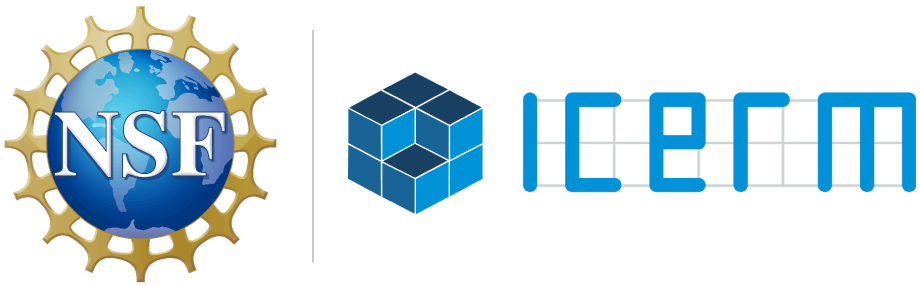


Institute for Computational and Experimental Research in Mathematics

Annual Report
May 1, 2024 – April 30, 2025

Brendan Hassett, Director, PI

Mathew Borton, Director of Information Technology
Jeffrey Hoffstein, Consulting Associate Director
Misha Kilmer, Deputy Director
Caroline Klivans, Deputy Director
Benoit Pausader, co-PI
Jill Pipher, Director Emerita, co-PI
Kavita Ramanan, co-PI
Bjorn Sandstede, co-PI
Jenna Sousa, Associate Director of Finance and Administration
Nathaniel Whitaker, Associate Director
Ulrica Wilson, Associate Director

Mission

The mission of the Institute for Computational and Experimental Research in Mathematics (ICERM) is to support and broaden the relationship between mathematics and computation: specifically, to expand the use of computational and experimental methods in mathematics, support theoretical advances related to computation, and address problems posed by the existence and use of the computer through mathematical tools, research and innovation.

Core Programs and Events

The following grid lists ICERM's scheduled programs and events from May 1, 2024 through April 30, 2025 supported by the core NSF award and other grants. All programs and events were in person with the option for virtual attendance as well. The grand total of "Unique Visits" during this timeframe was **2,109** for both in person and virtual attendees. There were 2,049 in person attendees and 60 registered virtual attendees. The "Unique Visits" total for ICERM's core programs was **1,903**. These figures show an overall increase of 75 participants since the 2023-2024 year. Virtual participation was significantly lower than in any other post-pandemic year, while in-person visits rates are returning to pre-pandemic rates.

For reporting purposes, a visit is defined as "A contiguous period of time that a person is physically at or virtually interacting with ICERM" based on known arrival and departure dates, without reported gaps. The "Total #" column includes individuals who attended multiple events within a set period of time. An example is long-term visitors who attended several workshops during a semester program. The public lectures list the number of people registered to attend.

Type	**Title**	**Start Date**	**End Date**	**# UNIQUE Attendees**	**# TOTAL Attendees**
Public Lecture	Mathematicians Helping Art Historians and Art Conservators	2-May-24	2-May-24	102	102
Topical Workshop	Interacting Particle Systems: Analysis, Control, Learning and Computation	6-May-24	10-May-24	99	99
Collaborate@ICERM	Mathematical Modeling, Deep Learning, and Optimization on Graph Structured Data	13-May-24	17-May-24	5	5
Collaborate@ICERM	Modeling and Analysis of Candidate Momentum in U.S. Primary Elections Using Campaign Contributions	13-May-24	17-May-24	4	4

Topical Workshop	The Ceresa Cycle in Arithmetic and Geometry	13-May-24	17-May-24	59	59
Hot Topics Workshop	Random Matrices and Applications	20-May-24	22-May-24	59	59
Topical Workshop	Recent Progress on Optimal Point Distributions and Related Fields	3-Jun-24	7-Jun-24	48	48
Collaborate@ICERM	Connections Between Alcoved and Flow Polytopes	10-Jun-24	14-Jun-24	4	4
Collaborate@ICERM	Hyperkahler Manifolds and Special Cubic Fourfolds	10-Jun-24	14-Jun-24	4	4
Special Event	Roots of Unity	10-Jun-24	14-Jun-24	35	35
Summer@ICERM	Mathematical Models to Predict, Prevent, and Prepare	10-Jun-24	2-Aug-24	26	26
Collaborate@ICERM	Isoperimetric Inequality in the 3D Cube	17-Jun-24	21-Jun-24	2	2
Collaborate@ICERM	Macdonald Polynomials and Catalanimals	17-Jun-24	21-Jun-24	5	5
Collaborate@ICERM	A Computational Approach to Plethysm	24-Jun-24	28-Jun-24	4	4
Topical Workshop	Queer in Computational and Applied Mathematics (QCAM)	24-Jun-24	28-Jun-24	53	53
Collaborate@ICERM	Counting Sections of Fano Fibrations	8-Jul-24	12-Jul-24	4	4
REUF	REUF Continuation Group	8-Jul-24	12-Jul-24	3	3
REUF	REUF Continuation Group	8-Jul-24	12-Jul-24	5	5
Topical Workshop	Solving the Boltzmann Equation for Neutrino Transport in Relativistic Astrophysics	8-Jul-24	12-Jul-24	41	41
Collaborate@ICERM	Vacillating Tableaux for Integer Sequences	15-Jul-24	19-Jul-24	4	4
Topical Workshop	Braids Reunion Workshop	15-Jul-24	19-Jul-24	52	52
Collaborate@ICERM	The Construction of Locally Recoverable Quasi-Cyclic Codes with Multiple Generators	22-Jul-24	26-Jul-24	2	2

REUF	REUF Continuation Group	22-Jul-24	2-Aug-24	4	4
Topical Workshop	Empowering a Diverse Computational Mathematics Community	22-Jul-24	2-Aug-24	45	45
Collaborate@ICERM	The Persistent Topology of Hypergraphs	5-Aug-24	9-Aug-24	5	5
Collaborate@ICERM	Roots of Bernstein-Sato Polynomials via Positive Characteristic Methods	5-Aug-24	9-Aug-24	6	6
REUF	REUF Continuation Group	5-Aug-24	9-Aug-24	5	5
Topical Workshop	Simulating Extreme Spacetimes with SpEC and SpECTRE	5-Aug-24	9-Aug-24	64	64
Collaborate@ICERM	Randomized Algorithms for Tensor Problems with Factorized Operations or Data	12-Aug-24	16-Aug-24	6	6
Collaborate@ICERM	Theory and algorithms for reduced order modelings	12-Aug-24	16-Aug-24	3	3
GoGetMath	GoGetMath@ICERM: Summer Math Camp for High School Students	12-Aug-24	16-Aug-24	28	28
Collaborate@ICERM	Lagrangian Relaxation Beyond Boundedness And Rationality	19-Aug-24	23-Aug-24	3	3
Collaborate@ICERM	Microlocal Analysis and Statistical Methods in Tomography	19-Aug-24	23-Aug-24	8	8
Topical Workshop	Spectral Analysis of Schrödinger Operators	19-Aug-24	23-Aug-24	49	49
Topical Workshop	Discrete Optimization: Mathematics, Algorithms, and Computation	26-Aug-24	30-Aug-24	46	46
Semester Program	Theory, Methods, and Applications of Quantitative Phylogenomics	4-Sep-24	6-Dec-24	54	55
Hot Topics Workshop	Modeling and Simulations in Fluids	7-Sep-24	8-Sep-24	33	33
Hot Topics Workshop	Robust Optimization and Simulation of Complex Stochastic Systems	13-Sep-24	15-Sep-24	57	57

Semester Program Workshop	Current Methods and Open Problems in Mathematical and Statistical Phylogenetics	16-Sep-24	20-Sep-24	32	77
Semester Program Workshop	From Phylogenetics to Phylogenomics: Mathematical and Statistical Challenges	21-Oct-24	25-Oct-24	25	68
Public Lecture	Count on Me to Write and Mathematics/Statistics Book	14-Nov-24	14-Nov-24	56	56
Special Event	Blackwell-Tapia Conference 2024	15-Nov-24	16-Nov-24	75	75
Semester Program Workshop	Algorithmic Advances and Implementation Challenges: Developing Practical Tools for Phylogenetic Inference	18-Nov-24	22-Nov-24	33	77
Collaborate@ICERM	Networks, Language, and Change: Advancing textual analysis methodology in the context of cultural change in STEM	9-Dec-24	13-Dec-24	4	4
Topical Workshop	Harmonic Analysis and Convexity	9-Dec-24	13-Dec-24	46	46
Collaborate@ICERM	Data-driven Predictive Modeling and Simulation for Lung Infections	6-Jan-25	10-Jan-25	8	8
Collaborate@ICERM	Topics in Tame Galois Theory	6-Jan-25	10-Jan-25	3	3
Topical Workshop	Computational Learning for Model Reduction	6-Jan-25	10-Jan-25	78	78
External Event	Summer@ICERM: Joint Mathematics Meeting 2025	8-Jan-25	11-Jan-25	18	18
Collaborate@ICERM	Structures of the Weak Order	13-Jan-25	17-Jan-25	6	6
Topical Workshop	Women in Mathematical Computational Biology	13-Jan-25	17-Jan-25	37	37
Collaborate@ICERM	Finiteness Properties and Computations of Derived Differential Operators on Singular Varieties	21-Jan-25	24-Jan-25	5	5
Topical Workshop	Patterns, Dynamics, and Data in Complex Systems	21-Jan-25	24-Jan-25	70	70

Semester Program	Geometry of Materials, Packings and Rigid Frameworks	29-Jan-25	2-May-25	43	46
Semester Program Workshop	Circle Packings, Minimal Surfaces, and Discrete Differential Geometry	10-Feb-24	14-Feb-24	35	66
Hot Topics Workshop	Fusing Theory and Practice of Graph Algorithms	20-Feb-25	22-Feb-25	93	93
Semester Program Workshop	Matroids, Rigidity, and Algebraic Statistics	17-March-25	21-March-25	38	76
Public Lecture	AlphaGeometry: A Step Toward Automated Math Reasoning	18-March-25	18-March-25	150	150
Semester Program Workshop	Geometry of Materials	7-Apr-25	11-Apr-25	32	65
Hot Topics Workshop	Autoformalization for the Working Mathematician	24-Apr-25	27-Apr-25	69	69

Participant Summaries by Program Type

The tables below display breakdowns of ICERM's confirmed participants by category during the reporting period for all funded programs. Each participant is represented once per unique visit regardless of the number of programs they attended during a visit. NOTE: "funded" refers to participants who had offered funding attached to their attendance.

ICERM Funded Participants

Program Type		Summer@ICERM 2024	4 REUF Continuation Groups	21 Collaborate@ICERM Groups	Fall Semester '24					Spring Semester '25					Topical '24-'25														Hot Topics '24-'25					
					Semester Program	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Workshop 6	Workshop 7	Workshop 8	Workshop 9	Workshop 10	Workshop 11	Workshop 12	Workshop 13	Workshop 14	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	% of # Reporting
Geographical Point of Origin	Total Participants	26	17	95	52	27	23	29		43	34	31	32		89	47	45	50	37	47	45	62	42	41	43	72	35	59		50	25	36	71	53	
	US - Midwest	10	3	25	9	5	4	6	18.32%	3	5	2	4	10.00%	13	13	11	10	3	9	4	5	7	5	17	6	5	12	16.81%	6	1	3	10	2	9.36%
	US - Northeast	6	7	32	7	10	3	6	19.85%	6	8	5	8	19.29%	27	13	11	11	5	16	16	22	14	10	6	18	10	13	26.89%	22	10	17	27	24	42.55%
	US - South	5	4	12	6	3	4	1	10.69%	6	4	6	5	15.00%	13	7	9	9	6	14	10	5	6	7	9	28	8	11	19.89%	7	5	7	9	3	13.19%
	US - West	5	3	15	10	3	5	10	21.37%	0	3	4	4	7.86%	20	6	7	10	7	6	10	18	3	7	2	12	8	13	18.07%	9	5	4	20	11	20.85%
	Africa	0	0	0	0	0	0	0	0.00%	0	0	0	0	0.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%	0	0	0	0	0	0.00%
	Asia	0	0	2	1	2	0	1	3.05%	2	2	3	1	5.71%	1	1	2	1	0	0	1	5	1	0	2	2	0	0	2.24%	1	1	2	0	1	2.13%
	Canada	0	0	3	1	3	2	2	6.11%	0	1	0	1	1.43%	0	2	0	6	0	0	0	0	6	0	3	0	0	1	2.52%	2	0	0	0	3	2.13%
	Europe	0	0	5	13	1	5	2	16.03%	25	10	11	8	38.57%	13	5	5	3	16	2	4	7	5	10	3	6	3	9	12.75%	3	3	3	5	7	8.94%
	Latin & South America	0	0	1	0	0	0	0	0.00%	0	0	0	0	0.00%	1	0	0	0	0	0	0	0	0	2	1	0	1	0	0.70%	0	0	0	0	1	0.43%
	Oceania	0	0	0	5	0	0	1	4.58%	1	0	0	1	1.43%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%	0	0	0	0	1	0.43%

All Participants (ICERM funded and Non-ICERM funded)

Program Type		Summer@ICERM 2024	4 REUF Continuation Groups	21 Collaborate@ICERM Groups	Fall Semester '24					Spring Semester '25					Topical '24-'25														Hot Topics '24-'25					
					Semester Program	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Workshop 6	Workshop 7	Workshop 8	Workshop 9	Workshop 10	Workshop 11	Workshop 12	Workshop 13	Workshop 14	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	% of # Reporting
Geographical Point of Origin	Total Participants	26	17	95	54	32	25	34		44	36	39	33		102	61	48	54	44	52	47	67	52	46	49	83	39	70		60	56	58	93	70	
	Domestic	26	17	84	34	26	18	27	78.02%	16	21	22	21	59.26%	86	53	41	44	27	49	42	54	38	33	40	74	35	60	83.05%	54	45	52	86	54	86.35%
	Foreign	0	0	11	10	6	7	7	21.98%	28	15	17	12	40.74%	16	8	7	10	17	3	5	13	14	13	9	9	4	10	16.95%	6	11	6	7	16	13.65%

ICERM Funded Speakers

Program Type		Fall Semester '24				Spring Semester '25				Topical '24-'25															Hot Topics '24-'25					
		Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Workshop 6	Workshop 7	Workshop 8	Workshop 9	Workshop 10	Workshop 11	Workshop 12	Workshop 13	Workshop 14	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	% of # Reporting
Geographical Point of Origin	Total Participants	11	8	15		18	12	16		29	14	21	7	17	17	2	8	21	22	23	21	0	18		15	11	15	7	8	
	US - Midwest	1	0	2	8.82%	3	0	3	13.04%	5	4	3	1	2	1	0	0	4	2	7	1	0	3	15.00%	2	0	2	0	0	7.14%
	US - Northeast	4	0	2	17.65%	3	3	4	21.74%	7	3	6	3	0	7	1	3	5	7	4	4	0	0	22.73%	4	3	6	3	3	33.93%
	US - South	1	2	1	11.76%	3	3	1	15.22%	3	2	8	1	5	4	1	0	4	6	5	8	0	2	22.27%	0	1	1	0	0	3.57%
	US - West	0	1	5	17.65%	1	2	2	10.87%	6	1	1	1	5	3	0	3	0	2	1	5	0	5	15.00%	5	4	2	2	4	30.36%
	Africa	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%	0	0	0	0	0	0.00%
	Asia	1	0	1	5.88%	0	1	1	4.35%	1	0	2	0	0	0	0	0	0	0	2	1	0	0	2.73%	1	1	1	0	0	5.36%
	Canada	3	2	1	17.65%	0	0	0	0.00%	0	1	0	1	0	0	0	0	3	0	3	0	0	1	4.09%	2	0	0	0	0	3.57%
	Europe	1	3	2	17.65%	7	3	4	30.43%	6	3	1	0	5	2	0	2	5	5	1	2	0	7	17.73%	1	2	3	2	1	16.07%
	Latin & South America	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%	0	0	0	0	0	0.00%
	Oceania	0	0	1	2.94%	0	0	1	2.17%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%	0	0	0	0	0	0.00%

All Speakers (ICERM funded and Non-ICERM funded)

Program Type		Fall Semester '24				Spring Semester '25				Topical '24-'25															Hot Topics '24-'25					
		Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Workshop 6	Workshop 7	Workshop 8	Workshop 9	Workshop 10	Workshop 11	Workshop 12	Workshop 13	Workshop 14	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	% of # Reporting
Geographical Point of Origin	Total Participants	11	8	15		18	12	16		30	15	21	7	17	17	2	8	21	23	24	21	0	20		15	12	16	8	9	
	Domestic	6	3	10	55.88%	10	8	10	60.87%	23	11	18	6	12	15	2	6	13	18	18	18	0	12	76.11%	11	9	11	6	8	75.00%
	Foreign	5	5	5	44.12%	8	4	6	39.13%	7	4	3	1	5	2	0	2	8	5	6	3	0	8	23.89%	4	3	5	2	1	25.00%

