

Writing a Compelling Statement of Purpose

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HIXON WRITING CENTER

Statement of Purpose Packet



Approaching the Graduate School Statement of Purpose

In general, a statement of purpose for admission to graduate school should tell your reader:

- Why you are compelled to do further study and research
- How you have become qualified to pursue that study and research
- What you hope to learn and what knowledge you want to produce
- Why this graduate school is the ideal next step for you

In the early stages of developing the statement, writers generally negotiate the following concerns:

1. How "personal" should the statement of purpose be?
 - A good statement is personal. It should showcase details about your intellectual background and goals that could not be in anyone else's statement.
 - Personal does not mean emotional. It means telling the unique story of your intellectual development. Rather than construct a narrative driven primarily by emotion, emphasize the evolution of your intellectual interests.
2. What kind of a history is appropriate to this genre?
 - Don't focus on narrating your initial discovery of your interest in your field. Unlike with undergraduate admissions essays, readers skim or skip such stories, because this information is perceived to be less relevant to your fitness for a graduate program. Do describe specific study and research experiences and explain how these experiences have motivated and prepared you to pursue advanced research in graduate school. If you did something exceptional in high school, it may be worth mentioning that work, but keep the primary focus on your work as an undergraduate and beyond.
3. What's the right balance in the statement between the work you've done so far and what you want to do?
 - Prioritize discussing interesting questions and findings that emerged out of your research and study experiences. This may include limitations that you found in one context that prompted you to seek out a different set of circumstances for future work. If you're not sure what your take-away was from a certain experience or how it relates to your desired field of study, look back on any documents you generated from those experiences (e.g. SURF reports).
 - Show your literacy in the field, including knowledge of current trends and leading research questions, as well as experience with of key methodologies or materials.
 - Connect past/current work to future research plans, i.e., questions or problems that you want to investigate (or that you need further training to be equipped to answer).

You'll find:

1. Approaching the Graduate School Statement of Purpose*
2. Get Inside Your Readers' Minds
3. Get To Know Your Schools
4. Develop Your Communication Goals
5. Meaning Making Worksheet
6. Drafting an Outline
7. Customize Your Statement
8. Make a Revision Plan
9. Seeking Feedback
10. Navigating Feedback
11. Editing Your Own Draft Checklist

* https://writing.sites.caltech.edu/documents/19385/Approaching_the_Graduate_School_Statement_of_Purpose_05_03_21.pdf

Workshop Goals

- Define the Statement of Purpose (SOP)
- Review strategies for writing the SOP
- Review approaches of the Introduction, Writing About Research Goals, Writing About Research Experience, Customizing Your Statement (with examples)
- Post-Workshop Q&A

Feel free to ask questions in the chat during the presentation!

Statement of Purpose

you as a researcher

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Personal Statement

you as a person

The Statement of Purpose (SOP)

A way for you to communicate:

- Why you are compelled to pursue a graduate degree in your field
- What skills/experiences qualify you to pursue a graduate degree
- What you hope to learn and what knowledge you want to produce while in grad school
- Why you have chosen this specific grad school
- What you plan to do with a graduate degree once you get it
- That you have the discipline/the drive to pursue a graduate degree

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- That you have the discipline/the drive to pursue a graduate degree

Discovery process:

Writing your SOP can help you *define and refine* who you are as a scientist, your research and career goals, and your reasons for pursuing graduate work.

Format



Greg Copeland, Paul Maier's
*Martin Luther: A Man Who
Changed the World*

- Typically 800-1,500 words, with a majority being 1,000 words
- Aim for no more than 2 pages if there is no word count specified
- 1 inch margins 11-12pt font unless indicated otherwise (don't use too much sorcery to get your statement to fit the page limit)

Get Inside Your Readers' Minds

Spend some time thinking about what your reader needs from you and how they will read your statement.



Illustration: uscourts

Get Inside Your Readers' Minds

**Extremely
busy!**



**They know who
they're looking for:
well-prepared
students!**

**Want to find evidence of this in CV,
transcript, letters, and SOP.**

Illustration: Ally Jaye Reeves

Get Inside Your Readers' Minds

You are also looking for students who will succeed in graduate school. The Statement of Purpose is key because a CV and transcript do not reveal this.



Illustration:
uscourts

Looking For Signs of Success

Are you genuinely interested in and dedicated to this field? Do you really want to do this? Do you understand what you're getting yourself into?

Grad school is a long, windy road with many bumps. Are you resilient? Can you make adversity and failure a productive part of learning?



