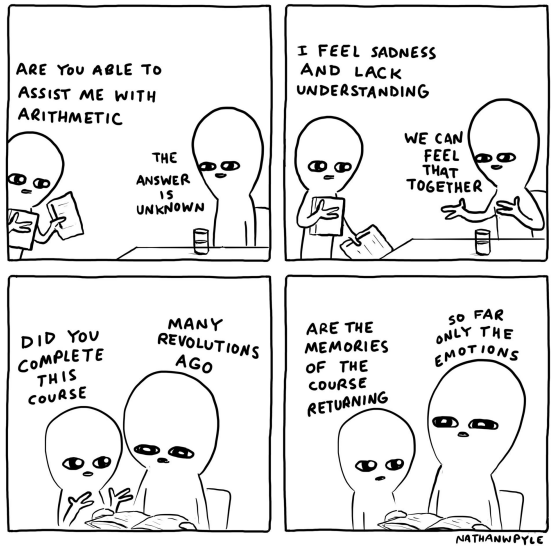
Humans Make Things Messy: Insights from Mathematical Modeling, Computational Social Science, and Consulting

Shelby Scott
Health Data Scientist, Senior Consultant
Guidehouse

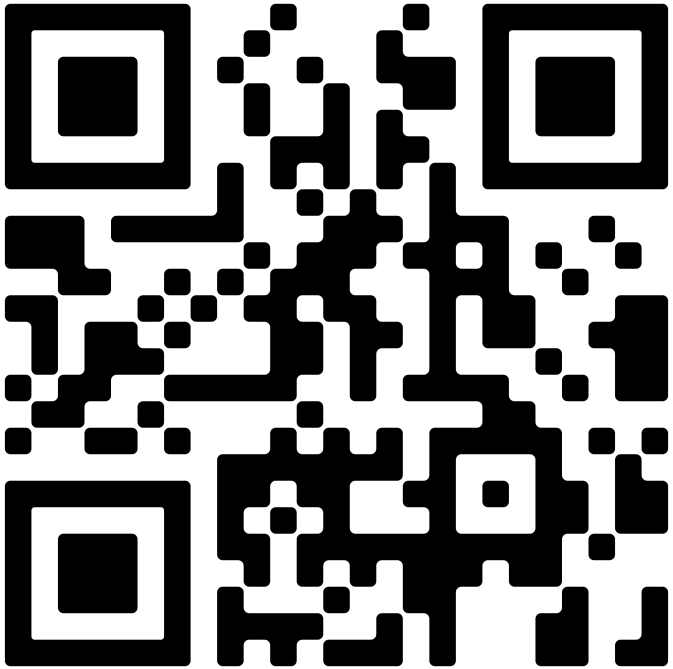


Acknowledgments

- Dr. Leah Edelstein-Keshet
- University of British Columbia MathBio Group
- NIMBioS Investigative Workshop: Mathematics of Gun Violence
- UTK Department of Ecology and Evolutionary Biology
- Funding: ASEE NDSEG Fellowship, NIH/NIGMS - IMSD #R25GM086761

Preliminaries

shelbymscott.github.io



Introduction

- May 2015: B.S. Rhodes College - Biomathematics
- Senior thesis: *An Agent-Based Model of Golden Eagle Predation on the Santa Cruz Island Fox*
- August 2015: Started in the Ecology and Evolutionary Biology Department at UTK
- Concurrently pursued a Masters in Statistics via the IGSP
- Masters project: *Analyzing Covariates of Diabetes Using Bayesian Linear Regression and Model Selection*
- Dissertation: *Spatio-Temporal Modeling of Gun Crime in Chicago, Illinois*
- Currently: Health Data Scientist and Senior Consultant at Guidehouse

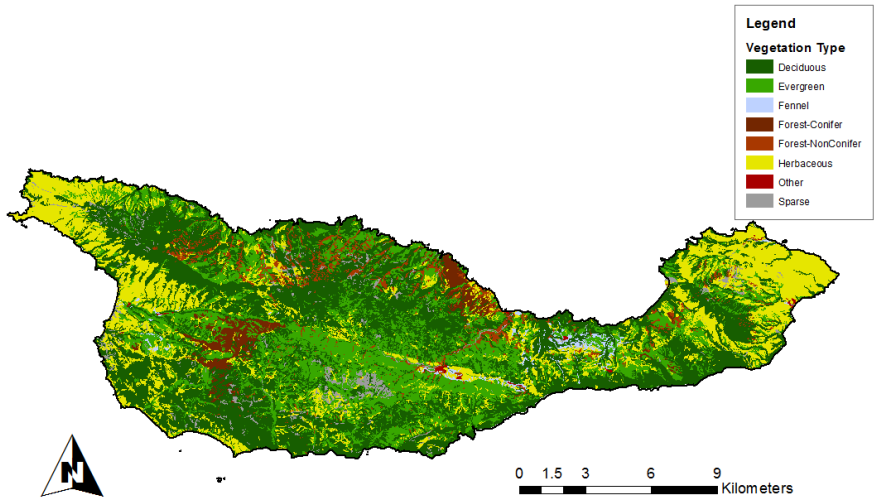
Overview

Motivation

- Common themes across my work:
  - Spatio-temporal modeling
  - Complex/big data
  - Epidemiology
  - **Humans**
- Hence: Humans Make Things Messy

The Santa Cruz Island Fox (*Urocyon littoralis santacruzae*)

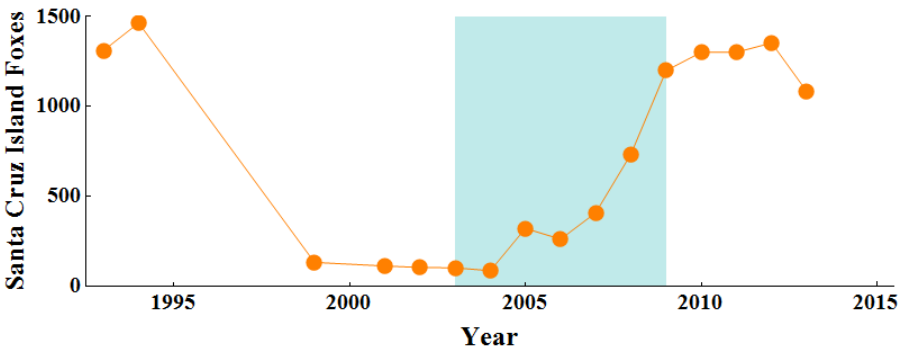
- Descendants of the mainland grey fox
- Monogamous
- Territorial – territory size dependent on vegetation
- Endangerment status



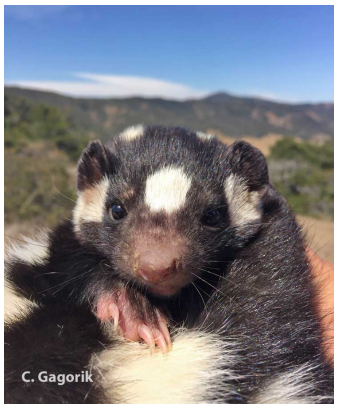
Reasons for Population Decline

- Human attempts at interventions and their failures.

Decline & Recovery of the SC Island Fox

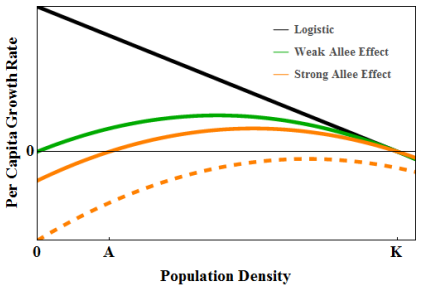


Golden Eagle Predation



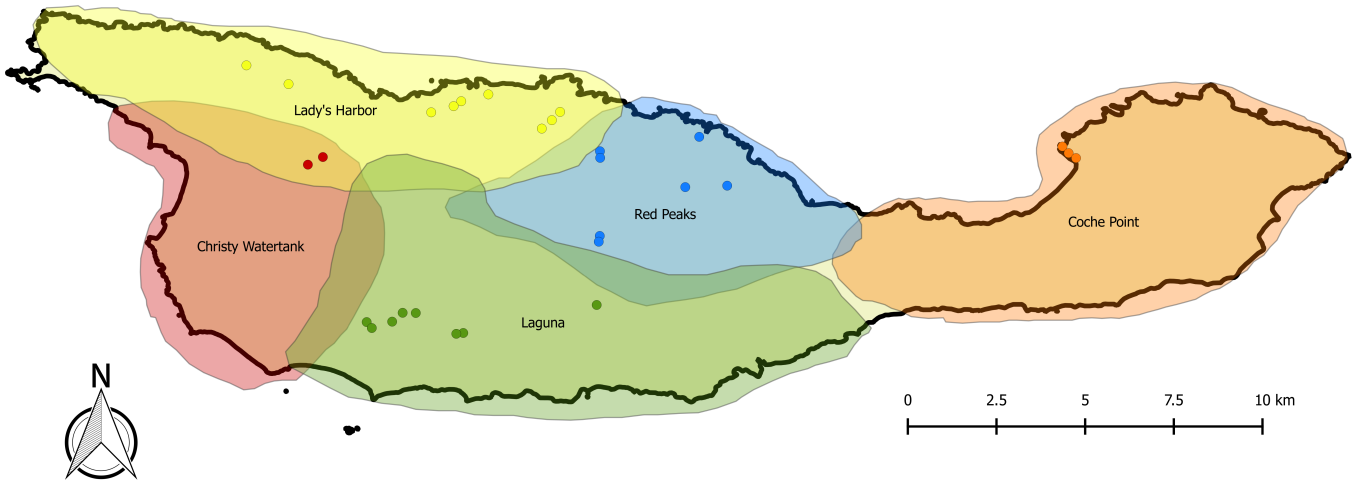
Island Spotted Skunk Competition

Rabies & Canine Distemper Virus



Allee Effect

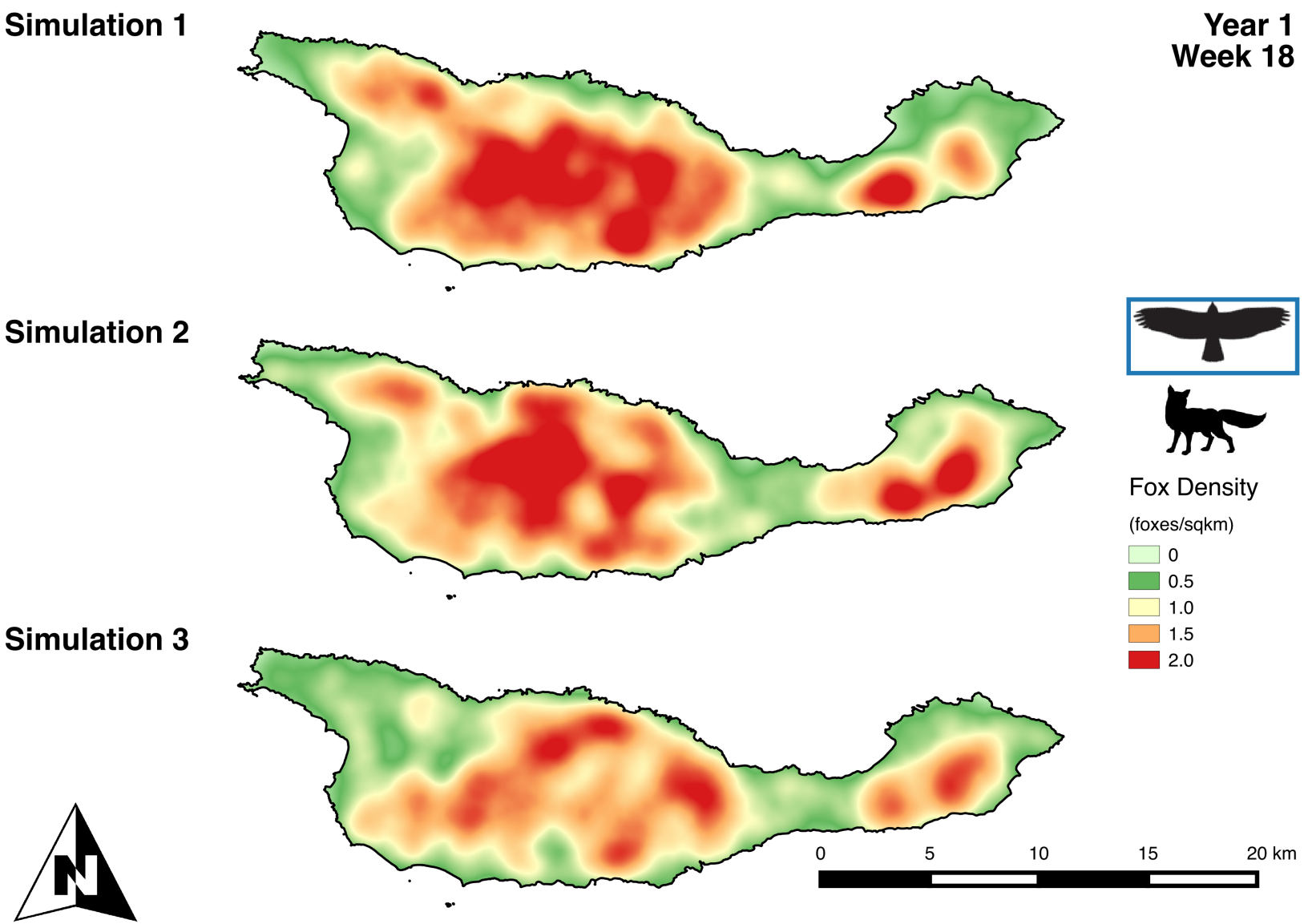
Methods



- **Objective**: Appropriately simulate the population dynamics of the Santa Cruz Island fox under predation of the golden eagle.
- **Tools**: Netlogo and QGIS.