ICERM Funded Postdocs

Program Type		Summer@ICERM 2024	4 REUF Continuation Groups	21 Collaborate@ICERM Groups	Fall Semester '24					Spring Semester '25					Topical '24-'25													Hot Topics '24-'25					
					Semester Program	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Workshop 6	Workshop 7	Workshop 8	Workshop 9	Workshop 10	Workshop 11	Workshop 12	Workshop 13	Workshop 14	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	% of # Reporting
Geographical Point of Origin	Total Participants	0	0	12	10	8	3	7		13	9	4	8		13	16	9	5	5	12	10	13	9	7	10	13	8	14		6	1	7	4	5	
	US - Midwest	0	0	2	2	3	1	1	25.00%	1	0	0	0	2.94%	1	3	1	1	0	1	0	1	2	0	3	1	1	2	11.81%	0	0	1	1	0	8.70%
	US - Northeast	0	0	5	1	2	0	0	10.71%	1	3	1	3	23.53%	4	5	1	1	2	2	2	2	3	1	1	3	3	4	23.61%	4	0	3	1	2	43.48%
	US - South	0	0	1	0	1	0	0	3.57%	1	0	1	1	8.82%	1	1	2	1	0	4	4	1	0	2	2	4	0	3	17.36%	1	0	2	1	0	17.39%
	US - West	0	0	4	3	0	0	5	28.57%	0	1	1	2	11.76%	4	1	2	1	3	3	2	4	1	3	1	2	3	4	23.61%	1	0	1	1	1	17.39%
	Africa	0	0	0	0	0	0	0	0.00%	0	0	0	0	0.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%	0	0	0	0	0	0.00%
	Asia	0	0	0	0	2	0	0	7.14%	1	1	0	0	5.88%	0	1	0	0	0	0	1	2	1	0	1	0	0	0	4.17%	0	0	0	0	1	4.35%
	Canada	0	0	0	0	0	0	1	3.57%	0	0	0	0	0.00%	0	1	0	1	0	0	0	0	1	0	0	0	0	0	2.08%	0	0	0	0	0	0.00%
	Europe	0	0	0	4	0	2	0	21.43%	9	4	1	2	47.06%	2	4	3	0	0	2	1	3	1	1	2	3	1	1	16.67%	0	1	0	0	0	4.35%
	Latin & South America	0	0	0	0	0	0	0	0.00%	0	0	0	0	0.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%	0	0	0	0	1	4.35%
	Oceania	0	0	0	0	0	0	0	0.00%	0	0	0	0	0.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%	0	0	0	0	0	0.00%

All Postdocs (ICERM funded and Non-ICERM funded)

Program Type		Summer@ICERM 2024	4 REUF Continuation Groups	21 Collaborate@ICERM Groups	Fall Semester '24					Spring Semester '25					Topical '24-'25													Hot Topics '24-'25					
					Semester Program	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Workshop 6	Workshop 7	Workshop 8	Workshop 9	Workshop 10	Workshop 11	Workshop 12	Workshop 13	Workshop 14	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	% of # Reporting
Geographical Point of Origin	Total Participants	0	0	12	9	8	3	7		13	10	5	9		17	18	9	5	8	13	10	14	10	8	12	14	8	16		7	6	10	6	6	
	Domestic	0	0	12	5	6	1	6	72.22%	3	4	3	6	54.17%	15	12	6	4	8	11	8	9	6	7	9	11	7	15	79.01%	7	3	10	6	3	82.86%
	Foreign	0	0	0	4	2	2	1	27.78%	10	6	2	3	45.83%	2	6	3	1	0	2	2	5	4	1	3	3	1	1	20.99%	0	3	0	0	3	17.14%

ICERM Funded Graduate Students

Program Type		Summer@ICERM 2024	4 REUF Continuation Groups	21 Collaborate@ICERM Groups	Fall Semester '24					Spring Semester '25					Topical '24-'25														Hot Topics '24-'25					
					Semester Program	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Workshop 6	Workshop 7	Workshop 8	Workshop 9	Workshop 10	Workshop 11	Workshop 12	Workshop 13	Workshop 14	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	% of # Reporting
Geographical Point of Origin	Total Participants	4	0	11	9	6	9	6		9	5	11	2		28	11	10	10	11	15	4	30	8	8	14	10	13	7		15	5	5	38	12	
	US - Midwest	2	0	4	4	0	1	2	23.33%	1	0	2	0	11.11%	5	5	4	3	1	4	1	2	0	2	7	2	3	1	22.35%	3	1	0	6	0	13.33%
	US - Northeast	2	0	3	1	3	1	2	23.33%	0	1	0	0	3.70%	12	2	2	2	0	6	1	14	5	2	2	0	3	2	29.61%	6	3	4	16	5	45.33%
	US - South	0	0	1	1	1	2	0	13.33%	1	0	1	0	7.41%	3	3	1	2	2	3	1	3	1	1	3	5	5	0	18.44%	1	0	1	4	0	8.00%
	US - West	0	0	3	1	2	4	2	30.00%	0	1	1	0	7.41%	4	1	2	1	1	2	1	7	1	2	1	2	0	3	15.64%	3	1	0	11	4	25.33%
	Africa	0	0	0	0	0	0	0	0.00%	0	0	0	0	0.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%	0	0	0	0	0	0.00%
	Asia	0	0	0	0	0	0	0	0.00%	0	0	2	1	11.11%	0	0	0	1	0	0	0	2	0	0	1	0	0	0	2.23%	0	0	0	0	0	0.00%
	Canada	0	0	0	1	0	0	0	3.33%	0	1	0	0	3.70%	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1.12%	0	0	0	0	1	1.33%
	Europe	0	0	0	1	0	1	0	6.67%	7	2	5	1	55.56%	3	0	1	0	7	0	0	2	0	1	0	1	2	1	10.06%	2	0	0	1	2	6.67%
	Latin & South America	0	0	0	0	0	0	0	0.00%	0	0	0	0	0.00%	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.56%	0	0	0	0	0	0.00%
	Oceania	0	0	0	0	0	0	0	0.00%	0	0	0	0	0.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%	0	0	0	0	0	0.00%

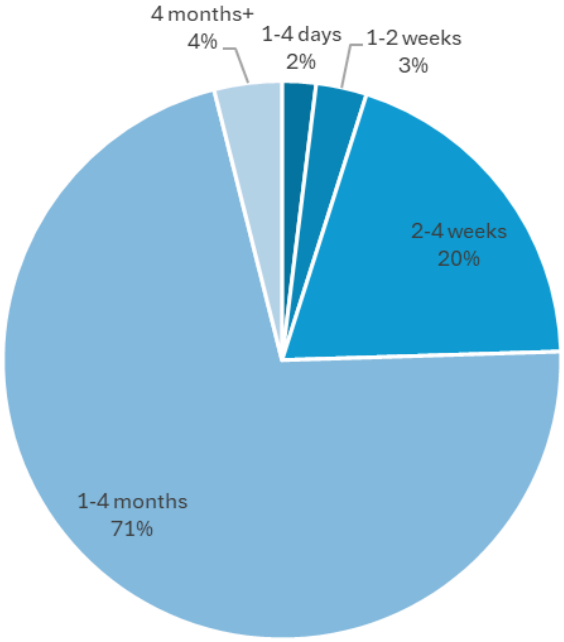
All Graduate Students (ICERM funded and Non-ICERM funded)

Program Type		Summer@ICERM 2024	4 REUF Continuation Groups	21 Collaborate@ICERM Groups	Fall Semester '24					Spring Semester '25					Topical '24-'25														Hot Topics '24-'25					
					Semester Program	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Workshop 6	Workshop 7	Workshop 8	Workshop 9	Workshop 10	Workshop 11	Workshop 12	Workshop 13	Workshop 14	% of # Reporting	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	% of # Reporting
Geographical Point of Origin	Total Participants	4	0	11	9	10	7	6		9	15	2	21		33	17	12	12	14	16	4	32	13	9	16	14	13	12		21	16	15	43	15	
	Domestic	4	0	11	7	10	6	5	91.30%	2	7	0	21	73.68%	29	17	11	10	6	16	4	28	12	8	15	13	11	11	88.02%	19	15	15	41	12	92.73%
	Foreign	0	0	0	2	0	1	1	8.70%	7	8	2	0	26.32%	4	0	1	2	8	0	0	4	1	1	1	1	2	1	11.98%	2	1	0	2	3	7.27%

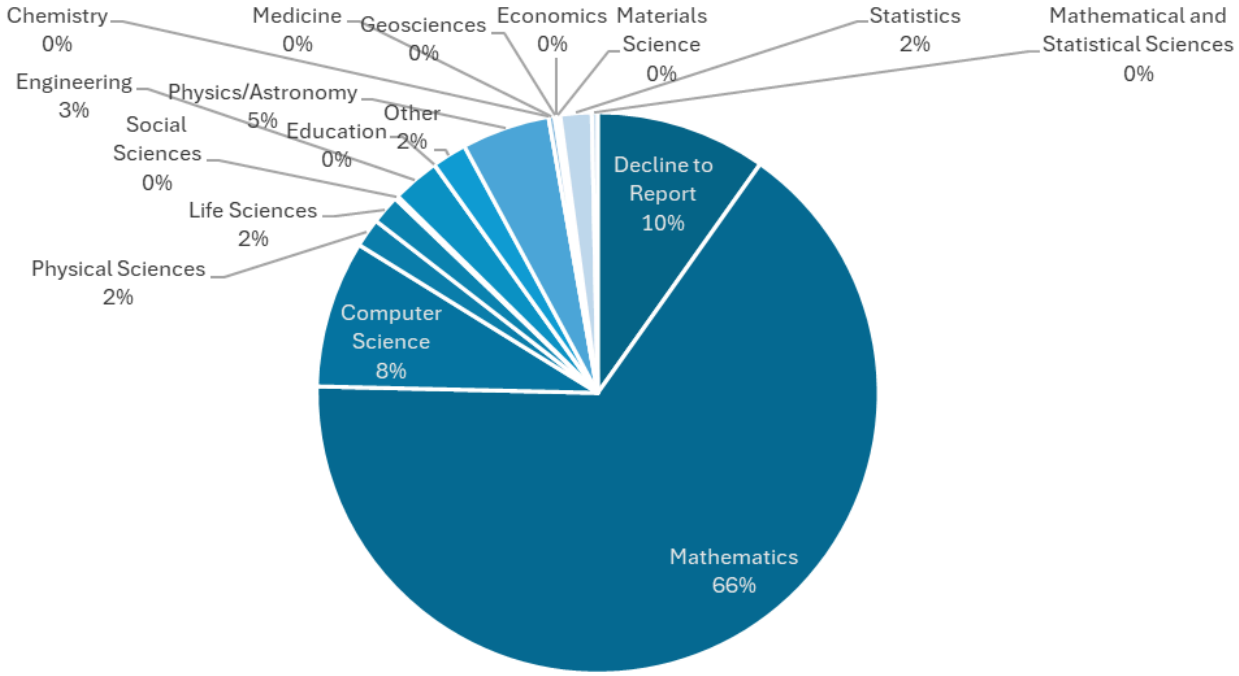
Additional Participant Data

The charts below display breakdowns of ICERM's confirmed NSF-funded participants by category during the reporting period for all funded programs. Each participant is only reflected once per chart regardless of the number of programs they attended.

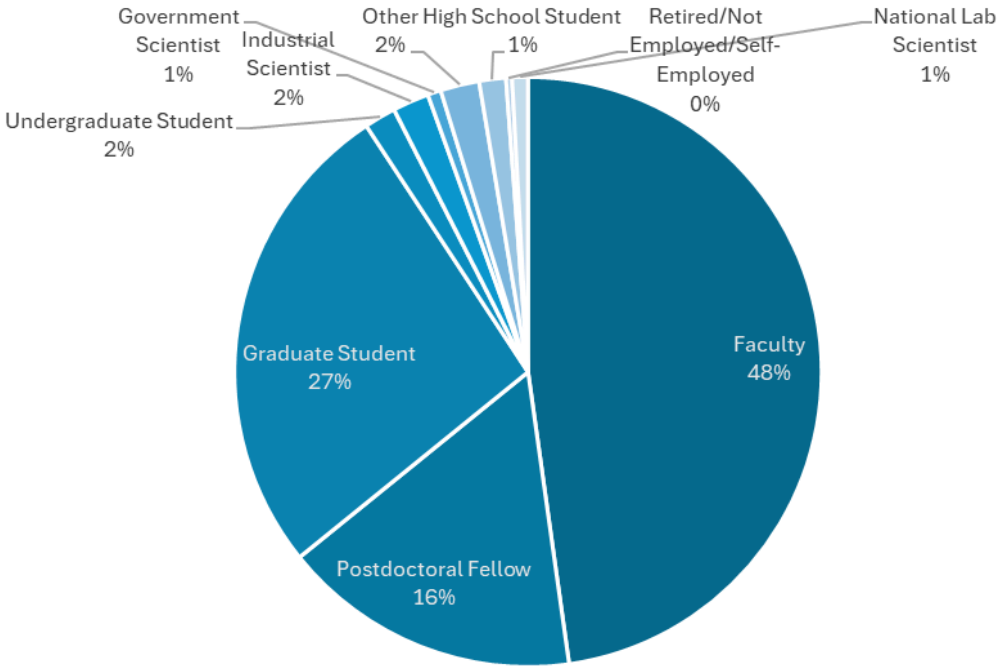
Semester Program Length of Stay



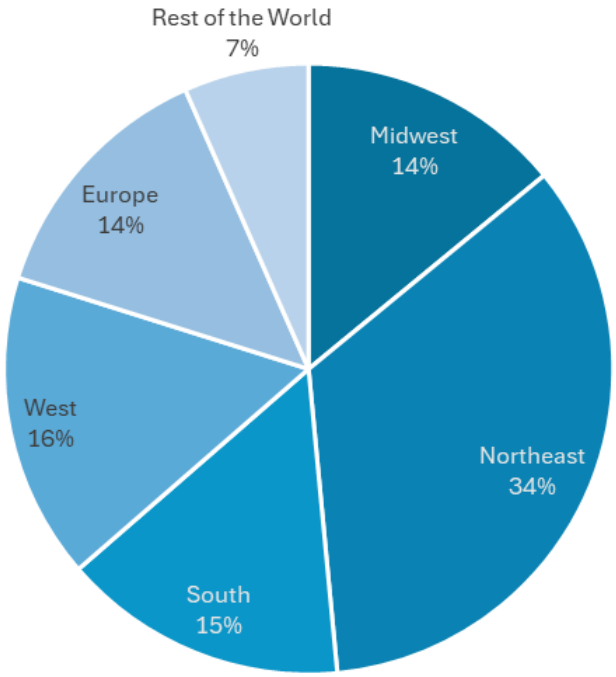
Primary Field of Interest



Position



U.S. vs Foreign-Based Participants



"Rest of the World" category includes: Africa, Asia, Canada, Latin & South America, and Oceania.

Notable Accomplishments

Autoformalization for the Working Mathematician

In 2024-2025, ICERM continued to support work at the intersection of mathematics and rapidly evolving machine learning and artificial intelligence tools. During the April 2025 Hot Topics Workshop "Autoformalization for the Working Mathematician," pure mathematicians looking to adopt automated theorem-proving software in their research joined forces with machine learning scientists, who increasingly use theorem-proving to test a system's automated reasoning abilities. The group specifically worked toward the goal of developing a dataset that can be used to benchmark machine learning models for tasks that are close to the use cases of working mathematicians.

Prior to the April Hot Topics Workshop, ICERM also hosted the March 2025 Public Lecture "AlphaGeometry: A Step Toward Automated Math Reasoning" with Dr. Junehyuk Jung (Brown University). The event was ICERM's first public-facing lecture on the topic of automated mathematical methods. Tickets to attend in-person quickly sold out. The talk introduced the inner workings of Google DeepMind's AlphaGeometry AI system, exploring the innovative techniques that enable it to tackle intricate geometric puzzles. Jung explained how AlphaGeometry combines the power of neural networks with symbolic reasoning to discover elegant mathematical solutions.

Fall 2024 Semester Program

During the Fall 2024 semester, researchers in the "Theory, Methods, and Applications of Quantitative Phylogenomics" Semester Program developed methods to advance evolutionary research with newly available genomic data. Over 130 experimental biologists, computer scientists, mathematicians, and statisticians visited ICERM for three major workshops addressing mathematical and statistical challenges in phylogenetic research, specifically the need for updated computational tools. Researchers addressed challenges in obtaining complex biological data, advanced standing mathematical problems with ties to biology, and developed novel phylogenetic software. As a direct result of the program, there have been several new collaborations related to phylogenetic network reconstruction algorithms, uses of neural networks to solve phylogenetic problems, identifiability of phylogenetic networks under various statistical models, and principles from tropical geometry to neural networks. We expect participants' work to inspire new directions in mathematical and biological research for years to come.

Spring 2025 Semester Program

ICERM's Spring 2025 Semester Program "Geometry of Materials, Packings and Rigid Frameworks" brought together mathematicians, engineers, and computer scientists to advance the study of discrete math, geometry, and materials science. The program succeeded in catalyzing collaborations between practicing engineers and academics, helping researchers identify impactful, pressing open problems. Notable lectures covered numerical approaches to structural engineering design, connections of rigidity to circular and sphere packings, and interactions between rigidity, algebraic statistics, and matroid theory. Early-career researchers

offered new perspectives on geometric frameworks for optimizing algebraic neural networks, Python packages for rigidity and flexibility of bar-and-joint frameworks, and various other topics related to hypersurfaces, rigidity theory, and matroids.

Spring 2023 Alumni Awards

A number of participants in ICERM's Spring 2023 Semester Program, Discrete Optimization: Mathematics, Algorithms, and Computation, have been recognized by the international mathematical community. At the 25th Conference on Integer Programming and Combinatorial Optimization, program alumni Gérard Cornuéjols and Siyue Liu (both at Carnegie Mellon University) were awarded the conference's Best Paper Award for "Approximately Packing Dijoins via Nowhere-Zero Flows," a publication partially based on work developed during the Spring 2023 gathering. Program alumni Samuel Fiorini (Université Libre de Bruxelles), Sebastian Pokutta (Technical University Berlin), and Ronald de Wolf (Dutch Centre for Mathematics and Computer Science) were co-recipients of a 2023 Gödel Prize for outstanding papers in the area of theoretical computer science; the other 2023 Gödel Prize was awarded to Thomas Rothvoss (University of Washington), who also attended the program. Spring 2023 Research Fellow Luze Xu (University of California Davis) was part of a research team that received the INFORMS Optimization Society's 2024 Young Researchers Paper Prize. Finally, program alumni Alberto del Pia (University of Wisconsin-Madison) and Aida Khajavirad (Lehigh University) were awarded the 2023 INFORMS Computing Society Prize for their series of papers on convexification of mixed-integer polynomial optimization problems.