Illustration:
uscourts

Looking For Signs of Success

Do you understand this field and how we solve problems?

Can you demonstrate original thinking in the way you've tackled research problems?



Illustration:
uscourts

Looking For Signs of Success

We're going to write a paper together some day (hopefully several) and maybe a few grant proposals. How well do you write?



Illustration:
uscourts

Get Inside Your Readers' Minds

- Diverse students from varied backgrounds
- A good fit for the program



Illustration: Ally Jaye Reeves

Write Down What You Want to Study

1-3 sentences of what you want to study.

Think beyond the field (machine learning versus computer science, and building novel technologies for biomedical imaging vs bioengineering).

Get To Know Your Schools

Search the program's website for:

- profiles and websites of 3-5 faculty you are interested in working with and their areas of specialization
- a list of these faculty members' recent research papers
- the department's mission statement and research program goals
- unique programs, seminars, or organizations that you are excited to participate in through your research, teaching, or community outreach
- the university's mission statement

Stay Organized



Illustration: Ally Jaye Reeves

Stay Organized

	A	B	C	D	E	F	G
1	Graduate Schools in Biology						
2							
3							
4		Professors	Website Description	Website	Papers	My Interest	
5	Caltech BBE	Pamela J. Bjorkman	Our laboratory is interested in immune recognition of viral pathogens. We are particularly interested in understanding the immune response against HIV-1 and influenza in order to develop improved therapeutics. We use X-ray crystallography, electron microscopy, and biochemistry to study pathogen envelope glycoproteins and host immune response proteins. Using structural information and alternate antibody architectures, we are engineering antibody-based reagents with increased potency and breadth. We are also investigating the structural correlates of broad and potent antibody-mediated neutralization of HIV-1 to better understand what leads to naturally-occurring broad and potent antibodies. In related work, we use 3D imaging techniques such as electron tomography and fluorescent microscopy to investigate HIV/SIV infection in animal and human tissues. Examples of our research are described below.	http://www.bbe.caltech.edu/content/pamela.j.bjorkman	a. Bjorkman PJ, MA Saper, B Samraoui, WS Bennett, JL Strominger and DC Wiley. (1987) Structure of the human class I histocompatibility antigen, HLA-A2. Nature 329:506-512. b. Bjorkman PJ, MA Saper, B Samraoui, WS Bennett, JL Strominger and DC Wiley. (1987) The foreign antigen binding site and T cell recognition regions of class I histocompatibility antigens. Nature 329:512-518.	My previous research experience involved studying immune recognition of viral pathogens. I'm interested in understanding the immune response against HIV-1 in order to develop improved therapeutics.	
6		David Van Valen	Our group studies how living systems and their respective viruses encode and decode information about their internal state and their environment by combining ideas from cell biology and physics with recent advances in imaging, machine learning, and genomics to make novel measurements.	http://www.vanvalen.caltech.edu/	bioRxiv 10.1101/305032v3	I'm interested in applying my programming skills to understanding how viruses access information about their host cell's environment and internal state.	
7							
8							

Find Statement Prompts

Keep track of each school's SOP prompt, which can be found on the program's website or the application portal. Remember: this statement may be titled differently, e.g. Statement of Intent, Statement of Objectives, and even "Personal Statement".

Also, some schools don't have a prompt.



Illustration: Ally Jaye Reeves

Example Prompt (from Caltech)

Provide a brief statement of your scientific and professional interests and objectives. Include a description of your past accomplishments that are not evident from the examination of other documents submitted. Report, if applicable, on any research in progress.

Example Prompt (from UC Berkeley)

The statement of purpose should convince readers– the faculty on the selection committee– that you have solid achievements behind you that show promise for your success in graduate study. Think of the statement of purpose as a composition with four different parts.

Part 1: Introduce yourself, your interests and motivations

Tell them what you're interested in, and perhaps, what sparked your desire for graduate study. This should be short and to the point; don't spend a great deal of time on autobiography.

Part 2: Summarize your undergraduate and previous graduate career

a) Research you conducted. Indicate with whom, the title of the project, what your responsibilities were, and the outcome. Write technically, or in the style of your discipline. Professors are the people who read these statements.

b) Important paper or thesis project you completed, as well as anything scholarly beyond your curricular requirements.

c) Work experience, especially if you had any kind of responsibility for testing, designing, researching or interning in an area similar to what you wish to study in graduate school.

