

RTG: electronic Computational Homotopy Theory Research Community

Year 1 report

FUNDED PARTICIPANTS

Funded participants in Year 1 were:

- Christy Hazel, UCLA, postdoctoral researcher. The project paid half of her academic year salary and also provided summer support.
- Sarah Petersen, Colorado, postdoctoral researcher. The project paid half of her academic year salary and also provided summer support.
- Scotty Tilton, UC San Diego, graduate student. The project fully supported Scotty during the academic year and provided summer support.
- Hari Rau-Murthy, Notre Dame, graduate student. The project fully supported Hari during the academic year.
- Kyle Ormsby, Reed College, faculty. The project will support Kyle for 0.75 months in Summer 2023 to direct the Summer REU.
- Six undergraduate students. The project will support these students for their participation in the Summer REU.

RESEARCH ACTIVITIES

Reading seminars. We hosted two research-oriented reading seminars: a Mahowald invariant seminar and a seminar on the Adams spectral sequence for topological modular forms.

Mahowald invariant seminar. The seminar was organized by co-PI J.D. Quigley, assisted by funded postdoctoral researcher Sarah Petersen. The seminar attracted approximately 30 participants, consisting of a mixture of graduate students, postdoctoral researchers, and tenure-track/tenured faculty. About two-thirds of the participants were located at U.S. institutions.

The organizers selected participants to give weekly talks on the general subject of Mahowald invariants. We have had great success with this model of having participants take turns giving presentations. The quality of the presentations does vary somewhat. In particular, we need to ensure that presenters give talks that are accessible to a variety of participants.

In this seminar, we experimented with a note-taking project. Each week, two participants were responsible for writing notes for the presentation. The work product contained a lot of valuable material, but it was too rough for any kind of formal publication. Nevertheless, there was value in the note-taking. First, it created opportunities for more participants to be actively engaged in the seminar. Second, it produced a record of the material covered for the private use of the participants.

Seminar on the Adams spectral sequence for topological modular forms. The seminar was organized by Robert Bruner and John Rognes. The seminar attracted approximately 60 participants, consisting of a mixture of graduate students, postdoctoral researchers, and tenure-track/tenured faculty. About half of the participants were located at U.S. institutions.

The primary source material was the recently published text by the organizers. As for the Mahowald invariant seminar, participants took turns giving presentations.

At least one publication resulted from a collaboration that was incubated by this seminar [IKL⁺23].

Research seminar. We held a regular research seminar that met once per month for two talks. The seminar was managed by Guchuan Li, co-PI J.D. Quigley, and funded graduate student Scotty Tilton. We experimented with a few “pre-talks”, in which the scheduled speaker gave an introductory background talk before the main research talk. These pre-talks were moderately but not overwhelmingly successful. In order to continue offering pre-talks, we will need to find a way to draw a larger audience.

The 15 speakers will nearly evenly split in location between the United States and outside of the United States. They were also nearly evenly split in seniority between tenure-track/tenured faculty and postdoctoral researchers. Six of the speakers were women.

Mini-courses. Our original plan called for mini-courses. In the end, we did not host this type of event. The main reason was simply that the organizers were busy managing other more essential activities. We think that mini-courses are an important part of an online research community; fortunately, a number of other organizations in related areas are offering online mini-courses.

INSTRUCTIONAL ACTIVITIES

We offered two synchronous online courses in Winter 2023 that were meant to serve as substitutes for comparable in-person courses:

- *Algebraic topology: homology and cohomology*, taught by Sarah Petersen and assisted by Scotty Tilton.
- *Topological K -theory*, taught by Christy Hazel and assisted by Hari Rau-Murthy.

Twelve students enrolled in the Topological K -Theory course. Three of these students were from U.S. institutions, seven were from western European institutions, one was from a Canadian institution, and one was unaffiliated in Guatemala. One student was an undergraduate, and the rest were graduate students. Six students were women, including one transgender woman.

Ten students enrolled in the Algebraic Topology: Homology and Cohomology course. Three of these students were from U.S. institutions, four were from India, one was from Turkey, one was from Brazil, and one was unaffiliated in the U.S. Two students were undergraduates, and the rest were graduate students. Two students were women.