Empowering a Diverse Computational Mathematics Research Community (EDCMC)

Alumni of ICERM's summer 2024 research and professional development workshop for early-career computational math researchers have advanced several projects catalyzed by the program. At the 2025 International Conference on Spectral and High Order Methods, workshop alum Andrés Galindo-Olarte (University of Texas at Austin) presented "A Novel Hybrid Low Rank Nodal Discontinuous Galerkin Method for the BGK Equation" during a session on high-order low-rank methods with applications to high-dimensional problems. The session was chaired by workshop attendee Jing-Mei Qiu (University of Delaware). Galindo-Olarte's talk directly resulted from the research clusters initiated during the summer 2024 program at ICERM.

At the Third Joint Meeting of the Society for Industrial and Applied Mathematics and the Canadian Applied and Industrial Mathematics Society, EDCMC program alumni will hold a minisymposium to disseminate results from the program's many ongoing collaborations. The minisymposium will highlight participants' results related to agnostic numerical filters based on convolution, mixed model Runge-Kutta methods, reduced order modeling for kinetic models, low rank tensor methods for high-dimensional multi-scale multi-physics PDEs, modeling and numerical simulation of microswimmers in confined domains, inverse problems and uncertainty quantification in imaging applications, and compatible discretizations for nonlinear optical phenomena.

Report on ICERM operations

Program Management Team

This reporting period continued to challenge ICERM's program staff, as they managed full in-person operations while continuing to offer virtual access to several programs. Planned virtual lectures are typically limited to 20% of all talks for each program. However, ICERM continues to respond flexibly to travel disruptions and health issues, offering alternatives whenever necessary. Program organizers have the final say in whether they will allow virtual or hybrid participation. Over the past several years, ICERM application systems and processes have been updated to reflect the full range of available options. ICERM's policy and procedure surrounding virtual offerings is subject to change, in order to ensure a positive impact on organizers, speakers, and attendees.

ICERM staff has also met challenges when facilitating programs and workshops that fall outside the traditional format of the institute's core programs. Running a variety of concurrent atypical programs over the course of the summer months has pushed the limits of staff bandwidth and physical space. In 2024-2025, there were several weeks-long periods when multiple Collaborate@ICERM programs ran in parallel with Summer@ICERM and a variety of Topical Workshops. ICERM leadership regularly reviews ways to balance the needs of all of its programming and provide support equitably.

Finally, due to changes in program staff structure, ICERM has had to adjust its communications strategy. In previous years, the Communications Specialist worked closely with participants and the directorate to curate institute newsletters and ensure the timely communication of scientific outcomes. As of January 2025, ICERM's IT Team has assumed temporary responsibility for maintaining the institute's social media page and publishing research highlights to mathinstitutes.org. In March 2025, ICERM created a part-time Communications Assistant position to help fulfill the responsibilities of the former Communications Specialist role.

Information Technology

AV and Video Conferencing

All meeting spaces in ICERM have remote conferencing capabilities and can host in-person, hybrid or remote sessions. ICERM also has an auxiliary portable AV system To make use of large spaces without integrated AV equipment.

Endpoint Computing

ICERM has an "flexible endpoint" solution for desktop computing due to low participant usage rates, and no longer puts terminals/thin clients on each desktop. ICERM supplies monitors, keyboards and mice for each desk. The IT group maintains a small pool of 15 laptops available for participant use on a temporary basis, as well as an array of cables, connectors and adapters. This strategy optimizes resource allocation by reducing hardware expenditures and maintenance overhead.

Compute and Software Resources

ICERM continues to leverage Brown's resources for software licensing and delivery and for high performance computing. ICERM also provides access to commonly used Software as a Service (SaaS) offerings such as Overleaf and CoCalc. ICERM is augmenting its technology portfolio by supporting commercially available cloud compute resources. These systems will provide the institute with a high level of flexibility and allow us to better support a broader range of programs and participants.

Web Services and Application Development

ICERM continues to iteratively develop Cube, its institute management application, in an effort to minimize administrative overhead for staff, improve the user experience for participants, and enhance reporting capabilities. Recent efforts include:

- created an API to increase flexibility in the utilization of data, particularly in presenting it via the website;
- added flexibility to outcomes reporting with the addition of mechanisms to report digital products such as code and datasets;
- updated the reimbursement process to reflect changes to Brown's processes.
- improved security of the application technology stack to mitigate risks to availability and data integrity.

Semester Programs

Since its inaugural semester program in September 2011, a large portion of the Institute's activity has taken place in the context of semester-long thematic programs together with their associated workshops. ICERM encourages proposals for programs that support its mission "to foster and broaden the relationship between mathematics and computation". The institute is open to proposals from any area of the mathematical sciences. Both pure and applied fields may benefit from the positive feedback between computation and theory that ICERM seeks to promote. ICERM Directors help proposers flesh out their ideas within the context of our mission; it is an iterative process, involving many conversations with ICERM Directors and proposal drafts in response to feedback from Directors and ICERM's boards, and fine-tuning after the event is publicly announced.

Semester Program Process

ICERM's Scientific Advisory Board SAB meets annually in November, and schedules conference calls as needed throughout the year. The Fall 2024 annual meeting and a subsequent conference call in May resulted in the selection of Semester Programs and Topical Workshops through Spring 2027.

The semester program selection process follows these steps:

1. Solicitation of Proposals

ICERM hosts two semester programs per year. Each has organizers and long-term participants who are expected to be in residence for the majority of the semester. Semester programs typically incorporate three week-long associated workshops.

Semester Program Full Proposal Requirements

A semester program proposal should be 6-10 pages and contain:

- List of 5-10 organizers, including the main contact for organizing committee
- Short abstract of the program's basic goals and underlying philosophy
- Description of the program area/theme and central scientific challenges, written for a general mathematical audience
- Description of the experimental and computational aspects of the program
- List of 8-10 high priority senior scientists likely to visit ICERM for a month or more
- Ranked list of 20+ potential long-term participants who will help form a critical mass for the scientific program
- Description of three proposed workshops, including potential organizers, if known
- Description of a 2-3 day opening event that will survey guiding problems or introduce key computational or experimental methodologies
- Concrete plans for involving and mentoring graduate students, postdocs, and early-career mathematicians in the program

Deadline and Review Process

Proposals are submitted to the ICERM Director. Annual target deadlines are October 1st and May 1st. ICERM Directors and the Scientific Advisory Board (SAB) review all proposals. Proposers receive feedback within a month of the SAB meeting.

2. Proposal Selection

The Science Advisory Board SAB approves the semester programs. The deadline for revised proposals is a week prior to the annual November SAB meeting. Once a proposal is accepted, an ICERM Director is assigned to assist the organizers who are also provided with a planning timeline. The “high priority” list of senior scientists are contacted and invited to participate immediately upon SAB approval. Program dates are scheduled with details posted on the ICERM website and various on-line math organization calendars SIAM, AMS, European Mathematical Society, National Math Institutes, and Conference Service Mandl. Program and/or workshop ads are placed in appropriate publications if recommended by the organizers and Directors. ICERM reserves some funds for applicants (non-invitees) to the program.

From this point on, organizers are involved in making decisions on the following: ICERM postdoc selection; applications for long-term visitors, graduate students, and workshop participants; mentoring of students and postdocs (an institute Director assists the organizers with mentor coordination). Members of the Directorate make the final decisions on all invitations. A designated organizer assists ICERM staff by providing appropriate program images for web and print ads and will be asked to review marketing materials.

3. Selection of Long-term Visitors/Research Fellows

The organizers propose a ranked list of 20 to 30 research fellows. ICERM Directors approve and/or suggest additions or re-rankings. The standard model for long-term participation for senior faculty is through paid leaves such as sabbatical.

4. Offers to Research Fellows

Once the list of research fellows has been finalized and funding determined, an invitation is sent to each. The invitation describes the program and outlines the support to be provided. ICERM research fellow invitations include language regarding Brown University's "Code of Conduct", which addresses sexual harassment, discrimination, and other unprofessional behaviors. Using its Cube database, ICERM tracks demographic information about, and all interactions with, research fellows.

5. Semester Workshops

Semester program organizers recommend organizers for each of the three-to-four workshops, taking into account feedback from ICERM's Scientific Advisory Board and responsible Directors. The organizers propose an initial ranked list of 20-25 possible speakers and a list of 10 alternates. The ICERM Directorate approves and/or suggests additions or re-rankings in consultation with assigned SAB members. Formal invitations are sent by ICERM staff describing the program and outlining the support to be provided to those who indicate an interest. During this reporting cycle, ICERM updated all of its workshop invitations to include language regarding Brown University's "Code of Conduct", which addresses sexual harassment, discrimination, and other unprofessional behaviors. A designated workshop organizer assists ICERM staff by providing appropriate program images for the workshop's web and print ads, and will be asked to review marketing materials.

6. Application Process

Once the organizers and Directors agree there is enough critical mass in terms of confirmed long-term visitors and/or workshop speakers, the on-line application for that particular program is opened on the ICERM website. All applications are stored in the institute's "Cube" database (see also the "Recruiting and Selection of ICERM-Funded Postdocs" later in this report). The ICERM postdoctoral fellow applicants who were not hired via MathJobs.org are alerted that the ICERM postdoc positions have closed and that they should apply online for partial support to attend as a participant if they are still interested.

7. Applicant Selection

Program organizers can view the applicants and their supporting documents as well as prioritize them within Cube. A member of the ICERM Directorate reviews the prioritized list, re-ranks as appropriate and makes the final selections, taking into consideration the remaining space in the program, participant support requested, and whether or not the applicant is a young researcher who has an advisor already participating in the program. ICERM staff then updates the applicant about their status, and any support they are eligible for, as appropriate.

Financial Decisions for Semester Programs

Financial decisions are made by ICERM Directors based on discussions with organizers. For a typical program, ICERM provides travel and lodging support for 5-10 organizers (at least a month in residence, with some for the full semester); 20-30 long-term participants (4+ weeks); 1 Institute and 5 Semester postdoctoral fellows (salaried); 60 short-term participants (1-4 weeks); 10-15 graduate students (6+ weeks); and workshop attendees. ICERM helps essential long-term participants negotiate sabbatical leaves or teaching releases to foster their participation.

In response to feedback from the ICERM Board of Trustees, a research fellowship support opportunity was advertised to the mathematical community as well as specific outreach sent to attendees of upcoming programs. The funding is available for fellowships to support faculty who attend one of its semester programs. These are often used to cover teaching release so that participants can be in residence throughout a semester program. ICERM particularly welcomed applications from those not based at R1 research universities. The program organizers for the relevant program encourage participants to request the support, identify participants whose attendance would be critical to the success of the program, and are consulted to ensure an applicant's background fits with the program.

Opening, Closing, and Related Events

Semester program opening and closing events are tailored to each program. Here are some examples of planned events during semester programs.

Opening event(s)

During the first week of program and can include:

- Opening reception
- 10-15 minute introductory presentations by the postdocs and grad students, designed to get everyone acquainted
- Talks related to upcoming workshops
- IT tutorial led by ICERM's IT staff

Weekly Seminar non-workshop weeks

- The weekly seminar includes talks by visitors in residence at ICERM. Program organizers are provided with names and dates to facilitate scheduling.

Mini-Series (Optional)

- Mini-courses or other multi-session events are encouraged.

Research Clusters (Optional)

A Research Cluster takes place during a semester program and is an independently organized research group activity in a focused subfield of that semester program.

A typical Research Cluster lasts at least 10 days, and as long as 4-6 weeks, and focuses on immediate progress on a major problem or on several problems of significance in the field of the

program. In addition to the invited participants, interested faculty, postdocs or graduate students in residence at ICERM may participate in the research cluster.

The activity period begins with a collection of tutorials or a short workshop. The research activities, planned by the organizers, may consist of teamwork, daily/weekly seminars, and closing presentations. In collaboration with an ICERM Director, Research Cluster organizers develop a list of 6-15 key scientists to form the core cohort of the cluster.

Prior to each of semester workshops (optional)

- Full-day tutorials the Thursday and Friday the week before each workshop
- Tutorials are given by long term visitors to the program

During Semester Workshops

- Workshops last one week and usually consist of 45-50 minute talks with 10 minutes of Q&A.
- Sometimes one afternoon is left "open" for collaborations and small groups
- A poster session is scheduled early in the workshop week
- Networking opportunities within workshops and semester programs, e.g., opportunities for participants to come together for lunchtime discussions (optional)

Non-workshop weeks

- Lectures occur through either mini courses, research seminars, special talks, and/or computational working group meetings
- Early Career Researcher Seminar, where graduate students and postdocs meet sans faculty and discuss scientific questions
- Postdocs and grad students are mentored throughout the program, both informally and with formal professional development seminars and meetings

Final Event

During the first week of the program discussion about a closing event occurs with the organizing committee. Some possible models include:

- Short talks from all long-term visitors who are still in residence
- Special Colloquium to close out the event on the last day of the program
- Time set aside for takeaways
- Closing reception

2024-2025 Semester Programs

Fall 2024

Theory, Methods, and Applications of Quantitative Phylogenomics

Sep 4 - Dec 6, 2024

Organizing Committee:

Elizabeth Allman, University of Alaska Fairbanks
Cécile Ané, University of Wisconsin - Madison

Elizabeth Gross, University of Hawai'i at Mānoa
Barbara Holland, University of Tasmania
Laura Kubatko, The Ohio State University
Simone Linz, University of Auckland
Siavash Mirarab, University of California San Diego
John Rhodes, University of Alaska Fairbanks
Sebastien Roch, University of Wisconsin-Madison
Leo Van Lersel, Delft University of Technology

Program Description:
A fundamental challenge that spans nearly all areas of evolutionary biology is the development of effective techniques for analyzing the unprecedented amount of genomic data that has become readily available within the last decade. Such data present specific challenges for the area of phylogenetic inference, which is concerned with estimating the evolutionary relationships among collections of species, populations, or sequences. These challenges include development of evolutionary models that are sufficiently complex to be biologically realistic while remaining computationally tractable; deriving and implementing algorithms to efficiently estimate phylogenetic relationships that use models whose theoretical properties are well-understood and therefore interpretable; and devising ways to scale novel methodology developed to handle datasets that are increasingly large and complex.

This semester program brings together mathematicians, statisticians, computer scientists, and experimental biologists to address the challenges involved in genome-scale phylogenetic inference. An overarching goal is to unite biologically-sound modeling with algorithms that can be implemented in a computationally tractable manner and that scale as both the number of species and the amount of genetic data increase. Specific topics to be investigated include: theory and practice of model-based inference for trees and networks, combinatorial and algebraic approaches for inferring phylogenies, software and algorithm development for inference and visualization, Bayesian approaches to phylogenetic inference, models for phylogenetic diversity and node dating, and methods for assessing model fit.

The list of all long-term visitors to the Fall 2024 Semester Program as well as the participant list for the affiliated workshops can be found in Appendix A.

Here follows a sample of the most substantive comments from long-term visitors:
Some Long-term Visitor Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *The program gave me an opportunity to interact with those in the discrete mathematics community who study phylogenetics, which is a community that I don't typically interact with as a biostatistician. I learned about algorithms for decomposing on phylogenetic networks that will be useful in programming network inference algorithms. I also learned about new models for horizontal transfer and have begun a collaboration working on this problem with a computer scientist and a mathematician.*

- *During the semester program and associated workshops I learned a lot about new computational methodologies and theoretical developments in the field. Coming from a combinatorics background, it was, for instance, really helpful to interact with statisticians and software developers, but also with people from the algebraic statistics community. The mix of people of different backgrounds at the semester program was amazing.*
- *Great collaborative atmosphere with many excellent scientists. The organization was perfect.*

Some Long-term Visitor Comments for "Briefly describe program highlights":

- *The whole program was a wonderful experience. Next to specific scientific talks and new collaborations, I really benefited from the sense of community and support among the long-term participants. As an early career researcher, I am sure that my interactions with both very senior people in the field but also the next generation of phylogeneticists will have a long-lasting impact on my career. So, thank you for making the program possible!*
- *Finding out about new potential directions of research; working face-2-face with colleagues whom I had not met in person for a long time which is far more enjoyable and beneficial to my research than meeting them online; starting new collaborative projects and making progress on the project with them on one of the ICERM blackboards; making many new junior researchers.*
- *The collaboration opportunities were far beyond anything I had ever experienced before. The research environment provided by ICERM was fantastic.*

Workshop 1: Current Methods and Open Problems in Mathematical and Statistical Phylogenetics

Sep 16 - 20, 2024

Organizing Committee:
Laura Kubatko, The Ohio State University
John Rhodes, University of Alaska Fairbanks
Sebastien Roch, University of Wisconsin-Madison
David Sankoff, University of Ottawa
Tandy Warnow, University of Illinois Urbana-Champaign

Program Description:
Computational phylogenetic methods have become essential tools for understanding the evolutionary relationships that underlie much life science research. Motivated by biological questions and insights, built on a broad spectrum of mathematical and statistical ideas and approaches, and implemented through novel and sophisticated algorithmic design, their development draws from multiple fields. Bringing together researchers spanning disciplinary perspectives and techniques, this workshop will present a diverse sample of work addressing current challenges in phylogenetics, with an eye toward future progress.