Part 3: Discuss the relevance of your recent and current activities

If you graduated and worked prior to returning to grad school, indicate what you've been doing: company or non-profit, your work/design team, responsibilities, what you learned. You can also indicate here how this helped you focus your graduate studies.

Part 4: Elaborate on your academic interests

Here you indicate what you would like to study in graduate school in enough detail to convince the faculty that you understand the scope of research in their discipline, and are engaged with current research themes.

a) Indicate the area of your interests. Ideally, pose a question, define a problem, or indicate a theme that you would like to address, and questions that arise from contemporary research. This should be an ample paragraph!

b) Look on the web for information about departments you're interested in, including professors and their research. Are there professors whose research interests parallel yours? If so, indicate this. Check the specific program; many may require you to name a professor or professors with whom you might work.

c) End your statement in a positive manner, indicating your excitement and readiness for the challenges ahead of you.



Managing Multiple Statements

Do I really need to write a different statement for every school/program I apply to?

Can I write a “base” draft and from that build a unique statement for every school?

If I want to write a different statement for every school/program, how do I do manage this?



Illustration: Ally Jaye Reeves

Reframing Questions as Communication Goals

- gives you freedom in choosing the experiences that will best demonstrate these qualities and how you might organize this information.
- allows you to draft a statement that will work for many schools.

