

## Personal statement

I am deeply interested in computational biology research after having developed a research passion for mathematical modeling and statistical analyses of large, complex datasets, particularly in the biological domain. In undergrad, I obtained new results about verbal problem-solving from the large and unprocessed eye-tracking data of an original experiment that I designed and oversaw. At NASA, I deployed statistical machine learning models to reveal algorithmic bio-signatures, which could inform the instrumentation protocols of life-detection missions. The team has expanded so that I am now working with my NASA mentor and an outside postdoc towards publication. Furthermore, I have completed numerous smaller projects, with the broad theme of applying a novel approach or answering an original question with mathematical modeling or programming. This includes a Markov chain model of polygenic inheritance, which enables novel intergenerational-movement calculations that have real-world implications. In my Master's at Oxford, I am deepening my skills in statistical, machine learning, and other computational methodologies, which I believe will be integral parts of my dissertation and doctorate research thereafter.

## Education

- Oct 2020 - Sep 2021 **Master of Science in Statistical Science**, *University of Oxford*, United Kingdom.  
Coursework: Stochastic Models in Mathematical Genetics, Computational Statistics, Statistical Machine Learning, Bayes Methods, Applied Statistics, Foundations of Statistical Inference, Statistical Programming (*in R*), Advanced Simulation Methods, Advanced Topics in Statistical Machine Learning. | Dissertation with an academic supervisor (three months) | Christ Church college placement. | Current departmental supervisor is François Caron.
- 2016 - 20 **Bachelor in Physics**, *Drew University*, Madison, New Jersey.  
Summa Cum Laude - GPA 4.000/4.000 | Minor in Mathematics | Additional coursework: Statistics, Modeling and Simulation, Molecular and Cellular Biology, Biochemistry, Organic Chemistry I & II, Biological Psychology. | GRE - Jan 2020 - 169/170 Quantitative, 165/170 Verbal, 5/6 Analytical Writing.
- 2015 - 16 **Cello Program**, *The Juilliard School*, New York, New York.  
Studied cello for a year at a competitive music program before transitioning career paths. | Example coursework: Music Theory, Advanced Ear Training, Music History, Piano, Ethics, and Chamber Music. | SAT - 770/800 Math, 750/800 Critical Reading, 800/800 Writing.

## Research Experience

- Jun 2020 - **Astrobiology Statistics Research**, *NASA Ames Research Center - Biospheric Science Branch*, Mountain View, California, Diana Gentry.  
Project: Statistical Classification of Biosignature Information. | Implemented machine learning classification algorithms of element composition and isotope fractionation data. | Demonstrated how combinations of chemical biosignatures can make accurate classifications and uniquely inform the instrumentation protocols of life-detection missions. | Continuing the research from a paid full-time summer internship. | Expanding the project through a collaboration with postdoc Sunanda Sharma to include spectral data. | Tools used: (in Python) Principal Component Analysis, K-Nearest Neighbors, Logistic regression, Linear Support Vector Machines, Gaussian Naïve Bayes, k-Means Clustering. | Presented research poster to NASA Ames and to the New Jersey Space Grant Consortium.
- May 2019 - Jun 2020 **Eye-Tracking Research**, *Drew University*, Minjoon Kouh.  
Project: Gaze sequences reveal how people gradually arrive at a solution to a word puzzle (anagram) | Designed and ran an original eye-tracking experiment of 29 participants. | Formed and led a small research team of undergraduate students and high school volunteers. | Structured and analyzed the raw eye-tracking coordinate-time-series data (90 million rows). | Obtained new results about how the beginnings and ends of solution words are significantly more informative than their middles. | Spring 2020 phase II experiments unfortunately still postponed due to the pandemic, delaying publication efforts.
- Dec 2019 - **Independent Statistics Research**.  
Project: Polygenic Markov Chain | Created a Markov chain model based on a normally distributed population reproducing under a linear regression model, analogized to polygenic inheritance. | Validity of model checked with data on the heights of parents and their adult children. | The model enables novel transition kernels to be calculated numerically, which correspond highly to those of height data as well as - surprisingly - family income data ( $R^2 = 0.96$ ).
- Summer 2017 **Atmospheric Chemistry Research**, *Drew University*, Ryan Hinrichs.  
Adsorption rates of Pinene onto dust and sand samples under varying temperatures and relative humidities. | Skills and technologies used: Infrared spectroscopy, Gaussian, IGOR Pro.