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *The spread of the workshop speaker and attendees, ranging from mathematically-informed experimental biologists, to statisticians and theorem-proving mathematicians was exceptionally helpful. Although I am a "theorem prover" who has always tried to orient my work toward what will affect empiricists, I gained new ideas for investigating the failings of certain methodologies, as well as a [sic] what questions are most relevant to advancing both understanding of methods and practical methods. This has easily been the most stimulating conference in my field I have attended over the 20 years I've been working in it.*
- *As an early-year grad student, I learned a lot about the particular problems that researchers care about, but perhaps more importantly what types of problems researchers care about.*
- *There were a good variety of explanatory talks and topic spotlights that helped round out my understanding of the way different research topics come together and compare.*

Some workshop participants comments for "Briefly describe workshop highlights":

- *I feel more excited about research and part of the community. I received great mentorship and advice for job applications. I really feel that everyone here wants me to succeed, and is interested in my work.*
- *High quality talks and exceptional opportunity for interact [sic] across a broad range of research perspectives.*
- *The opportunity to closely connect with scientists in the community is fantastic. The communications were very effective in such workshop settings.*

Workshop 2: From Phylogenetics to Phylogenomics: Mathematical and Statistical Challenges in the Era of Big Data

Oct 21 - 25, 2024

Organizing Committee:
Cécile Ané, University of Wisconsin - Madison
Mareike Fischer, University of Greifswald
Tracy Heath, Iowa State University
Leo Van Lersel, Delft University of Technology
Norbert Zeh, Dalhousie University

Program Description:
The unprecedented amount of genomic data that has become readily available presents specific challenges for the field of phylogenetic inference, which is concerned with estimating the evolutionary relationships among collections of species, populations, or sequences. These challenges include the development of evolutionary models that are sufficiently complex to be biologically realistic while remaining computationally tractable; deriving and implementing algorithms to efficiently estimate phylogenetic relationships that use models whose theoretical

properties are well-understood and therefore interpretable; and devising ways to scale novel methodology developed to handle datasets that are increasingly large and complex.

This workshop focuses on statistical modeling and the scaling of phylogenetic methods. Topics will include modeling (e.g. multispecies coalescent model with extension to networks; diversification models) and inference with speed to scale to genomic datasets, consistency, and robustness using statistical, combinatorial, and algebraic approaches. This workshop will present the latest advances in these areas and serve as a forum to spark new ideas and collaborations.

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *We set up new collaborations and strengthened existing collaborations, gained a better understanding of related research and identified exciting new research directions.*
- *I learned about some of the statistical questions that people are interested in in phylogenetics, and how they might link to my own more mathematical and combinatorial perspectives.*
- *Great topics presented by the speakers during the workshop and amazing people to talk to. Also, great poster session!*

Some workshop participants comments for "Briefly describe workshop highlights":

- *The speaker selection was fantastic, very diverse in topic and research.*
- *The development of community and the open atmosphere of sharing of ideas.*
- *The reunion of two sub-communities, see my other comment. Also just the high level of quality of the talks in general. I'll also note that some of them were on topics I had no knowledge about, but since the speakers were given lots of time, they were able to explain most of the concepts needed to understand their work. This is important, because it may impact our vision of the field and how we conduct future research.*

Workshop 3: Algorithmic Advances and Implementation Challenges: Developing Practical Tools for Phylogenetic Inference

Nov 18 - 22, 2024

Organizing Committee:
Elizabeth Allman, University of Alaska Fairbanks
Barbara Holland, University of Tasmania
Simone Linz, University of Auckland
Erin Molloy, University of Maryland, College Park

Program Description:
Inferring phylogenetic relationships requires complex mathematical models. As advances are made in modeling complex evolutionary processes, we need practical algorithms that translate the mathematical advances into software tools. This translation of theory to usable tools is more challenging than it may appear. Phylogenetic problems are often NP-hard, necessitating heuristic solutions that can compromise accuracy. The accuracy and scalability of such heuristics are often

established only empirically, creating a need for careful simulation and testing. Moreover, software tools are used within complicated pipelines, so the input to tools may be impacted by errors from prior data processing steps. In addition, the output has many aspects, from the discrete-spaced topology to continuous-spaced branch lengths and other numeric parameters, and measures of uncertainty and visualizations. Furthermore, software tools need to be evolvable, allowing the incorporation of new features and new models, and optimized, allowing efficient use of vectorization, parallelization, and memory hierarchy.

In this workshop, we will consider challenges and best practices in translating theory to software for phylogenetic inference. We will discuss strategies adopted by the tool development community, their relative advantages, and lessons learned through software development. We will discuss a variety of objective functions (parametric and non-parametric) and algorithmic techniques used by inference methods. We will cover parallelization and how it interacts with the choice of objective function and algorithmic technique. Finally, we will discuss best practices for evaluating new and existing software tools, not just to validate the implementation but also to study accuracy and scalability in relation to theory and usage in realistic bioinformatics pipelines. In addition to discussing how theory influences tools, we will examine how tool development can inform the theoretical questions asked.

Some workshop participants comments for “Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.”:

- *As a third year math PhD student I have learned so much from being in a community of people with similar research interests. I learned by working on projects with more experienced collaborators and reading papers and being able to ask people questions because the people who wrote the papers are either my newfound collaborators or they were working in nearby offices. I have also had the opportunity to have in depth talks with people on the more applied side of things and I learned a lot from all of the workshops which were a nice mixture of experimental and theoretical. Some things I learned more about were algebraic matroids, the biology behind our statistical models (ie horizontal gene transfer, polypolids, and how the genetic data is collected) and numerical algebraic geometry.*
- *I found out about new tools and techniques in my area of research that I was not aware of.*
- *The two topics that stood out most for me were the potential of composite likelihood methods in phylogenetic applications and the exploration of deep learning techniques.*

Some workshop participants comments for “Briefly describe workshop highlights”:

- *Establishing new connections and learning fascinating new things during the networking lunch was a highlight. Allowing enough ‘quiet time’ between talks proved particularly useful for revisiting and elaborating on previous discussions through repeated visits to the same ideas and conversations. I also appreciated talks from senior researchers, especially their ability to provide a unifying vision for the broader research community. Lastly, having access to boards was invaluable for elaborating on ideas and mapping out*

research horizons; structuring the program to include dedicated sessions or breaks near board spaces could actively encourage and facilitate more board-based discussions.
- *Finding out about new software tools in my area as well as computational complexity results of relevance to my research.*
- *Excellent selection of participants and talks, and plenty of time in between talks to connect and discuss research with others.*

Spring 2025

Geometry of Materials, Packings and Rigid Frameworks

January 29 - May 2, 2025

Organizing Committee:
Alexander Bobenko, Technische Universität Berlin
John Bowers, James Madison University
Philip Bowers, The Florida State University
Robert Connelly, Cornell University
Steven Gortler, Harvard University
Miranda Holmes-Cerfon, University of British Columbia
Sabetta Matsumoto, Georgia Institute of Technology
Anthony Nixon, Lancaster University
Meera Sitharam, University of Florida

Program Description:
Given an incidence structure, one may model a variety of geometric problems. This Semester Program will revolve around two fundamental examples and their applications to modern challenges in the study, analysis, and design of materials. (1) Packings and patterns of circles where the underlying combinatorics are mixed with advanced geometric concepts and strong links are made to discrete differential geometry. (2) The rigidity and flexibility of bar-joint structures where real algebraic geometry is intertwined with sparse graph theory and matroidal techniques. A prime objective of the program is to advance the applicability of these topics to fundamental applications, most notably in statistical physics and materials science.

The program will integrate diverse fields of discrete mathematics, geometry, theoretical computer science, mathematical biology, and statistical and soft matter physics. Various workshops will be designed to attract both theoretical and applied practitioners and to stimulate the cross-fertilization of ideas between these disparate communities.

The list of all long-term visitors to the Spring 2025 Semester Program as well as the participant list for the affiliated workshops can be found in Appendix B.

Here follows a sample of the most substantive comments from long-term visitors:
Some Long-term Visitor Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *This was one of the best organized and intellectually stimulating semesters I had ever attended. The unifying theme was rigidity theory, but it reached into a wide range of theoretical, experimental, computational and applied directions that even I, working in this field for a long time, have not seen brought together within a single venue.*
- *Useful discussions with colleagues and stimulating talks at the workshops, all in a good working environment.*
- *I am a 9-month postdoctoral fellow participating in this program. Since November, I have been collaborating with one of the program organizers, Prof. Steven Gortler. Together, we developed a foundational theoretical paper on high-order flexibility in mechanisms, which has been accepted for publication in the Fields Communications Series.*

Some Long-term Visitor Comments for "Briefly describe program highlights":

- *I can't say that it was a particular lecture or a particular result that I had learned about. It was more the whole semester-long structure of the program which helped build up, piece by piece, a coherence between the various pieces I heard about. It was the camaraderie and friendliness that builds up when people share such a welcoming place. During the weekly working seminar I attended, it was the thinking about a few very difficult problems and trying to simplify some published arguments that helped distill some new ideas. Other times, it was just sitting there late in the evening and striking a conversation with a participant - that led to us deciding to have our own shorter smaller seminar and thus ending formulating a program for what I hope will become a fully proven result. The fact that all of these can happen is what makes ICERM so special. Thank you!*
- *Collaborative spaces and reading groups*
- *The venue was especially suited for collaborations.*

Workshop 1: Circle Packings, Minimal Surfaces, and Discrete Differential Geometry

Feb 10 - 14, 2024

Organizing Committee:
Alexander Bobenko, Technische Universität Berlin
John Bowers, James Madison University
Philip Bowers, The Florida State University
Steven Gortler, Harvard University
Meera Sitharam, University of Florida

Program Description:
This workshop brings together researchers from three distinct streams of mathematics: the classical rigidity theory of bar-joint and tensegrity frameworks in combinatorics and discrete geometry; the theory of generalized circle packing that arose from the study of 3-manifolds in geometric topology, extending to sphere packing and jamming; and discrete differential geometry. A scattering of results in recent years has started to forge connections among these fields.

Since the discovery that circle packings from triangulations could be used as a scheme for approximating the Riemann mapping of a simply connected proper domain in the plane to the unit disk, the theory of circle packing has enjoyed enormous development and has found widespread theoretical and practical applications. In the theoretical realm, circle packing provides a discrete analytic function theory that is faithful to its continuous cousin and it is closely associated with studies of hyperbolic and projective polyhedra. The theory has been applied to build discrete minimal surfaces, conformally flatten curved and crumpled surfaces, and push further our understanding of the rigidity and existence of non-compact hyperbolic polyhedra.

Recent work has shown that Euclidean frameworks have an affinity with circle and sphere packings, with Euclidean rigid motions replaced by Mobius transformations, and that the language and methods of rigidity theory could provide a guide for how to approach certain problems in circle packings, sphere packings, and jamming. For example, working in the space of circles in which circles are points, coaxial families of circles are lines, and certain bundles of circles are planes, a 3-dimensional incidence geometry appears that behaves in many ways as the usual Euclidean 3-dimensional space.

The main aim of the workshop is to encourage the cross-fertilization of such ideas, with particular emphasis on the rigidity of inversive distance packings. Participants will attend presentations on cutting-edge research and initiate new collaborations.

Some workshop participants comments for “Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.”:

- *The talks throughout the week provided a very nice overview of different research areas in discrete geometry and circle packing. As I am still early in my PhD it was eye opening to get this perspective and see connections to my own problems. The informal session during one of the evenings which described the general philosophy behind discrete differential geometry transformed my view of the goals of the research I'm participating in by illuminating some of the key goals.*
- *There was a tremendous group of researchers working on lots closely related work that I was unaware of.*
- *The talks which list circle packings and patterns to Minkowski space is new and very interesting to me. It definitely could affect my research directions.*

Some workshop participants comments for “Briefly describe workshop highlights”

- *Being in the company of so many wonderful mathematicians who were willing to discuss the subject and their own research in areas related to what I'm working on. At my institution I am the only grad student working in this area (as far as I know) which leaves me exploring the subject unaccompanied outside of talks with my advisor; so it was wonderful to have people to ask the "lower order" questions I've had on my mind that don't really have room in the weekly research meetings. The conversations that these questions generated were often very enlightening, and provided a level of clarity that I was missing.*

- *The highlight of the workshop was probably the poster session: it can sometimes be intimidating to approach more senior colleagues and ask them questions. During the poster session, the fact that these more senior colleagues would approach you first made it much easier. xD*
- *This workshop was a great learning experience for me. I witnessed some excellent talks as it also gave me some new ideas/problems to work on related to the things I am currently pursuing. Overall this was a great workshop.*

Workshop 2: Matroids, Rigidity, and Algebraic Statistics

Mar 17 - 21, 2025

Organizing Committee:
Robert Connelly, Cornell University
Elizabeth Gross, University of Hawai'i at Mānoa
Tibor Jordán, ELTE Eötvös Loránd University
Anthony Nixon, Lancaster University
Shin-ichi Tanigawa, University of Tokyo

Program Description:
Given an incidence structure, one may model a variety of geometric problems. This Semester Program will revolve around two fundamental examples and their applications to modern challenges in the study, analysis, and design of materials. (1) Packings and patterns of circles where the underlying combinatorics are mixed with advanced geometric concepts and strong links are made to discrete differential geometry. (2) The rigidity and flexibility of bar-joint structures where real algebraic geometry is intertwined with sparse graph theory and matroidal techniques. A prime objective of the program is to advance the applicability of these topics to fundamental applications, most notably in statistical physics and materials science.

The program will integrate diverse fields of discrete mathematics, geometry, theoretical computer science, mathematical biology, and statistical and soft matter physics. Various workshops will be designed to attract both theoretical and applied practitioners and to stimulate the cross-fertilization of ideas between these disparate communities.

Some workshop participants comments for “Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.”:

- *All of the talks included accessible fundamentals which enabled me to better understand somewhat unfamiliar contexts, followed, in most talks, presentation that led me to at least the gist of new developments. I easily met new people who answered many questions, and were interested in corresponding about studies the workshop led me to think of. The workshop organization fostered networking very effectively.*
- *Before the workshop, I was—aside from a few definitions—largely unfamiliar with rigidity theory. However, I had a sense that it could offer insights into the problems I’m working on. A conversation with Robert Connelly confirmed this intuition, and I’m now*

hoping to further develop these ideas with him into tangible applications in reticular chemistry.
- *I learnt of new theoretical results and open problems, started new research collaborations and made progress on existing joint research projects with other attendees.*

Some workshop participants comments for "Briefly describe workshop highlights":
- *This was a great mixture of people from distinct but overlapping research areas. Over the last decade I have seen more and more crosstalk between algebraic statistics and rigidity theory, but this was the largest, longest, meeting that I have seen between the two groups.*
- *It's hard to say, because several of the talks very much resonated with me. I'd also say conversing with a few particularly friendly, enthusiastic and broadly-knowledged people. The (unrelated) public talk on AlphaMath was a highlight too.*
- *Lightning talks are great! The topics of this workshop cover a few related areas which is very interesting.*

Workshop 3: Geometry of Materials
Apr 7 - 11, 2025

Organizing Committee:
Zeyuan He, University of Cambridge
Matthias Himmelmann, ICERM, Brown University
Miranda Holmes-Cerfon, University of British Columbia
Sabetta Matsumoto, Georgia Institute of Technology
Ileana Streinu, Smith College
Louis Theran, University of St Andrews

Program Description:
The geometric arrangement of a material's constituents plays an important role in governing its behaviour. Concepts from discrete mathematics to describe these geometric arrangements, including notions of rigidity and flexibility, can bring fundamental insight into how a material might respond to stress, be designed, be reconfigured, etc. This workshop aims to build connections between the field of mathematical rigidity theory, and other areas of applied mathematics, science and engineering where such ideas might be used.

Rigidity and flexibility form a dichotomy: either a system's constraints allow for a non-trivial deformation under an external load or they don't. However, there is a long history, dating to before the Industrial Revolution, of designing mechanisms by starting from a system that has the minimal number of constraints required for rigidity and then removing one of them. One degree of freedom mechanisms obtained this way are a rich class. In recent years, there has been a revival of building deployable mechanisms, inspired by the Japanese arts of origami and kirigami. Generalizing these systems and the mathematics behind their rigidity and deformation has captured the interest of physicists interested in topological materials. On a different lengthscale, our bodies also play out the dance of building rigidity and compliance into different

organs and systems, from the packing of cells during embryogenesis to networks of collagen and cartilage that support our skeletons, to the dynamic networks that are formed and broken within our cells. Even continuum systems can have notions of rigidity and flexibility, both intrinsic and extrinsic to their geometry. Beyond materials, the notions of network rigidity can be applied to more abstract networks and geometries, such as those found in data science. Join us in exploring the many ways that rigidity and flexibility influence the world around us and within us.

