



**OLD DOMINION**  
UNIVERSITY

# What's Grad School All About?

## Graduate School and Graduate Career Paths in Computer Science

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ODU Disinformation REU Site

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*Acknowledgements: Some slides and material are courtesy Dr. Justin Brunelle, Dr. Kris Cooper, and Dr. Tracy Camp - gathered from course materials and personal conversations.*







@weiglemc, @phonedude\_mln, @oducsreu, @WebSciDL

# Should You Go to Graduate School?

Yes! (*but we're biased*)

Getting a Master's in Computer Science will significantly broaden your career potential. In fact, many employers are now preferring candidates with a master's degree over those with a bachelor's -- for jobs that previously only required a bachelor's. According to [Fast Company](#), 32 percent, almost one in three, employers have increased their education requirements for new hires.

<https://www.noodle.com/articles/is-a-masters-in-computer-science-worth-it>

	OCCUPATION	JOB SUMMARY	ENTRY-LEVEL EDUCATION	2021 MEDIAN PAY
	<a href="#">Computer and Information Research Scientists</a>	Computer and information research scientists design innovative uses for new and existing computing technology.	Master's degree	\$131,490
	<a href="#">Computer Network Architects</a>	Computer network architects design and build data communication networks, including local area networks (LANs), wide area networks (WANs), and Intranets.	Bachelor's degree	\$120,520
	<a href="#">Information Security Analysts</a>	Information security analysts plan and carry out security measures to protect an organization's computer networks and systems.	Bachelor's degree	\$102,600
	<a href="#">Computer Systems Analysts</a>	Computer systems analysts study an organization's current computer systems and design ways to improve efficiency.	Bachelor's degree	\$99,270

<https://www.bls.gov/ooh/computer-and-information-technology/home.htm>

# Don't Pay for CS Grad School

- CS departments fund graduate assistantships
  - Graduate Research Assistantship (GRA) - stipend paid by faculty research grant, tuition waiver paid by grant or college
  - Graduate Teaching Assistantship (GTA) - stipend and tuition waiver paid by department
- PhD - assistantships are guaranteed as long as student is making progress
- MS - assistantships are often available, good students are in high demand

**Now that we've convinced you  
to go to grad school...**

**What's the difference between  
MS vs. PhD?**

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# MS vs PhD - Jobs

- MS - equipped to do high level, complex design and potentially lead software engineering teams.
- PhD - equipped to do original research and potentially lead R&D teams.
- “With a Ph.D. you will have a better chance of spending the rest of your life doing what *you* want to do, instead of what *someone else* wants you to do.”
  - William Lipscomb, a Nobel Prize winner in chemistry

<https://www.quora.com/What-are-the-main-differences-between-a-Masters-and-a-PhD-in-computer-science/answer/Vijay-Chidambaram>  
Vijay Chidambaram, computer science grad student

# BS vs MS vs PhD - Q&A

- BS - you are given the questions and the answers
- MS - you are given the questions and you get to find the answers
- PhD - you must come up with both the questions *and* the answers

Dr. Kris Cooper (my undergraduate advisor)

# Undergrad (BS)

- You are given a course schedule
- Instructors pose questions, you give answers, you're told if you're right or wrong
- You show up, do what you're told for ~4 years, and get a degree in return
- You are certified to be competent in your topic area (e.g., CS)

# Masters

- Increased depth and/or specialization
  - You have a few core courses
  - You probably selected about half of your courses
- This is your introduction to research
  - You are asked a question and you need to determine the answer *and* whether or not you are correct  
Answers become less definite!
- You are certified to understand the complexities of your field, potentially with a specialization



# PhD

- No emphasis on courses (you only take a few)
- No one has the questions OR the answers!
  - You embark on original research
  - You define the questions, the answers, and have to prove that you are correct
  - Wide-open, not concrete
- “You know more and more about less and less”
  - You are highly specialized
- You will work extremely closely with your advisor (so make sure you work well together!)

# A PhD is All About Questions

- "A PhD teaches you how to ask the right questions" <http://blog.skanev.org/2013/03/why-not-do-phd-in-computer-science.html>
- Your PhD advisor's job is to ask questions about your work
  - why does the output/graph/result look like this?
  - what would happen if you ran the experiment/analysis another way instead?

# MS vs. PhD – Requirements at ODU

- MS
  - 34 hours of coursework (11 courses)
  - project (10 courses) or thesis (8 courses)
    - project - usually a software development project
    - thesis - requires some novel research contribution
  - partial tuition waiver (often full for in-state students)
  - ~2 years
- PhD (after MS)
  - 48 credit hours
  - 24 hours of coursework (8 courses)
    - 4 "real" courses (not seminar or special topics) from 3 different research areas
    - CS 800 - Research Methods
    - 3 CS 891 or CS 896 courses with your advisor
  - 24 hours of dissertation credits (CS 899)
  - full tuition waiver
  - variable (often 3-5 years after MS)

ODU Linked Program -  
~5 yrs for BS *and* MS

<https://odu.edu/compsci/academics/graduate/requirements>

# PhD – Requirements at ODU

- Candidacy Exam
  - option 1: summary of papers
  - option 2: research event (MS thesis, academic submission/publication)
- Approved Dissertation Topic

Once finished coursework (except CS 899), passed candidacy exam, and approved dissertation topic, you are a PhD candidate (*past candidacy, ABD*)

- Dissertation Prospectus (proposal)
- Dissertation Defense

<https://odu.edu/compsci/academics/graduate/requirements>

# PhD – Requirements at ODU

- CS 899 Dissertation Credits are mainly for accounting
  - it's not like once you complete all 24 credits, you're done
- Your main goal is research: publish papers, write a dissertation, make a significant and original contribution to the field