- **Agent-Based Models**: A class of mathematical and computational models in which individuals (or agents) are unique and autonomous entities that can interact with other individuals and also with their environment.

Spatial Distribution of Foxes



How Did Humans Make Things Messy?

Ecologically/Modeling Purposes

- Rising DEET levels in the water
- Feral hog interventions
- Canine presence on the island

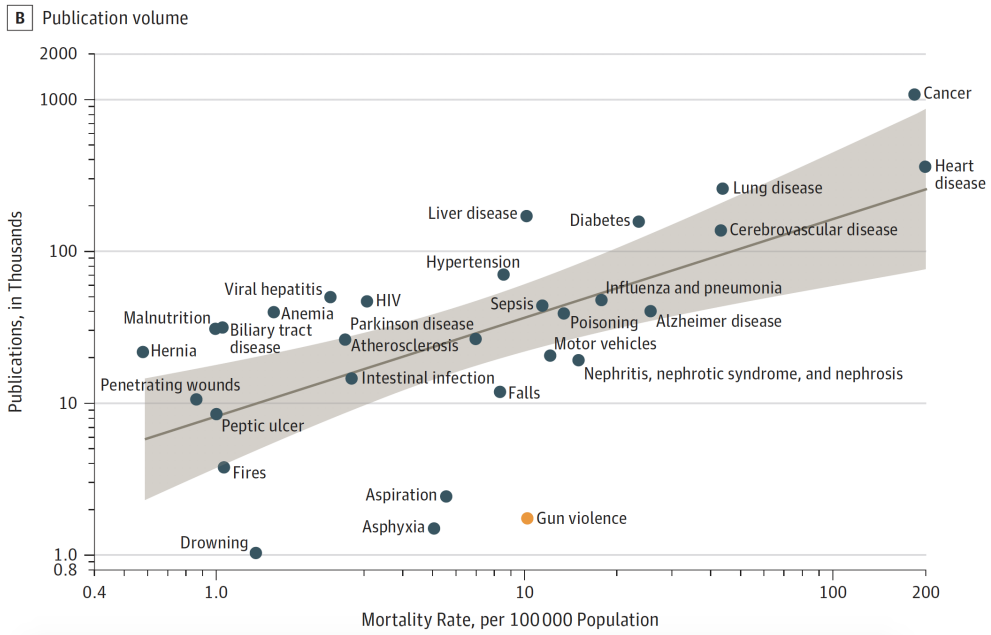
Research Purposes

- Working with a team
- Finding an appropriate home for the paper(s)
- Life events affecting research

Questions?

The Cost of Gun Violence in the United States

- Gun violence costs the United States $229 billion annually
- It leads to the death of 36,000 individuals and the non-fatal injury of 85,000 others
- Homicide is the leading cause of death in black males aged 10-24
- 75% of homicides involve the use of a firearm
- (Kellerman 1993) Having a gun in the home increases the risk for homicide occurring in the home
- (1996) Dickey Amendment removes CDC funding for gun violence research



Stark 2017, Joint Economic Committee 2019, APA 2013, CDC 2017, Kellerman 1993

Individual Cost of Gun Violence

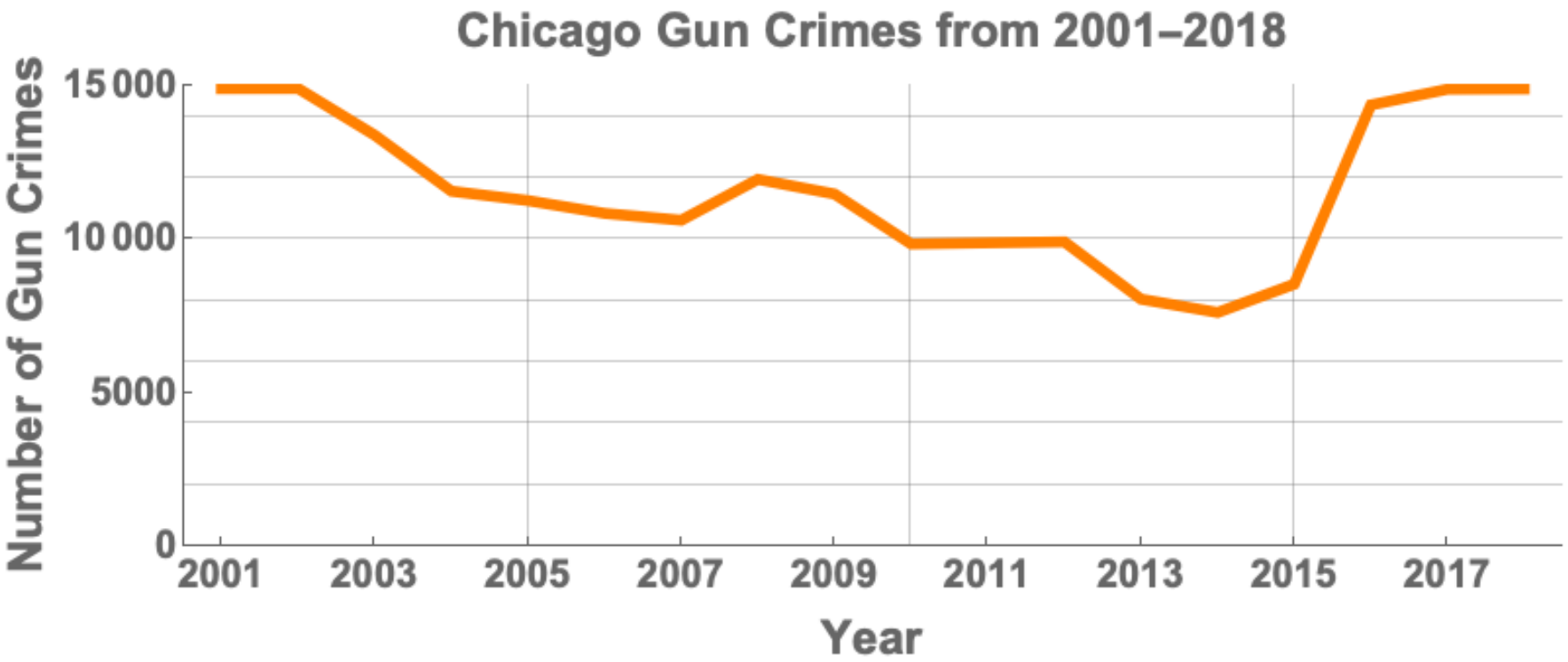
- Adults reporting exposure to gun violence as children showed an increased likelihood for chronic health conditions and risky behaviors

Health Outcome	**Risk Increase**
Heart Disease	2.2
Stroke	2.4
Chronic obstructive lung disease (COPD)	3.9
Hepatitis	2.4
Ecstasy Use	9.2
Marijuana use	2.9
Poor mental health	2.7
Involvement in juvenile justice system	3.5
Use of substances during sex	6.5
Lack of condom use during sex	2.2

Byrdsong 2016 and Voisin 2016

The Impact of Gun Crime in Chicago

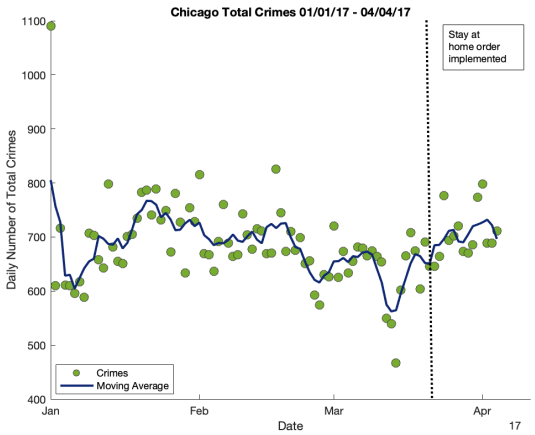
- Past studies have shown a diffusion of gun crime in both space and time
- Between 2015 and 2016 there was a 68% increase in gun crimes, disproportionately affecting disadvantaged neighborhoods
- Data used for this study:
  - Chicago city crime dataset, 2001 - 2017
  - Selected socio-economic indicators in Chicago, 2008 - 2012

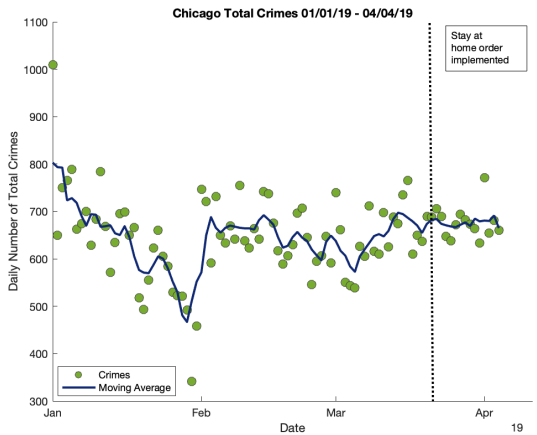


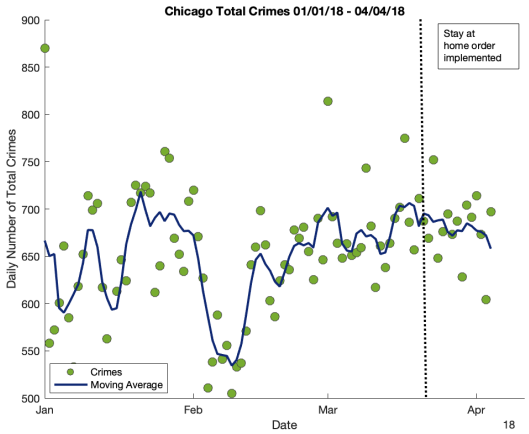
Loeffler and Flaxman 2017, Kapustin 2016, Chicago City Data Portal

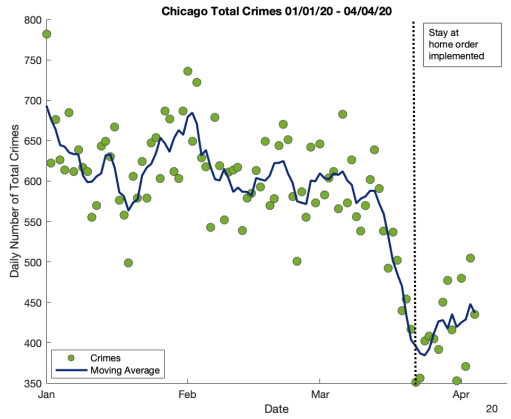
Impact of COVID-19 on Crime

- January 24, 2020: First case of COVID-19 in Chicago
- March 9, 2020: State of Emergency declared
- March 21, 2020: Stay at Home order implemented