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *This was an exceptionally successful program for bringing together several disciplines, yet still being very specific and narrow in focus. I was able to appreciate the methodology used in developing new results, and gained insight to theoretical developments in the field, which I can directly implement in my research in the visual arts and in art&math education. I connected with several participants and discussed future collaborations. One of these we are already in the ideation phase, and hoping to develop more in the coming year.*
- *There was an excellent mix of speakers, from different communities, but they all made an effort to present their work in a way that was accessible to a broader audience of mathematicians interested in materials, and all speakers had a similar aim of combining geometry with materials. This made for excellent discussions and cross-fertilizations.*
- *The organizers brought together a wonderful mix of related topics and researchers from computational, experimental, and theoretical aspects of creating/discovering new materials. I think most workshops separate these disciplines; this workshop is a great example that interdisciplinary collaboration has a lot of unexplored potential.*

Some workshop participants comments for "Briefly describe workshop highlights":

- *Interdisciplinary interaction across computational, experimental, and theoretical aspects of creating/discovering new materials was unique.*
- *I loved the interdisciplinary aspect of the workshop and the fact that it involved physics, engineering, maths, art and architecture!*
- *The workshop broadened my view on the geometry of materials and provided an invaluable opportunity to meet many interesting people from diverse places and backgrounds.*

Topical Workshops

ICERM's Topical Workshops run over 5 weekdays and focus on a timely and exciting theme that aligns with the institute's mission of supporting and broadening the relationship between mathematics and computation. ICERM hosts several Topical Workshops each year. They are typically scheduled in December, January, and May through August (around the dates of the semester programs).

1. Solicitation of Topical Workshop Proposals

A Topical Workshop proposal should be 2-4 pages and contain:

- List of 3-6 organizers, and the main contact for the organizing committee
- Description of the program area/theme, written for a general mathematical audience
- Description of the experimental and computational aspects of the program

2. Topical Workshop Selection

Proposals are submitted to the ICERM Director. The Science Advisory Board (SAB) approves the Topical Workshops. The deadline for proposals is October 1, prior to the annual November SAB meeting, and May 1, prior to a mid-May conference call.

Approved program dates are scheduled and the workshop's lead organizer will assist ICERM staff by providing appropriate program images for web and print ads, and will be asked to review marketing materials. Details are posted on the ICERM website and various on-line math organization calendars SIAM, AMS, European Mathematical Society, National Math Institutes.

3. Recommendation of Speakers

The organizers propose a ranked list of 20-25 speakers, which the ICERM Directors approve and make additional suggestions as needed.

4. Invitations to Speakers

Once the list of workshop speakers has been finalized and funding determined, an invitation is sent to each. The invitation describes the program and outlines the support to be provided. During this reporting cycle, ICERM updated all of its Topical Workshop invitations to include language regarding Brown University's "Code of Conduct", which addresses sexual harassment, discrimination, and other unprofessional behaviors.

5. Application Process

Once the organizers and Directorate agree there is enough critical mass in terms of confirmed speakers, applications are opened and accepted on-line for that particular workshop on the ICERM website. All applications are stored and evaluated in the institute's "Cube" database.

6. Applicant Selection

Program organizers can view the applicants and their supporting documents as well as prioritize them within Cube. A member of the ICERM Directorate reviews the prioritized list, re-ranks as appropriate and makes the final selections, taking into consideration the remaining space in the program, participant support requested, and whether or not the applicant is a young researcher who has an advisor already participating in the program. ICERM staff then updates the applicant about their status, and any support they are eligible for, as appropriate.

Financial Decisions for Topical Workshops

Financial decisions are made by ICERM Directors based on discussions with organizers. ICERM covers travel and lodging expenses of the organizers and 20-25 invited speakers/lead participants; some applicants to the workshop may also be supported.

Topical Workshops in 2024-2025

ICERM hosted fourteen Topical Workshops from May 1, 2024 to April 30, 2025. These workshops focus on topics of current interest in the mathematical sciences.

The list of participants for each of ICERM's 2024-2025 Topical Workshops can be found in Appendix C.

Topical Workshop 1: Interacting Particle Systems: Analysis, Control, Learning, and Computation

May 6 - 10, 2024

Organizing Committee:
José Carrillo, University of Oxford
Katy Craig, UC Santa Barbara
Massimo Fornasier, Technical University of Munich
Fei Lu, Johns Hopkins University
Mauro Maggioni, Johns Hopkins University
Kavita Ramanan, Brown University

Workshop Description:
Systems of interacting particles or agents are studied across many scientific disciplines. They are used as effective models in a wide variety of sciences and applications, to represent the dynamics of particles in physics, cells in biology, people in urban mobility studies, but also, more abstractly in the context of mathematics, as sample particles in Monte Carlo simulations or parameters of neural networks in machine learning.

This workshop aims at bringing together researchers in analysis, computation, inference, control and applications, to facilitate cross-fertilization and collaborations.

Participant comments are not available for this event.

Topical Workshop 2: The Ceresa Cycle in Arithmetic and Geometry

May 13 - 17, 2024

Organizing Committee:
Daniel Corey, University of Nevada, Las Vegas
Jordan Ellenberg, University of Wisconsin
Wanlin Li, Washington University in St. Louis
Daniel Litt, University of Toronto
Congling Qiu, Massachusetts Institute of Technology
Padmavathi Srinivasan, Boston University

Workshop Description:

In the 1980s, Ceresa exhibited one of the first naturally occurring examples of an algebraic cycle, the Ceresa cycle, which is in general homologically trivial but algebraically nontrivial. In the last few years, there has been a renewed interest in the Ceresa cycle, and other cycle classes associated to curves over arithmetically interesting fields, and their interactions with analytic, combinatorial, and arithmetic properties of those curves. We hope to capitalize on this momentum to bring together different communities of arithmetic geometers to fully explore explicit computations around the arithmetic and geometry of cycles when these various approaches are systematically combined.

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *Great selection of talks and participants, ample time for discussions with people, all the talks were somehow related but still very diverse.*
- *The open problem session was really helpful for knowing the state of the art in research about the Ceresa cycle.*
- *During this workshop I learned a lot about the Ceresa cycle, which was a topic I was only vaguely familiar with before attending. I got very inspired by some of the talks, especially the ones focusing more on the arithmetic aspects of this story. I now want to explore things in that direction. I have ideas on constructing possibly interesting new 1-cycles on certain abelian 3-folds. Most of these ideas were inspired by discussions I had with some of the organizers and participants. I hope this discussion will lead to a successful collaboration.*

Some workshop participants comments for "Describe the highlight of this workshop":

- *Having the opportunity to meet many people from a range of disciplines, with a common interest in different facets of the same underlying concept. It was great to see the hugely different perspectives that topologists and tropical geometers can bring to complement my understanding as a number theorist.*
- *I was a remote speaker… I should add that, from a distance, the conference looked great. The technical support for the remote talk was also excellent --- clear communication and no technical issues.*
- *The talks were of great quality and the facilities were amazing.*

Topical Workshop 3: Recent Progress on Optimal Point Distributions and Related Fields

Jun 3 - 7, 2024

Organizing Committee:
Dmitriy Bilyk, University of Minnesota
Xuemei Chen, University of North Carolina Wilmington
Emily King, Colorado State University
Dustin Mixon, Ohio State University
Kasso Okoudjou, Tufts University

Workshop Description:

Certain problems in mathematics, physics, and engineering are formulated as minimizing cost functions that take as input a set of points on a compact manifold. In applied and computational harmonic analysis one is usually interested in finding tight frames and equiangular tight frames, which are respectively minimizers of different cost functions. In quantum information theory, the study of SIC-POVMS is equivalent to the existence of a point configuration made of antipodal points on a complex sphere. There seems to be a phenomenon where highly symmetric configurations are optimizers and optimizers often exhibit (partial) symmetries. The theory of spherical designs in combinatorics and discrete geometry with applications in approximation theory in the form of cubature formulas is deeply related to point configurations and distributions. Training a neural network involves minimizing a cost function relating to the desired task; it was recently discovered that doing so often results in the last layer of the neural network corresponding to an optimal configuration of points on a sphere, a phenomenon called neural collapse.

Numerical solutions to optimization problems are used to study the putative geometric and arithmetic structure of the corresponding optimal configurations. Linear programming bounds have been a major tool in point configurations and led to the recent breakthrough in sphere packing problems in dimensions 8 and 24. Semidefinite programming is used to find exact solutions of maximal two-distance sets. Many spherical designs and point distribution problems are motivated by numerical integration and interpolation. Moreover, understanding neural collapse requires an understanding of the training of neural networks. As such, there is a need to expand the use of numerical and computational methods to solve these problems. Our goal is to provide a forum to explore problems in point configurations and distributions from the various aforementioned perspectives.

Some workshop participants comments for “Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.”:

- *The participants formed an interesting mix of theoretical and experimental/numerical researchers. This is unusual for meetings and gave me the opportunity to gain complementary insights.*
- *I learned that tight frames being the only minimizers of the Frame Energy was a special case of a more general collection of objects where one can use the same methods. I learned of methods to use graphs to describe pointsets and information that could be gleaned from their incidence matrices.*
- *I saw examples of construction of sequences of unit norm tight frames (by mathematicians working in signal processing) that can be helpful in the theory of spherical designs (which is our field) and vice versa. I learned about many new results and ideas in the field of optimal point distribution (our field).*

Some workshop participants comments for “Describe the highlight of this workshop”:

- *Mixing several different but closely related research communities.*
- *I found a vivid community that is currently interested in my research area. This encourages me to continue.*

- *Linear programming bounds and certification of optimality were a main theme that came up in many talks. The universality of this method is surprising! Apart from that, the use of determinantal point processes to accelerate convergence beyond the usual rate in the Central-Limit Theorem was noteworthy.*

Topical Workshop 4: Queer in Computational and Applied Mathematics (QCAM)

Jun 24 - 28, 2024

Organizing Committee:
Rowan Barker-Clarke, Cleveland Clinic Lerner Institute
Rustum Choksi, McGill University
Alexander Hoover, Cleveland State University
Hermie Monterde, University of Manitoba
Michael Robert, Virginia Tech
Colton Sawyer, Regis University
Becca Thomases, Smith College

Workshop Description:
The Queer in Computational and Applied Mathematics (QCAM) workshop will be the first workshop to celebrate research advances and foster stronger research networks of LGBTQIA+ mathematicians specializing in computational and applied mathematics. Goals of QCAM are to support LGBTQIA+ academics through mentoring and research opportunities, as well as providing a safe space for researchers across the subfields of computational and applied mathematics to connect, collaborate, and build support networks within the field. In addition, QCAM intends to address issues of diversity, equity, and inclusion in mathematics pertaining to LGBTQIA+ people, especially those with intersectional identities. This conference will be open to all and will ideally engage the wider mathematical audience of LGBTQIA+ allies to develop a community of support.

The scientific program will have invited speakers and contributed sessions that span the field of computational mathematics, with a planned focus on research in computational methods which may include the following fields:

- Mathematical Biology, Ecology, Epidemiology, and/or Oncology;
- Fluids, Materials, and/or Mathematical Physics;
- Data Science;
- Numerical Analysis and Computational Science; and
- Applied Algebra, Discrete Mathematics, Geometry, and/or Topology.

These general frameworks will be the basis for the creation of working groups during the conference. In these working groups, QCAM participants will be invited to develop supportive and collaborative research networks with other participants of differing career stages. Furthermore, QCAM will include programming that is dedicated within the LGBTQIA+ community and at the intersection with other underrepresented groups, as well issues pertaining to the leaky STEM pipeline for LGBTQIA+ individuals.

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *I learned a lot about topological data analysis and how it may be applied to our workshop project on pharmacy disparities. In my own research, I often think about spatial aspects of tumors, another spatial layout that would be amenable to topological analyses.*
- *The working group I joined was in an area of interest to me but one in which I was already familiar with in terms of broad subject matter and approaches (ode [sic] models, epidemics).*
- *During my time at ICERM, I was introduced to several new methods of data analysis (e.g., topological data analysis, TDA). Currently, I am part of a working group that is looking into pharmacy refusals using various methods including TDA.*

Some workshop participants comments for "Describe the highlight of this workshop":

- *Connecting with a diverse set of computation math researchers! Making new connections and providing a space for future networking for early career researchers.*
- *The participants and the events were all very welcoming and warm, which felt different (and nicer) than other conferences.*
- *As an early career mathematician, this workshop has been very impactful for me, both as a venue to forge new connections and collaborations, but also as a source of perspective as to the state of queer applied math today. I had an amazing time and feel inspired.*

Topical Workshop 5: Solving the Boltzmann Equation for Neutrino Transport in Relativistic Astrophysics

Jul 8 - 12, 2024

Organizing Committee:
Isabel Cordero-Carrión, University of Valencia
Francois Foucart, University of New Hampshire
Steven Liebling, Long Island University
Carlos Palenzuela, Universitat de les Illes Balears
Lorenzo Pareschi, Heriot Watt University
David Radice, Pennsylvania State University

Workshop Description:
The spectacular observation of gravitational waves from a binary neutron star merger by the LIGO-Virgo Collaboration (GW170817), and a successful follow-up campaign by nearly every electromagnetic telescope ushered in this new era of multi-messenger astrophysics. Much of the understanding of such events arises from numerical modeling. An important part of this modeling is the inclusion in simulations of neutrino transport, as described by Boltzmann's equation. Because of inherent computational resource limits and given the high cost of the transport equations and the complexity of neutrino-matter interactions, there is a trade-off between computational cost and physical realism in all simulations. This workshop covers various approaches to solving the neutrino transport problem in compact object mergers and

core-collapse supernovae, including Monte Carlo methods, moment truncation schemes, and other techniques.

Participant comments are not available for this event.

Topical Workshop 6: Braids Reunion Workshop

Jul 15 - 19, 2024

Organizing Committee:
Matthew Hedden, Michigan State University
Matt Hogancamp, Northeastern University
Jonathan Johnson, Oklahoma State University
Miriam Kuzbary, Amherst College
Nancy Scherich, Elon University

Workshop Description:
This conference is intended to celebrate and amplify the mathematics of the Braids Semester Program at ICERM in 2022. The aim is to bring together mathematicians who participated in the program, or whose research interacts with its themes, for an event that will rekindle the interactions between fields that the subject of braid groups naturally stimulated during the semester. A central goal is to showcase work that resulted from the semester's activities, and a further goal is to incorporate new participants whose research has fruitful connections with researchers who were a part of the semester.

The workshop will have a variety of activities, with research talks, problem sessions, and dedicated work time for collaboration. Special emphasis will be placed on highlighting the work of early-career mathematicians and providing space to develop new collaborations.

Some workshop participants comments for “Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.”:

- *Through conversations with workshop participants during tea time.*

Some workshop participants comments for “Describe the highlight of this workshop”:

- *I liked the number of talks, their duration, and the scope of topics that they covered. I felt like I got to learn a lot of cool stuff about a variety of topics, but didn't feel overloaded with talks. The conference had a great balance between talks and breaks, and they did a great job finding speakers from a lot of different subjects.*
- *The sense of community and the ability to network with other knot theorists.*
- *As a PhD student, this is my first workshop/conference, and everything is new here. Not everything happened in the workshop is really related to my interests, but this workshop really gives me a better and broader understanding of the area beyond what I learned and used in my own research (which may be never achieved by myself), and also gives me a concrete example about how a workshop/conference may look like in math in general. I met people in the area, and enjoy most of the talks and interactions with other people.*

Topical Workshop 7: Empowering a Diverse Computational Mathematics Research Community
Jul 22 - Aug 2, 2024

Organizing Committee:
Vrushali Bokil, Oregon State University
Sigal Gottlieb, University of Massachusetts Dartmouth
Fengyan Li, Rensselaer Polytechnic Institute
Suzanne Weekes, SIAM

Workshop Description:
The goal of this two-week research and professional development workshop is to support the retention and success of junior and mid-career computational mathematicians who are from groups that are underrepresented in the field. Participants will forge strong collaborations in mentored research groups and engage in professional development via no-lead learning communities. The larger goal of the workshop is to form a positive, diverse community of researchers who are committed to supporting each other's professional and scholarly growth.

In research teams led by experienced mentors, participants will be introduced to cutting-edge opportunities in numerical analysis and scientific computing, and will actively work on and contribute to a research project with their team. The supportive formal and informal mentoring will help participants grow their scientific and collaborative skills. In addition, the collaborative learning communities will provide the participants with a forum for personal and professional growth in their self-identified areas of need and will deliver professional and leadership development in a small group setting. The workshop will also include panels and discussions on a range of issues including addressing intersectional issues involving gender, race, and LGBTQ+ status in the profession.

This research collaborative effort is run in collaboration with SIAM which will provide support for sustained interaction and collaboration even beyond the two-week workshop.

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *Both the application and the computational approach for my project was entirely new to me and at least half of my group. The workshop model of sharing a few preparatory readings a few weeks in advance and having two weeks to work daily (in person!) on this new project was very effective. By the end of the workshop, I felt sufficiently oriented to the project application/approach and made contributions to my team's work. I feel prepared to continue collaborating with my team on extensions of our workshop results.*
- *I learned new numerical algorithms during this ICERM program as well as the underlying theory behind the algorithms. I may be able to apply the methods to a problem in mathematical biology that I am currently researching.*
- *1. experimental/computational methodology: I am introduced to the reduced order modeling which I haven't learned before and learned many basic approaches and ideas in*

this topic. By working with the research team together, I learned many small but useful tricks in coding and version control that is not easy to learn through other approaches. 2. theoretical development: I learned some theoretical guarantee and analysis results that is related to the research project I work on at this workshop. I also learned different perspectives of thinking and raising questions and how to make an idea to some concrete projects and tasks.