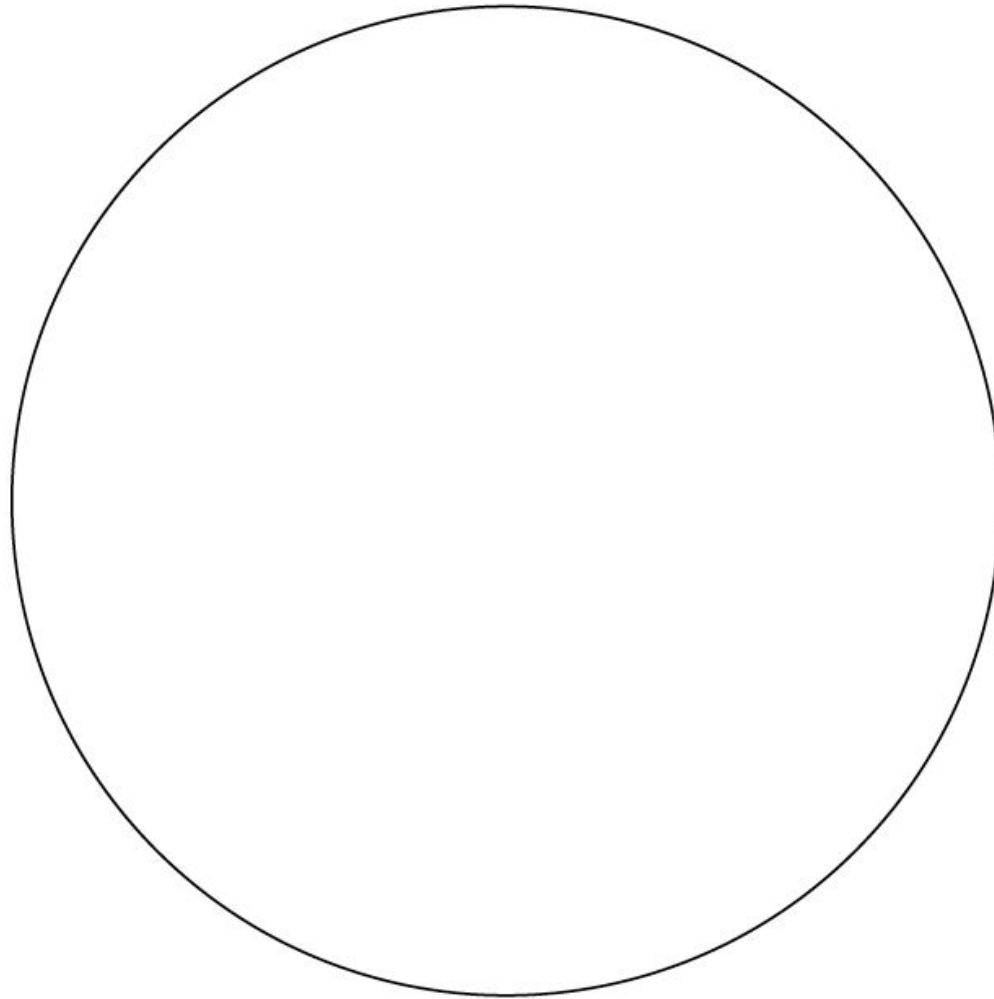
# What is Research?

Matt Might (<http://matt.might.net/>), a professor in Computer Science at the University of Utah, created "The Illustrated Guide to a Ph.D." to explain what a Ph.D. is to new and aspiring graduate students.

*[Matt has licensed the guide for sharing with special terms under the Creative Commons license.] <http://matt.might.net/articles/phd-school-in-pictures/>*

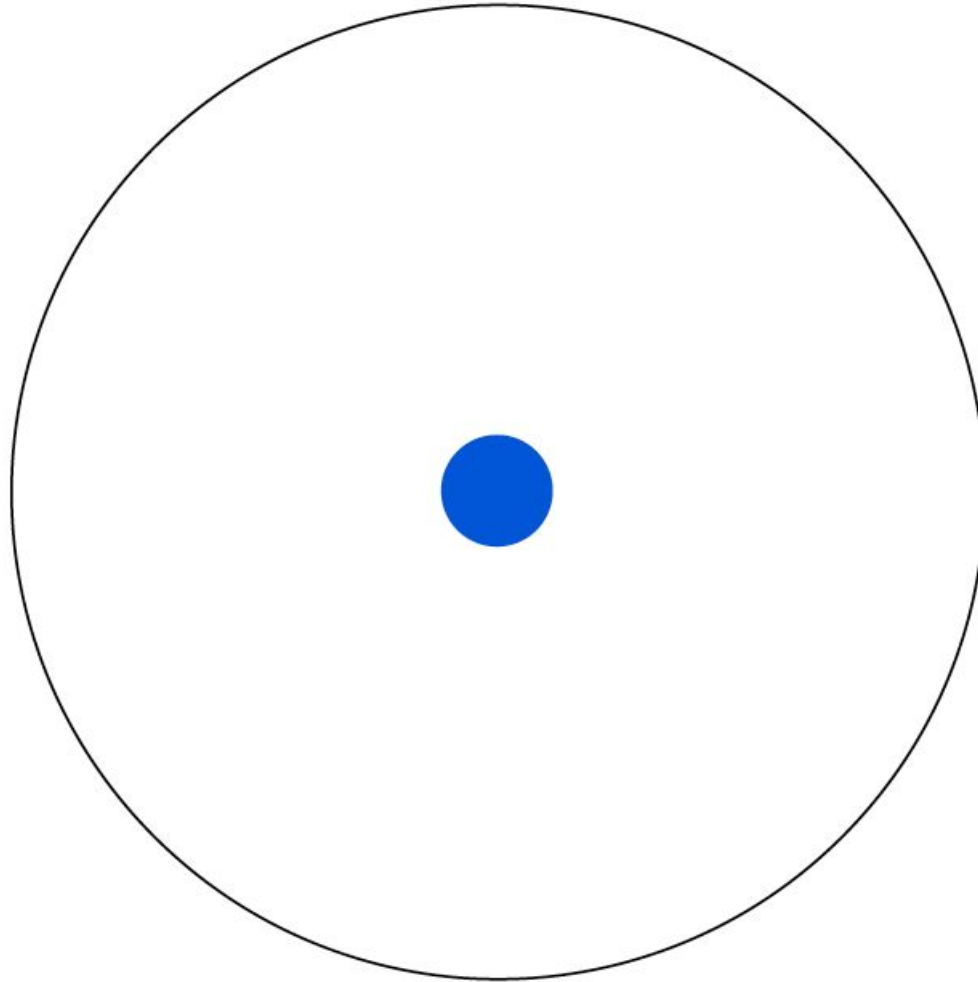
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# Imagine a circle that contains all human knowledge