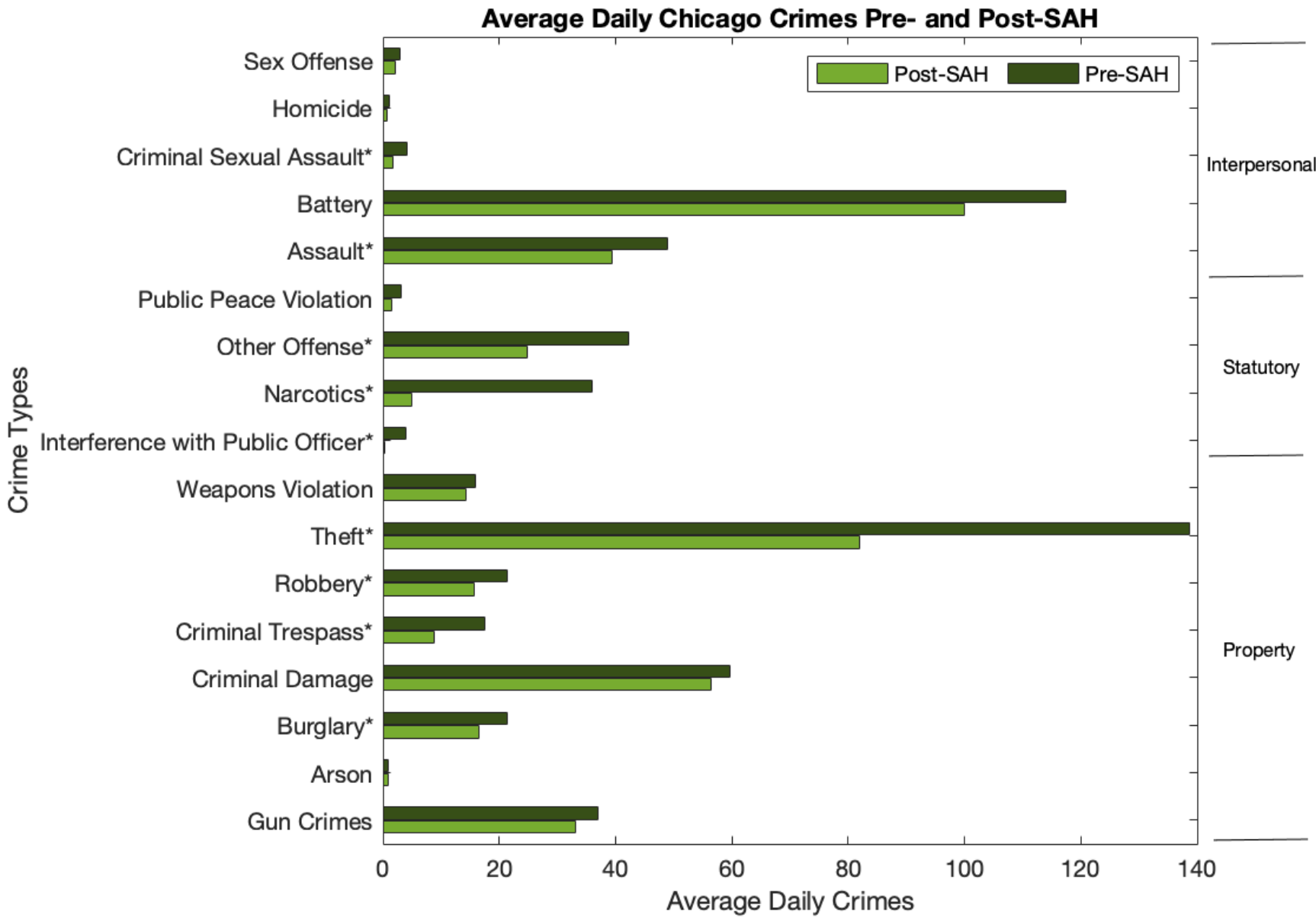








Do the Impacted Crime Types Differ?

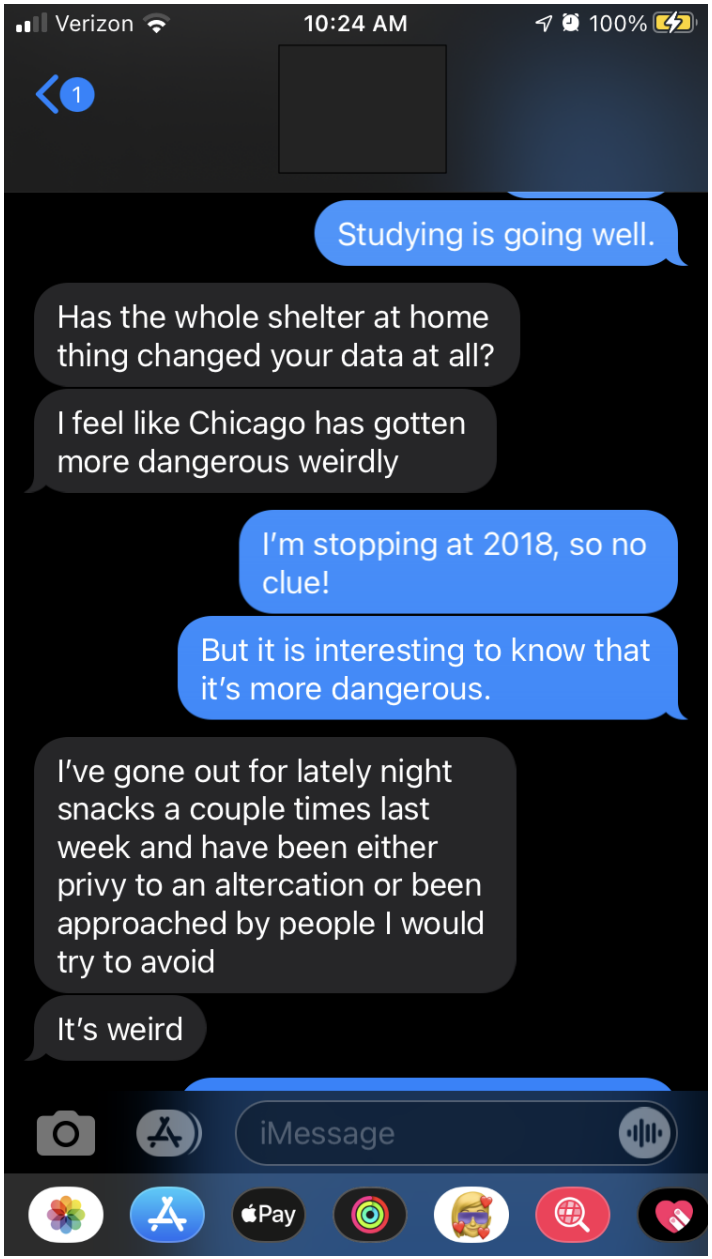


Significant Events Impact Crime

- March 26, 2020: Text from friend in Chicago
- April 3, 2020: Meeting with Lou, during which this topic was mentioned
- July 31, 2020: First manuscript submitted to Science for publication

The Takeaways:

- Research ideas can come from anywhere
- “A quick little paper,” is never quick
- In fact, a quick little paper can become a dissertation chapter



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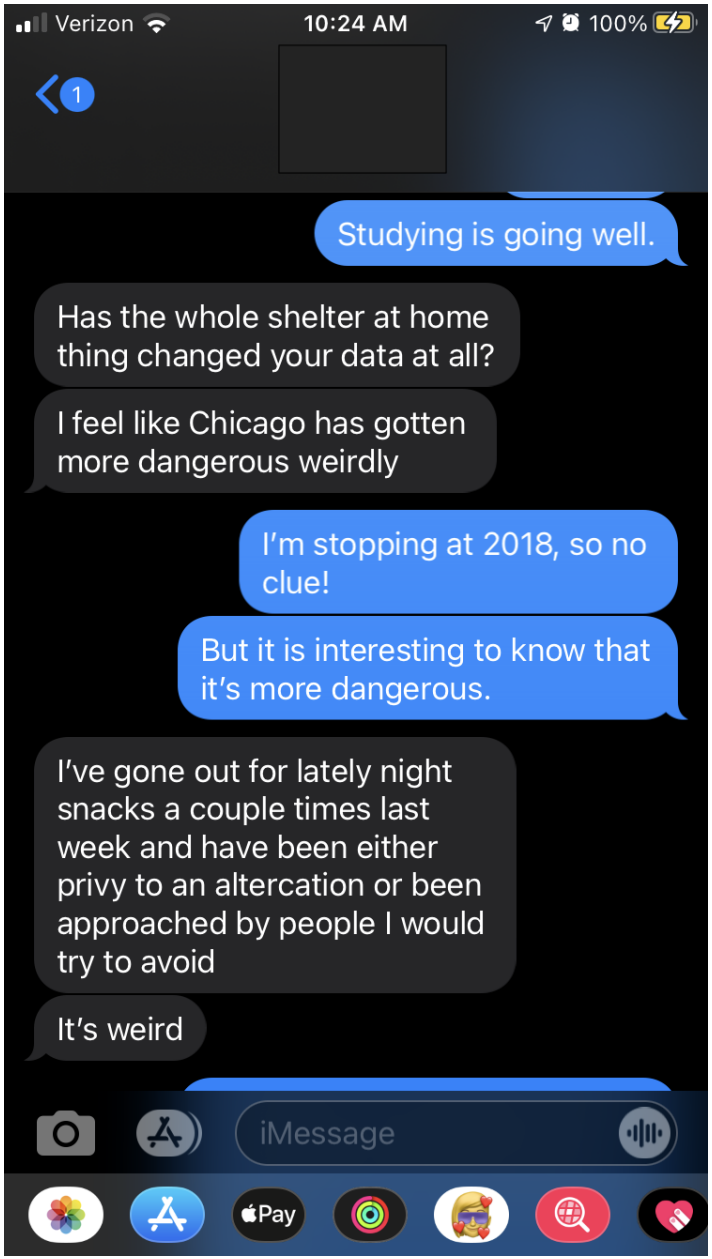


Which socio-economic conditions impact the number of gun crime events?

- Method: Negative Binomial Regression with Subset Selection
- Factors tested:
  - Crowding
  - Poverty
  - Unemployment
  - Education level
  - Dependents
  - Per capita income

Predictor	Coefficient
Poverty	1.0344
Unemployment	1.1123
Dependents	- 0.9477

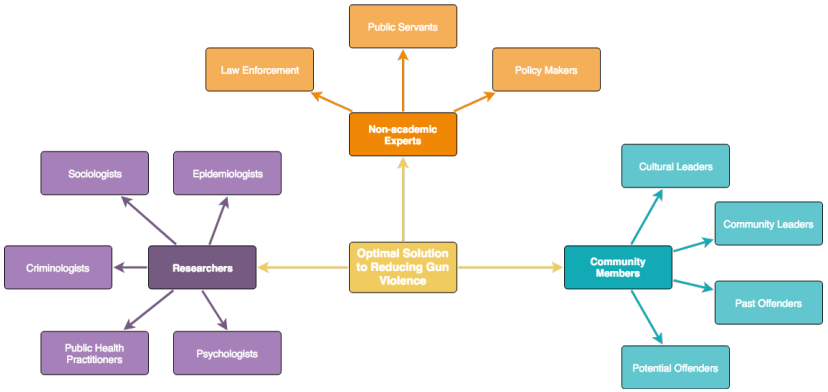
Regression Results

$$log(\text{\# Gun Crimes}) = 4.1258 + 0.0338 * \text{poverty} + 0.1064 * \text{unemployment} - 0.0537 * \text{dependents}$$

How Did Humans Make Things Messy?

Socially/Modeling Purposes

- There is a need for more funding to study gun crime in the United States
- Applying powerful conclusions in practice is more complex than expected
- Systems involving humans require looking at the holistic picture



Research Purposes

- Limitations of identity
- Interdisciplinary work can be lonely
- Life events affecting research

Questions?

What is Consulting?

What is Consulting?

In general:

- Company
- Clients
- Deliverables
- Management

Personally:

- Health Data Science
- Modeling
- Communication of results
- Problem solving
- Teamwork

How Do Humans Make Things Messy?

