

The robustness of a mathematical method determines its utility. Just imagine designing a communication network that fails to account for topological perturbations, or modeling an epidemic with strictly deterministic differential equations. My goal, then, is to study robust methods in algebraic topology and apply them in abstract and computational settings.

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 (PRF). Corresponding with Nikki Sanderson, I learned a computer trained on PRFs more accurately classifies tone signatures than one trained on Fast Fourier Transforms. Here, a topological invariant answers the question "which instrument?" with higher fidelity than the Fourier Transform.

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 study¹ examined how Galois theory constrains the solution space of Fuchsian-type DiffEqs. Following Michio Kuga, we developed a correspondence between the fundamental group on $D = \mathbf{C} \setminus \{x_1, \dots, x_n\}$ and this region's universal covering space \tilde{D} . Exploiting the representation of the group of covering transformations $\Gamma(\tilde{D} \rightarrow \tilde{D})$ 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 reasoned from topological counter examples, finding errata in our notes by discovering non-intuitive spaces, e.g., the space whose open sets are those sets with countable complements. Further, we drew out analogies from topology to introduce category theory. 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 gained insight to the necessity of *applications* (especially with positive societal impact) by completing two years of service work. In Houston, under Shaoli Bhadra, I developed 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 small refugee population transitioning from state to federal medical care. In Olympia, I am coordinating the volunteer program for a 24/7 homeless shelter. I rely on a distributed workflow—with `git` for version control and `pandoc` markdown for administrivia. I built [volunteer.fscss.org](#) to maintain a schedule of events and to "reply all" to volunteers. As we rely on interns 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. To prepare for graduate study, I have enrolled in correspondence courses at the University of Idaho. By May 2018, I will have reviewed Differential Equations, Probability and Numerical Analysis. I am also reading from Hatcher's *Algebraic Topology*, surveying topics in Gower's *Companion to Mathematics*, and building a base of computing skills in the UNIX philosophy.

While I am open to a breadth of mathematical inquiry at CU Boulder, I am most enthusiastic to develop a rigorous foundation in algebraic topology. My career goal is to become an applied mathematician, working in machine learning or environmental preservation. I would be glad to collaborate with Profs Beaudry, Farsi, or Pflaum, potentially also with Profs Meiss and Bradley across departments. Having surveyed their recent publications and seminar webpages, I believe the doctoral program in mathematics at CU Boulder would be a great fit for my interests.

Thank you for your consideration.

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