<http://matt.might.net/articles/phd-school-in-pictures/>

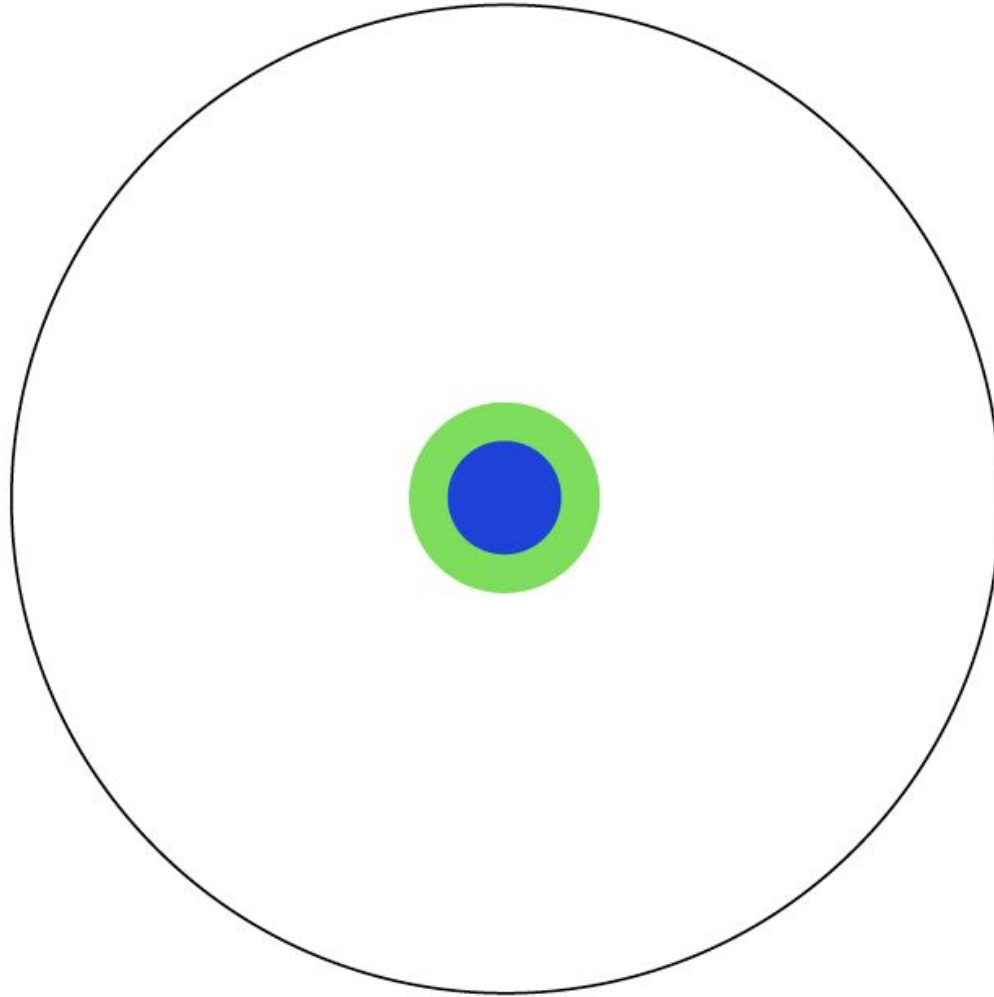
# By the time you finish elementary school, you know a little



