Welcome!

2023 NSF Applied Math Research Training Grant Workshop

Optimization and Inversion for the 21st Century Workforce

What do the following things have in common?

satellite

Harry Potter

blood

polar bear

They all represent topics we study in the RTG! optimization



cloak of invisibility

optimal design of metamaterial



microstructures for negative index of refraction applications

foraging in polar ecosystems

optimal travel paths to minimize energy loss (swimming costs 5 X walking)





remote sensing

inversion of EM data to monitor Earth's climate system and environment



measuring blood pressure

inversion of EM data to monitor pressure-induced changes in cell geometry (inverse homgenization)



Humans have been grappling with optimization and inverse problems for a long time.



Which fur makes the warmest coat?

What's the quickest path to the next water source?

Is there anything in the ground we can use?











The applied math group at the U has been awarded an NSF RTG grant on optimization and inverse problems.

\$4M in funding from NSF & the U July 2022 - June 2027

Overall goal: Build and grow an advanced, competitive U.S. STEM workforce via vertically integrated training of undergraduates, graduate students, postdocs, and faculty in structured research programs + novel oureach to HS, JHS.

Strengthen our graduate and postdoctoral programs in applied math to attract top students in the nation, and place them in top jobs.



Diversify the pipeline with recruiting efforts at the HS and early undergrad levels; broaden participation in research experiences at these levels.



Provide transformative experiences that draw students into math.



Focus on educational transition points as critical moments in attracting students into math careers.

RTG team



Tom Alberts



Andrej Cherkaev



Elena Cherkaev



🛛 Yekaterina Epshteyn



Will Feldman



Ken Golden



Fernando Guevara Vasquez



Christel Hohenegger



Anna Little



Graeme Milton



Akil Narayan



Braxton Osting



Jody Reimer







Jingyi Zhu

For more information, contact a member of the <u>directorate</u>, or visit the website: https://www.math.utah.edu/amrtg/

Intellectual rationale to NSF for the RTG:

Meld our classical strengths in math of materials and fluids, with newer departmental focus on data science, ML, AI, UQ to solve problems of great scientific and societal impact.

- metamaterials
- porous media
- photonics
- climate modeling
- medical imaging

- remote sensing
- polar ecology
- materials topology
- geophysical exploration
- **fluid mechanics**

- uncertainty quantification
- statistical mechanics
- data compression
- machine learning
- topological data analysis



optimal and energy minimizing structures

cross pollination »





compressed powder



radar absorbing coating



Kusy & Turner Nature 1971



sea ice

Golden, Ackley, Lytle Science 1998



human bone Golden, Murphy, Cherkaev J. Biomechanics 2011

spectral analysis & RMT



twisted bilayer materials

Morison, Murphy, Cherkaev, Golden Communications Physics 2022

twistronics, stealth technology, medical imaging, climate science

RTG opportunities and benefits

What financial opportunities are available for students involved in RTG initiatives?

- Funded research assistantships
- Funded summer stipends
- Funds for professional development: conference travel, textbooks, etc.

Recipients of RTG support <u>must</u> be US citizens, nationals, or permanent residents.

Competitive applications *should* generally come from students advised by RTG-related (applied math) faculty.

The RTG organizes several activites and events:



Vertical Integration

FRG: Focused Research/Reading Groups PRE: Polar Research Experiences AMC: Applied Mathematics Collective Research Seminars Professional Development Seminars Curriculum Redesign UTOPIA Conference

K-12 Students

STEM Outreach to Underserved Students High School REUs

Undergraduates

SRI: Science Research Initiative DCC: Design Competition Course HSA: High School Ambassadors REU: Research Experience for Undergraduates

Graduate Students

Summer & Job Transition Funded Master's Program Student Retreat Optimization Qual + Focus

Postdocs

Mentorship Training Community Engagement

RTG activities of particular interest to students:

- Undergraduate research projects with RTG faculty
 - Travel funds
- Math 4800 Design Competition 2025, Andrej Cherkaev
- FRG: Focused Reading Groups / Focused Research Groups Fall 2023 Optimization/ML, Bao Wang Spring 2024 Climate Science, Ken Golden / Tyler Evans (?)



Polar Research Experiences - May 2024, May 2026

RTG Arctic Expedition, May 2024 on the frozen Arctic Ocean north of Utgiagvik, AK



U. of Utah students in the Arctic and Antarctic (2003-2022): closing the gap between theory and observation - making math models come alive and experiencing climate change firsthand.

Our first two speakers:

Anthony Lee, Milton Academy, MA since Nov 2022 (11th grade) Jody Reimer, Akil Narayan, Ken Golden

Adam Dorsky, Academy of Math, Engineering and Science, SLC since Jan 2023 (11th grade) Nash Ward, Tyler Evans, Ken Golden

Let's get more faculty working with high school students!