Some workshop participants comments for "Describe the highlight of this workshop":

- *The highlight of this workshop for me was connecting with this wonderful community of applied and computational mathematicians, getting to know each other and working together in our learning communities and research groups, and making substantial progress on a brand new research project with my team that I anticipate will lead to several publications and new research directions.*
- *It was a very productive two-weeks. I truly enjoyed it. I learned a lot, worked collaboratively on a research project, met people who care about the things I care about, had opportunity for professional growth besides research. This was by far the best workshop among ~30 I attended in my career.*
- *The highlight of this workshop was making connections with my research group. Everyone was incredibly kind and welcoming, not to mention highly-motivated. We worked very well together as a group and were encouraging each other in whatever direction our research took. I'm thrilled to have made new connections and started a new research project with excellent people.*

Topical Workshop 8: Simulating Extreme Spacetimes with SpEC and SpECTRE

Aug 5 - 9, 2024

Organizing Committee:
Katerina Chatziioannou, Caltech
Nils Deppe, Cornell University
Scott Field, University of Massachusetts Dartmouth
Lawrence Kidder, Cornell University
Geoffrey Lovelace, California State University Fullerton
Mark Scheel, California Institute of Technology
Leo Stein, University of Mississippi
Saul Teukolsky, Cornell University
Nils Vu, California Institute of Technology

Workshop Description:
A new era of astronomical observation was announced in 2016 when the first-ever detection of gravitational waves from a binary black hole system occurred. Gravitational waves encode detailed information about the astrophysical systems they emerge from and complement what can be learned through traditional light-based observation.

Gravitational wave science requires high-fidelity numerical simulations of the expected merger events. The Simulating eXtreme Spacetimes (SXS) collaboration has managed the development

of two distinct codes for this purpose: (i) the Spectral Einstein Code (SpEC) based on pseudospectral methods, and (ii) an open-source code SpECTRE, an hp-adaptive discontinuous Galerkin scheme that also includes a sub-cell finite volume scheme in regions of strong shock formation that is ideally suited for multi-scale, multi-physics problems. SpECTRE targets problems in multi-messenger astrophysics, including neutron star mergers, core-collapse supernovae, and gamma-ray bursts. It runs at petascale and is designed for future exascale computers.

Our weeklong program includes two contemporaneous activities: (i) a focused SpEC and SpECTRE code developers meeting and (ii) a SpECTRE workshop. The code developers' meeting will bring together researchers who are actively developing these codebases. The SpECTRE workshop aims to provide graduate students, postdocs, and faculty with the tools needed to install, run, and contribute to the open-source code SpECTRE. Our SpECTRE workshop will cover topics such as the generalized harmonic formulation of the Einstein field equation, general relativistic hydrodynamics, the discontinuous Galerkin method with finite volume sub-cells, the Cauchy characteristic extraction method, installing, running, and visualizing numerical simulations, and how to get involved with code development.

Some workshop participants comments for “Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.”:

- *ICERM educated me on the current state of numerical relativity. While I was not very familiar with the intricacies and challenges involved in numerical relativity, I do think I now have a better idea and will at least understand better these simulations whose results I use.*
- *I have delved into the amazing world of numerical relativity and learned how to work with the Spectre code. And now I have the necessary skills and toolkit to realize my old idea.*
- *I learned about GPU computing. We had a new idea which could potentially lead to a fundamental breakthrough in our calculations.*

Some workshop participants comments for “Describe the highlight of this workshop”:

- *It [sic] workshop's introductory lectures, tutorials, coding sessions, and other sessions were very engaging, and I had an awesome learning experience. Also, I could interact with researchers who work on similar things, and could plan out possible directions that I would explore ahead. Overall, it was a great workshop. The arrangements and all the assistance provided by ICERM for participants was fantastic.*
- *To be introduced to the current developments in the field and having a hands-on experience of the aforementioned in a healthy, encouraging environment*
- *Meeting the people behind the numerical relativity codes that I work with and understanding what goes into these codes and how I can use them for my own research was probably the highlight of this workshop for me.*

Topical Workshop 9: Spectral Analysis of Schrödinger Operators

Aug 19 - 23, 2024

Organizing Committee:
Jianfeng Lu, Duke University
Benoit Pausader, Brown University
Fabio Pusateri, University of Toronto
Wilhelm Schlag, Yale University
Israel Michael Sigal, University of Toronto
Ebru Toprak, Yale University

Workshop Description:
The central theme of this workshop is the analysis and computation of Schrödinger operators and applications to nonlinear problems in several areas of Mathematical Physics, Analysis of Partial Differential Equations, Quantum Chemistry, and more. The simplest, most basic example, of such an operator is of the form $H = -\Delta+V$ on an appropriate Hilbert space, and their Dirac analogues.

Many problems in Quantum Physics and Chemistry require a precise understanding of the spectra of Schrödinger operators, $H = -\Delta + V$, for various classes of potentials $V(x)$, and in various regimes, especially in the semi-classical and adiabatic ones. The analysis entails determining eigenvalues and eigenvectors and more generally the evolution generated by H, the study of wave operators, and of the "distorted Fourier transform" and its mapping properties. All of these can be interpreted as diagonalization procedures which are especially delicate for non-selfadjoint operators that can arise as linearizations of nonlinear PDEs about solitons.

Indeed, addressing the high-dimensionality of the quantum many-body problems leads to effective, universal approximation schemes given in terms of nonlinear evolution equations in a few dimensions, namely, the Hartree-Fock, Kohn-Sham (density functional theory), Ginzburg-Landau, and Gross-Pitaevskii (nonlinear Schrödinger) equations. Dynamics generated by these equations could be described in terms of interacting spatially localized or periodic solutions (such as solitons, vortices, skyrmions, domain walls, collectively known as coherent structures) plus radiation. Determining the stability of these solutions plays a key role in the understanding of the overall dynamics, formation and stability of crystalline structures. A key step is the linearization of the corresponding equations around the coherent structures which leads to (often, non-selfadjoint) Schrödinger-type operators.

This workshop aims to bring together experts in numerical studies, physical modeling, and applications of theoretical analysis to Schrödinger operators, to compare and contrast the different ideas, various tools and methods developed, as well as their implementation and usage by different communities.

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *ICERM has added to my knowledge of theoretical developments within the topic of spectral theory of Schrödinger operators by creating and maintaining a space where talks on new developments and conversations amongst colleagues can be held.*
- *I have not been working on blow-up profiles for the nonlinear Schroedinger equation, so hearing several talks explaining how to address this issue and what common pitfalls are, has been very helpful, as I use these results usually as a blackbox. From the computational aspect, one of the talks described a fast algorithm that I might be able to use in my own research.*
- *I learnt of new developments of the distorted Fourier transform which allow me to see a path towards a long-standing problem of mine, which I did not really know how to attack (namely understanding the formation of solitons on lagoons by waves coming the deep ocean). I also learned of a few sandboxes to adapt variations of problems that I study (in this case, the quantum analogue of the VlasovPoisson system with an external magnetic field). Finally, I learnt a little more about General relativity, which is always a pleasure.*

Some workshop participants comments for "Describe the highlight of this workshop":

- *For me the highlight was to meet a very diverse set of researchers that have different focus, but still just about speak a common language. It was great to understand the interests and point of view of applied mathematicians like E. Cances about the relationship between the talks and chemistry.*
- *Great variety and quality of speakers, nice collaborative atmosphere, many interesting discussions. Organizational and technical support from ICERM were excellent.*
- *The highlight of the workshop was the diverse range of talks showcasing exceptional work and innovative mathematical techniques that I am excited to incorporate into my research.*

Topical Workshop 10: Discrete Optimization: Mathematics, Algorithms, and Computation

Aug 26 - 30, 2024

Organizing Committee:
Jesús De Loera, University of California, Davis
Antoine Deza, McMaster University
Marcia Fampa, Federal University of Rio de Janeiro
Volker Kaibel, Otto-von-Guericke Universität Magdeburg
Jon Lee, University of Michigan
Laura Sanità, Bocconi University

Workshop Description:
This reunion workshop will bring together participants from ICERM's Spring 2023 Discrete Optimization Semester Program and researchers with related interests. Participants will discuss recent advances and catalyze new collaborations related to combinatorial optimization and mixed-integer linear and non-linear optimization.

The Spring 2023 Semester Program at ICERM explored unsolved fundamental questions in discrete optimization and connected areas of mathematics, computer science, and data analytics.

Participant comments are not available for this event.

Topical Workshop 11: Harmonic Analysis and Convexity

Dec 9 - 13, 2024

Organizing Committee:
Javier Gomez Serrano, Brown University
Irina Holmes Fay, Texas A&M University
Alexander Koldobskiy, University of Missouri-Columbia
Sergei Treil, Brown University
Alexander Volberg, Michigan State University
Artem Zvavitch, Kent State University

Workshop Description:
In recent years, there has been a significant increase in the interaction between harmonic analysis and convex geometry, leading to solutions for several longstanding open problems, the discovery of new phenomena, and many new intriguing open questions. These connections were studied during the Fall 2022 Harmonic Analysis and Convexity Semester Program at ICERM. The objective of this workshop is to revisit and review the results produced during the semester and the subsequent year.

The primary areas of focus for the workshop will encompass the Fourier approach to geometric tomography; volume and duality; the Bellman technique for extremal problems in harmonic analysis; convexity of solutions to Hamilton–Jacobi–Bellman equations; as well as numerical computations and computer-assisted proofs. The workshop will explore the use of computational methods for theoretical aspects, including optimal algorithms, as well as practical implementation.

Some workshop participants comments for “Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.”:

- *I learned about topics in classical harmonic analysis that I had not been exposed to, and which I plan to incorporate in my own research in convex geometry.*
- *I have met researchers from different areas that were looking at same type problems and that led to conversations about methods that I would have not envisioned on my own. Additionally, I have met a group of people I knew and some of whom I collaborate (and collaborated in the past). Meeting in presence led to renewing long term projects by defining more precise short term goals.*
- *Participating in the program allowed me to learn about some of the latest and ongoing developments in my research area, and allowed me to form new connections for potential collaborations in the future.*

Some workshop participants comments for “Describe the highlight of this workshop”:

- *Every day was amazing, ICERM is a great place that encourages interaction - the layout of the space, the newly introduced working lunches - a total success!*
- *I appreciated all the moments during which we could connect with other participants, like all the working lunches and the coffee breaks. The staff was also extremely nice. Steve was very welcoming, and Erik (Senior IT) was always so on top of things!*
- *I made some progress on some ongoing projects, and for two of those projects, some of my collaborators were in attendance, which made working much easier and efficient.*

Topical Workshop 12: Computational Learning for Model Reduction

Jan 6 - 10, 2025

Organizing Committee:
Yanlai Chen, University of Massachusetts, Dartmouth
Sigal Gottlieb, University of Massachusetts Dartmouth
Serkan Gugercin, Virginia Tech
Misha Kilmer, Tufts University
Fengyan Li, Rensselaer Polytechnic Institute
Akil Narayan, University of Utah

Workshop Description:
Reduced order modeling (ROM) has become an important tool in computational science for accelerating model-based simulations, including those governed by parametrized differential equations. Through the approximation of high-dimensional features with low-dimensional representations, ROM consists of proven strategies that build accurate emulators for the field or response of computationally expensive high-fidelity models using only a fraction of the simulation cost. In forward prediction or outer loop design and optimization, ROM has the potential to substantially improve the efficiency of current simulation-based techniques.

While ROM has seen considerable success in numerous applications, it continues to attract active research and development. This workshop showcases emerging frontiers in ROM by bringing together researchers whose core interests lie in model reduction and approximation theory, but who have also explored and developed novel methods that utilize various aspects of statistical learning and data science. Topics of the workshop will include: 1) new mathematical and computational nonlinear ROM formulations required for prediction of transport phenomena, 2) new model reduction and meta-learning opportunities necessitated by the prevalence of large neural network models, 3) new paradigms for ROM capable of attacking parameter inference and ill-posed inverse problems, 4) new frontiers in the automated learning of latent representations due to the availability of computationally feasible optimization in statistical and machine learning, 5) an appropriate computational balancing of observational or experimental data with simulation-based models and ROM that would lead to the usage of ROM in digital twin-scale applications, and 6) challenges and new developments in ROM that aims to preserve inherent physical structure of the underlying dynamics.

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *As someone who was not very familiar with the field of model reduction at all, I have gained enough understanding of the basic principles and seem some very interesting computational applications in the workshop that have sparked ideas on how I can use it in my own research. The workshop was enough to gain the foundations of the theory and see the computational implementation and results.*
- *I learned of many developments in the area of reduced-order modeling, including theoretical results (such as convergence of operator inference methods) and computational results (such as implementation of projection methods at very large scale).*
- *I was able to indirectly experience how some existing data-driven model order reduction approach, which has not been tried by our research group before, performs for interesting physics and engineering problems. Also, I was exposed to new data-driven model order reduction approaches, which I think I can apply it to our own physics and engineering problems.*

Some workshop participants comments for "Describe the highlight of this workshop":

- *I am simply impressed by the excellence of ICERM in conducting this workshop. The timing and punctuality were impeccable. The systems and computers were excellently managed by Erik and his team. The speakers and participants were great, And the support of the ICERM staff was just extraordinary.*
- *I learn the new development and find many interesting methods related to MOR, which is helpful a lot I find this is very cherished.*
- *Overseeing the frontiers of various scientific directions related to computational methods for reduced-order modeling was very helpful. There was plenty of time for discussions and establishing new collaborations. Thank you!*

Topical Workshop 13: Women in Mathematical Computational Biology

Jan 13 - 17, 2025

Organizing Committee:
Ashlee Ford Versypt, University at Buffalo
Rebecca Segal, Virginia Commonwealth University
Suzanne Sindi, University of California, Merced

Workshop Description:
Biological systems are typically highly interconnected and complex. With technological advances, it is possible to collect massive amounts of data from these systems, but it is not always clear how to organize the information to draw conclusions and make predictions. In such cases, mathematical formulations are powerful tools allowing researchers to frame questions, explore patterns, and synthesize information. Augmenting and expanding computational algorithms, machine learning algorithms, and data science techniques is necessary to keep pace with the complexity of the models needed for predictive modeling. The interdisciplinary nature

of mathematical biology requires a variety of skills and facilitating interaction among research groups and institutions is important to moving the discipline forward.

The workshop aims to build research collaboration among researchers in mathematical biology. Participants will spend a week making significant progress on a research project and foster innovation in the application of mathematical, statistical, and computational methods in the resolution of significant problems in the biosciences with the goal of publishing research results in a collected volume. The workshop will also include career development lunchtime sessions.

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *With no background in cancer modelling or interpreting experimental cell data, I learned how to understand clinical data and develop mathematical models to specifically target the research question in hand.*
- *This projects [sic] topic was new to me. But the project leaders had played their part well in making me understand the objective of research collaboration and future direction to complete this project. ICERM always provides great platform for these type [sic] of collaborations to increase the knowledge of early career researchers in their respective fields.*
- *The workshop was insightful and it significantly expanded my knowledge on biofilm research. It introduced me to biofilm formation and detachment strategies using agent based modelling methodologies. I have also gained valuable networking opportunities, the workshop has undoubtedly broadened my research horizons and inspired novel approaches to address the challenges of bacterial infection control.*

Some workshop participants comments for "Describe the highlight of this workshop":

- *The highlights of the workshop for me is the interdisciplinary exchange of ideas from diverse fields of the participants in industry and academia which provided valuable insights from different perspectives. The panel discussion lunch was particularly interesting for me, it provided useful job insights and strategies.*
- *Working closely with a group of diverse PhD students and postdocs on a project that was new to the group. Definitely seeing things in action and who in the group was excited/willing to jump into new modeling frameworks and computational platforms.*
- *The highlight of this workshop was working with and learning from exceptional women in mathematical biology. I learned a great deal on how to approach a problem and work efficiently in a group environment. Overall, it has been an invaluable experience. Thank you.*

Topical Workshop 14: Patterns, Dynamics, and Data in Complex Systems

Jan 21 - 24, 2025

Organizing Committee:
Paul Carter, University of California, Irvine

Veronica Ciocanel, Duke University
Stephanie Dodson, Colby College
Anna Ghazaryan, Miami University
Alexandria Volkening, Purdue University

Workshop Description:
The study of pattern formation in biological, ecological, physical, and social systems involves a rich interplay between theory, modeling, and computation. Analytical approaches using the theory of dynamical systems and partial differential equations have made powerful contributions to our understanding of nonlinear waves and patterns, yet many open questions remain in the study of higher-dimensional patterns and complex spatiotemporal behaviors. These analytical tools go hand-in-hand with computational methods, including numerical continuation and agent-based simulations. Together these approaches also complement empirical techniques, particularly in studies of biological pattern formation, leading to experimentally testable predictions and quantitative summaries of data.

In recent years, new opportunities have emerged for pattern detection and identification in applications using data-scientific approaches. These applications include spiral waves in cardiac dynamics, vegetation patterns in arid ecosystems, and cell organization in biological tissues. The aim of this workshop is to bring together researchers at the interface of these diverse aspects of pattern-formation theory, computation, and applications in order to share ideas and identify new challenges and open problems. The scientific program will focus on the use of dynamical systems methods in the study of pattern formation, as well as the integration of dynamics, data, and computation.

Some workshop participants comments for “Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.”:

- *I was exposed to a wide variety of techniques and ideas. Even if I did not learn everything about them, I now have a better idea of the research landscape and where new work is happening, and key ideas and work to look up in order to learn more.*

Some workshop participants comments for “Describe the highlight of this workshop”:

- *Getting together with people I have not seen for many years. And, meeting new people. It was great to see what work is being done, and to find out some of the new directions that research in the field of nonlinear dynamics is going.*

Collaborate@ICERM (C@I)

ICERM hosted 21 Collaborate@ICERM programs from May 2024 through April 2025.

Collaborate@ICERM offers teams of 3-6 researchers the opportunity to spend five days at the institute during the summer (May-August) or during the month of January. The team research project should have a computational or experimental component. ICERM provides access to a variety of software packages as well as to high performance computing through Brown's Center for Computation and Visualization.

Proposals involving research projects that continue a collaboration fostered at one of the past ICERM semester programs are encouraged. Collaborate@ICERM provides limited funding for travel to the institute and local accommodations for six nights. The majority of participants must be from U.S. institutions. The entire team should be present for the week at ICERM.

