

# The Ph.D. in CS: Getting There and Being Successful



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Computing Research Association  
Education

# What is a Ph.D. in CS and Why Should I Consider It?



## Increase Knowledge & Hone Research Skills

Study advanced topics, increase your CS knowledge & be trained to be a successful researcher



## Advance the State-of-the-Art

Learn about and contribute to cutting edge CS research



## Pursue Your Interests

Opportunity to pursue your own professional and intellectual interests in CS

# More Great Reasons to Pursue a Ph.D

## Gain Opportunities to Teach and Mentor

Pursuing a Ph.D. provides you with a unique opportunity to teach and mentor

## Satisfy Your Intellectual Curiosity

- *Discover new things*
- *Develop creative solutions*
- *Identify new problems*
- *Push the boundary of knowledge*
- *Develop a habit of lifelong learning*



## Get Paid to Learn!

Many students don't realize that most C.S. Ph.D programs pay a comfortable stipend! Get paid to learn and increase your career earning potential!

# The C.S. Doctorate (Ph.D) in a Nutshell



## Timeline

- Typically 5-6 years from Bachelor's
- Depending on school, starting with a Master's degree may shorten timeline



## Coursework

- Typically “next level” CS foundations and (more) advanced electives



## Research

- Dissertation (aka Doctoral Thesis)
- Oral/Written Exam along the way (e.g., qualifying exam)



## Tuition & Stipend (Get paid to learn!)

- Generally *tuition is waived* and you typically receive *a stipend and health insurance* from a teaching or research assistantship or fellowship



## Career Paths

- Academia (e.g., a professor)
- Industrial, NPO, or government researcher or engineer
- Entrepreneur (e.g., a start-up)
- Higher-level development/leadership positions

# Typical Timeline for Ph.D. Degree

Foundational coursework to prepare for research. Join a lab with advisor & initial project.



Obtain preliminary results and publish papers. Formulate PhD research plan. Identify PhD committee. Begin writing proposal.



Continue to publish. Write & defend dissertation. Prepare and interview for next job.

**Year 1**

**Year 2**

**Year 3**

**Year 4**

**Years 5-6**



Complete a majority of your coursework. Take qualifying exam. Identify research area. Potentially earn Master's degree "along the way".



Complete and defend PhD proposal. Continue with research and publishing your results. Identify your future career path.



# How a Ph.D. differs from an M.S. Degree

## Academic Master's Program

3-4 courses/term in first year.  
1-2 courses/term with a research and MS thesis or project in second year.  
Typically not funded, but there is the potential serve as a teaching assistant.

## Professional Master's Program

3-4 courses/term for 1.5- 2 years.  
Geared towards industrial careers.  
Typically not funded by the school, but could be funded by a company you work for.



## Doctoral Program

Similar to Academic Master's in the first 2 years. In years 3-5, primarily research.  
May serve as a teaching assistant, usually only for a few terms, then research assistant.

# Presentation Roadmap

**Preparing a Strong Application**

**Making a Smooth Transition**

**The First Few Years**

**The Research Apprenticeship**

**Preparing for After Graduation**



# Preparing a Strong Application for Ph.D. Admission

*How to set yourself up for success, and make yourself an attractive applicant*



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# General Preparation During Your Undergrad Years



## Choose Courses Carefully

Take challenging courses (maybe even grad classes) and get broad foundations.



## Seek Support to Excel in Class

Performance in advanced courses is important. Set yourself up for success by working hard and seeking support when you need it.



## Get Involved in Research

Undergraduate research is typically expected by admissions committees. Find a faculty member and ask to work with them.



## Know Your Professors

Get to know your professors. Talk to them about your plans and interests. Build a relationship!

# What Graduate Schools are Looking For...

**Prior Research  
Experience,  
Publications**

**Potential for  
Becoming a  
Leader in the  
Field**



**Evidence of being  
Creative,  
Hardworking, &  
Persistent**

**Your Academic  
Choices and  
Performance**

# The Four Major Application Components

**Personal  
Statement(s)**

**Undergraduate  
Transcripts**



**Letters of  
Recommendation**

**GRE  
Test Scores  
(for now)**

# Writing an Effective Personal Statement

- Describe your prior research experience
- Describe your future research interests
- Demonstrate that you have ideas for interesting and important problems to study
- Make it personal or unique to you!
- Personalize your statement with at least one paragraph about why the department interests you
- Have at least one faculty member give you feedback

- More guidelines:
  - [Statement of Purpose Guidelines](#) (MIT)
  - [Writing the Statement of Purpose](#) (UC Berkeley)
  - [Statement of Purpose for Graduate School](#) (Princeton Review)

# Getting Strong Letters of Recommendation



## 3-4 Letters Typically Required

Have at least one letter from a faculty member with whom you did research. No letters from advisors or TAs. Limit letters from lower-level instructors.