<http://matt.might.net/articles/phd-school-in-pictures/>

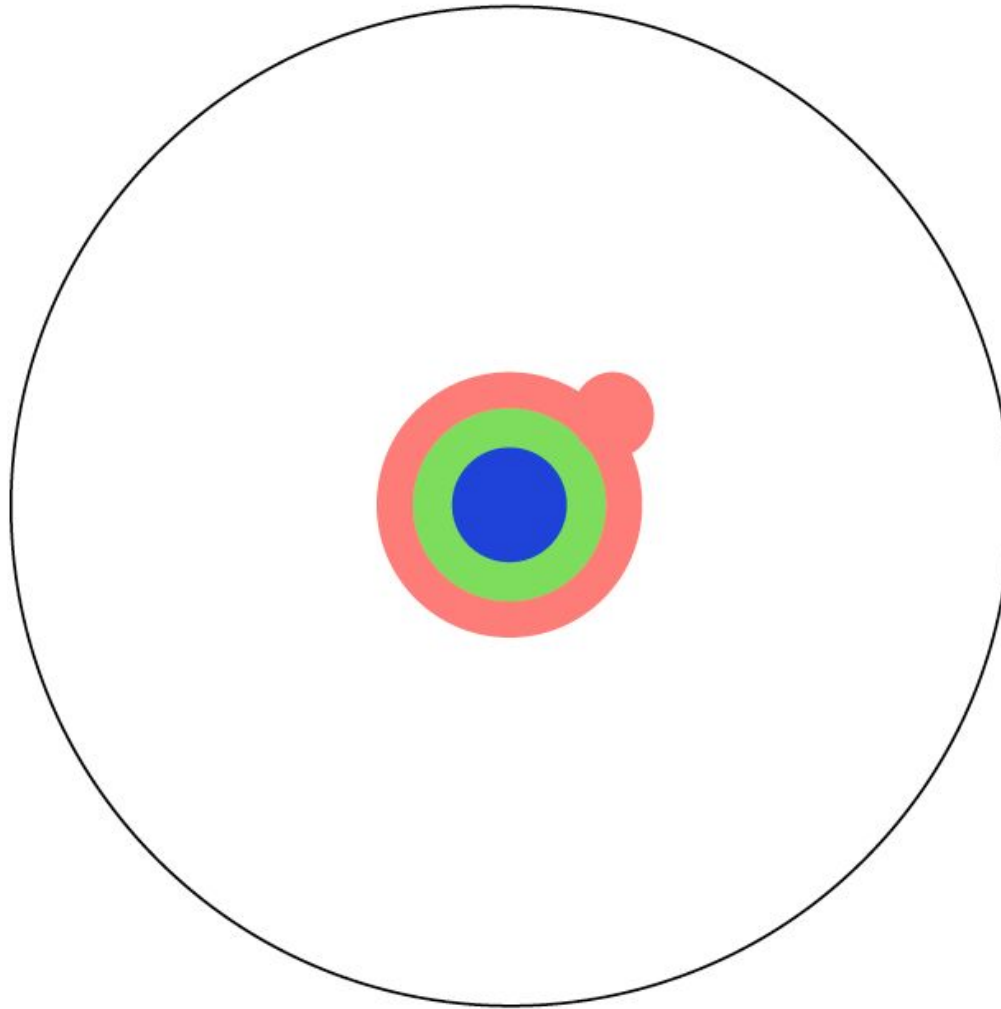


# By the time you finish high school, you know a bit more



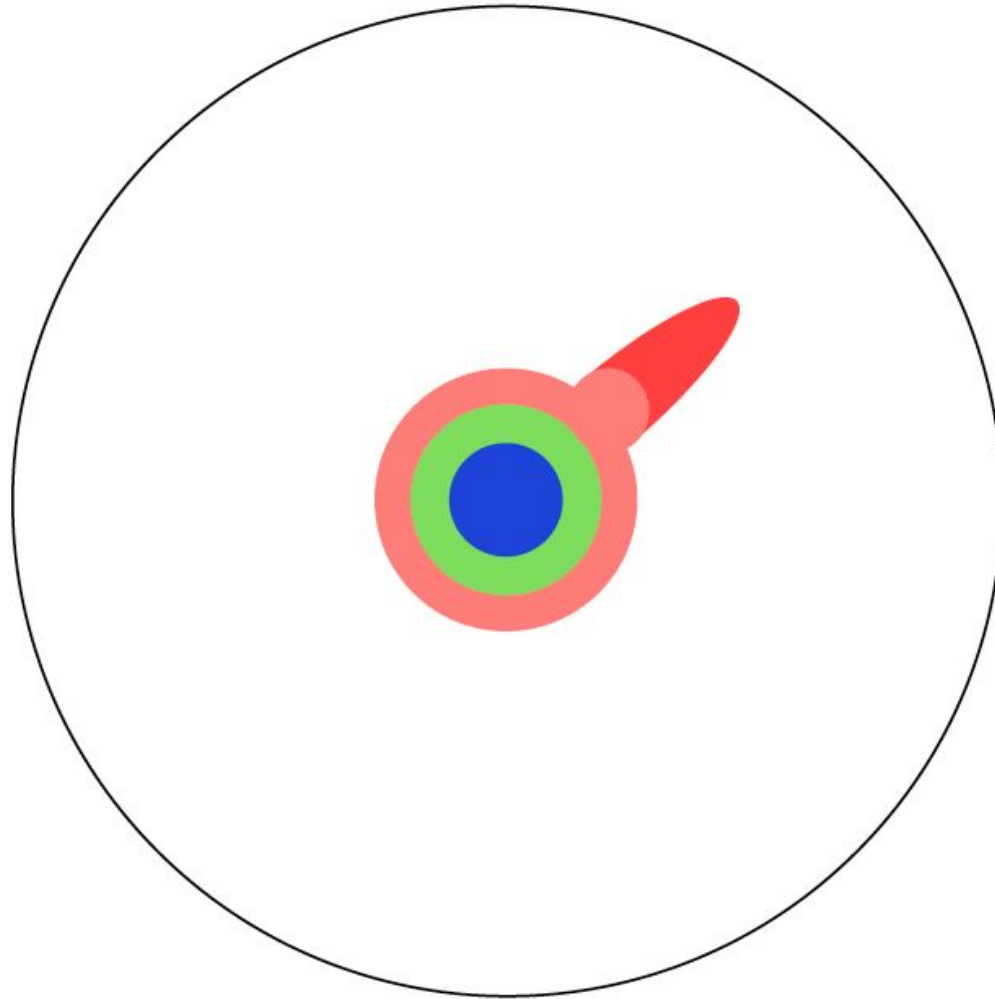
<http://matt.might.net/articles/phd-school-in-pictures/>

# With a bachelor's degree, you gain a specialty



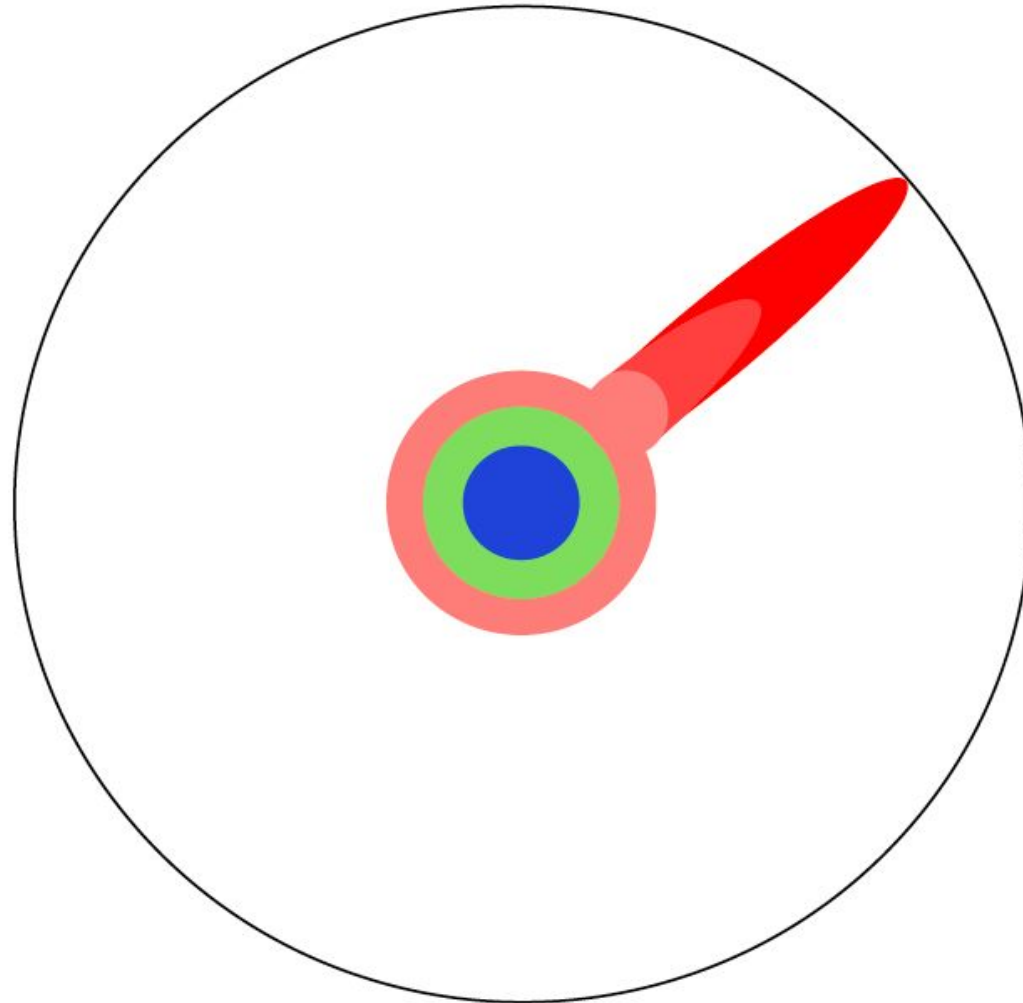
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# A master's degree deepens that specialty