- 2017 - **Independent Research Projects**, Available to view on [jessemurray.com](http://jessemurray.com).  
Completed about a half-dozen small research projects that apply computational simulation, data analysis, and mathematical modeling to real world situations. | Some examples include: Machine Learning to Predict COVID-19 Cases from US Census Data, Modeling the Growth of Non-decomposed Municipal Solid Waste in US Landfills, Proposed Musical Tuning Algorithm, etc.

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## Conferences

- Dec 2020 **Algorithmic detection of elemental biosignatures**, *American Geophysical Union Fall Meeting*.  
Accepted for research poster presentation at the Planetary Sciences session: *Getting the Most Out of Data in Astrobiology: Overcoming the Too Little, Too Rare, and Too Different*.
- Mar 2020 **Gaze sequences reveal how people gradually arrive at a solution to a word puzzle (anagram)**, *Brain and Behavior Conference - University of Scranton*.  
Presented research poster.

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## Skills

- Computational Expertise: Python (NumPy, Scikit-learn, Pandas, SciPy, Matplotlib, Seaborn), R, Excel | Fluency: Git/GitHub, MATLAB, Octave, C | Some experience: Mathematica, Java, Julia, HTML, and SQL.
- Mathematical Statistics, Probability, Statistical Machine Learning, Linear Algebra, Multivariable Calculus, Differential Equations.
- Scientific Molecular and Cellular Biology, Genetics, Spectroscopy, Biochemistry, Organic Chemistry, Mathematical Physics, Mechanics, Electricity and Magnetism, Optics, Electronics.
- Presentation  $\LaTeX$ , Jupyter Notebook, Markdown, Powerpoint, Microsoft Word.
- Musical Cello, Piano, Music Theory, Improvisation, Absolute Pitch.

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## Teaching Experience

- 2017 - 20 **University Tutor**, *Center for Academic Excellence*, Drew University.  
Physics I & II, Calculus I, II, & III, Pre-Calculus, Statistics, Astronomy, Biology, Chemistry, Organic Chemistry | 5-6 hours per week. | Led 'Quant Camp' - a drop-in session for quantitative skills in which I explained problems to groups of students.
- Jul 2020 **Research and Teaching Assistant**, *New Jersey Governor's School in the Sciences*.  
Project: Implementing machine learning with iRobot hardware for human detection. | Graded and answered students' questions about Special Relativity problem sets. | Full-time paid position. | Made a time-travel simulator spreadsheet, which calculated and put into real-life terms the energy requirements and length contraction under special relativity.

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## Additional and volunteer experience

- 2019 **President**, *Math Club*, Drew University.  
Completely redesigned the club. | Put up posters of beautiful and real-life math problems, began weekly meetings to discuss and solve them. | Began presentations of original projects and research. | Created a talk series in which quantitative professors gave fun and informative lectures. | Changed electoral process to use Condorcet method of ranked choice voting.
- 2019 - **Science contributor**, *Wikipedia*.  
Hundreds of contributions to mathematics and science-related articles. | Improving the clarity of the writing, and drawing connections between related topics. | After my contributions were noticed, I was interviewed for an article in *Mashable* on the scientific communication of climate change, releasing in November 2020.
- Fall 2018 **Volunteer**, *Morristown Medical Center, Emergency Department*.  
Assisted medical staff with patient intake and evaluation. | 50 hours total.

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## Awards, Scholarships, and Societies

- Awards Marshall C. Harrington Prize in Physics and Astronomy (for completion of an outstanding research project) - Spring 2020 | Arnold S. Boxer Memorial Prize in Physics - Spring 2019 | John F. Ollom Prize in Physics - Spring 2017
- Scholarships Weddell Family Scholarship - Spring 2018 | Dean's Transfer Scholarship - Fall 2016
- Societies Pi Mu Epsilon - Spring 2020 | Sigma Pi Sigma - Spring 2019 | Phi Beta Kappa - Spring 2018