## Make Each Letter Count

A letter that only says *"this student did well in my class"* is not very helpful.



## Letters from Other Disciplines

Sometimes it can be hard to find 3-4 CS professors who know you well. It's okay to have letters from faculty in other related technical fields ( e.g., EE, Math, etc.)



## Internship Supervisors

A letter from a supervisor during a summer internship is fine. However, the internship supervisor should have a PhD, and it is preferable if the internship is research focused

# Getting Strong Letters of Recommendation

For example...

*"I'm applying to graduate school. Would you feel comfortable writing a positive letter for me? If so, I'd be grateful. If you are not able to do this for any reason, I'll certainly understand."*



## Give Them a Way to Say "No"

Neutral letters will not have much impact. Make sure such writers can decline your request



## Helps to Have Built a Relationship

Provide a resume and a transcript when asking. Ask which other materials they would like to see (e.g., a statement of purpose).

Additional tips for requesting letters: <https://gradschool.cornell.edu/diversity-inclusion/recruitment/prospective-students/requesting-letters-of-recommendation/>

# GRE Exam & Scores



Check if GRE Scores are required by the institutions that you are applying to



Investigate the expected GRE score ranges, and the scores importance to the application



Prepare for the exam! Taking practice tests can help immensely



You can retake the exam if you feel you could do better. However, the previous scores will still appear on your application

## Resources:

- <https://www.princetonreview.com/grad/gre-information>
- <http://www.ets.org/gre>

# What if I Don't Have a CS Undergrad Degree?

- You can still apply, but demonstrate your technical knowledge, ability to do graduate level research and equivalent coursework
- Consider obtaining a research-focused MS degree first
- You may be able to take foundational courses in the first year to build background.
- The requirements depend on the school.
  - Make sure to check the admissions requirements for the schools you apply to



# Working Before Grad School: Pros & Cons

## Advantages

- Work can give a clearer picture of your interests, and research interests.
- Work can teach discipline and time management
- Graduate schools tend to value work experience; can make up for less-than-stellar grades
- Some employers will pay or provide time off for a professional Master's

## Disadvantages

- It can be difficult to go back to school with family and/or financial responsibilities
- Giving up a good salary can be tough
- Balancing part-time graduate school with a full time job can be challenging
- Getting recommendation letters from previous faculty can be tough

# What About Pursuing a Ph.D. Part-time?

- **Earning a Ph.D. part-time is uncommon**
  - This can be difficult as the research component of the PhD often requires full-time attention
- **This is somewhat common for Master's degrees**
  - Some employers will cover tuition costs if you continue to work full time
  - Typically, a full-time Master's will take about 2 years (part-time often 4 years).



# The Admissions Process

*How to decide where to apply and choose among your acceptances*



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# Typical Admissions Timeline

- Take challenging CS courses
- Prepare for and take the GRE
- Continue doing research

**Junior Year**



**Summer  
after Junior  
Year**



**Fall Senior  
Year**



**Spring  
Senior Year**

- Ask letter writers
- Give them Resume, Personal Statements & transcripts
- Finalize application materials and get feedback
- Submit applications

