Benjamin Holmgren

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Education

2018-Present **BS in Computer Science and Mathematics, Montana State University** *Bozeman, MT*

- Dual degree in CS (interdisciplinary) and Mathematics (pure)
- Cameron Presidential Scholar
- School of Engineering John C. Felton and John L. Magaret Scholarships
- 2019-2020 School of Computing Undergraduate Researcher of the Year
- MSU Honors College, 3.95 GPA, President's List
- Phi Kappa Phi and Pi Mu Epsilon Honors Societies

2018 **General Coursework, Middlebury College** *Middlebury, VT*

2013-2017 **Bozeman High School** *Bozeman, MT*

- Bozeman Public Schools Worthy Student Scholar, Valedictorian

Experience

2018-Present **MSU Computational Topology & Geometry Group**

Undergraduate Researcher - Through Grant funding from the Undergraduate Scholars Program at MSU, and through Dr. David Millman and Dr. Brittany Terese Fasy

Areas of focus: In this time, I've studied discrete Morse theory, persistent homology, and various computational geometry problems. Namely, variants on the "Art Gallery" problem, terrain guarding, and the search for the (57,5) Moore Graph. I've also given a host of talks in our group's weekly seminars.

Projects

- CCCG 2020 Publication *If You Must Choose Among Your Children, Pick the Right One*
  In this paper we propose novel efficient algorithms to generate a discrete Morse function on point data, building from the work in King, et al. This was published in CCCG '20, and I gave an accompanying talk at the conference.
- *Topology For Data Science Workshop 2020* (Postponed)
  I began a tutorial project in 2018 on techniques in TDA which gained NSF funding to become a national workshop in 2020. Though postponed, we anticipate to hold the workshop in 2021
- *Poking a Simplicial Complex*
  Multidisciplinary Research Project to visualize Morse Theory and simplicial collapses.
- *Discrete Morse Theory Techniques to Capture Branching Neuronal Morphologies*
  Though this was a final project for my Advanced Algorithm topics course, these are hopefully publishable results.

Talks

- CCCG 2020: https://www.youtube.com/watch?v=kHpD-J4EzI8&t=608s
- NCUR 2020 Poster Session *Using Hasse Diagrams to Compute a Gradient Vector Field* (Postponed to 2021)
- MSU Undergraduate Research Celebration 2019 Poster Session: *Updating the R Package 'TDA'*

Current Work

- *Efficient Methods to Generate Discrete Morse Functions from Point Data*
  We have results stemming from those in the CCCG 2020 publication which indicate significant time complexity reductions from the results proposed in King et al. We are currently polishing up this second publication, and deciding between submitting it to a journal or to SoCG.
- *The Search for the* (57,5) *Moore Graph*
  We've developed an algorithm to search for this long unknown graph. We are publishing our algorithm and accompanying code as part of a 'citizen science' initiative. If this graph is found before the heat death of the universe, I'll be an extremely happy man.
- *Dynamic Data Structures for Morse Complexes*
  I'm also developing novel data structures to handle dynamic data in order to modify discrete Morse functions, which I plan to submit to the Young Researchers Forum.

Other Relevant Work

- Numerai: Active contributor to the numerai platform, where models are uploaded to attempt to predict the stock market. I've been experimenting with manifold learning techniques for such problems.
- Computer Graphics: Implemented interactive scenes in C++ with movement, smoothing, shading, and other techniques using OpenGL and Ray-tracing.
- Machine Learning: Implemented algorithms including Bayesian learning models, nearest neighbor, k-means clustering algorithms, neural networks, and population based algorithms.
- Computer Networks: Implemented HTTP client-server networks to play simple games, protocols for RDT.
- Advanced Algorithm Topics: Provided novel discrete Morse theory techniques to categorize neurons for my final project which could replace persistent homology techniques used by Hess et. al.
- Web Development: I also like making websites. Here are a couple sites I've made:
  https://benholmgren.github.io/brittany-fasy/
  https://benholmgren.github.io/csci-491-final/

Other Activities

Selected Trail Ultramarathon Running

- Sweep for Bridger Ridge Run in 2019
- Traverses of the Devil's backbone, Bridger Ridge, the Teton range, most of the Wind River Range, and countless other long runs throughout the northern Rockies
- Beartooth mountains 'Beaten Path' 60 mile out-and-back in record time

Selected Rock, Ice and Alpine Climbing

- 'The Nose' of Yosemite's El Capitan in a day
- 'Cannon Fodder' in Glacier National Park, solo
- Establishment of numerous new ice routes in the Northern Absaroka mountains
- Long routes throughout the Sawtooth, Bitterroot, Beartooth, Absaroka, Bridger, Crazy, Wind River, Mission, Canadian Rockies, and Teton mountain ranges.

Other

- I grew up playing soccer, and still am active in the Bozeman area. In my heyday, I participated in the olympic development program at a state and regional level.
- I worked on the Jon Tester senate campaign in 2018 as a volunteer
- Also an avid elk hunter and fly fisherman