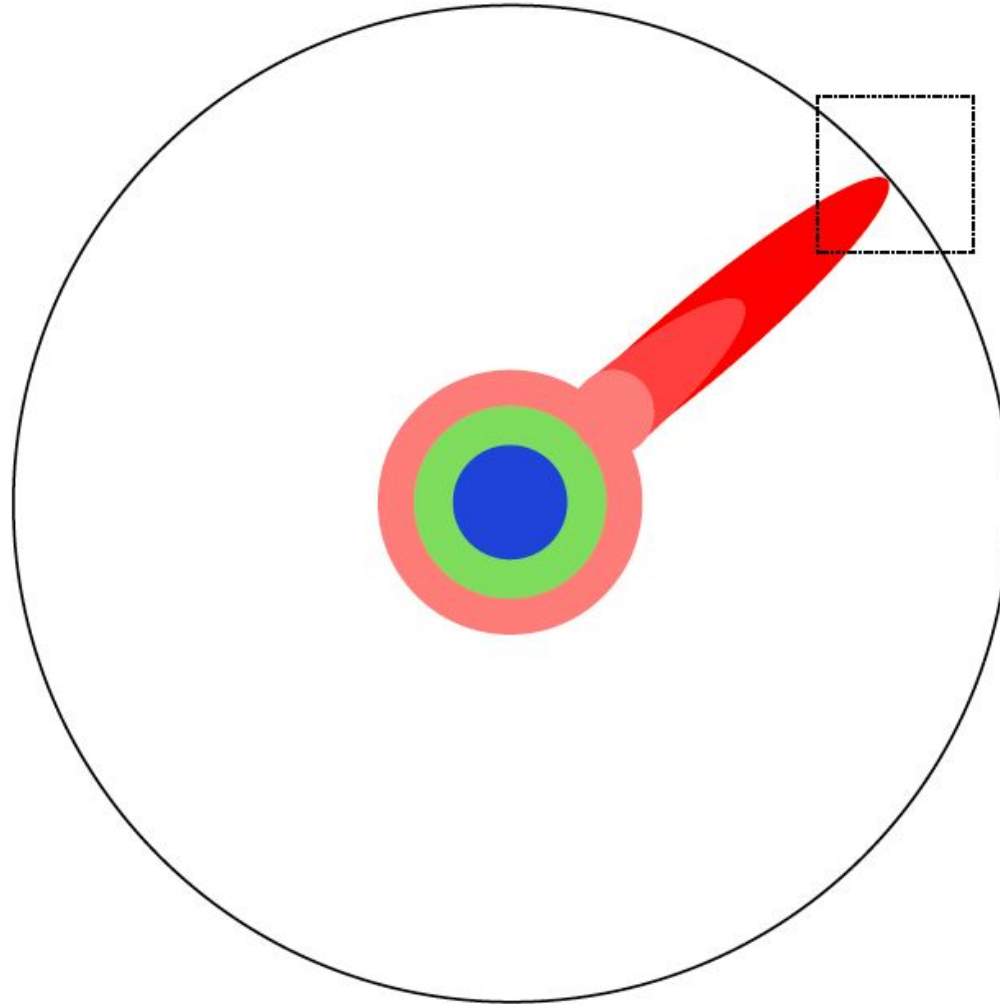
<http://matt.might.net/articles/phd-school-in-pictures/>

# Reading research papers takes you to the edge of human knowledge



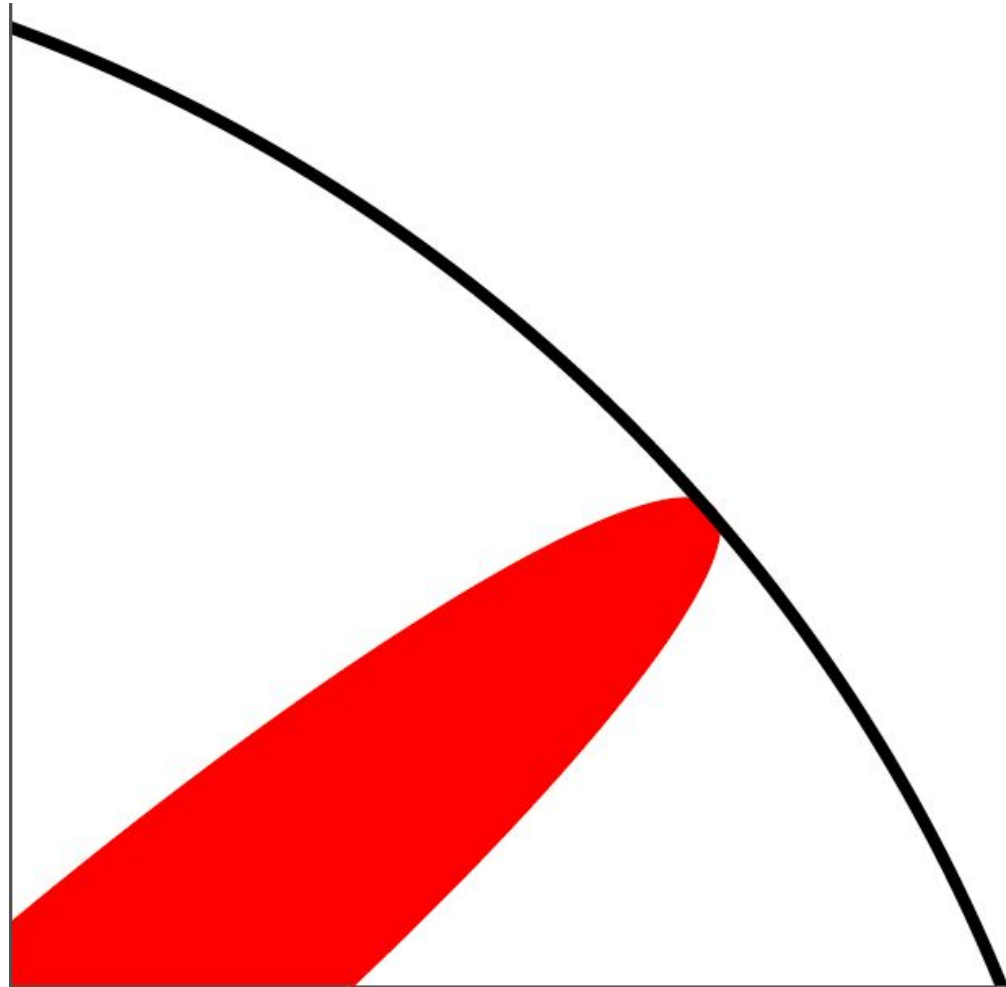
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# Once you're at the boundary, you focus