Methodological Purposes

- Communicating the feasibility of a project to a client
- Meeting the needs of a client when they may not know their own needs
- Compromising on the “best” way to do something when it doesn’t fall within the scope of the project

Personal Purposes

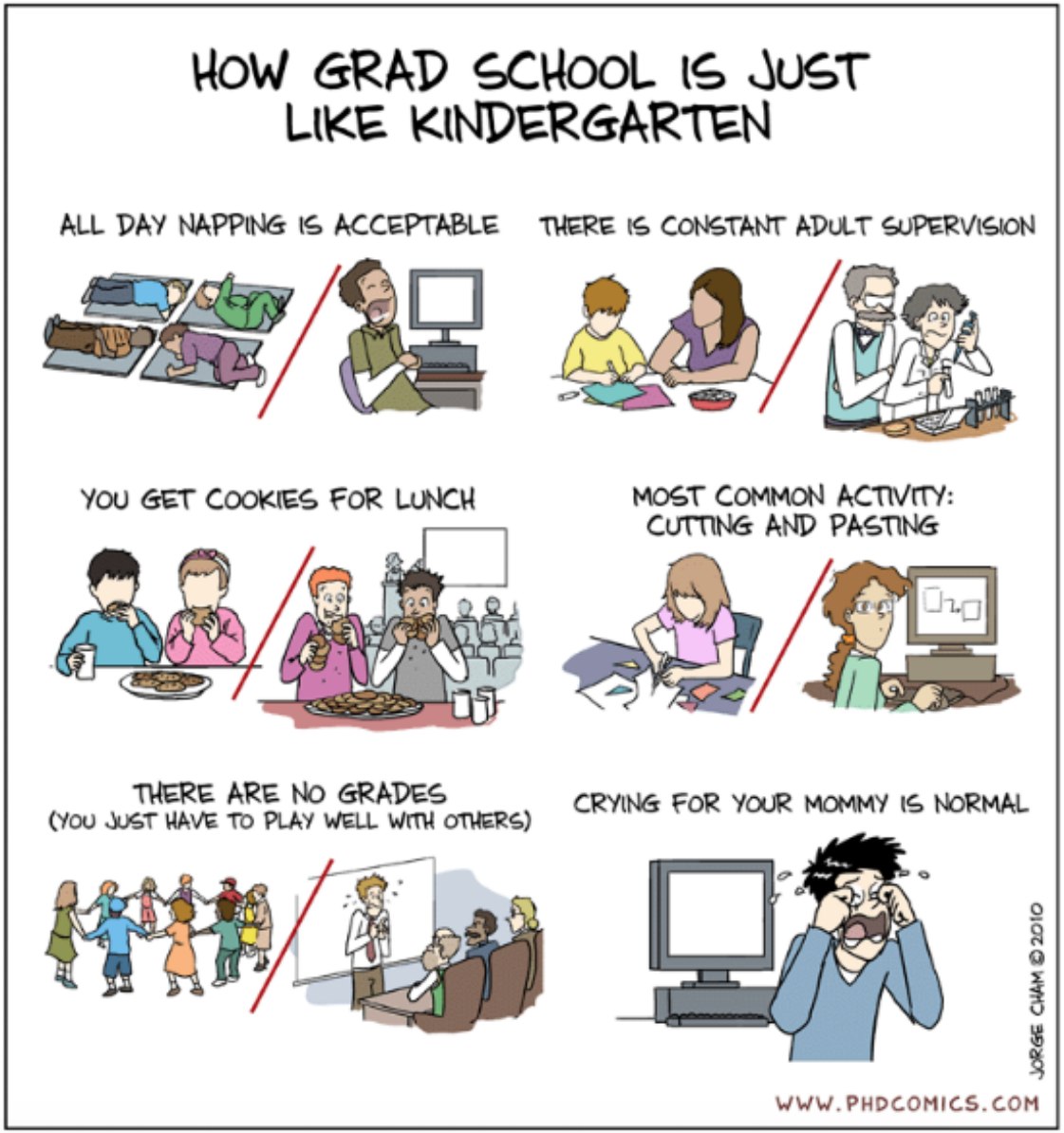
- Remote work in a new field
- Imposter syndrome
- Work boundaries

Client: Nice slide. What’s the source?

Me: We asked our internal expert

Questions?

Graduate School Explained



Things to do in Undergrad: Academic Edition

- Get involved with research:
  - Summer REU Programs
  - Internships and externships
  - Informal experiences
- Attend conferences
- Develop valuable skills:
  - LaTeX
  - Effective Oral and Poster Presentation
  - Coding
  - Teamwork
- Publish (if possible)
- Enroll in classes outside of your major

Things to do in Undergrad: Non-Academic Edition

- Determine your work style
- Find an extra-curricular (or a few)
- Start to develop work-life balance

- Explore your city
- Establish a mentor/mentee relationship
- Develop a support system

Applying for Graduate School

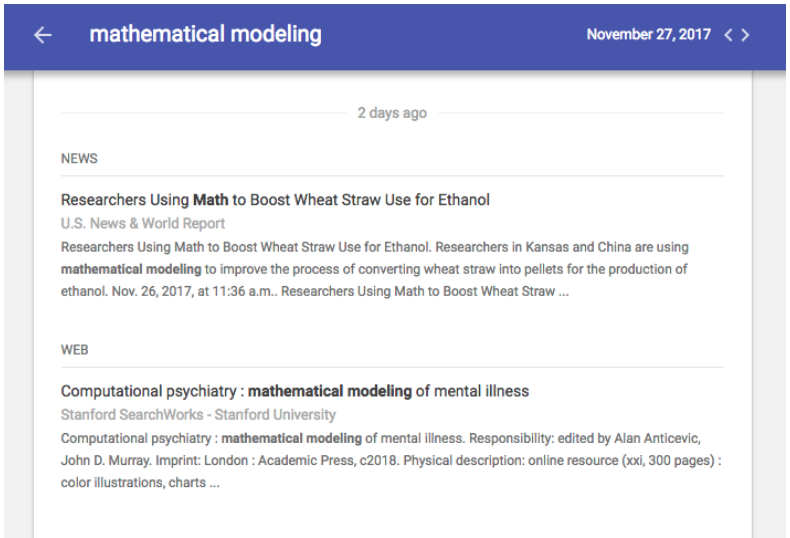
- Step 1: Decide if graduate school is the right path
- Step 2: Question Step 1
- Step 3: Decide that graduate school is the right path
- Step 4: Look for graduate programs

Item #	Date	Time	Recs		Subject
009926	03/02/04	19:18	57		PhD student - Ecological Modeling and Spatial Statistics; Germany
009545	02/12/18	16:24	51		PhD opportunity in Microbial Ecology
009526	02/12/17	11:12	26		PhD graduate assistantship in aquatic and quantitative ecology
009402	02/11/27	09:50	36		PhD assistantship
009331	02/11/19	08:39	42		PhD assistantships in Plant Ecophysiology
009328	02/11/18	14:12	64		PhD Fellowship
009320	02/11/17	15:25	38		PHD Assistantships - announcement
009043	02/10/10	11:18	42		Environmental Sciences PhD program
008965	02/09/27	10:33	59		PhD assistantships in aquatic and/or quantitative ecology, MSU
008863	02/09/11	13:23	33		PhD Graduate Research Assistantship
008785	02/08/30	09:46	37		PhD position in Landscape Modelling
008774	02/08/28	17:35	33		PhD Inquiry
008711	02/08/15	15:34	54		PhD assistantship in tallgrass prairie
008377	02/06/13	16:49	25		Postdoc, Technician, PhD Assistantships in Stream Ecology
008125	02/05/06	17:03	59		PhD assistantships
008126	02/05/05	23:14	92		
007988	02/04/23	20:16	82		Temporary fellowship for European PhD students
007853	02/04/09	12:37	32		Graduate Research Assistantship (PhD) in Land Cover Change
007498	02/03/11	10:50	39		Job posting: PhD Research Fellowship - Coyote Ecology

- Once you have narrowed down your program options:
  - Check for any outstanding course work
  - Find professors you want to work under (and contact them)
  - Ask current graduate students their perspective
  - Look up career trajectories of past students
  - Determine funding availability
- Take the GRE (if necessary)
- Start working on applications ASAP

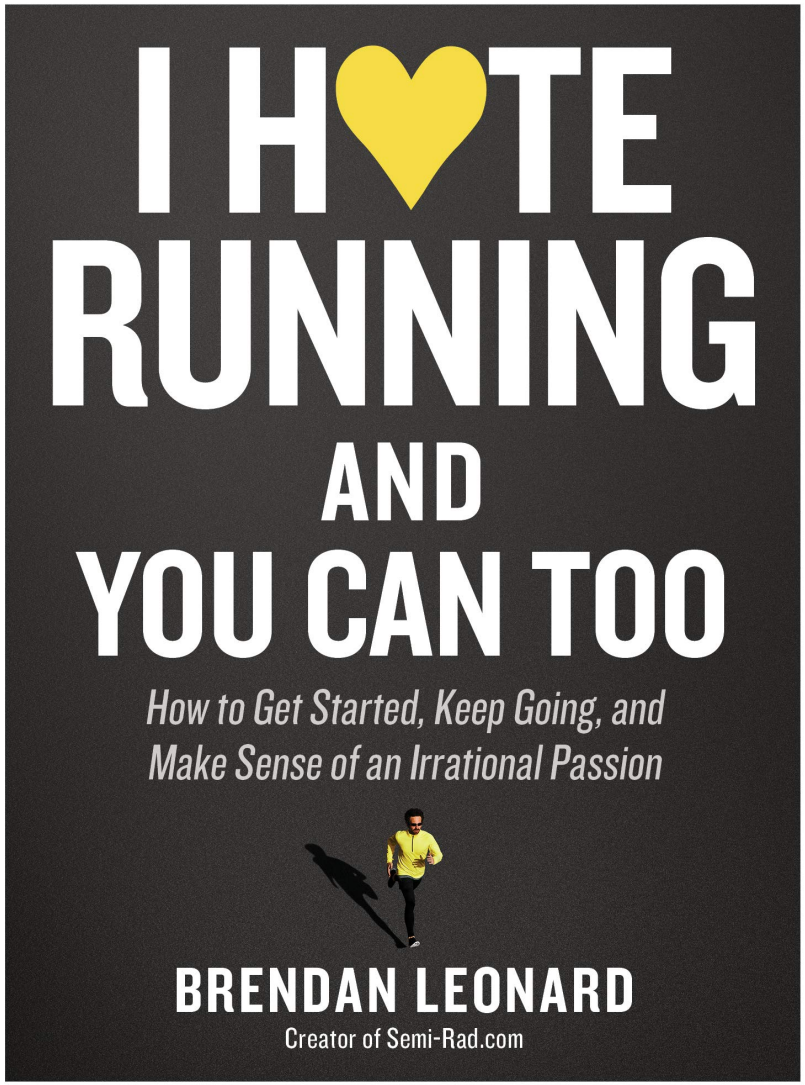
The Interim

- Following the application process:
  - Recruitment Weekend
  - Advisor interviews
  - Decision
- Second-semester senior slump
- Graduation



- Apply for external fellowships
- Prevent burnout
- Stay engaged in the field

For Context


I HATE RUNNING AND YOU CAN TOO
How to Get Started, Keep Going, and Make Sense of an Irrational Passion
BRENDAN LEONARD
Creator of Semi-Rad.com

Introduction: A Complicated Relationship with Science

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- Senior thesis: *An **Agent-Based Model** of **Golden Eagle Predation** on the Santa Cruz **Island Fox***
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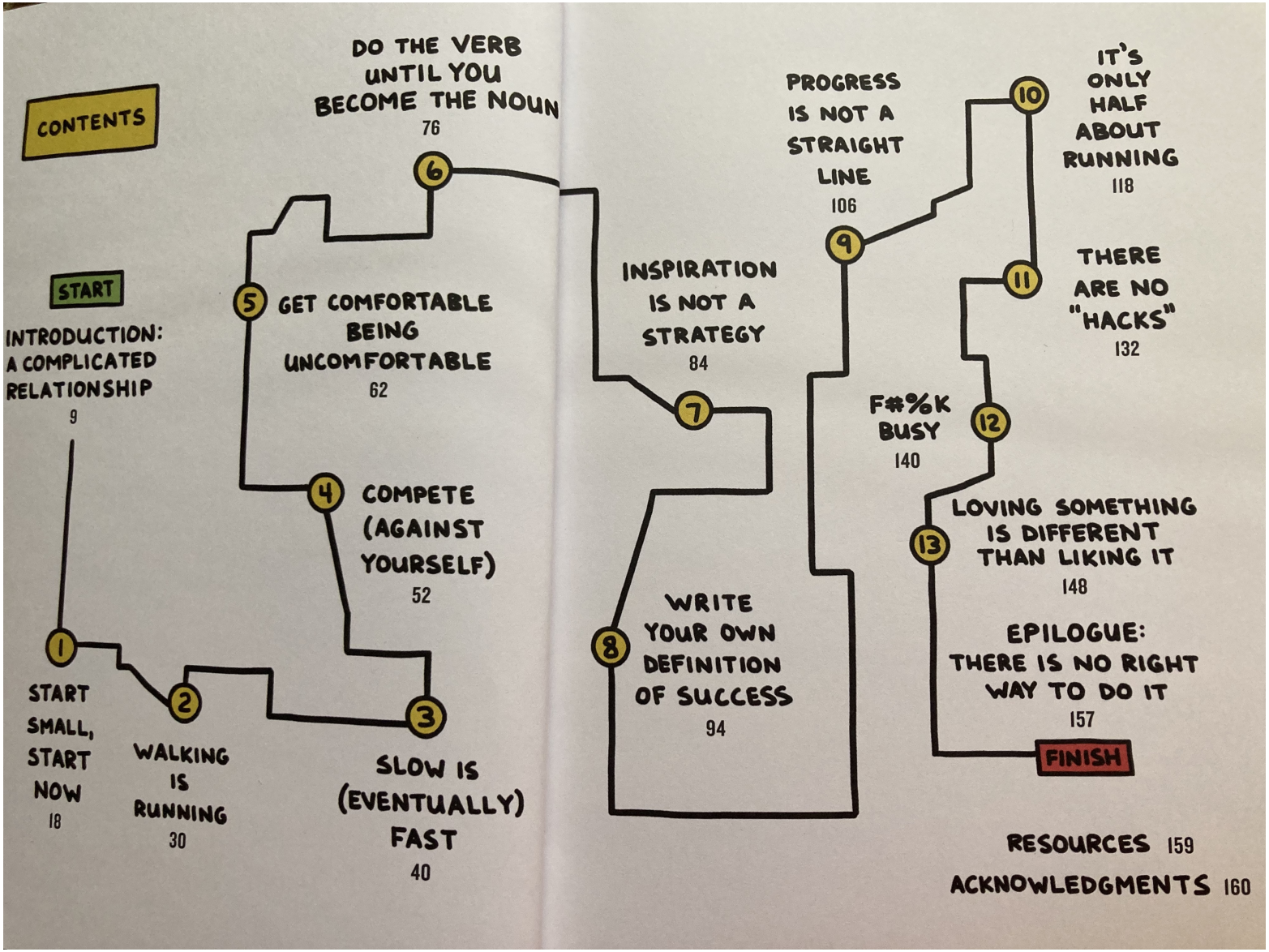
- Dissertation: *Spatio-Temporal Modeling of **Gun Crime** in Chicago, Illinois*
- Currently: **Health Data Scientist** and Senior Consultant at Guidehouse
- Service and Extracurriculars: SMB Education Subgroup, SMB Writing Group, Criminology Writing Group, EKEE Co-Founder and Past President