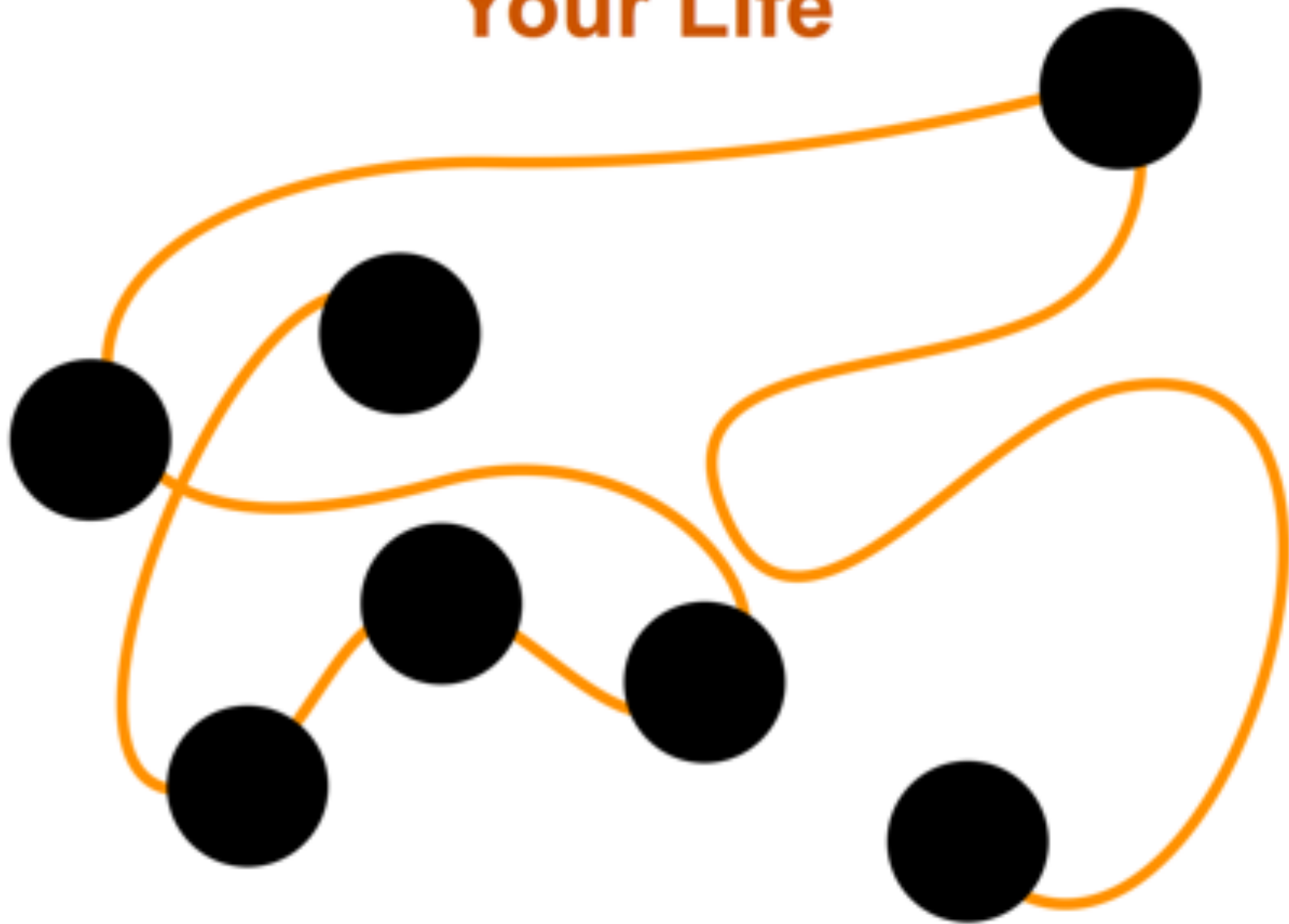
Communication Goals

- Your preparedness for graduate work
- Your potential for success as a grad student in their program and beyond
- Your fit with the program and whether you will contribute to the program's intellectual culture
- Evidence of deliberate decision-making: have you carefully considered your decision to pursue a graduate degree in this field?

**How do I meet my
communication goals?**

**What do I write about to
get there?**

Your Life



Your Statement of Purpose



Your Statement of Purpose

Be selective!



Draw Meaning From Experiences

What experiences will help you meet your goals?



Illustration: Ally Jaye Reeves

SOP Meaning Making Worksheet

This worksheet is designed to help you (1) evaluate the strength and relevance of your experiences and (2) develop a structure and outline for your SOP. Write down major experiences you're considering for your SOP and the meaning/value of each experience (e.g. what quality or skill it demonstrates, how it shaped your decision to pursue grad school, how it shaped your research interest, or what it made you do next). In this stage of your planning, focus on major experiences and worry about whether they belong in your SOP later. Use the Communication Goals on the right to check off whether your experiences meet that specific goal. You may write in your goals from the Develop Your Communication Goals page.

COMMUNICATION GOALS

Write in your own goals:

1	
2	
3	

	Experience / Background	Meaning / Value	Preparedness for GS	Potential for success	Fit for school/program	Deliberate decision-making	Your goals		
							1	2	3
1			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Example

COMMUNICATION GOALS

	Experience / Background	Meaning / Value	Preparedness for GS	Potential for success	Fit for school/program	Deliberate decision-making	Your goals		
							1	2	3
1	SURF 2016 - Astronomy	My first research experience that gave me a glimpse of astronomy and also helped me developed my passion for the stars.	✓	✓	✓	✓			
2	SURF 2017 - Astrophysics (Prof Marcolli lab)	This experience brought me close to what I want to study in grad school. I also learned how to think creatively on how to solve problems. I also had a great female professor as a mentor.	✓	✓	✓	✓	✓	✓	
3	(continued from SURF 2017) SURF 2018 - Astrophysics (Prof Marcolli lab)	Showed that I can stick with a problem and work hard to produce meaningful results. It also confirmed my decision to go to grad school. My first author papers show off my communication skills and my potential.	✓	✓	✓	✓	✓		
4	Facebook 2019 Computer Vision Internship	I learned how to work with deadlines and as a part of a team. I got to enhance my CS skills, which will be useful in astrophysics. Although this experience showed me that I do not want to be in industry, I will focus on the research aspect rather than the industry aspect.	✓	✓	✓		✓		
5	Published peer-reviewed conference papers from SURF 2016-2018	I have strong communication skills and I am familiar with the peer review process. I also know what it's like to see a project through from the beginning to the end.	✓	✓	✓				
6	Outreach: robotics for disadvantaged communities (2016-2018)	I care deeply about diversity and the advancement of underrepresented groups in STEM. This experience demonstrates my leadership and compassion for science.			✓			✓	
7	Both of my parents are engineers	I come from a family that values education. I've been taught from a young age that science is important.							
8	Won national awards for piano	I can stick with something difficult and I have an artistic side. I understand that mastery of your subject comes from hard work, dedication, and persistent practice.		✓					
9	Summer Science Program (2014, sophomore in HS)	Shows that I have been interested in science from a very young age							
10									

Example

COMMUNICATION GOALS

	Experience / Background	Meaning / Value	Preparedness for GS	Potential for success	Fit for school/program	Deliberate decision-making	Your goals		
							1	2	3
1	SURF 2021 in neurobiology	First research experience that showed me the power of using imaging technology to better understand the brain; mentorship; communication skills; shows I'm capable of doing research	✓	✓	✓	✓	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Outreach for STEM in K-12	Leadership and caring about my community	<input type="checkbox"/>	<input type="checkbox"/>	✓	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Tutoring and TAd in biology	Demonstrates my love for teaching and wanting to be a professor	✓	✓	✓	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Took graduate level courses in Biology/Neurobiology as an undergraduate	Demonstrates my knowledge and skillset in my area of study	✓	✓	✓	✓	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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9			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Reflect on Your Meaning Making

[illegible]

- Reflect on the experiences you listed in the SOP Meaning Making Worksheet and how you evaluated them.
- Can you see how you might separate and group your experiences?
- Can you logically connect different experiences?
- Can you organize these experiences in an order that makes sense?
- Can you see what experience can easily find a home in your statement and which do not?