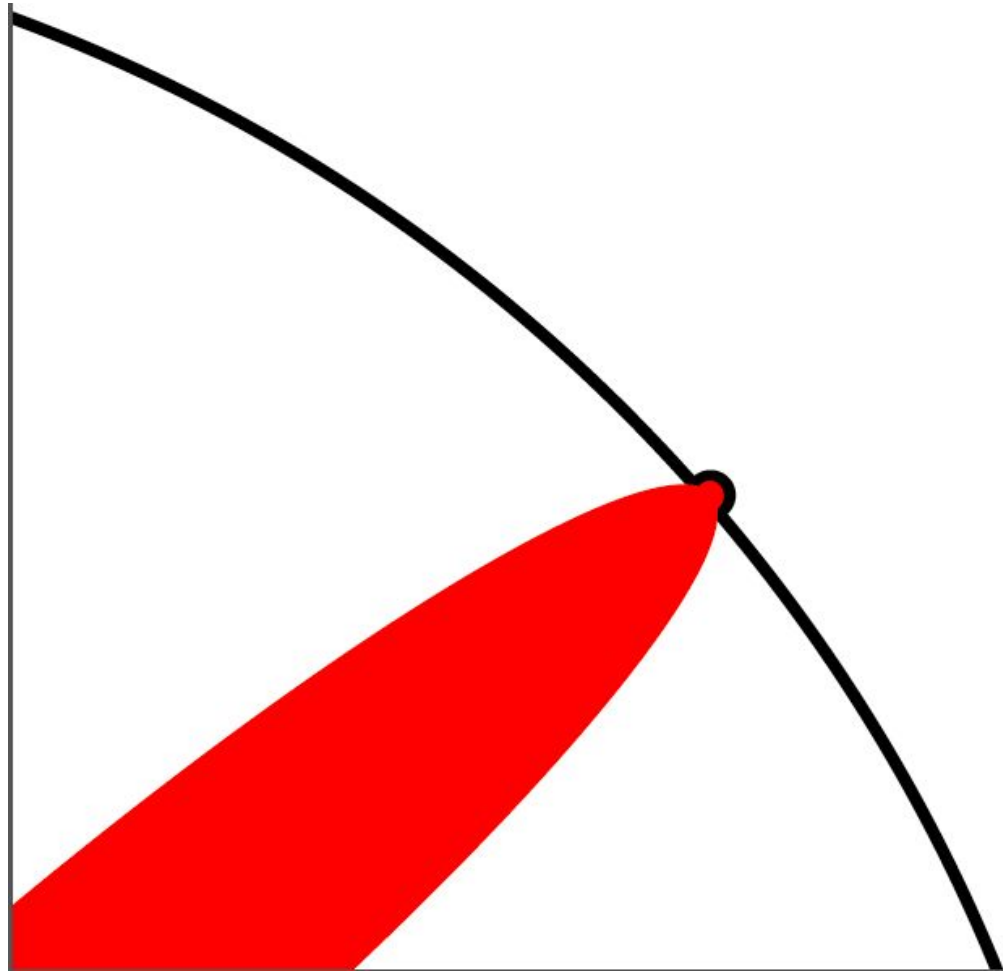
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# You push at the boundary for a few years



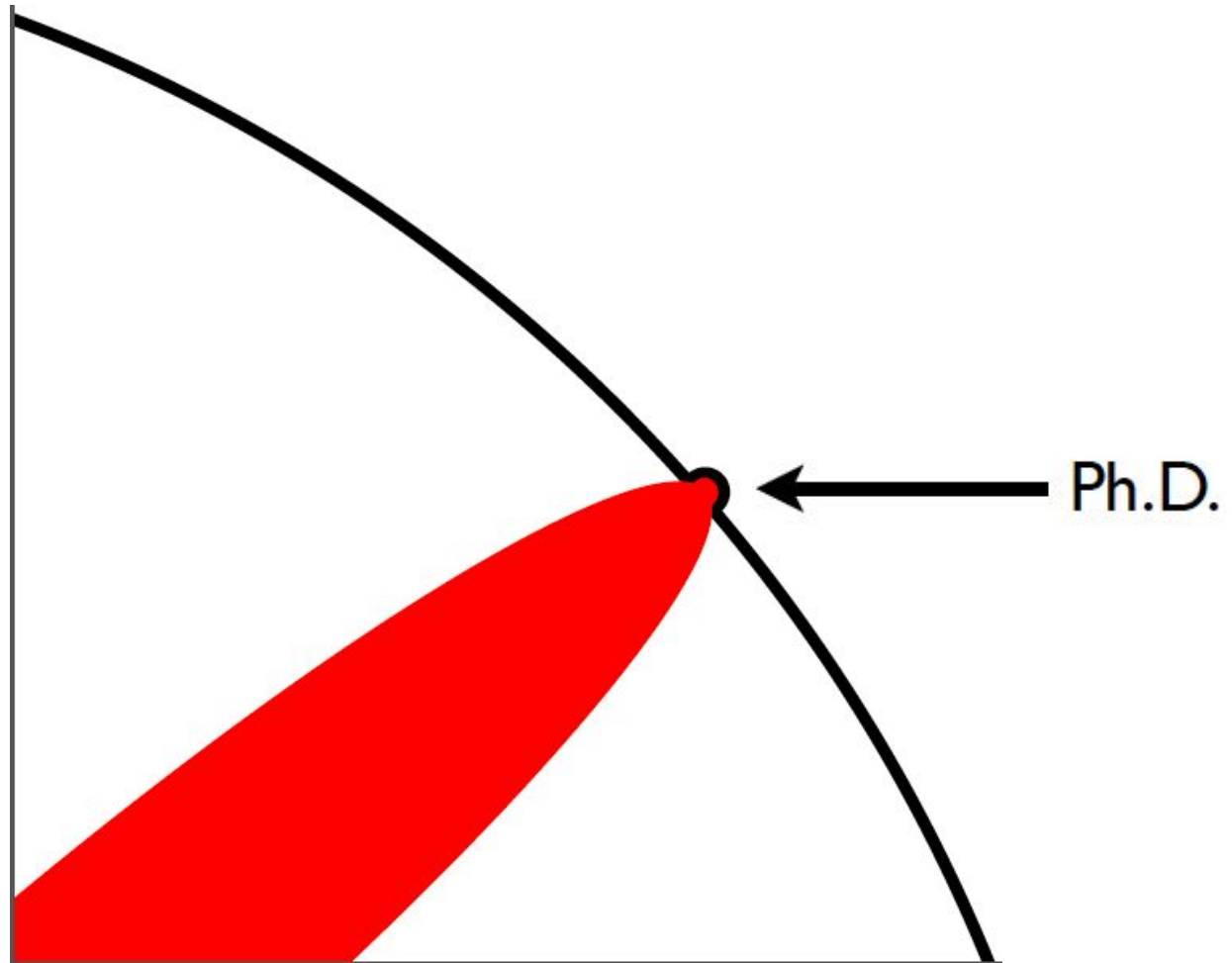
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# Until one day, the boundary gives way