Overview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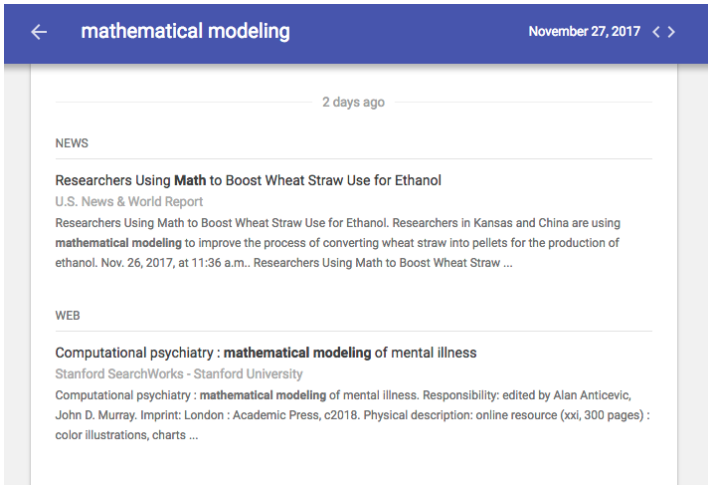
Reading IS Research

- Read, and then read some more
- Google Alerts
- Literature organization



Gun violence, phenomenal reality and parallel worlds: Christina Kallas's multi-protagonist narratives in The Rainbow Experiment
MC Riggio - Journal of Screenwriting, 2021
The second film in writer-director Christina Kallas's New York trilogy, which includes 42 Seconds of Happiness (2016) and Paris is in Harlem (forthcoming), The Rainbow Experiment (2018) portrays the powerful but flawed American experiment. Its script …

Evaluating the impact of Project Safe Neighborhoods (PSN) initiative on **violence** and **gun** crime in Tampa: does it work and does it last?
B Fox, SF Allen, A Toth - Journal of Experimental Criminology, 2021
Project Safe Neighborhoods (PSN) is an increasingly popular **violence** and **gun** crime prevention program which aims to identify prolific violent offenders, and deter or incapacitate them from offending. While PSN programs generally show moderate …

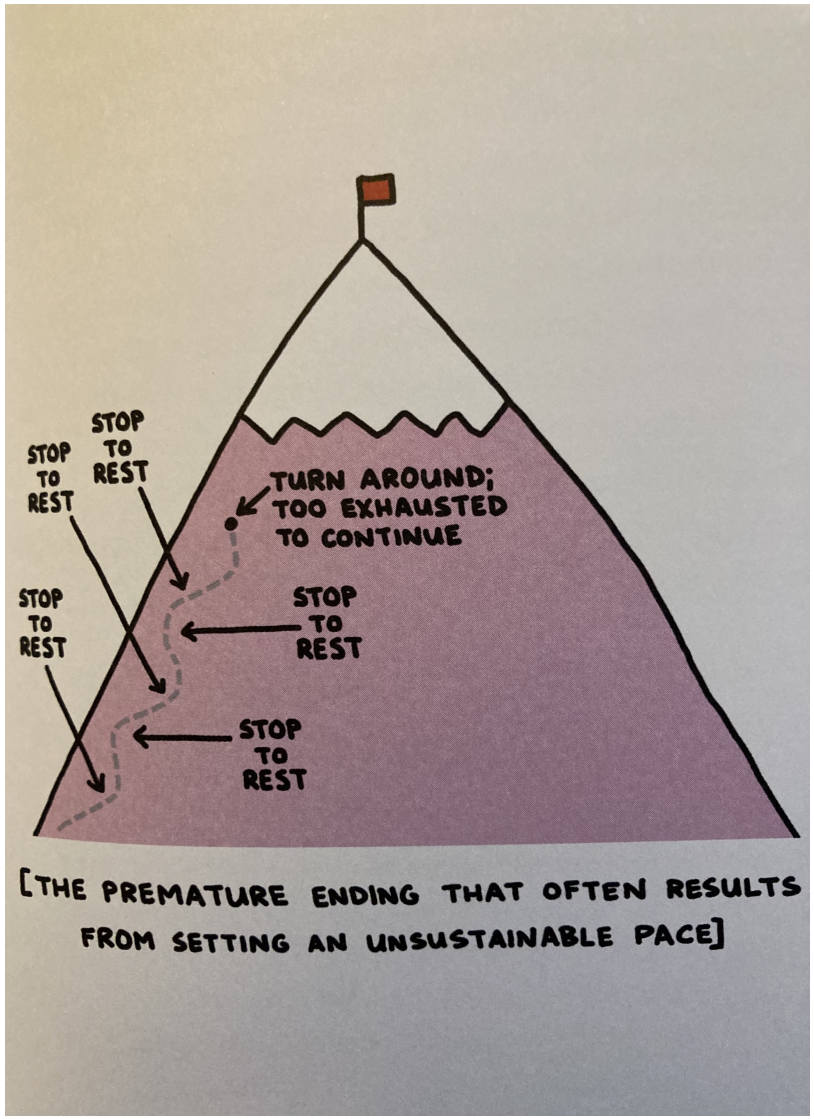
Integrating the Literature on Lethal **Violence**: A Comparison of Mass Murder, Homicide, and Homicide-Suicide
EE Fridel - Homicide Studies, 2021
… Tips on citation download. Download Citation. Download article citation data for: Integrating the Literature on Lethal **Violence**: A Comparison of Mass Murder, Homicide, and Homicide-Suicide. Emma E. Fridel. Homicide Studies 0 …

Existing Crime Models Paper Breakdown

Paper Title	Authors	Journal	Year	Question Asked	Method Used	Major Conclusion
Novel evaluation metrics for sparse spatio-temporal point process hotspot predictions - a crime case study	Monsuru Adepeju, Gabriel Rosser, Tao Cheng	International Journal of Geographical Information Science	2016	Develop a practical toolkit of evaluation metrics for spatio-temporal point process predictions	Spatio-temporal point process	The developed toolkit of evaluation metrics can be used to determine the accuracy, compactness, dynamic variability, and complimentarity of sparse spatio-temporal point process observations.
An Exploratory Analysis of Guns and Violent Crime in a Cross-National Sample of Cities	Irshad Altheimer	Southwest Journal of Criminal Justice	2010	Examines the relationship between gun availability and crime in a cross-national sample of cities	Limited information maximum least squares regression	Gun availability influences rates of assault, gun assault, robbery, and gun robbery. Increasing city levels of gun availability increases the likelihood that violent crimes are committed and that guns are involved in these crimes
A Secondary Spatial Analysis of Gun Violence near Boston Schools: a Public Health Approach	Gia Barboza	Journal of Urban Health	2018	Quantify the concentration of shootings near schools to elucidate the place-based dynamics that may be focal points for violence prevention; determine the degree of spatial dependence of shootings around schools	Spatial statistics for point pattern data: distance matrix and K function methodology	1. In Boston between 2012 and 2015, there was a clustered pattern of gun shooting incidents indicative of a spatially non-random process; 2. A significantly greater number of shootings were clustered within short distances from schools
Neighborhood Co-Offending Networks, Structural Embeddedness, and Violent Crime in Chicago	Sara Bastomski, Noli Brazil, Andrew Papachristos	Social Networks	2017	Examines the role of neighborhood-level criminal networks in shaping the distribution of crime throughout cities. Investigate how a focal neighborhood's homicide rate is influenced by its structural embeddedness within the larger inter-neighborhood co-offending network	Network models	A neighborhood's embeddedness increases the local homicide rate, even after controlling for the neighborhood's internal propensity toward crime and accounting for unobserved spatial processes
Robberies in Chicago: A Block-Level Analysis of the Influence of Crime Generators, Crime Attractors, and Offender Anchor Points	Wim Bernasco, Richard Block	Journal of Research in Crime and Delinquency	2010	Examine the effects of crime generators, crime attractors, and offender anchor points on the distribution of street robberies across the 25,000 census blocks of Chicago	Negative binomial model	Blocks that host crime attractors and generators not only have elevated numbers of robbery themselves, but also radiate their elevated crime risk to adjacent blocks. Modeling effects of the spatial environment in situations where the spatial units of analysis are

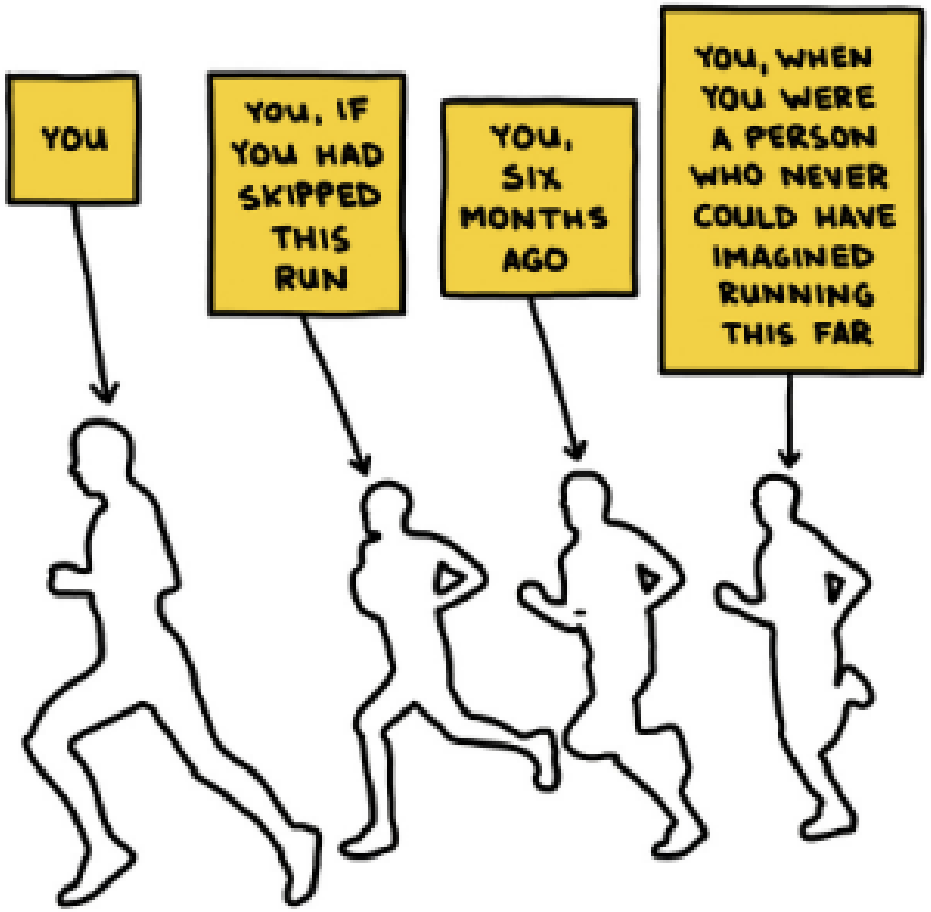
Slow is (Eventually) Fast

- 1. Undergrad vs. Grad: Tasks take less time now and are less intimidating
- 2. If you, “go out too fast,” you’ll burn out.