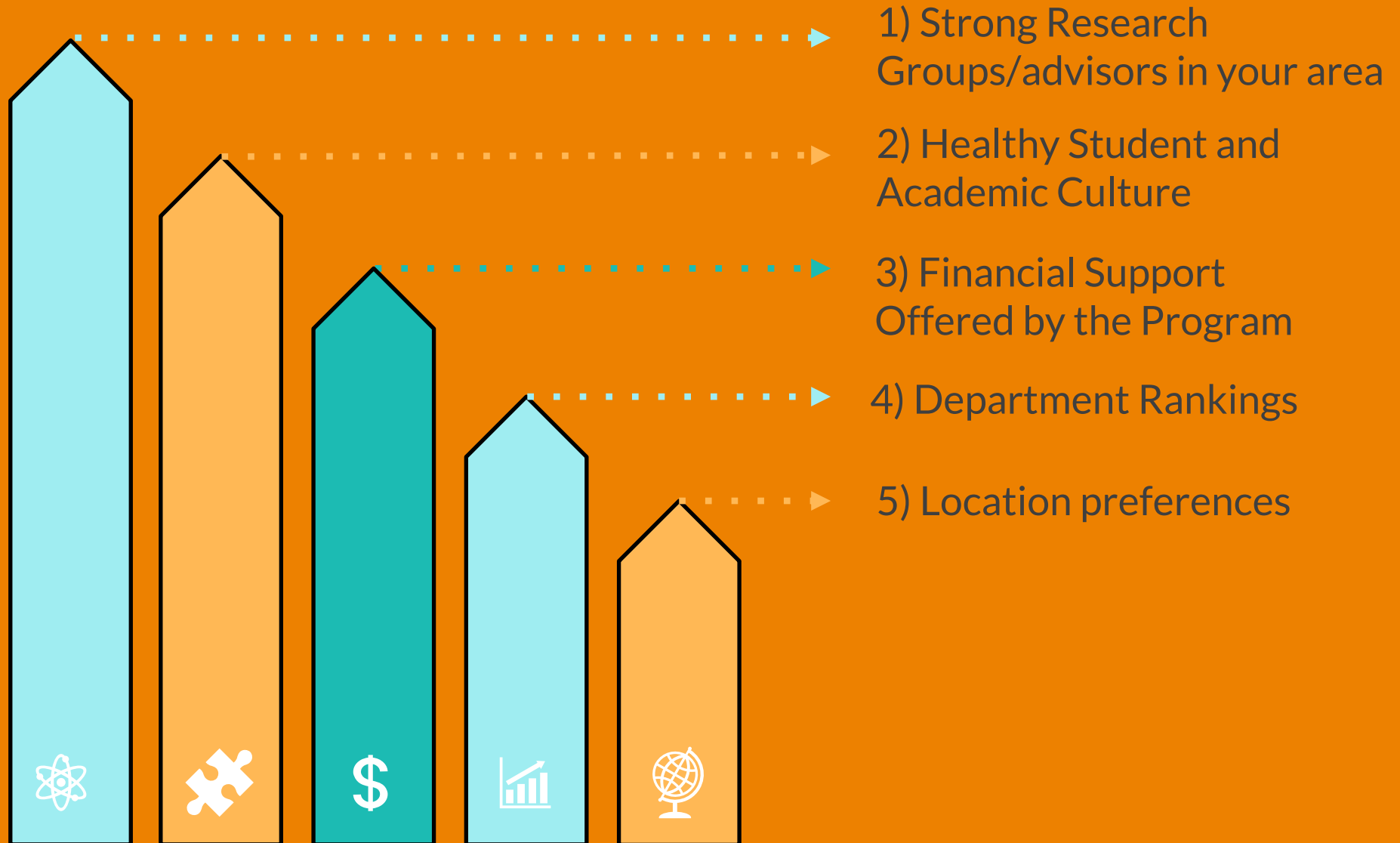


- Decide which schools to apply to
- Narrow down list of professors for recommendation letters
- Update your Resume
- Conduct Summer Research
- Draft Personal Statements



- Hear back from Schools
- Go on Campus visits
- Make a decision!

# Five Factors to Consider When Applying



# How many Applications to Submit?

## Minimum:

2 "Safe Schools", 3 "Good Matches", 3 "Slight Stretches"

- Most students are advised to apply to 8-12 schools, selected in communication with their advisor.
- The "top few" schools should be considered stretches in almost every case.
- *Talk to your Advisor and other faculty in your research areas of interest with whom you feel comfortable.*