<http://matt.might.net/articles/phd-school-in-pictures/>

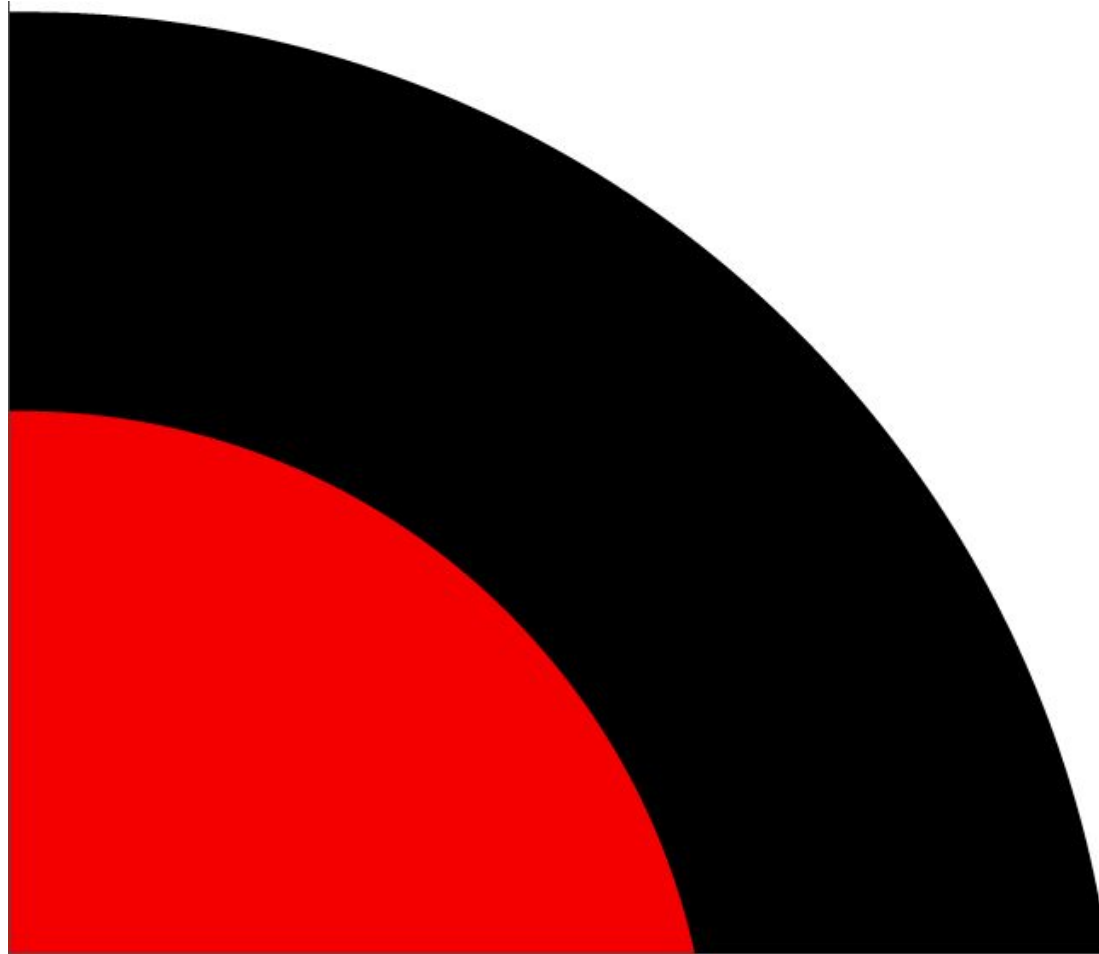
# And, that dent you've made is called a Ph.D.



<http://matt.might.net/articles/phd-school-in-pictures/>

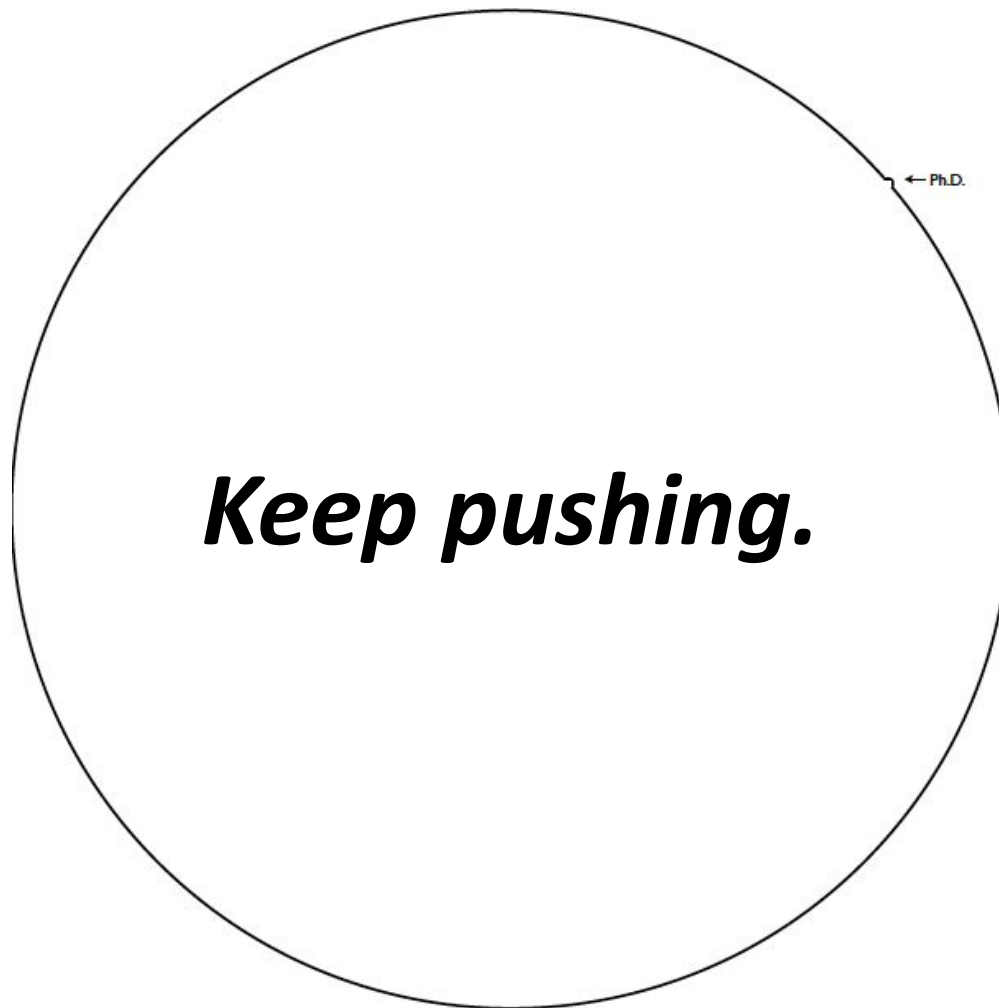


# Of course, the world looks different to you now



<http://matt.might.net/articles/phd-school-in-pictures/>

# So, don't forget the bigger picture



# Life as a PhD Student

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# So long, and thanks for the PhD!

Ron Azuma's classic article (PhD, UNC 1995)

<http://www.cs.unc.edu/~azuma/hitch4.html>

**“So long, and thanks for the Ph.D.!”**

**a.k.a.**

**“Everything I wanted to know about C.S. graduate school at the beginning but didn’t learn until later.”**

**The 4th guide in the Hitchhiker’s guide trilogy (and if that doesn’t make sense, you obviously have not read Douglas Adams)**

**by Ronald T. Azuma**

**v. 1.13**

**Original version 1997, last revised February 2017**

# A PhD is a Means to an End

- Employment
  - startup
  - commercial business
  - government or industrial research lab
  - academia

# Where do GRAs Come From?

- Academia is a business, and “graduate student” is a job title.
- Faculty write grant proposals to external agencies (NSF, NEH, IMLS, ...).
  - fund GRA stipends, travel, small amounts of faculty summer support
  - *without grant funding, there is no GRA funding*
- These agencies expect concrete deliverables (software, publications, etc.).
- *My chances of future funding are largely based on your performance.*

# Treat Your GRA Like a Job

- You must prove to your professors that you are capable of
  - getting the work done,
  - being a team player,
  - communicating your results, and
  - most of the other characteristics needed to do well in regular jobs.