Reminder: You don't need to include everything you listed in your Meaning Making Worksheet.

Drafting an Outline / Structuring Your Statement



(1) Chronological

- Common structure
- Works well for demonstrate how research interests and goals have evolved and matured
- Be sure to energize your writing by weaving in a narrative between your experiences, else you run the risk of your statement reading like an extended CV

- I. Introduction
- II. 2016 Harvey Mudd Research Internship in Astronomy
- III. 2017 Harvard REU Astronomy
- IV. 2018 SURF Caltech Astrophysics
- V. 2018-present Caltech ongoing academic research in Astrophysics
- VI. Advanced Coursework and TAs in physics, astrophysics
- VII. Conclusion

(2) Relevance to Field of Study

- Common structure
- This approach works well if you:
 - (1) find your current or most recent experience to be more relevant or more meaningful than earlier experiences
 - (2) take a more circuitous route to your intended field or grad school altogether.
- Grouping and prioritizing experiences by relevance can help streamline your story and keep you from having to write a tangled narrative around your less relevant but significant experiences.

- I. Introduction
- II. Advanced Coursework and TAs in CS
- III. 2018 SURF Caltech - CS- Machine Learning
- IV. 2016 SURF NASA JPL- Astronomy - Mathematical Modeling
- V. 2017 Venture Capital Firm - Software Engineering Internship
- VI. Conclusion

(3) Quality / Expertise

- Less common structure
- This approach works well if you:
 - (1) do not have much experience in intended field of study.
 - (2) have multiple/extended research projects with one research professor over several years — although you can certainly use other organization schemes.
- Challenge: a single experience may illustrate multiple qualities and different areas of expertise; if experiences are divided and distributed over the entire SOP, your readers may struggle to keep track of your growth as a scientist, identify deliberate decision making toward graduate school, or understand your contributions to a specific research project.

- I. Introduction
- II. Advanced Coursework in CS
- III. Algorithm Development Expertise
- IV. 2018-2019 in Chemistry
- V. Creative and Critical Thinking Skills
 - A. 2018 SURF in Chemistry
 - B. 2017 SURF in Neuroscience
- VI. Communication skills
 - A. Co-authored a paper in chemistry (2018)
 - B. Presented posters and gave talks at conferences
- VII. Conclusion

Approaching the Introduction



There are several common approaches to the introduction and none of them are the “right” way.

Continue to step inside the mind of the reader and evaluate your introduction as this reader.

Seek the guidance of your research mentors and peers in your field.

Illustration: Ally Jaye Reeves

Common Approaches to Intro

- **Keep it simple:** Take a no frills approach that simply tells them what you came for (the PhD), what you want to study, and what you hope to do with it.

Example: Keep It Simple

I would like to pursue a PhD in computer science at [REDACTED]. My areas of interest include parallel algorithm design, communication complexity lower bounds, and data structure analysis. These interests developed gradually through my undergraduate career, beginning with work in computational simulation using GPU computing as a freshman and progressing to an ongoing, purely theoretical project on data structure memory lower bounds. In graduate school, I hope to leverage this breadth of experience to build algorithms and data structures with provable performance guarantees as well as practical, scalable performance.

Example: Keep It Simple

I wish to pursue a PhD in computer science with the goal of becoming an academic researcher. I am primarily interested in theoretical machine learning and its applications in solving interdisciplinary problems. Using tools from theory, I aspire to improve current algorithms, motivate new algorithms, and establish provable guarantees on running time and solution quality.

My interest in machine learning research developed from my research projects at [REDACTED]. These projects have shown me the beautiful interplay between theory and practice in machine learning. Each problem was motivated by practical applications, and then abstracted and analyzed within a theoretical framework. As a result of this process, practical solutions were developed and then applied to real problems. Through my PhD and beyond, I wish to continue researching theoretical aspects of machine learning and developing practical methods with real-world impact.