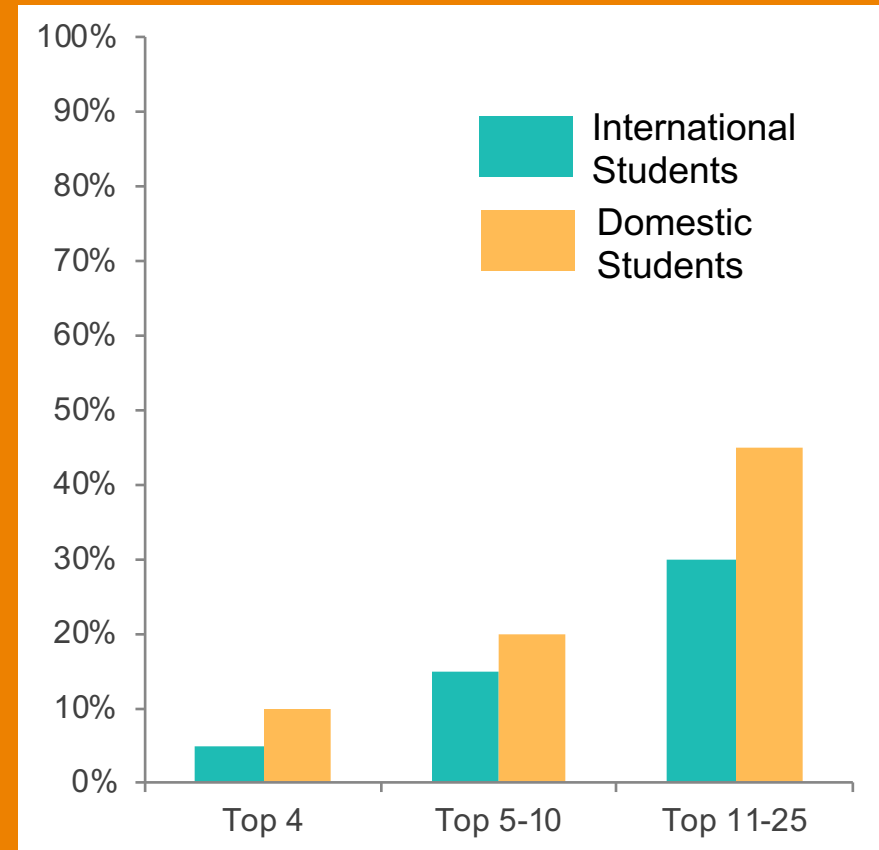
# What are Typical Acceptance Rates?

Only estimates on ranges exist

Type of School	Acceptance Rate
Top 4	5-10%
Top 5-10	15-20%
Top 11-25	30-45%

## Keep in Mind

- Ranges are based upon individuals with admissions experience
- Applicant pool is more self-selected than for undergrad admissions.
- Acceptance rates tend to be lower for international students
- Acceptance rates for professional master's programs are much higher








# Acceptances and Campus Visits (Winter/early Spring semester)

## Go on Campus Visits!

- Many schools invite accepted applicants for a campus visit.
- Make use of it (often free) and meet people and see the department!
- If/when you get too many visit invitations, prioritize based on your factors, ask your advisor for guidance

## Campus Visit Checklist

-  Book your accommodations through the university (if possible)
-  Set up meetings with faculty and staff. Meet with grad office staff.
-  Ask to meet with Ph.D. students
-  If you have special needs, meet with the appropriate campus office
-  Inform yourself about the department.



# On Choosing the Right Ph.D. Program for You

## Questions to Ask:



Are there a number of faculty in your desired research area?  
Are they taking on students?



How does funding work in the department? Are you supported the first year? Does the support come from faculty or the department?



What is the atmosphere like in the Department/Lab? Collaborative? Competitive?



Do you have to work with advisors who currently already have funding?



How frequently do students meet with their advisor?  
Are their advisors helpful?



How many years of funding are guaranteed with good progress?  
Does the school have accessible resources (library, counseling, etc.)?



Were students in the department excited about their research?



What is the cost of living in the area where the school is located?

# Knowing your Research Interests vs. Being Unsure

## Knowing Your Area

- Top programs will expect you to have an area of research interest before enrolling.
- However, other schools may offer more flexibility in choosing a research area.
- Knowing the area you would like to work in (and having research experience in that area) can, however, make a big difference

## Contacting Potential Advisors

- Usually, professors do not respond to e-mails until students are admitted.
- More likely to get responses from a smaller departments receiving fewer applications.

# Financial Support Options

## Teaching Assistantship

Requires 20 hours of work per week to help the course instructor develop and offer in course. Typical duties include grading and running lab/discussion sections.

## Research Assistantship

RAs typically require working with your research advisor on a funded project. Having an RA typically requires that your advisor has research funding.



## Fellowships

NSF Graduate Fellowship, DOE, DOD, DHS, industry and foundation fellowships as well as university designated fellowships. May be viewed as more prestigious and offer more research freedom.

# Applying for Fellowships



Ask advice on what is best for your career stage.  
Get example applications.  
Get feedback on your application.



**NSF GRF**  
Early November  
Deadline



**Hertz Foundation**  
Late October Deadline



**NDSEG**  
Early January  
Deadline



**Homeland Security  
Fellowships**  
Early January Deadline



# Making a Smooth Transition into Grad School

*How to prepare for a successful start to your graduate studies*



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# Before Classes Start: Settling in & Learning the Ropes

## Know Your Program Requirements

- What are the hurdles associated with completing a Ph.D. degree?
- What are the course requirements?
- What exams will you need to pass and when?
- Are there teaching requirements?
- By when do you need to find an advisor?
- How many years do you have to complete your degree?