Academically, both courses were successful. A few students were unable to complete the course, but attrition was no higher than one might expect from an in-person course. In the Homology and Cohomology course, students were assessed primarily through written homework and written exams. In the Topological K -Theory course, students were assessed primarily through group work and in-class presentations. Students were assigned formal grades. These grades were reported to the students and also directly to their home institution advisors.

Both courses relied heavily on active participation. Small group work played a key role in engaging students in the instructional community. This was especially important in an online course, where one cannot rely on physical proximity to build community. Some participants reported a higher level of engagement than in a typical in-person course. We suspect that this was a consequence of the pro-actively participatory course design.

In the Algebraic Topology: Homology and Cohomology course, some of the class time was dedicated to small group work on problem sets. Students were required to submit homework assignments on a regular schedule, as well as a video project and a written project on a topic related to the course. They were also required to take traditional written exams.

In the Topological K -Theory course, each student was required to give a full hour presentation on a topic. Students were also required to participate in weekly group work. The group work problems were closely aligned with the material from the presentations. This alignment was a particularly effective aspect of the course design.

We advertised the courses through a variety of channels:

- Subject-specific mailing lists such as `algtop-1`.
- The American Mathematical Society's Mathematical Opportunities webpage: www.ams.org/opportunities.
- Direct outreach by email to graduate directors at departments throughout the United States.

The most significant weakness in our instructional program was the enrollment in the Algebraic Topology: Homology and Cohomology course. If we are to continue to offer courses at the first-year graduate level, we must recruit more students. The best plan may be to concentrate our efforts on more advanced graduate students, where we have demonstrated success.

Kan seminar. The Kan seminar was led by Hana Jia Kong (Institute for Advanced Study), assisted by funded graduate student Scotty Tilton. Thirteen graduate students participated in the seminar. Each student gave a presentation about a classic paper in algebraic topology. Eight students were enrolled at U.S. institutions; five students were enrolled at institutions outside of the U.S. The seminar is an electronic version of the well-known Kan seminar at MIT.

We have offered Kan seminars every year since 2019. They have been one of our most popular activities. They are well-suited for graduate students who are making the difficult transition from coursework to independent study. We plan to offer Kan seminars yearly in the future.

REU

This report precedes the main activities of the Summer REU, so we cannot report yet on outcomes.

We advertised our REU through several channels:

- The American Mathematical Society: www.ams.org/opportunities
- The Institute for Broadening Participation: pathwaystoscience.org
- The Math Alliance: mathalliance.org
- The Math REU Programs website: www.mathreuprograms.org
- NSF's list of REU Sites: Mathematical Sciences:
www.nsf.gov/crssprgm/reu/list_result.jsp?unitid=5044
- Individual emails to administrators at historically black colleges and universities and Hispanic-serving institutions.

Overall, we consider the REU advertising to be a success. We received a large, diverse applicant pool of 87 applications. Of the six participating undergraduate students, three

are women, including one transgender woman. One of the women is married. We draw attention to this latter student because married students are typically not in positions to participate in in-person REUs.

PROFESSIONAL DEVELOPMENT AND COMMUNITY BUILDING

Employment networking. In Fall 2022, we hosted a employment networking event. Presenters submitted short videos that described their research. Prior to the event, potential employers (and other interested participants) could view these videos. During the live event, each presenter had an individual breakout room. Participants moved themselves between breakout rooms in order to meet with presenters and to discuss their research.

Unfortunately, the employment networking event was not a total success due to low participation. We are seeking ways to make this kind of event more robust.

Panel discussions. We offered two panel discussions:

- In Fall 2022, Anna Marie Bohmann, Teena Gerhardt, and Bert Guillou served as panelists for a discussion about “How to plan and give a good talk”.
- In Winter 2023, Eric Hogle (Gonzaga University), Angélica Osorno (Reed College), and Carolyn Yarnall (CSU Dominguez Hills) served as panelists for a discussion about “Academic careers at primarily undergraduate institutions”.