Common Approaches to Intro

- **Keep it simple:** Take a no frills approach that simply tells them what you came for (the PhD), what you want to study, and what you hope to do with it.
- **Come in with the science:** Lead with the field or the problem you're interested in and situate yourself, your interest, and your goals here.

Example: Come in With the Science

Modern cosmology is entering a new era with upcoming missions like the Large Synoptic Survey Telescope, Euclid and the Square Kilometer Array. These missions will present us with unparalleled amounts of data, and thus the ability to make inferences about fundamental aspects of our universe. Yet, these data sets will be large and complex, necessitating the development of refined statistical methods to analyze them. Since beginning my undergraduate astrophysics studies at [REDACTED], I have undertaken multiple research projects in cosmology, studying dark energy, inflation, and modified gravity. While each of these projects was in a different sub-field, they all focused on optimal mathematical and statistical methods which we can apply to cosmological data sets. The development of these methods will be essential for optimally extracting information from upcoming astronomical surveys. By pursuing a PhD in Astrophysics at [REDACTED] I hope to study the applications of these methods to a range of astronomical measurements, thereby honing my understanding and skills in the field of astrostatistics.

Common Approaches to Intro

- **Keep it simple:** Take a no frills approach that simply tells them what you came for (the PhD), what you want to study, and what you hope to do with it.
- **Come in with the science:** Lead with the field or the problem you're interested in and situate yourself, your interest, and your goals here.
- **Open with a story:** Tell a short story that meets a communication goal. You'll want to make sure that the story isn't being told just because it's entertaining or shows off creative writing skills. Don't focus on narrating your initial discovery of your interest in your field. Unlike with undergraduate admissions essays, readers often skim or skip such stories, because this information is perceived to be less relevant to your fitness for a graduate program. Also, don't go too far back in history.

Example: Open With a Story

I enrolled in the physics class excited for the intellectual adventure. My mind yearned for a challenge: an experience I rarely encountered by day as a financial advisor. My role at the investment firm was extremely rigid and presented little opportunity for mental stimulation. I craved a creative environment where critical thinking was valued. To fill this cerebral void, I read voraciously spanning all genres. But the popular science books were always the most captivating. While reading, I learned that the atoms inside our bodies were forged within an exploding star eons ago and have coalesced into intelligent beings capable of understanding the universal laws that govern that event. And that a single galaxy contains more stars than all the human beings who have ever lived. Galvanized by these books, I matriculated into that physics night course to engage with science from an academic perspective. This course provided many avenues for problem solving and each night I felt my cognitive abilities returning. The class was demanding, yet this was just the challenge I was seeking. I finished the class invigorated by a sense of accomplishment I had scarcely experienced before. That was five years ago.

Although that class seems long ago, my enthusiasm and curiosity in the discipline is unwavering. I enrolled in the physics program at the [REDACTED] to take the prerequisite undergraduate courses for pursuing a graduate degree. These courses are extremely engaging and introduced me to many concepts prevalent in the aerospace industry. In an effort to explore this discipline, I attend many of the [REDACTED] meetings on campus and seek out pertinent course projects.

Common Approaches to Intro

- **Keep it simple:** Take a no frills approach that simply tells them what you came for (the PhD), what you want to study, and what you hope to do with it.
- **Come in with the science:** Lead with the field or the problem you're interested in and situate yourself, your interest, and your goals here.
- **Open with a story:** Tell a short story that meets a communication goal. You'll want to make sure that the story isn't being told just because it's entertaining or shows off creative writing skills. Don't focus on narrating your initial discovery of your interest in your field. Unlike with undergraduate admissions essays, readers often skim or skip such stories, because this information is perceived to be less relevant to your fitness for a graduate program. Also, don't go too far back in history.
- **Use a mixed model:** You can mix and match any of these approaches described above.

Example: Use a Mixed Model

My research interest lies at the intersection of numerical algorithms, data science, statistics, and machine learning. I want to pursue a PhD degree where I can apply ideas and tools from probability, numerical analysis, mathematical optimization, and partial differential equations (PDEs) to improve existing numerical methods and lead new advancements in machine learning, data science, and computational engineering.