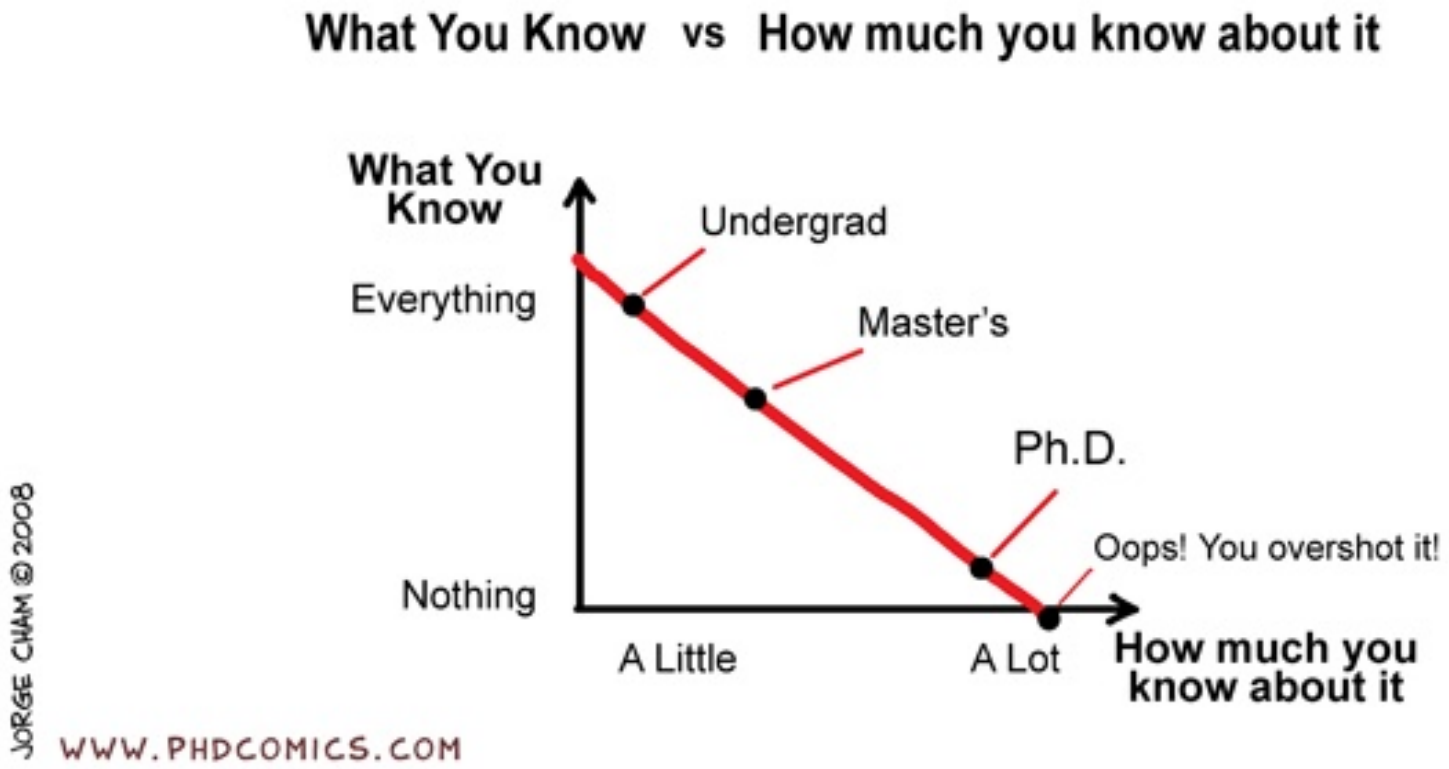
Compete (Against Yourself)

- Your PhD is an individual event
- Grad school is a team sport
- Imposter Syndrome is the worst



Get Comfortable Being Uncomfortable

- Interdisciplinary work means interacting with and establishing new contacts
- This means new conferences and new collaborations
- You'll quickly learn: you know nothing



Do the Verb Until You Become the Noun

How to become an Applied Mathematician

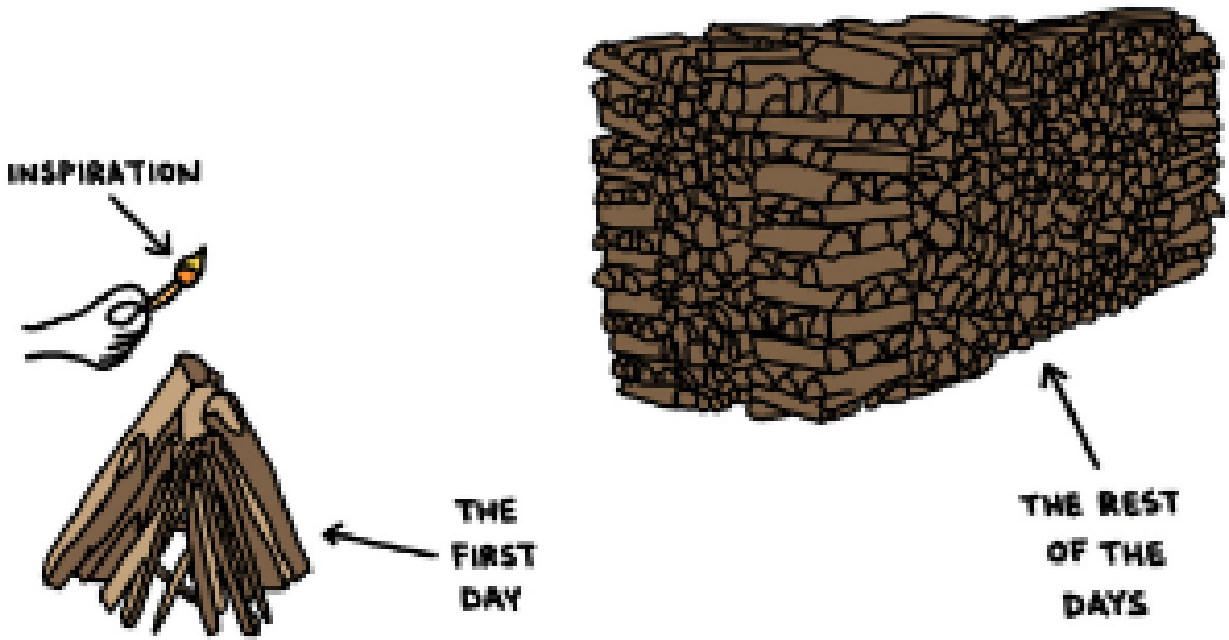
$$\text{Applied Mathematician} = \int_0^n n(\text{Apply Math}), \tag{1}$$

where n is the number of times you apply math.

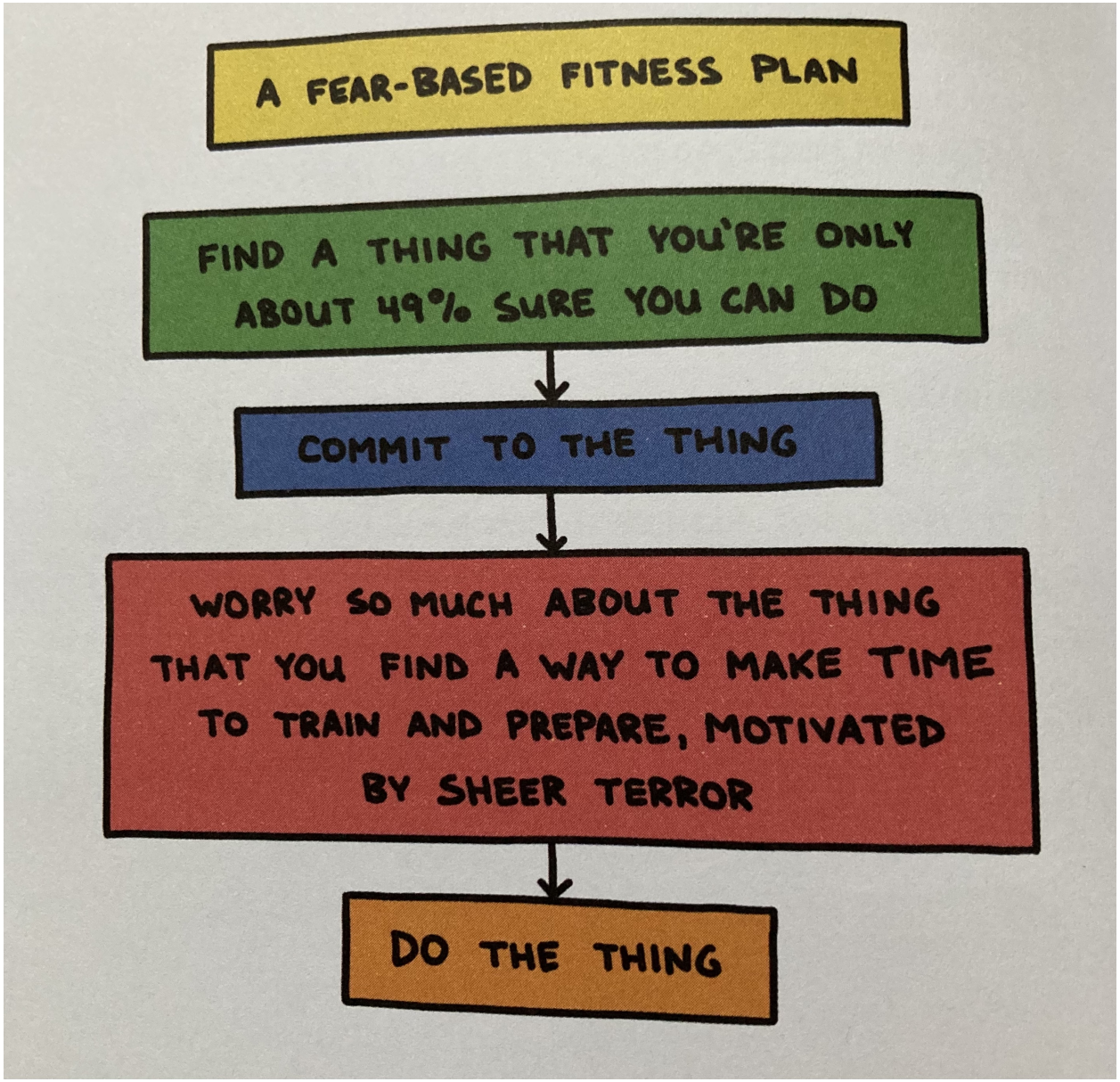
- If you do something often enough, it starts to become your academic identity
- This can be hard and soft skills – choose wisely
- Practice doesn't necessarily make perfect, but practice does make permanent

Inspiration is (Unfortunately) Not a Strategy

- Inspiration isn't enough
- Find your fuel
- Planning is important



A Fear-Based PhD Plan



Write Your Own Definition of Success

What makes a successful PhD Candidate?

- Papers published
- Conferences attended
- Courses taken
- Dissertation quality/length
- Service

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What makes a successful person?

- Focus and self-control
- Perspective
- Communication
- Making Connections
- Critical Thinking
- Taking on Challenges
- Self-Directed, Engaged Learning

Write Your Own Definition of Success

What makes a successful PhD Candidate?

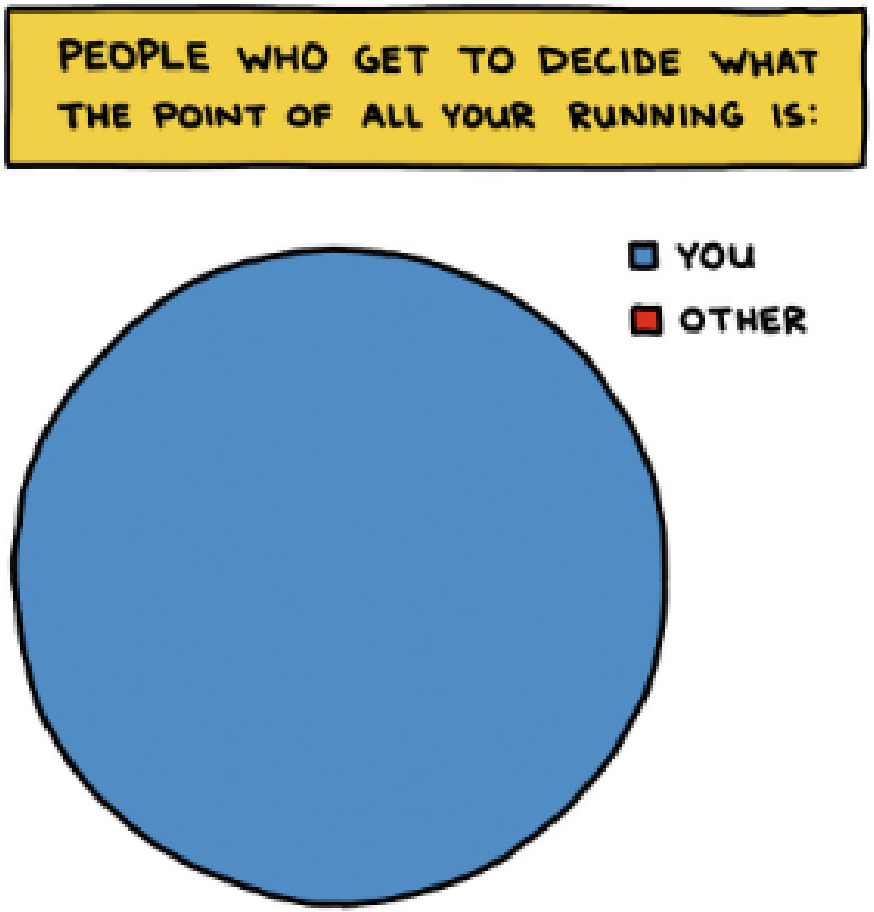
- Papers published
- Conferences attended
- Courses taken
- Dissertation quality/length
- Service

What makes a successful person?

