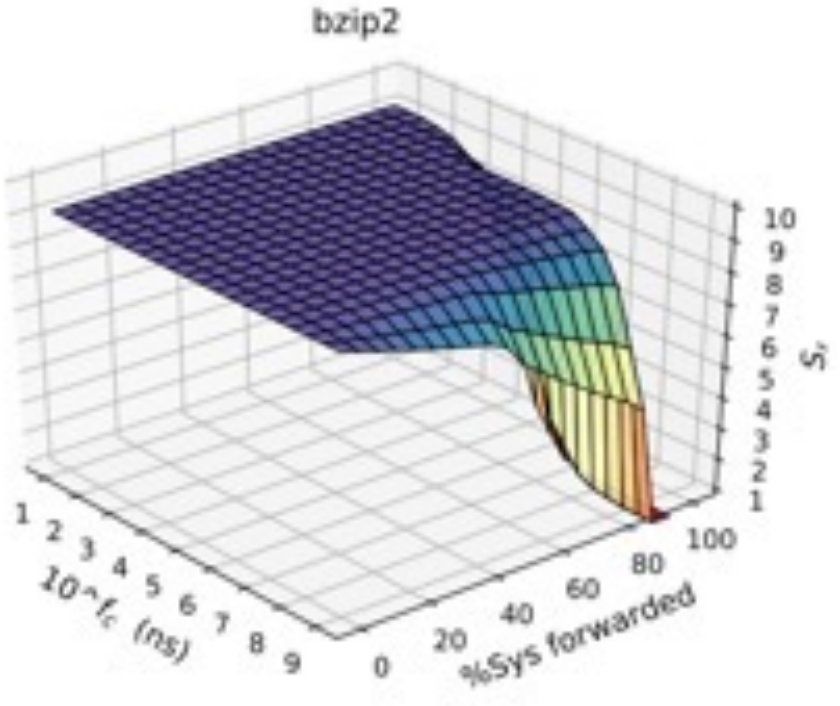
Our research OS has
involved contributions from *many* undergraduates!

Nautilus is the first example of an *AeroKernel* that is available for public use and development. AeroKernels are extermely lightweight OS kernels that are intended to support the Hybrid Runtime (HRT) model, in which a parallel runtime enjoys full access to the entire machine. An AeroKernel like Nautilus provides a minimal set of functionality to the runtime. Nautilus currently runs on modern x64 HPC-class hardware and on the Intel Xeon Phi accelerator. Some features of Nautilus include the following:

- Support for large-scale, many-core architectures
- NUMA-aware memory subsystem
- Multiboot2 compliant
- Minimal ACPI and SFI support
- Fast, lightweight synchronization and threading facilities (see the publications below)
- Configurable to run in x64, Xeon Phi (KNC/KNL), and HVM/HRT environments
- An extremely light-weight event subsystem called *Nemo*

Technical Skills

- You'll learn how to design experiments and interpret results
- and make pretty graphs too!



Technical Skills

- Writing papers (and using typesetting software, i.e. LaTeX)

IIT undergrads!

Isolating Functions at the Hardware Limit with Virtines

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Abstract

An important class of applications benefit from isolating the execution of untrusted code at the granularity of individual functions or function invocations. However, existing isolation mechanisms were not designed for this use case; rather, they have been adapted to it. We introduce *virtines*, a new abstraction designed specifically for function granularity isolation, and describe how we build virtines from the ground up by pushing hardware virtualization to its limits. Virtines

however, were not designed for individual functions. Applications that leverage this isolation model must resort to repurposing off-the-shelf mechanisms with mismatched design goals to suit their needs. For example, databases limit UDFs to run in a managed language like Java or Javascript [21, 46], and serverless platforms repurpose containers to isolate users' stateless function invocations from one another. The latter example is particularly salient today. As others have shown at this venue, the challenges[1] that arise from using the container

Technical Skills

- Reading research literature
- Cutting edge material ain't in your textbooks!
- Paper reading is important even in non-research industry ("tech transfer")
- Real problems often solved with solutions published many years before in a paper…
- **Reading papers takes a lot of practice**

Technical Skills

- ***Finding* papers is just important as reading them**
- What keywords to use?
- Is a Google search sufficient? (often, no)
- Chasing the citation chain
- Google Scholar, ACM DL, IEEE Xplore
- Asking around

Technical Skills

- Presenting your research
- 5 min elevator
- 30min beer chat
- 1 hour talk
- Paper
- Must learn to navigate different levels of abstraction
- Confidence comes from practice, practice, practice

Technical(?) Skills

- You will learn to manage your ego:
  - Probably won't be smartest person in the room
  - You could be wrong (and so can anyone else)
  - Asking questions and probing is important
- Seek out and accept criticism (criticism is part of the process)
- Be open-minded, stop taking things for granted

It's fun!

- I get paid to think about and build cool stuff
- Research allows you to explore ideas *you* think are cool
- You get to contribute to human knowledge
- Maybe make a positive impact on peoples' lives