I encountered the rigorous system of theoretical mathematics during high school at the Ross Mathematics Program, where I obsessed over the ineffable beauty of mathematics that lies in the concise and subtle logic of each definition and lemma. This passion continued throughout college, where I have enjoyed proving theorems in analysis and algebra, as well as tackling intricate problems in the Putnam Competition. While I have been deepening my understanding of theoretical mathematics, the interdisciplinary nature of [REDACTED] also gave me the opportunity to explore my interest beyond the scope of theoretical mathematics in my first two years. By taking various physics, chemistry, biology, and computer science classes, I learned that unlike pure math, which is usually clean and deterministic, real-world problems are filled with uncertainty and approximations. Therefore, choosing appropriate mathematical models and algorithms in terms of accuracy and efficiency is crucial. The potential of mathematics to solve challenging real-world problems really ignited my passion for the more applied side of mathematics.

What Are Your Research Goals?

How specific do I need to be in describing what I want to study in grad school?

What if I only know in general what I want to study but not the specific problem? Do I need to know this before I apply? Before I write my SOP?

Writing Your Research Goals

- Be as specific as possible but stay open.
- Your reader understands that you will likely explore different problems as a grad student.
- Your reader understands that you have only seen a sliver of your field.

Writing About Research Experience



Illustration: Ally Jaye Reeves

Writing About Research

- **Reveal your understanding of the field and communication skills**
- **Reflect on your experiences and how they shaped your understanding, plans, or interests**
- **Highlight accomplishments and noteworthy details**

Example: Research Experience

The next summer, I designed a project with Dr. [REDACTED], to study inflation using galaxy clustering on ultra-large scales. Galaxy catalogs from future missions, including Euclid, will allow us to measure the parameter $f_{\text{NL}}^{\text{loc}}$, which gives us information about various inflationary models. I am studying new, optimal methods to construct the galaxy power spectrum from these catalogs, and thereby measure $f_{\text{NL}}^{\text{loc}}$. I have built a data analysis pipeline in C and Python, which first creates mock galaxy catalogs based on input values of $f_{\text{NL}}^{\text{loc}}$. I then use different methods to estimate the galaxy power spectrum from these catalogs and finally estimate the value of $f_{\text{NL}}^{\text{loc}}$ that best fits this spectrum using an MCMC. Through this pipeline, we can compare the constraints on $f_{\text{NL}}^{\text{loc}}$ obtained by different data analysis methods, including the traditional Feldman Kaiser Peacock estimator and an optimal quadratic estimator. This project has also developed into my senior thesis, and I plan to extend it to study pixel-based likelihood functions, and include general relativistic effects in my analysis. I will be giving a poster presentation on this work at the American Astronomical Society Winter Meeting in January 2018. My senior thesis work will also be an essential component of the proposal for SPHEREx, a NASA Medium Explorer mission which aims to measure $f_{\text{NL}}^{\text{loc}}$.

In the course of my cosmology research, my interests have gravitated towards the mathematical methods which we employ in the field. One of the primary challenges in cosmology today lies in extracting the maximum amount of information from individual measurements with large uncertainties. I have found this to be a common theme in all my past research experiences,

Example: Research Experience

I became interested in parallel and scientific computing shortly after arriving at [REDACTED]. Over the span of an academic year and a summer, I contributed in a computational capacity to a team led by [REDACTED] trying to understand the characteristics of magnetized cells formed by the uptake of iron nanoparticles. My project involved building a simulation to track the spins of water molecules affected by magnetic fields within cells, and I proposed using a GPU to parallelize the process. Although such Monte Carlo simulations are natural candidates for parallelization, the challenges I faced in my first attempts were poor locality of memory accesses when computing the magnetic field strength and data structures with several layers of indirection that performed poorly on a GPU, such as an octree tracking nanoparticle locations. After researching GPU caching and thread scheduling behavior, I reorganized the control flow of the simulation to track water molecule location and spin state in two separate phases, which maximized the uptime of the parallel processors. By further rewriting the control flow to reduce branch divergence between threads, optimize memory access locality, and reduce the number of indirections required to compute nanoparticle locations, I produced a GPU-based simulation that ran in a fraction of the time of a baseline non-parallelized version. Moreover, my results confirmed the physical theory, and I was a co-author on the resulting paper [1].

Example: Related Work Experience

In conjunction with my lab research, I worked as a data center student assistant at the [REDACTED]. This position exposed me to a mission critical environment and allowed me to develop projects related to the sustainability of essential computer hardware. A pertinent project I executed was to model the heat flow in the computer room using computational fluid dynamics software for the three primary data centers at [REDACTED]. This required creating CAD drawings of the data centers, calculating the power consumption for each rack, and conducting simulations of the computer room's airflow. As a result, I discovered that one of the data centers was circulating air inefficiently. Due to back pressure from the shallow ground, the air handlers were not generating the cooling power that the manufacturer stated. I strategically reorganized perforated tiles within the room to minimize stagnant thermal characteristics, thus creating a healthy computational climate. My work in the mission-critical industry earned me an academic scholarship from the [REDACTED] organization and a [REDACTED] special recognition award. I acquired many useful skills during my time at [REDACTED] but learning the value of developing positive professional relationships was indispensable.