We plan to offer more of these panel discussions in future years. Participants were very enthusiastic about them. We feel that they would be of interest to graduate students who are specializing in a variety of subfields, and we are looking for ways of advertising them more widely.

Speed-networking. We hosted a speed-networking event that was attended by approximately 20 graduate students, postdoctoral researchers, and tenure-track/tenured faculty. Participants were randomly assigned into breakout rooms for five-minute sessions. The goal was for people to introduce themselves to each other. The organizers provided “ice-breaker” prompts to help the conversations if necessary.

Participants provided very positive feedback about this simple event. The time commitment is minimal, and it created a tangible sense of community.

Zulip. The eCHT community uses the Zulip chat platform. Zulip has features that are similar to the better-known Slack, but it Zulip has excellent LaTeX integration. Separate channels are created for the various seminars and courses. There are also channels reserved solely for graduate students.

Meetup. In March 2023, many of the regular eCHT participants attended a conference at Northwestern University. We hosted a lunchtime meetup on one day of the conference. Participants broke into groups of 4–5 and went to lunch together. This model allowed for people to get to know each other in small groups.

We hope to organize additional meetups at future in-person conferences. Possibilities include other topical conferences, as well as the Joint Mathematics Meetings.

ASSESSMENT

Course and reading seminar evaluations. We conducted a formal evaluation for each course and reading seminar. Participants were invited to provide anonymous feedback. Response rates were appropriately high. Overall, participants were enthusiastic about the experiences. Some participants offered specific suggestions that we intend to act upon in future years.

Annual report. A draft version of this report was circulated amongst the co-PIs and Senior Personnel. Their feedback was incorporated into the final version of this report.

Interviews with funded participants. The PI conducted individual end-of-year interviews with the two funded postdoctoral researchers and the two funded graduate students. We received valuable feedback that will contribute to minor improvements in the project in future years:

- The funded participants reported a positive impact on their research productivity.
- The reduction in instructional responsibilities was consistently reported as a major benefit.
- Some mentoring relationships were not robust enough. The PI will take a more pro-active role in ensuring that these relationships are healthier.
- The postdoctoral researchers appreciated that they were only 50% committed to eCHT. This allowed them to participate with in-person communities at their home institutions.

REU assessment. At the time of this report, the main activities of the REU had not yet occurred. We plan to assess the REU at its end through:

- an evaluation form, to be submitted by the undergraduate participants.
- individual exit interviews between the PI and each undergraduate participant.
- a group debriefing involving all of the leaders of the program.

Instructor debriefing. At the end of the 2022–2023 academic year, instructors Christy Hazel and Sarah Petersen met with the PI and co-PIs J.D. Quigley and Bert Guillou. The discussion covered various aspects of the eCHT instructional activities. Both successes and failures inform on next year’s instructional plans.

Participant survey. Near the start of the 2023–2024 academic year, a survey will be widely distributed amongst the topology community. This survey has several goals:

- assess the activities of 2022–2023.
- generate interest for activities in 2023–2024.
- determine interest levels for various options in 2023–2024.

BUDGET AND ADMINISTRATION

The project administration requires cooperation amongst a variety of departments at different institutions, as well as their sponsored programs offices. There was some concern that these complicated interactions could lead to ineffective management. This turned out not to be an issue. Some effort was involved to make sure that all units communicated with each other, but there were no major problems of this nature.

CONDUCT

Unfortunately, many online communities degenerate into unhealthy, negative interactions. We are consciously building a healthy online community. This requires the leaders to take active roles in setting constructive tones. We are pleased with the results of our efforts.

We wrote and posted an official eCHT Code of Conduct:
s.wayne.edu/echt/echt-code-of-conduct.

We offer an online reporting tool, with optional anonymity. We are fortunate that we received no reports.

One incident was reported verbally to the project director. It was resolved directly between the conflicting parties.

REFERENCES

- [IKL⁺23] Daniel C. Isaksen, Hana Jia Kong, Guchuan Li, Yangyang Ruan, and Heyi Zhu, *The $\mathbb{C}$ -motivic Adams-Novikov spectral sequence for topological modular forms* (2023), available at arxiv.org/abs/2302.09123v1.