- Focus and self-control
- Perspective
- Communication
- Making Connections
- Critical Thinking
- Taking on Challenges
- Self-Directed, Engaged Learning

Write Your Own Definition of Success

- What do you want to do after a PhD?
- Who do you want to be after a PhD?



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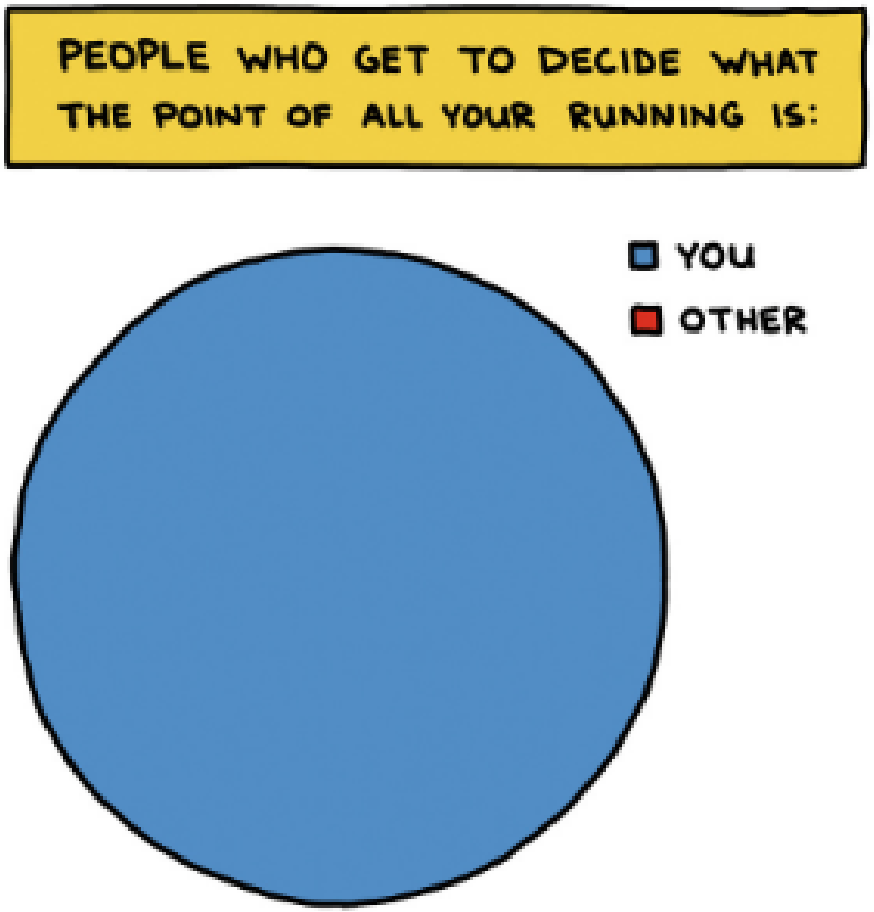
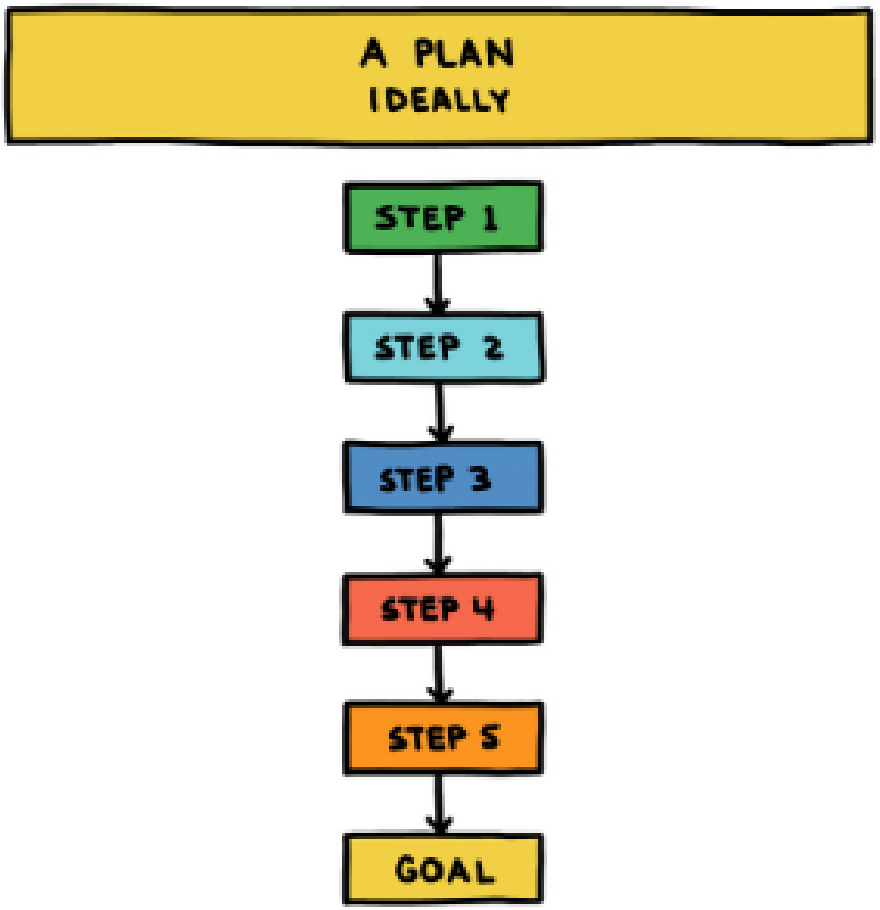


Progress is Not a Straight Line



- Step 1: Get into PhD program
- Step 2: Pass qualifying exam
- Step 3: Pass comprehensive exam
- Step 4: Defend dissertation
- Step 5: Graduate, get dream job.

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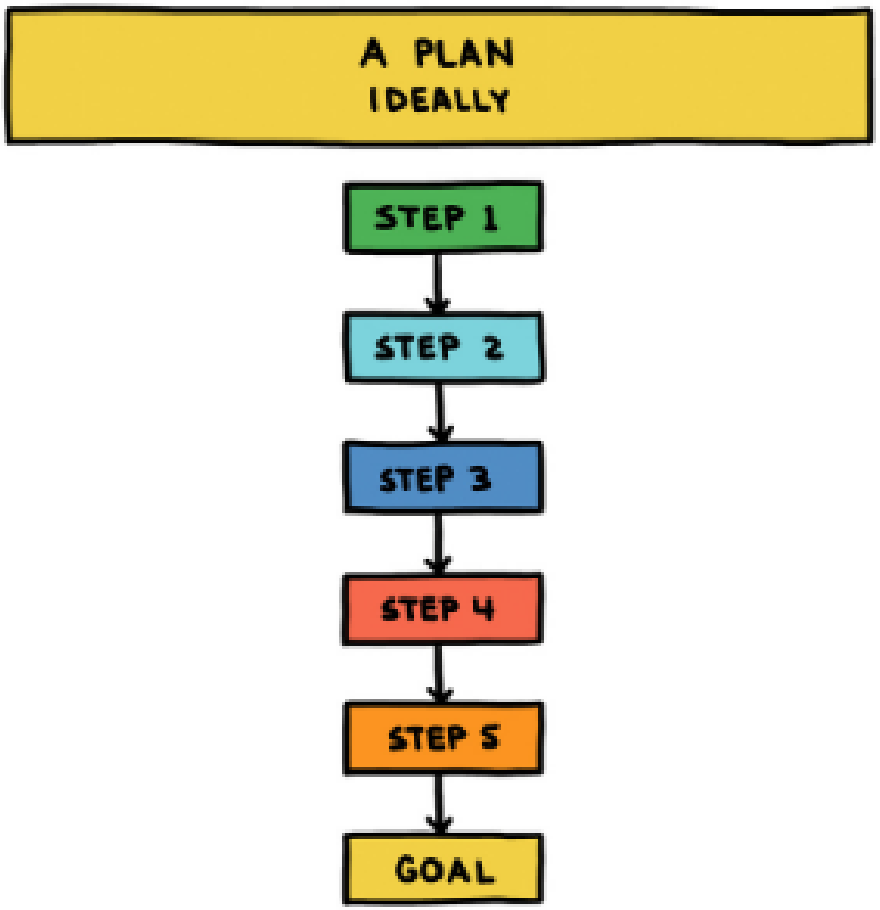

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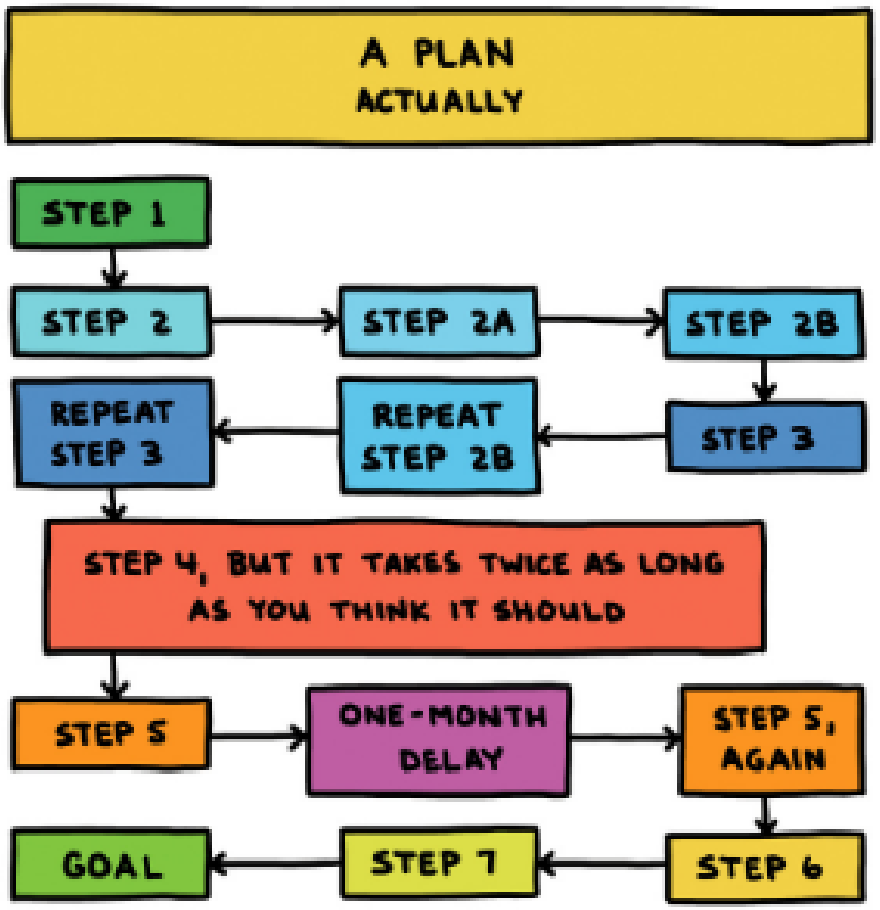


It's Only Half About Science - The Science

An Agent-Based Model of Santa Cruz Island Foxes (Urocyon littoralis santacruzae) which Exhibits an Allee Effect

Shelby M. Scott, Erin N. Bodine & Anne Yust

Technology as a tool in teaching quantitative biology at the secondary and undergraduate levels: a review

Miranda M. Chen, S. M. Scott & Jessica D. Stevens

An Agent-Based Model of the Spatial Distribution and Density of the Santa Cruz Island Fox

Shelby M. Scott*, Casey E. Middleton† and Erin N. Bodine[1,†]

A Report from the NIMBioS/DySoC Investigative Workshop on the Mathematics of Gun Violence

Shelby Scott

COVID-19 and crime: Analysis of crime dynamics amidst social distancing protocols

Shelby M. Scott*[1¶#a], Louis J. Gross[1,2&]

