The robustness of a mathematical method determines its utility. Just imagine designing a communication network that fails to account for dynamical perturbations, or modeling an epidemic with strictly deterministic differential equations. My goal, then, is to research robust topological methods for data analysis and physical applied mathematics.

For example, consider training an AI to distinguish the tone signature of different musical instruments. Applying persistent homology, we associate holes in an audio recording's time-delay phase-space with a sample statistic: the persistent rank function. Corresponding with Nikki Sanderson, I learned a computer trained on such PRFs will more accurately classify tone signatures than one trained on FFTs. Here, a topological invariant answers "which instrument?" with higher fidelity than frequency analysis.

My research interest stems from (i) my exposure to topology and its applications as a college senior, and (ii) insight from two years of service work since graduating.

Advised by Dr. Jonny Comes, my senior independent study[1] examined how Galois theory constrains the solution space V of Fuchsian-type DiffEqs. Following Michio Kuga, I developed a correspondence between the fundamental group on $D = \mathbf{C} \setminus \{x_1, \ldots, x_n\}$ and this region's universal covering space $\tilde{D}$. Exploiting the representation of the group of covering transformations $\Gamma(\tilde{D} \to \tilde{D})$ as a group of linear automorphisms, I parameterized solutions to the hypergeometric DiffEq. For interesting cases, I found the monodromy representation at singular points, and generated plots. I presented my method, its history, and an application to fluid flow at The College of Idaho's 2016 student research conference. At the same time, I studied point-set topology under Dr. Dave Rosoff. He led seminar in a modified Moore method. I built foundations from counter examples, often finding errata in our notes by discovering non-intuitive spaces, e.g., the space X whose open sets are those sets with countable complements. We explored category theory and progressed to connectivity and compactness. I am enthusiastic to build from this ground to higher results, one of which I reached in my senior study, another of which Nikki Sanderson demonstrated ahead of me.

I have gained insight to the necessity of *applications* (esp. with positive impact) by completing two years of service with displaced persons. In Houston, under Shaoli Bhadra, I developed novel, scalable resources for refugee case management. I crowd-sourced a map of clinics and languages spoken with the Google Maps API. I wrote bug reports for the implementation of a SQL case-notes database, and, when Texas cut funding for Refugee Medical Assistance, I contributed to a data management plan for the transition from state to federal indigent medical care. In Olympia, I am coordinating the volunteer program for a 24/7 shelter. I cleave to a distributed workflow. I built volunteer.fscss.org to manage a schedule of community events and to "reply all" to FAQs. As we rely on internships and work-studies, I am also collaborating with the Evergreen State College to write service-learning syllabi.

I am serious, however, to pursue math as my vocation. While I am grateful for the opportunity to manage projects and cultivate transparency, I find myself constrained in social services as an end-user of inefficient systems. To prepare for advanced study, I have enrolled part-time in the University of Idaho's Engineering Outreach program. I will complete courses in Probability, Ordinary Differential Equations, and Numerical Methods. Independently, I am learning to process data with UNIX tools and to write expositions in the Juptyer notebook. This computational literacy leverages my mathematical ability.

Though I am open to a variety of research at CU Boulder, my experience with messy data-sets and my appetite for topology leads naturally into topological data analysis. I would be enthusiastic to collaborate with Prof. Meiss (APPM), Prof. Bradley (CSCI) and Prof. Agnes (MATH). I see fruitful work to be done with TDA in signal processing and network analysis; I am also curious to study higher-dimensional data in material science. Having read through recent publications from the above faculty, I get the sense that the doctoral program at CU Boulder would be a great fit for my interests.

[1] C. Grainger, Applications of Galois Theory: Monodromy Groups and Fuchsian DiffEqs, College of Idaho SRC, 2016.