## Helpful Tips

- Get to know your peers and near peers
  - Create study groups
  - Establish hobbies and friends outside the department
  - Find mentors
- Get to know your school environment and resources
- Create a comfortable studying and living environment for yourself

# A Typical Semester in a C.S. Ph.D. Program

## Structure of Coursework

- Undergrad is CS + breadth courses; Usually 4-5 courses/semester.
- B.S. and M.S. degrees are about taking courses: 3-4 courses/semester. Mostly or all are CS courses.
- While you still take <10 courses during the Ph.D. in the first 3-4 semesters, the emphasis is on research!

## Key Differences between Classes & Research

- Class assignments have known answers; research problems may not even have a solution
- In classes, you are assigned problems; in research, you get to pick ones to work on
- In classes, you can ask for help. In research, help may not be available (in some cases even your advisor may not have immediate response)
- In research, you work side by side with other research students, post-docs, and your advisor

# The First Few Years

*Taking courses and getting involved in research*



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# Taking Courses

- Ph.D. typically requires <10 courses
- Remember, focus during the Ph.D. is on *research*!
- Choose classes related to the potential research area
  - Ask your adviser for advice and recommendations. They may have expectations.
  - If you are interested in working with a particular faculty, take their course. Do very well. Possibly consider a course project as research.
  - Consider taking courses outside CS relevant to your research (e.g., Stat, Math, Psychology, Computational Linguistics)

# Getting Involved in Research Early

- Getting involved in research early is the most important thing to do for overall success!
- The research process (finding an advisor, a research problem, obtaining initial results, getting these results published) takes time, so the sooner you start the better!

- *“Keep in mind that no one can give you a complete picture of what research is. The best way to learn what research is, and whether you like it, is simply to start doing it. The earlier the better!”*

<https://www.cs.cmu.edu/~harchol/gradschooltalk.pdf>

# Finding a Healthy Work/Life Balance

***Graduate school does not have to be 9-5***

Find the most productive hours for you and schedule ~8 working hours at that time

## **Make working time productive!**

Research is much more about the quality of the output rather than the hours spent

## **Schedule personal time!**

It is easy to keep working; however, time off is important



## **Set clear goals, get feedback and reward yourself**

Talk regularly to your advisor; make sure goals and expectations are aligned

## **Banish the Guilt!**

Take breaks to be able to produce your best work. Tap your support network!



# The Research Apprenticeship

*Finding an advisor that fits you and  
conducting impactful research*



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# How to Find an Advisor

- Choice of an advisor is one of the most important decisions to make in graduate school
- Renowned vs. beginning researchers
- Do your homework! Check the following information for a potential advisor's Ph.D. students:
  - How many students and when they graduated?
  - How many papers (and where) students published with their advisor?
  - Where are those students now (academia, industry)?
- Talk to faculty during office hours, attend their talks
- Ask to attend research meetings of a group you are interested in joining
- What is the advisors collaboration style like? 1:1 Meetings?

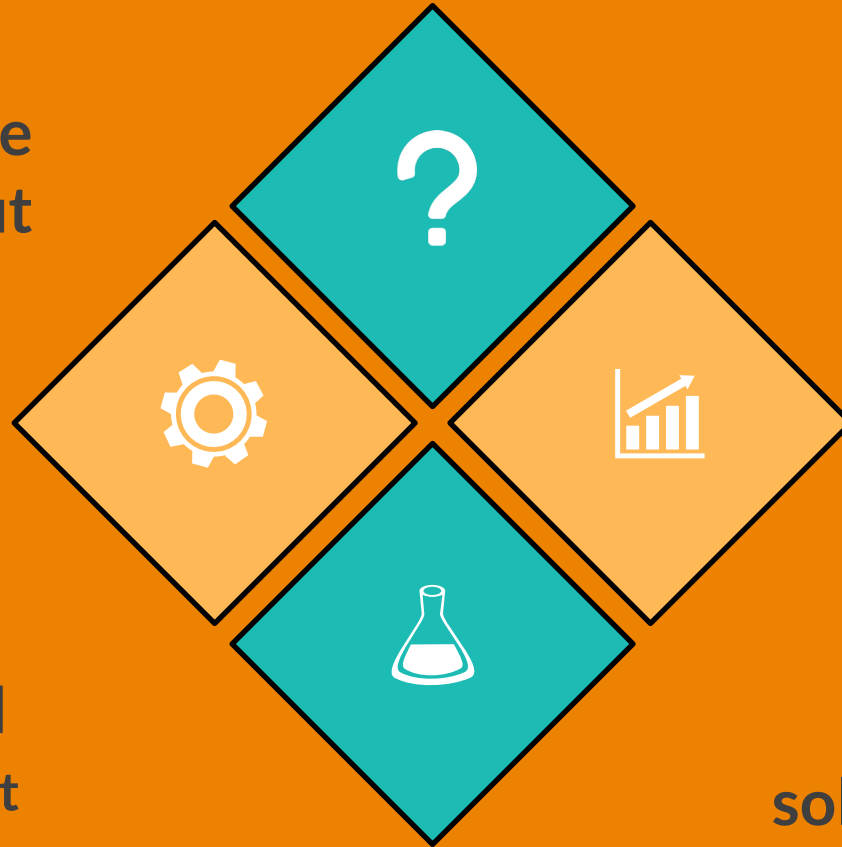
# What are Advisors Looking for?