Collaborate@ICERM Process

1. Solicitation of Proposals

ICERM solicits proposals from faculty through announcements about the opportunity during welcoming remarks at other ICERM programs, and calls for proposals in quarterly newsletters.

Though it is not required, Collaborate@ICERM proposers are welcome to contact the ICERM Director prior to submitting a proposal for preliminary feedback.

The 2-3 page Collaborate@ICERM proposal should include a research title and the list of team members on the first page, as well as:

- Broad research objectives and specific goals for the week at ICERM, written for a general mathematical audience
- Members of the team (3-6)
- The case for convening at ICERM
- A list of possible dates (5 weekdays in May-August or in January)
- 2-page CVs for each team member.

During this reporting cycle the following eligibility guidelines for Collaborate@ICERM (C@I) were developed:

The majority of group participants must be from U.S. institutions. C@I groups can include self-funded participants. The entire team should be present for the week at ICERM. An individual invited to more than one accepted C@I proposal within a given review cycle will only receive funding for one of the visits. Individuals should not participate in a C@I program more than twice within three years.

2. Deadline and Review Process

Completed proposals should be submitted to the ICERM Director. Annual target deadlines are October 1st and May 1st. ICERM Directors and the Scientific Advisory Board (SAB) review all proposals. Proposers receive feedback within a month of the SAB meeting.

3. Evaluation

ICERM recently revised its evaluation process, which will apply to all groups meeting since the pandemic. Now ICERM surveys group members one year after their meeting, asking about publications, research products, grant proposals, and other outcomes resonating with ICERM's computational missions.

Collaborate@ICERM Participants and Projects

C@I 1: Mathematical Modeling, Deep Learning, and Optimization on Graph-Structured Data (May 13 - 17, 2024)

- Weihong Guo, Case Western Reserve University
- Yifei Lou, The University of North Carolina at Chapel Hill
- Jing Qin, University of Kentucky
- Yangyang Xu, Rensselaer Polytechnic Institute
- Liangliang Zhang, Case Western Reserve University

C@I 2: Modeling and Analysis of Candidate Momentum in U.S. Primary Elections Using Campaign Contributions (May 13 - 17, 2024)

- Izabel Aguiar, Stanford University
- Ekaterina Landgren, University of Colorado, Boulder
- Samantha Linn, University of Utah
- Alexandria Volkening, Purdue University
- Sam Zhang, University of Colorado, Boulder

C@I 3: Connections Between Alcoved and Flow Polytopes (June 10 - 14, 2024)

- Rafael Santiago Gonzalez De Leon, Loyola University Chicago
- Christopher Hanusa, Queens College, CUNY
- Alejandro Morales, University of Massachusetts, Amherst
- Martha Yip, University of Kentucky

C@I 4: Hyperkahler Manifolds and Special Cubic Fourfolds (June 10 - 14, 2024)

- Corey Brooke, Carleton College
- Sarah Frei, Dartmouth College
- Lisa Marquand, Courant Institute of Mathematical Sciences, New York University
- Xuqiang Qin, Unaffiliated

C@I 5: Isoperimetric Inequality in the 3D Cube (June 17 - 21, 2024)

- Gioacchino Antonelli, Courant Institute
- Federico Glaudo, Institute for Advanced Study and Princeton University

C@I 6: Macdonald Polynomials and Catalanimals (June 17 - 21, 2024)

- Ying A Pun, CUNY Baruch College
- Jonah Blasiak, Drexel University
- Mark Haiman, University of California, Berkeley
- Jennifer Morse, University of Virginia
- George Seelinger, University of Michigan

C@I 7: A Computational Approach to Plethysm (June 24 - 28, 2024)

- Rosa Orellana, Dartmouth College
- Franco Saliola, Université du Québec à Montréal

- Anne Schilling, UC Davis
- Mike Zabrocki, York University

C@I 8: Counting Sections of Fano Fibrations (July 8 - 12, 2024)
- Roya Beheshti Zavareh, Washington University
- Brian Lehmann, Boston College
- Eric Riedl, University of Notre Dame
- Sho Tanimoto, Nagoya University

C@I 9: Vacillating Tableaux for Integer Sequences (July 15 - 19, 2024)
- Ying A Pun, CUNY Baruch College
- Zhanar Berikkyzy, Fairfield University
- Huafei Yan, Texas A&M University
- Chenchen Zhao, University of California, Davis

C@I 10: The Construction of Locally Recoverable Quasi-Cyclic Codes with Multiple Generators (July 22 - 26, 2024)
- Angelynn Alvarez, Embry-Riddle Aeronautical University, Prescott
- Gustavo Bastos, Federal University of São João del-Rei (UFSJ)
- Zachary Flores, Two Six Technologies

C@I 11: The Persistent Topology of Hypergraphs (August 5 - 9, 2024)
- Ellen Gasparovic, Union College
- Bei Phillips, University of Utah
- Emilie Purvine, Pacific Northwest National Laboratory
- Radmila Sazdanovic, NC State University
- Lori Ziegelmeier, Macalester College

C@I 12: Roots of Bernstein-Sato Polynomials via Positive Characteristic Methods (August 5 - 9, 2024)
- Josep Àlvarez Montaner, Universitat Politècnica de Catalunya
- Daniel Hernández, University of Kansas
- Jack Jeffries, University of Nebraska-Lincoln
- Luis Núñez-Betancourt, CIMAT
- Pedro Teixeira, Knox College
- Emily Witt, University of Kansas

C@I 13: Randomized Algorithms for Tensor Problems with Factorized Operations on Data (August 12 - 16, 2024)
- Jamie Haddock, Harvey Mudd College
- Paulina Hoyos Restrepo, The University of Texas at Austin
- Lara Kassab, University of California, Los Angeles
- Alona Kryshchenko, California State University of Channel Islands
- Shambhavi Suryanarayanan, Princeton University
- Karamatou Yacoubou Djima, Wellesley College

C@I 14: Theory and Algorithms for Reduced Order Modeling (August 12 - 16, 2024)

- Yanlai Chen, University of Massachusetts, Dartmouth
- Yingda Cheng, Virginia Tech
- Fengyan Li, Rensselaer Polytechnic Institute

C@I 15: Lagrangian Relaxation Beyond Boundedness and Rationality (August 19 - 23, 2024)

- Santanu Dey, Georgia Institute of Technology.
- Frédéric Meunier, École nationale des ponts et chaussées
- Diego Moran Ramirez, Rensselaer Polytechnic Institute

C@I 16: Microlocal Analysis and Statistical Methods in Tomography (August 19 - 23, 2024)

- Anuj Abhishek, Case Western Reserve University
- Gaik Ambartsoumian, The University of Texas at Arlington
- Raluca Felea, Rochester Institute of Technology
- Sean Holman, University of Manchester
- Venkateswaran Krishnan, TIFR Centre for Applicable Mathematics, India
- Clifford Nolan, University of Limerick
- Eric Quinto, Tufts University
- James Webber, Brigham and Women's Hospital

C@I 17: Networks, Language, and Change: Advancing Textual Analysis Methodology in the Context of Cultural Change in STEM (December 9 - 13, 2024)

- Carrie Diaz Eaton, Bates College
- Drew Lewis, None
- Stefanie Marshall, Michigan State University
- Rachel Roca, Michigan State University

C@I 18: Data-driven Predictive Modeling and Simulation for Lung Infections (December 9 - 13, 2024)

- Mingchao Cai, Morgan State University
- Wenrui Hao, Pennsylvania State University
- Kali Konstantinopoulos, Purdue University
- Po-Chun Kuo, Purdue University
- Elsje Pienaar, Purdue University
- Jindong Wang, The Pennsylvania State University
- Shun Wang, The Pennsylvania State University
- Ning Wei, Purdue University

C@I 19: Topics in Tame Galois Theory (January 6 - 10, 2025)

- Farshid Hajir, University of Massachusetts Amherst
- Christian Maire, University of Franche-Comté, FEMTO-ST Institute
- Ravi Ramakrishna, Cornell University

C@I 20: Structures of the Weak Order (January 9 - 13, 2025)

- Benjamin Adenbaum, Dartmouth College
- Nestor Fernando Diaz Morera, Fitchburg State University
- Jennifer Elder, Missouri Western State University
- Pamela E. Harris, University of Wisconsin Milwaukee
- Molly Lynch, Hollins University
- Juan Carlos Martinez Mori, Georgia Institute of Technology

C@I 21: Finiteness Properties and Computations of Derived Differential Operators on Singular Varieties (January 21 - 24, 2025)

- Jack Jeffries, University of Nebraska-Lincoln
- Devlin Mallory, University of Michigan
- Claudia Miller, Syracuse University
- Josh Pollitz, Syracuse University
- Eamon Quinlan-Gallego, University of Michigan

Hot Topics Workshops

Hot Topics workshops are designed to allow ICERM to move quickly in order to start the public exploration of breakthroughs and emerging mathematical areas. They run 2-3 days and are organized on a few months' notice. They can originate through suggestions from ICERM boards or the community. A Simons Foundation Targeted Grant originally provided financial support for Hot Topics workshops, including honoraria to attract key speakers and organizers. Since July 2023, we have continued the Hot Topics format (without honoraria) using our core NSF award.

The institute welcomes suggestions for Hot Topics Workshops and encourages researchers to contact the ICERM Director with ideas. The Director and a SAB Hot Topics subcommittee considers proposals for such workshops, which should include:

- List of potential organizers
- Description of the program area/theme (1 paragraph)
- Explanation about why it is a "Hot Topic" (1 paragraph)
- List of 8-10 high-level speakers/participants, their research areas, and how they connect to the goals of the workshop.

Hot Topics suggestions are accepted on a rolling basis. Suggestions are considered by the ICERM Directors, and a sub-committee of ICERM's Scientific Advisory Board that decides which ideas are developed into workshops. ICERM responds to all Hot Topics suggestions within two weeks.

Hot Topics Workshop 1: Random Matrices and Applications

May 20 - 22, 2024

Organizing Committee:
Hoi Nguyen, Ohio State University
Oanh Nguyen, Brown University

Konstantin Tikhomirov, Carnegie Mellon University
Roman Vershynin, University of California, Irvine
Van Vu, Yale University

Workshop Description:
This workshop focuses on the role of random matrices in data science, machine learning, and theoretical computer science.

Playing a significant role in modern data science, random matrices provide an elegant way to represent both (a) the data and (b) the way we process it. To give an example of (a), the classical model of high-dimensional data is a set of points drawn from a certain distribution in a high-dimensional space which can be represented as a random matrix. An even more natural example is that most data in practice is noisy, so it can be represented as a deterministic matrix plus a random noise, which is a random matrix with a non-zero mean. An example of (b) is data compression, which can be realized by applying a random matrix of smaller sizes to the data in (a), thereby reducing its dimensions. Another example is data completion, where we need to reconstruct data (in the form of a matrix) from a random sub-matrix, given that the original matrix satisfies certain structural constraints (such as being low rank).

To deal with these problems, we need to develop techniques beyond the scope of standard random matrix theory. For example, while the sensitivity of matrix spectrum to small random perturbations is extensively studied in the mean field regime, the problem in the setting of structured random matrices, which allows for more adequate modeling of real-world data, is wide open. As another example, the core mechanism of an artificial neural network is a composition of linear and nonlinear transformations, leading to nonlinear generalizations of random matrices. Our understanding of mathematical principles behind examples like this is still in its infancy.

The goal is to discuss a number of hot topics in these areas, focusing on recent theoretical progress and the potential pool of applications, in a manner that is accessible to a wide audience, including researchers in data science, electrical engineering, statistics, and numerical analysis.

Some workshop participants comments for “Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.”:

- *I have written a collaborative paper as a direct result of the ICERM conference.*

Some workshop participants comments for “Describe the highlight of this workshop”:

- *The talks were excellent. I also really enjoyed the trip to the math museum.*
- *When a speaker started describing a construction that tied in with some work that I did a couple of years ago, revealing a connection I had been unaware of.*

Hot Topics Workshop 2: Modeling and Simulations in Fluids

Sep 7 - 8, 2024

Organizing Committee:
Remi Abgrall, University of Zurich
Tulin Kaman, University of Arkansas
Gretar Tryggvason, Johns Hopkins University

Workshop Description:
Understanding the dynamics of unpredictable systems such as turbulent mixing and combustion has been one of the most important and challenging problems in scientific and engineering applications. The validation, verification, and uncertainty quantification (VVUQ) studies are crucial to achieving reliable and accurate results through high-fidelity multi-physics and multi-scale modeling and simulations. This workshop honors Dr. James Glimm, member of the National Academy of Science and the American Academy of Arts and Sciences, and winner of the National Medal of Science for his outstanding contributions to computational fluid dynamics.

The workshop themes include analysis, modeling, and computation of partial differential equations and applications in turbulent mixing and combustion. The workshop will bring together researchers to highlight recent advances and challenges in modeling and simulations of realistic fluid flows. Topics will include: (1) interface instabilities; (2) mixing in multiphase flows; (3) turbulence models; (4) scalable solvers; (5) uncertainty quantification; and (6) applications in nature and technology.

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *This workshop was organized very well, and I regularly attend workshops organized by ICERM in the area of Applied Mathematics more specifically in the area of nonlinear PDEs and their Numerical Simulation . In my opinion, it is an excellent platform to connect with world-class researchers working in the areas of mathematical modeling and scientific computation. It is always a pleasure to meet brilliant minds, listen to their insights, and further discuss research problems.*
- *Chance to hear about these directly in an interactive presentation format. This is always best before diving into papers and perhaps getting side-tracked by details that are secondary. You get an overview on the concepts.*
- *I have already applied for computing resources to pursue a question with another speaker that was posed during his talk and to which I think I can contribute.*

Some workshop participants comments for "Describe the highlight of this workshop":

- *The topics were very interesting! And the speakers were enjoyable to engage with!*
- *The quality of presentations and networking*
- *The diversity of the shared knowledge*

Hot Topics Workshop 3: Robust Optimization and Simulation of Complex Stochastic Systems
Sep 13 - 15, 2024

Organizing Committee:
Rami Atar, Technion
Amarjit Budhiraja, University of North Carolina at Chapel Hill
Kavita Ramanan, Brown University

Workshop Description:
The program will explore different perspectives on uncertainty quantification, efficient simulation, and the analysis of complex stochastic systems. The topics covered will include exciting recent developments on efficient methods for approximating quasi-stationary distributions, simulation of equilibrium distributions, information divergences in sensitivity analysis of rare events, large deviations methods for efficient importance sampling, accelerated Monte Carlo via nonlinear PDE, and complex probabilistic models including reflected diffusions and high-dimensional dynamics arising in chemistry and physics.

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *I learned quite a few new things from the talks on information theoretic divergences and generative modeling, especially on methods for dealing with non absolutely continuous distributions. This spurred some thoughts about new research directions using these divergences.*
- *Through the speakers' presentations at ICERM on cutting-edge developments in stochastic optimization, machine learning, and the theory of probability distances.*
- *I learned about recent works in different sub-directions in this field. Speakers showcased their results with technical ingredients in the proof, which provided literature for me to explore.*

Some workshop participants comments for "Describe the highlight of this workshop.":

- *All the talks and posters were excellent. I learned a great deal from the presentations and had valuable interactions with the presenters and participants throughout the workshop. This experience has greatly enhanced my research in this area.*
- *Excellent collection of presentations on closely related themes, helped me catch up with many recent developments.*
- *Excellent collection of presentations on closely related themes, helped me catch up with many recent developments.*

Hot Topics Workshop 4: Fusing Theory and Practice of Graph Algorithms
Feb 20 - 22, 2025

Organizing Committee:
Jakub Lacki, Google
Blair Sullivan, University of Utah

Workshop Description:

Researchers working on graph algorithms use a broad range of different criteria for deciding what makes an algorithm efficient. While in theory the dominant benchmark is the asymptotic running time, in practice the story is more nuanced: an algorithm needs to be simple enough to be implementable, fast on graphs of bounded size, space efficient, cache-friendly, and easy to test. While many of these requirements motivate interesting algorithmic questions that are highly relevant in practice, they are often overlooked by the theory community. The goal of the workshop is to foster the exchange of ideas between researchers working on graph algorithms, which have high practical relevance. The workshop will include overview talks on the various perspectives, research talks, an open problem session, and structured time for collaboration.

The topics of the workshop include fundamental data science graph algorithms (e.g., clustering, partitioning, graph embedding), graph neural networks, and modeling data using networks (e.g. approximate nearest neighbor search). Additionally, the workshop program incorporates problems and approaches necessitated by scaling graph algorithms to large datasets (e.g. parallel, distributed, dynamic and external memory models, as well as algorithm engineering).

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *This workshop was astonishing. I really enjoyed the different talks. In my opinion, the participation of people from big companies, such as Microsoft and Google, was a great opportunity to listen to the explanation of how they use Graph Theory in these products was remarkable.*
- *I am coming from a very applied background (engineering), and I was able to connect with researchers who are doing work that I can see value to integrating into my own work. I was able to connect with these researchers and share contact information for future discussions. I also was able to get a better idea of what researchers more focused on theory look for and consider.*
- *In this ICERM event, people from theoretical research groups brought their methods to reduce some problems of graph clustering which I didn't think of. Besides, speakers from Google shared an interesting point of view about the equivalence between transformer and MPC that extends the application of graph algorithms combined with ML scenarios.*

Some workshop participants comments for "Describe the highlight of this workshop.":

- *Seeing the importance of graph-based methods in modern big-data problems.*

Hot Topics Workshop 5: Autoformalization for the Working Mathematician

Apr 24 - 27, 2025

Organizing Committee:
Jarod Alper, University of Washington
Daniel Halpern-Leistner, Cornell University
Albert Jiang, University of Cambridge
Kim Morrison, Lean Focused Research Organization
Sean Welleck, Carnegie Mellon University

Workshop Description:
A large community of pure mathematicians has recognized the importance of formal verification in modern mathematics and is looking forward to systems like Lean becoming an everyday tool in research. At the same time, automated theorem proving has recently become popular in the machine learning community as a benchmark and stepping stone for the more general task of automated reasoning. The goal of this workshop is to bring these communities together.