It's Only Half About Science - The Not-Science

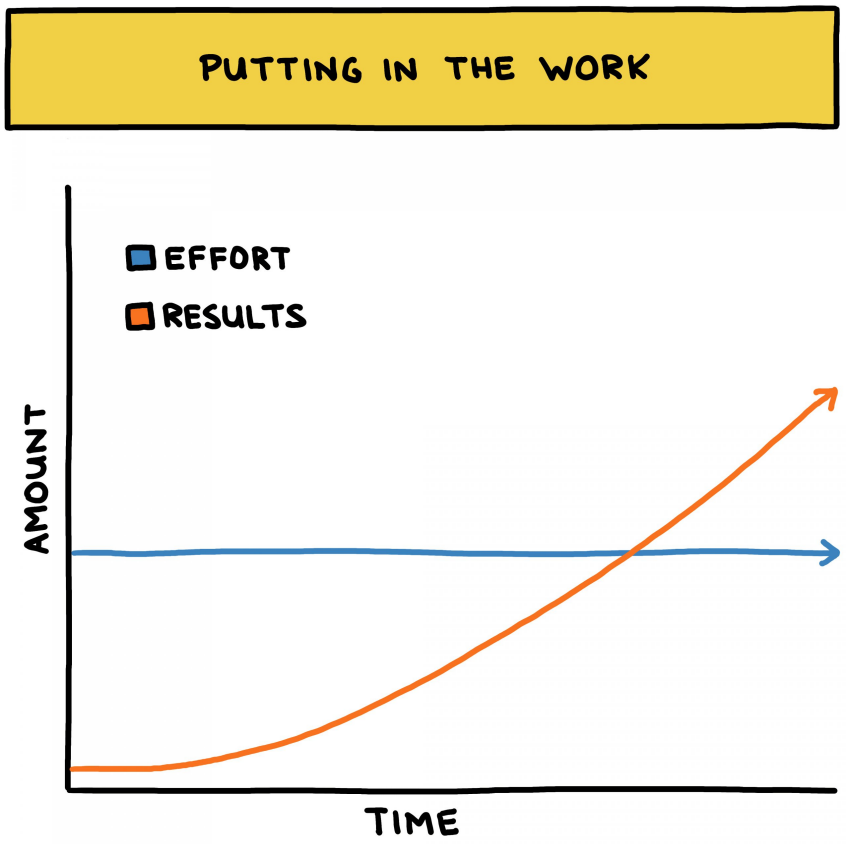
It's Only Half About Science - The Not-Science

It's Only Half About Science - The Not-Science

There Are No “Hacks”

At some point, you just have to:

- Read the textbook
- Learn the coding language
- Write the manuscript
- Ask for help



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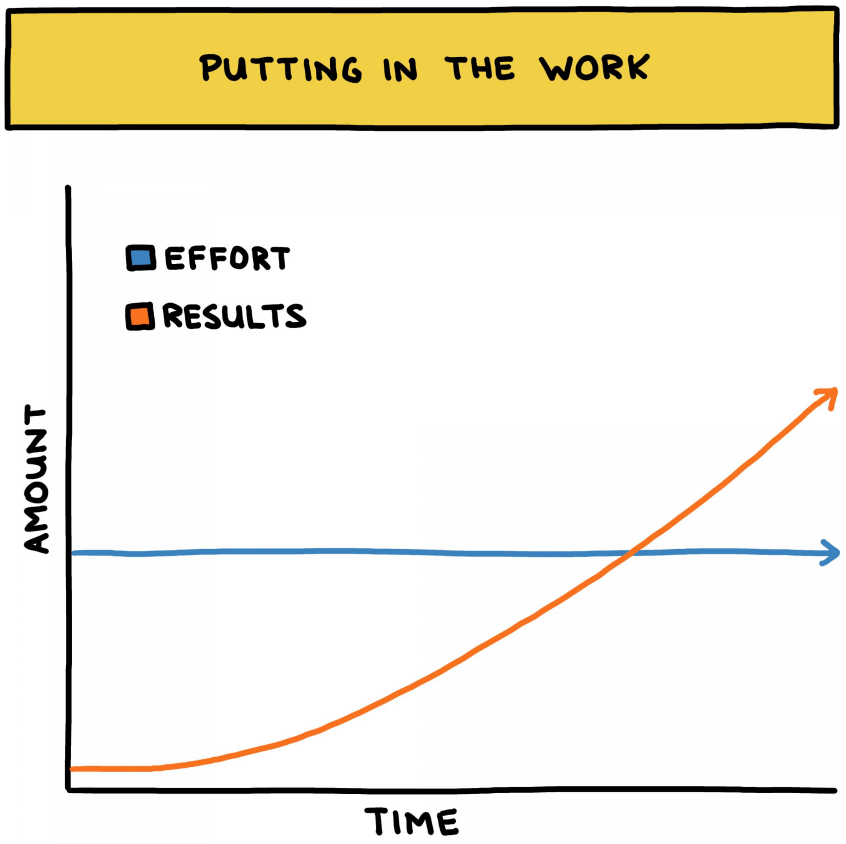
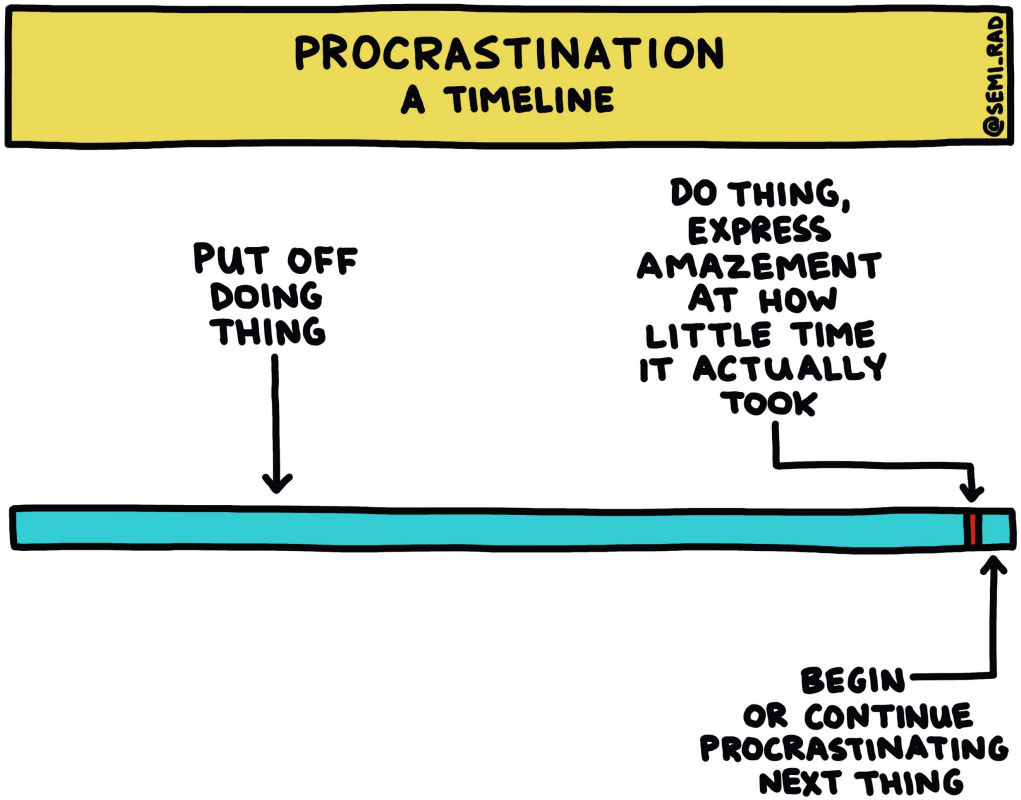


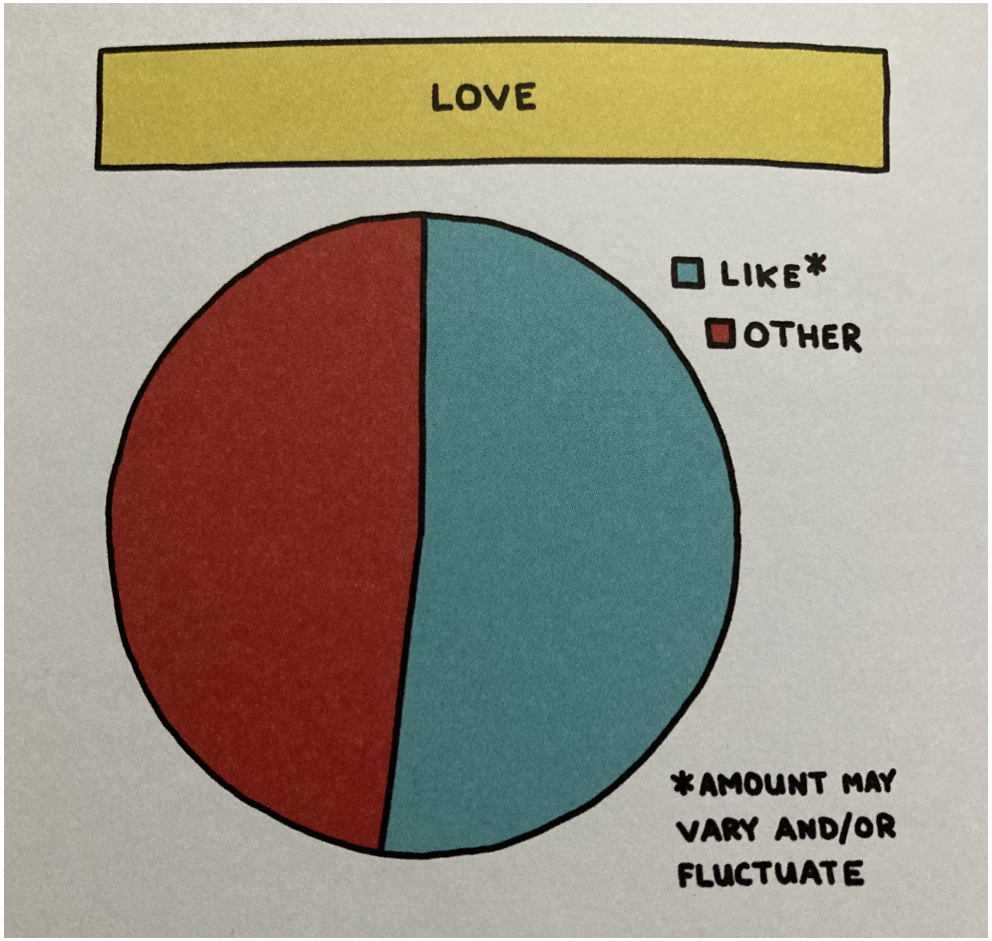
Screw Busy

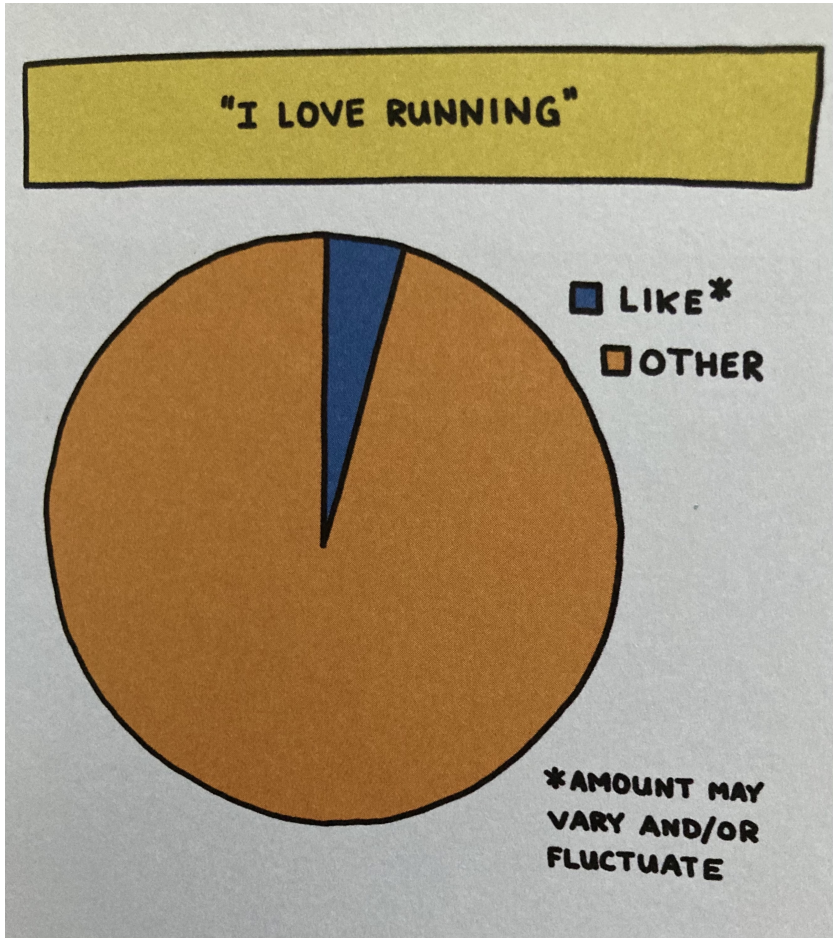
- Graduate school is a master class in time management
- You can be as busy as you want to be*



* This will differ based on your non-grad school responsibilities. Parents – how are you doing?

Loving Something is Different from Liking It





Epilogue: There is No Right Way to Do It

Questions?