Writing About Research

- **Frame your work; situate your reader.**
- **Do not teach or dump data.**
- **Build narrative around your skillsets instead of just listing.**
- **Don't obsess over failed projects or lack of results.**

Customizing Your Statement

Customize your Statement of Purpose to every school/program. Tell the committee why you chose to apply to their school/program and why it stands apart from other schools.



Source: Beth Kobliner

Customizing Your Statement

- Why am I interested in working with the faculty I've listed?
- What are each of these faculty member's current research interests and how do these interests align with my research and career goals? Read more than one of their papers to develop a deeper understanding of the direction of their work.
- With an understanding of each faculty member's current research, how can I contribute meaningfully to their lab and its respective field? How does my relevant experiences make me a good fit for the research being done by this faculty member?
- How can I connect my findings about this specific program to support my intended communication goals for my intended readers?

Example: Tailored Last Paragraph

In the course of my cosmology research, my interests have gravitated towards the mathematical methods which we employ in the field. One of the primary challenges in cosmology today lies in extracting the maximum amount of information from individual measurements with large uncertainties. I have found this to be a common theme in all my past research experiences, and a PhD in [redacted] University would be the logical continuation of this trend. The [redacted] department would offer me the opportunity to work with both theoretical and observational cosmology research groups. This will allow me to become familiar with both the theories which we are trying to test, as well as the measurement techniques we use to test them. I would like to work between these two steps, by attempting to understand how we can efficiently and optimally make inferences about physical theories from raw data. I would like to work with Prof. [redacted] on data analysis methods for CMB S-4 experiments, particularly those that would allow us to search for primordial gravitational waves, such as CMB delensing. I am also interested in forecasting cosmological parameter constraints from WFIRST with Prof. [redacted]. I would enjoy working with Prof. [redacted] on constraining cosmological parameters using the large-scale distribution of galaxies. Pursuing a PhD at [redacted] University would give me the chance to study a number of applications of astrostatistics, due to [redacted] involvement in surveys like WFIRST, LSST and ACT. [redacted] will offer me an extremely well-rounded research experience, which will uniquely position me as a scientist in the advent of surveys which will present us with larger and more complex data sets. My work at [redacted] will prepare me to use these data sets to extract fundamental information about the workings of our universe.

Example: Tailored Last Paragraph

I would be open to pursuing any in a range of topics as a graduate student at [REDACTED]. For example, I am interested in Prof. [REDACTED]'s designs of parallel data structures for dynamic range query and graph connectivity. My work with data structures has centered on lower bounds up until now, and I am enthusiastic about exploring the corresponding upper bounds through the novel construction of efficient data structures. In the realm of parallel computation, I am interested in Prof. [REDACTED]'s general frameworks for parallelism such as the DAG-calculus. In the area of performance analysis, I am interested in Prof. [REDACTED]'s work on cache modelling. I find caching intriguing from a theoretical perspective (analyzing tradeoffs between cache space usage and miss rate) and an applied one (for example, quantifying in practice the miss rate of the EVA policy). The computer science department at [REDACTED] hosts a unique set of faculty and resources aligned to my interests, and I hope to undertake a PhD there that is both intellectually stimulating and productive.

Example: Tailored Body Paragraph

In addition to research, I believe that the role of a scientist involves increasing diversity in their field by reducing the barriers facing underrepresented groups. At [REDACTED] I helped found the Women in [REDACTED] group. We organize workshops and discussions about the barriers that women often face and aim to create a safe space where we can work together to tackle these issues. I am also [REDACTED] I helped start the [REDACTED], under which students go through a short training about how to support [REDACTED] Communication and collaboration are necessary skills for effective outreach and promotion of diversity, and I have built these skills by working as a [REDACTED]. I was also the chair of the [REDACTED] committee at [REDACTED], for which I worked with professors and students to critically evaluate the astrophysics curriculum and make changes to better prepare students to address current research problems. At Johns Hopkins, I would like to continue these efforts by helping create a community to support underrepresented groups in my field. I also plan to be actively engaged in outreach and would love to get involved with the Center for Educational Outreach and the Women in Science and Engineering Program.

Post-Workshop Q&A



Illustration: pngwave