Meeting in the Middle for RandNLA, Optimization, and Inverse Problems

Recapping the 2024 Gene Golub SIAM Summer School in Ecuador

By Matthias Chung, Juan Carlos De los Reyes, Petros Drineas, Rosemary Renaut, and Alex Townsend

Near the equator at an altitude of 2,850 meters above sea level, a group of 50 graduate students from around the world converged for the 2024 Gene Golub SIAM Summer School[1] (G2S3), which took place in Quito, Ecuador, from July 22 to August 2. As co-organizers of G2S3 2024, we formed an instructional team that also included Carola-Bibiane Schönlieb (University of Cambridge) and Malena Español (Arizona State University). The theme of this year's school was "Iterative and Randomized Methods for Large-scale Inverse Problems," and attendees learned about randomized numerical linear algebra (randNLA), optimization, and inverse problems while simultaneously appreciating the awe-inspiring natural beauty and rich culture of Quito. Uplifting research discussions and valuable cultural exchanges became contagious amongst all participants; we dubbed this unbridled enthusiasm the "Gene Golub virus."

The locals call Quito the "Mitad del Mundo," which translates to "middle of the world." Given its central location, students hailed from 12 different countries in the Northern Hemisphere and seven countries in the Southern Hemisphere. Through a

[1] https://g2s32024.github.io

series of lectures and group activities, these students explored the latest ideas and concepts in randNLA — inspired by both theoretical computer science and traditional numerical linear algebra. They also studied the use of optimization methods for the solution of discrete, continuous, large, and challenging inverse problems.

Sketching is a popular randNLA technique that utilizes randomly generated near-isometries to efficiently represent a large matrix or dataset with a smaller one that still preserves essential properties. Although we sketched matrices, datasets, least-squares problems, and inverse problems, we never sketched our subsampling of Ecuadorian coffee, chocolate, or bananas. The banana is one of Ecuador's jewels, and we ate many surprising dishes made from the popular fruit. Our favorite was *caldo de bolas de verde*, a delicious soup made from salty bananas.

Quito was the perfect location for the 2024 iteration of G2S3. Throughout the 12-day school, Juan Carlos De los Reyes (Research Center for Mathematical Modeling) served as our incredible local guide; he and his team of graduate students ensured that we experienced all of Quito's offerings. For example, Quito's unique geographical location is known as the "Camino del Sol" or "path of the sun." Twice a year—on the solar equinoxes—the sun is directly overhead at noon and shadows vanish. Three attendees challenged

Students and instructors gather for a group photo at Laguna de Cuicocha during the 2024 Gene Golub SIAM Summer School, which took place in Quito, Ecuador, from July 22 to August 2. Photo courtesy of the authors.

themselves by practically testing out the steepest descent approach in pitch-black mountain terrain. Although they did not discover a converging path of the sun, they did encounter friendly locals who helped them down the mountain.

At the end of G2S3 2024, all of the graduate students presented their work and shared details about their ongoing projects. These presentations were certainly a highlight of the program and will likely inspire several long-lasting collaborations. Ultimately, we are proud to have delivered a thought-provoking, culturally stimulating summer school that hopefully would have made the late Gene Golub smile. We are thankful for his incredible generosity—as well as that of SIAM—for allowing us to provide 50 students with a wonderful sense of community, a strong research base, and unforgettable memories for years to come.

The 2025 Gene Golub SIAM Summer School on "Frontiers in Multidimensional Pattern Formation" will take place at Concordia University in Montréal, Québec, Canada, from **August 11-26, 2025**. More information—including application instructions—will be available on the G2S3 webpage[2] later this fall.

Interested in organizing a future school? Letters of intent that propose topics and organizers for the 2026 iteration of G2S3 are due to Richard Moore, SIAM's Director of Programs and Services, at **moore@siam.org** by **January 31, 2025**. Visit the G2S3 webpage[3] to learn more.

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[2] https://www.siam.org/programs-initiatives/programs/gene-golub-siam-summer-school

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Juan Carlos De los Reyes of Ecuador's Research Center for Mathematical Modeling delivers a lecture at the 2024 Gene Golub SIAM Summer School, which was held in Quito, Ecuador. The 12-day program attracted 50 student attendees and focused on iterative and randomized methods for large-scale inverse problems. Photo courtesy of Matthias Chung.