- ***It's important to understand what Advisors are looking for:***
  - a trial period before committing an RA position
  - excellent performance in their class
  - specific technical or research skills (e.g., systems building, ability to come up with proofs etc)
  - writing skills
  - critical thinking skills

- **More advice/resources on finding an advisor:**
- Tao Xie's Guide: <http://taoxie.cs.illinois.edu/advice/gradstudentsurvival.pdf>
- Philip Guo's Ph.D. Grind: <http://www.pgbovine.net/PhD-memoir.htm>

# Tips for Conducting a Successful Research Project

1) Identify an important problem you are *passionate* about



2) Devise a new solution or study – approach the problem from a new viewpoint

3) Create a plan for the work, and stick to it! – Expect setbacks, and work through them

4) Rigorously evaluate your solution or explain your findings

# What do Ph.D. Students do in the Summer

Internship with  
an industrial or  
government  
research lab

Work on  
research full  
time



Attend  
conferences or  
summer schools

Teach a course at  
your home  
institution to gain  
experience





# Preparing for Graduation & Beyond

*Preparing for your chosen career path*



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# Making the most of your Final Years in the Ph.D.

## Interested in a Faculty Position?

Signup to teach a class

*Above all, use your time at conferences and your grad school contacts effectively to network with peer researchers and develop possible future collaborations*

Inter

hing

?

Take at least one internship  
Often, students interested  
in industry will take  
multiple internships

Sign up to teach multiple  
classes, develop curricula,  
collect student feedback

# Becoming a (Tenure-Track) Professor at a University

- Do research on anything you like!
- Working with graduate and undergraduate students
- Teaching classes
- Applying for grants
- Attending conferences and giving talks
- Doing service for your department, university and research community
- If you are interested in becoming a Research Professor than you do pretty much everything listed above but the teaching

# Becoming a Teaching-Focused Professor at a Research University

- Workload is focused primarily on teaching and curriculum development
- Occasionally advising MS and/or undergraduate students
- Doing service for the Department, University and CS education community
- Potentially conduct some CS education research based on your interests and curriculum development and course activities
- Typically, promotion in academic rank, but no tenure (multi-year contracts). Positions vary across universities

# Becoming a Professor at a Teaching University

- Primarily teaching classes
- Occasionally advising MS and/or undergraduate students
- Occasionally attending conferences and giving talks
- Doing service for your Department, University and Research community

# Becoming a Scientist at a Research Lab

- Doing research
  - typically a mix of what you want and what your company needs
- Working with other people in the company
- Occasionally attending conferences and giving talks
- Doing service for your Research community
  - Serving on program committees reviewing papers
  - Participating in organizing conferences
  - Serving on advisory boards for universities etc.

# In Summary: Why should you pursue a Ph.D. in C.S.?



## **Increase Knowledge & Hone Research Skills**

Study advanced topics, increase your CS knowledge & be trained to be a successful researcher



## **Advance the State-of-the-Art**

Learn about and contribute to cutting edge CS research



## **Pursue Your Interests**

Opportunity to pursue your own professional and intellectual interests in CS



# Want More Info? Check Out Conquer!

A website specifically for undergraduate research and graduate school advice in CS

<http://www.conquer.cra.org>



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**CRA-E's mission is to address society's need for a continuous supply of talented and well-educated computing researchers.**

**<http://www.cra.org/crae>**



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