*Even if you're supported by a GTA, you should still be involved in research every semester. And treat your research work like a job.*

# Surviving the PhD

- Read Ron Azuma's guide and David Patterson's "How to Have a Bad Career in Research/Academia",  
<https://people.eecs.berkeley.edu/~pattrsn/talks/BadCareer.pdf>
- Perseverance
  - it can be slow, it can get boring, some days you just have to get through it
- Initiative
  - no one can say "these are exactly the things you need to do" each day, must set your own goals
- Curiosity
  - PhD students are usually ready to graduate once they start asking their own questions about their data and research
- Coffee
  - *my PhD students told me to add this one*



# PhD Students Must Break Away From Undergraduate Mentality

- A PhD is not about courses. Grades don't matter much anymore
  - main form of evaluation is research progress (i.e., publications)
- There is no one who can tell you exactly what to do, so own your research
  - secret: *your advisors don't know all the answers!*
- When you graduate, you will be the world's expert on your dissertation topic

<https://cacm.acm.org/magazines/2013/7/165494-ph-d-students-must-break-away-from-undergraduate-mentality/fulltext>

# One More Good Resource

## Do You Need a Ph.D.?

Whether you need—or should get—a Ph.D. ultimately depends on why you're doing it, and if you're doing it for the right reasons.



Nick Feamster

Follow



Aug 31, 2020 · 15 min read ★



### Nobody “Needs” a Ph.D.

I recently saw a social media post that claimed “you don’t need a Ph.D.” Of course you don’t **need** a Ph.D. To claim that you don’t need a Ph.D. is completely besides the point. Here was my reply to that post:

*You also don’t “need” to climb Everest, yet some people find that a worthwhile experience. A Ph.D. is about the journey, the experience of growth, learning, contributing to knowledge, deep expertise. Not for everyone, but for many it is incredibly rewarding.*

<https://medium.com/great-research/do-you-need-a-ph-d-f78d2fb0f286>

# Graduate Careers

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# ODU's Career Pathways Program

<https://sites.wp.odu.edu/careerpathways/>

<https://www.youtube.com/channel/UCnzhxTxGkpglo77iZyCMBqA/>



## Preparing Future Faculty (PFF)

Designed for graduate students and postdocs interested in an academic career.



## Preparing Future Professionals (PFP)

Designed for graduate students and postdocs interested in a non-academic career.

A screenshot of the ODU Career Pathways YouTube channel page. The channel has 21 subscribers and a 'SUBSCRIBE' button. The page is organized into sections: HOME, VIDEOS, PLAYLISTS, CHANNELS, and ABOUT. Under the 'Uploads' section, there are 12 video thumbnails with titles and view counts. The videos include: 'The Post-Doctoral Option: What is it? Is it for me?' (12 views), 'Creating Your Individual Development Plan (IDP)' (25 views), 'Thinking About Careers Reflections From The Field' (11 views), 'Strategies For Success In The Academic Job Search' (14 views), 'Publish, Don't Perish: The Use of ePublishing in...' (8 views), 'Framework for Grant Writing' (10 views), 'Strategies for Success in the Academic Job Search' (11 views), 'Working with Students with Disabilities: What Can and...' (5 views), 'Testing and Evaluation: Preparing Assessments an...' (3 views), 'Thinking About Careers: Reflections From The Field' (No views), 'Teaching Elements of The Job Search' (30 views), and 'Collaborations/Working With Others To Increase Resear...' (8 views).

# Academia Isn't the Only Option



Google



amazon



Microsoft®  
Research



MITRE

# Lots of PhDs are *not* faculty

- **58%** of new PhD recipients in 2020 went to non-academic jobs in North America
- Compared to
  - 10% tenure-track faculty
  - 11% postdoc
  - 4% teaching faculty

# Non-Academic PhDs

- Industry hires PhDs to lead R&D teams (research and development)
  - friend who has worked at CapitalOne, Audible, now at Disney (Disney+ streaming)
- Government research labs hire PhDs to lead research teams

# Types of Academic Jobs

## Teaching faculty

- primarily at universities with no PhD program in computer science
- teach 3-4 courses/semester
- encouraged to do research with undergrads
- are some "Professor of the Practice" positions at research universities

## Tenure-track

- at universities with a PhD program in CS
- teach 1-2 courses/semester
- expected to do research and publish with PhD students
- expected to obtain external grant funding



# Perks of Academia

- Work with really smart people
  - faculty colleagues
  - students
- Always learning new stuff
  - research
  - teaching courses
- Control your own destiny
  - no one's looking over your shoulder to see if you're in your office 9am-5pm
  - change research projects and focus

# Once you go industry, you can't come back

- If you ever want an academic job, don't take an industry job right out of school
  - it's *possible* to come back, but the likelihood is tiny

## Working in industry is a one-way street out of academia

Standard advice I give to graduating Ph.D. students: If you're absolutely sure that you don't want an academic position (i.e., become a faculty), then it's fine to go to industry. If you are *not* sure, pursue a postdoc (which could be in industry), because a permanent position in industry is a one-way street out of academia. A faculty member can always get an industry position, but once you're in industry for a while, it's very difficult to get an academic position.

I've heard countless times a student say something along the lines of: Oh, I'll just work a few years in industry, see how I like it, and then come back to pursue an academic position. This is highly unlikely.

It comes down to publications: To qualify for a good academic position, you can't stop publishing. Let's say you work in industry for two years and want to apply for an academic position: Your competition consists of postdocs who have spent the last two years with a singular focus on pumping out publications to get the best possible academic position. Who do you think is going to "win"?

<https://github.com/lintool/guide/blob/master/industry-one-way-street.md>

# Data Points - The Taulbee Survey

- The Taulbee survey documents trends in
  - student enrollment
  - degree production
  - employment of graduates
  - faculty salaries
- 2020 Taulbee Survey,  
<https://cra.org/wp-content/uploads/2021/05/2020-CRA-Taulbee-Survey.pdf>

# Summary

- You should go to graduate school. 😁
- Don't pay for CS grad school - GRA, GTA
- Jobs
  - MS - software development, lead software engineering team
  - PhD - research, lead R&D team, doesn't have to == professor
- MS thesis is good prep for PhD
- PhD is not about courses, it's about research
- Research is about asking questions