We will have talks and tutorials that introduce mathematicians to Lean and to state-of-the-art technologies in automated theorem proving. We will also discuss future research directions, tooling, and other ways to make this technology more useful to working mathematicians. Our medium-term goal is to initiate an effort in the mathematical community to develop a well-aligned dataset that can be used to benchmark models for tasks that are close to the use cases of working mathematicians. The first afternoon of the workshop will be a hackathon whose goal is to create tools that will aid mathematicians in this dataset creation.

Some workshop participants comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *The variety of participants (academia, industry, government) and different but complementary areas of expertise made this one of the most stimulating mathematics meetings I have attended. I gained insight into the state of the art that is more difficult to gain solely from reading papers.*
- *This ICERM workshop brought together forward-thinking mathematicians with ML researchers both from academia and industry. It was an ideal confluence of researchers that despite having vastly different areas of expertise are all aligned with autoformalization visions. Moreover, the hack-a-thon, panel discussions, tutorials, and research talks together with plenty of time for open discussion led to an inspiring environment. This has made me reflect deeply on my research goals and future plans.*
- *This workshop greatly contributed to my understandings of the intersections of Machine Learning and Formalization, and helped me develop my understanding of the theoretical underpinnings of autoformalization, and computational methods used in this subject.*

Some workshop participants comments for "Describe the highlight of this workshop.":

- *It was very well organized and comprehensive. The effort to bring in people from different backgrounds paid off very well, I think. Kudos to organizers! The highlight for me was to learn that the state of the art in automatic formalization is far beyond what I imagined it to be.*
- *Talking to the mathematicians about what they need from an AI assistant gave me confidence to pursue some aspects of my own research project.*
- *Being able to connect with other mathematicians, and learn about how formalization is being used across disiplinces [sic], and what the cutting edge of autoformalization.*

Program Promotions

ICERM programs and events are typically marketed through a variety of outlets: its website, dedicated social media (Facebook, Twitter, and Instagram) accounts, targeted email campaigns, placement of advertisements in mathematical journals and newsletters, ICERM directorate participation in conferences and exhibits, upcoming program fliers and announcements made available to ICERM participants, and various on-line math organization calendars (AMS, AWM, European Mathematical Society, National Math Institutes, and Conference Service Mandl). ICERM has discontinued the use of posters for large mailings as alternative digital advertising methods are effective, inexpensive and environmentally friendly.

ICERM's email database is made up of former and upcoming participants, local partners and community leaders, ICERM board members, academic and corporate sponsors, and the department managers from higher education math departments in both the US and overseas. It currently has over 18,000 contact emails.

Communications Plan

ICERM's various communications, funder acknowledgements, and presence on Brown's fundraising page have helped ICERM maintain contact with board members, corporate and academic sponsors, and the general mathematical research community.

ICERM's communications strategy emphasizes maintaining regular contact with recent, current, and upcoming program participants and amplifying scientific results from workshops and collaborations initiated at ICERM. To meet these objectives, ICERM has continued its semesterly (Spring, Summer, and Fall) newsletter highlighting research fellows, scientific program outcomes, upcoming opportunities to visit ICERM, and various funding and career opportunities. Participants with significant scientific outcomes are invited to work with the Director to share their results on mathinstitutes.org/highlights, or in the ICERM newsletter. ICERM also maintains regular contact with Brown University's Physical Sciences Communications Manager to highlight ICERM researchers and programs in Brown's publications. In addition, frequent social media posts sharing workshop photos, high-interest events (e.g. GoGetMath and public lectures), ICERM-Brown connections, and alumni achievements help ICERM remain visible in the mathematical community and attract prospective participants.

Brown University Advancement supports ICERM by sharing its activities with mathematically-interested Brown alumni, handling donor transactions, and providing timely donor reports. Supplementary grants and gifts from organizations are supported by Brown Corporate and Foundation Relations. However, contacting non-Brown alumni is not a high priority for Brown Advancement stewardship unless they make a particularly large gift. Since most ICERM participants are not Brown affiliates, this gives the Institute flexibility in soliciting donations without direct supervision from the University. To avoid overwhelming its constituencies with requests for donations, ICERM uses a range of opportunities to make subtle-to-direct solicitations:

- Website (subtle: static donation page)
- In-person (subtle: fliers with QR codes made visible to in-person participants)
- E-Newsletter (gentle: 3 times per year, “If you’d like to donate, click here”)
- Direct email solicitation (direct: sent mid-year and end-of-year to frequent ICERM visitors, former leadership, former postdocs, and Brown Math/Applied Math faculty)

Organization/Infrastructure

ICERM’s governing body is a Board of Trustees (BOT). The Scientific Advisory Board (SAB) oversees all scientific activities of the Institute and selects the scientific programs. The Education Advisory Board, or EAB coordinates the oversight of educational activities at all levels at ICERM.

Board of Trustees (BOT)

The Board of Trustees oversees all institute activities. This includes being responsible for reviewing the budget for the coming year, developing policies and procedures, advising on the appointment of new Directors and actively recruiting for the position as needed, and taking a leadership role in fundraising and public awareness. The Board of Trustees has a face-to-face meeting at ICERM for one day each year (usually in late spring), and one or two conference-call meetings if needed.

Board of Trustee member appointments are for four years. Chairs from the Scientific Advisory Board (SAB) and the Education Advisory Board (EAB), as well as the ICERM Directors and co-PIs, are invited to sit in.

Board of Trustee Members:

Name	Institution
Leon Bottou	Facebook
Lisa Fauci	Tulane University
Illya Hicks	Rice University
Rachel Kuske (Chair)	Georgia Tech
Mark Lewis	Cornell University
Lois McInnes	Argonne National Laboratory
Andrea Nahmod	University of Massachusetts Amherst
Nataša Pavlović	University of Texas
Daniel Szyld	Temple University
Carol Woodward	Lawrence Livermore National Laboratory

The following people rotated off the BOT at the end of June 2024: Ron Buckmire, Anna Gilbert, and Leslie Greengaard.

Note: The minutes from the May 20, 2024 annual Board of Trustees meeting can be found in Appendix D.

Scientific Advisory Board (SAB)

The Scientific Advisory Board (SAB) is responsible for approving the programs and scientific activities of the Institute. In addition, through direct communication with the Directors, Science Board members will be involved in shaping the direction of the scientific enterprise through specific suggestions of thematic programs, program organizers.

Terms are three years. The ICERM Directors act as ex officio members of this committee.

Scientific Advisory Board Members:

Name	Institution
Jacob Bedroissian	University of Maryland
Fioralba Cakoni (Chair)	Rutgers University
Ricardo Cortez	Tulane University
Ioana Dumitriu	University of California, San Diego
Eli Grigsby	Boston College
Lior Horesh	IBM Research
Smita Krishnaswamy	Yale University
Michael Mahoney	University of California, Berkeley
Youssef Marzouk	Massachusetts Institute of Technology
Anna Mazzucato	Pennsylvania State University
Juliane Mueller	National Renewable Energy Laboratory
Dana Randall	Georgia Institute of Technology
Andrew Sutherland	Massachusetts Institute of Technology
Eric Vanden-Eijnden	New York University
Jared Wunsch	Northwestern University

The following people rotated off the SAB at the end of June 2024: Jennifer Balakrishnan, Michael Holst, Yael Kalai, Daniel Krashen, and Nathan Kutz.

Upcoming Programs

ICERM already has a number of programs scheduled to take place in the coming years. The below listings have already been approved by the Scientific Advisory Board and are in the process of being developed.

Semester Programs (each with 3-4 associated workshops)

Fall 2025

Categorification and Computation in Algebraic Combinatorics

C. Bowman, N. Gonzalez, K. Lee, N. Libedinsky, R. Orellana, G. Panova, A. Schilling, J. Vicary, A. Wagner, L. Williams

Spring 2026

Stochastic and Randomized Algorithms in Scientific Computing: Foundations and Applications
H. Antil, J. Chung, P. Drineas, Y. Marzouk, A. Miedlar, A. Saibaba

Fall 2026
K3 surfaces and computation
J. Berg, P. Comparin, K. De Vleming, D. Festi, K. Kedlaya, A. Logan, A. Sarti, C. Salgado, A. Várilly-Alvarado

Spring 2027
Metric Algebraic Geometry: Going Global
P. Breiding, S. Di Rocco, J. Kileel, K. Kohn, L. Lerario, C. Meroni, J. Rodriguez, A. Seigal

Fall 2027
Applied and Computational Complex Analysis in the 21st Century
D. Crowdy, L. Cummings, L. Lanzani, S. Smith, B. Protas, T. Trogdon, J. Weideman

Topical Workshops

2025

1. **Uncertainty Quantification for Mathematical Biology**
   D. Calvetti, N. Cogan, L. Huynh, A. Narayan, J. Reimer
2. **Links in Dimensions 3 and 4**
   M. Kuzbary, G. Martin, B. Owens, R. Stees
3. **Scientific Machine Learning for Gravitational Wave Astronomy**
   S. Caudill, K. Chatziioannou, M. Fishbach, B. Keith, J. McIver, M. Puerrer, S. Speagle, V. Varma
4. **Algebraic Points on Curves**
   A. Bourdon, R. Lemke Oliver, A. Shnidman, I. Vogt, A. Zureick-Brown
5. **LMFDB, Computation, and Number Theory (LuCaNT) 2025**
   J. Jones, J. Paulhus, A. Sutherland, J. Voight
6. **Innovative and Efficient Strategies for Stiff Differential Equations**
   S. Gottlieb, Z. Grant, J. Hu, D. Ketcheson
7. **Fostering Cross-Disciplinary Collaboration in Biology, Medicine, and Computational Science**
   B. Apka, J. Deng, W. Hao, J. Lee, J. Petrella, L. Shahriyari, I. Zervantonakis
8. **Random Polynomials and Their Applications**
   H. Nguyen, O. Nguyen, S. O'Rourke, I. Pritsker
9. **Graduate Workshop on Linear Algebra over Finite Fields and Applications**

L. Conte, J. LeGrow, H. López, G. Matthews, A. Robinson, J. Rosenthal

10. **Webs in Algebra, Geometry, Topology, and Combinatorics**
    I. Le, P. Pylyavskyy, J. Striker, J. Swanson

2026

1. **Extremal Black Holes and the Third Law of Black Hole Thermodynamics**
   S. Aretakis, R. Gannouji, E. Giorgi, G. Khanna, S. Liebling, T. Maedler
2. **Nonparametric Bayesian Inference: Computational Issues**
   T. Broderick, P. Mueller, I. Pruenster, S. Williamson, Y. Xu
   D. Bilyk, X. Chen, E. King, D. Mixon, K. Okoudjou
3. **Nonlinear Waves: From Theoretical and Computational Advances to Experimental Observations**
   J. Holmer, P. Kevrekidis, V. Koukouloyannis, Z. Zhang
4. **Techniques and Tools for the Formalization of Analysis**
   J. Gomez Serrano, J. Loreaux, H. Macbeth, P. Massot, T. Tao

Collaborate@ICERM

2025

1. **Interpretable Algorithms for High-Dimensional Data Sets: Analysis, Computation, Machine Learning, Optimization, and Statistics**
   J. Huang, S. Kovalsky, Y. Li, J. Marzuola, Y. Wu, K. Zhang, P. Zhong, W. Zhou
2. **Chow Polynomials of Partially Ordered Sets**
   Y. Cid-Ruiz, L. Ferroni, J. Matherne
3. **Machine-Learning Interatomic Potentials for Moire Materials**
   V. Gavini, M. Luskin, D. Massatt, C. Ortner, Z. Zhu
4. **A Construction of Quantum Error-Correcting Codes from Classical Quasi-Cyclic Locally Recoverable Codes**
   A. Alvarez, G. Bastos, M. Hamidi, C. Williams
5. **Stable Tamari Posets**
   Y. Pun, H. Chau, S. Daugherty, S. Grate, J. Martinez Mori
6. **Modeling the Impact of Human Movement on Malaria Immune Dynamics**
   L. Childs, D. Patterson, J. Ponce, O. Prosper, Z. Qu, L. Zhao
7. **Computational Modeling of Biofilm Breakup**
   R. Luke, S. Olson, Z. Wang, Y. Xu
8. **Arithmetic Data for Delsarte K3 Surfaces**
   R. David, T. Gomes Ribeiro, E. Orvis, A. Salerno, L. Sturman, U. Whitcher
9. **Noise is Not Always Bad: A Case Study with the Randomized Kaczmarz Algorithm**
   E. Bergou, X. Chen, A. Butta, X. Li

10. **Finding Geometric and Topological Cores of Higher Graphs**
I. Garcia-Redondo, C. Landi, S. Percival, B. Phillips, A. Skeja, L. Zhou
11. **Dynamics of Gentrification**
M. Cortez-Rodriguez, T. Fernandes Nunez, E. Landgren, J. Martinez Mori
12. **VECINA**
C. Diaz Eaton, J. Fang, R. Hashemi, J. Hibdon, V. Piercey, A. Rafiee, K. Sanchez, B. Thompson, D. Turner
12. **Modeling the Stability and Effectiveness of Dosing Regimens of Oral Hormonal Contraceptives**
L. de Pillis, E. Graham, L. Oremland, E. Schwartz, L. Zhao, H. Zinn Brooks

2026

1. **Toward a Juggling Analog for Kostant's Partition Function on the Exceptional Lie Algebras**

Summer@ICERM

2025

Building Useful Insights from Local Data
J. Humpherys, R. Levy, M. Meysami, K. Socha

2026

Pure and Applied Mathematical Models
A. Harsy, A. Schulze, B. Stephenson, C.Sulyok

Reunion Events - These programs are designed to bring together attendees of past programs to discuss the state of their fields and expand on work initiated at ICERM.

2025

1. **Illustrating Mathematics: Reunion/Expansion**
D. Bachman, A. Nasar, N. Scherich, S. Schleimer, M. Skrodzki, L. Taalman

Note: The minutes from the May 24, 2024 mid-year SAB conference call and the November 18-19, 2024 SAB annual meeting can be found in Appendix E.

Education Advisory Board (EAB)

The Education Advisory Board 1) oversees the undergraduate research programs, and helps to develop and identify successful proposals, 2) helps to develop proposals for outreach programs and events that are aligned with the mission of the institute, and 3) helps to identify sources of funding for education and outreach activities.

Terms are three years. The ICERM Directors act as ex officio members of this committee.

Education Advisory Board Members:

Name	Institution
Paul Bendich	Duke University
Cathy Boutin	West Warwick School Department (Math)
Ron Buckmire	Marist College
Amalia Culiuc	Brown University
Malena Español	Arizona State University
Edray Goins	Pomona College
Kathleen Kavanaugh	Clarkson University
Maria Klawe	Math for America
Ralph Morrison	Williams College
Julianna Tymoczko (Chair)	Smith College
Ulrica Wilson	Morehouse College
Darryl Yong	Harvey Mudd College

The following people rotated off the EAB at the end of June 2024: Katharine Ott

Note: The minutes from the September 2024 annual Education Advisory Board meeting can be found in Appendix F.

Mathematics Institute Directors Meeting (MIDs)

The April 2024 MIDs meeting minutes can be found in Appendix G.

ICERM's Early Career Training and Mentorship

A special focus of the operations of the institute is the training and mentorship of younger and early career mathematicians, through specific outreach programs and directed opportunities for connections between mathematicians at different stages in their career. This includes ICERM's postdoctoral program, integration and support of graduate students in the context of semester programs, and summer research programs for undergraduates (Summer@ICERM). The addition of postdoctoral fellows (as described above) and graduate students is essential to the success of ICERM's programs.

Postdoctoral Program

ICERM's postdoctoral program brings early career mathematicians to the institute in order to support and expand their research and to create lasting career collaborations and connections. ICERM supports postdoctoral researchers in two salaried categories: "Semester" postdoctoral fellows who participate in a single semester-length program, and a smaller number of "Institute" postdoctoral fellows, who stay at ICERM for an academic year.

Recruiting and Selection of ICERM-Funded Postdocs

ICERM's postdoctoral positions are widely advertised using MathJobs.org, print and online publications of the Society for Industrial and Applied Mathematics News, Notices of the American Mathematical Society, the Association of Women in Mathematics, the Society for the

Advancement of Chicanos and Native Americans in Science, and on the ICERM website. These positions are also advertised at the NSF Institute Reception at the Joint Mathematics Meeting. ICERM collects applications via Mathjobs.org, an online job application service provided by the American Mathematical Society.

ICERM sets an early-January deadline for postdoctoral applications. Application review begins immediately and continues until the positions are filled.

The Postdoctoral Fellow Search Committee consists of the ICERM Semester Program organizers for the upcoming programs with input from the Directors.

The program organizers review all of the applications and provide a rank-ordered list to the ICERM Directors for each of the two types of positions (Semester and Institute postdocs). The Directorate reviews the ranked lists, and may suggest changes to ensure field balance. The Director approves all offers, and Brown University's Dean of the Faculty oversees postdoctoral offers and appointment terms.

2024-2025 ICERM Postdoctoral Cohort

ICERM Semester Postdoctoral Fellows and Associates (4 months w/benefits; funds for research travel):

Name	Previous Institution	ICERM Semester Program
Marina Garrote López	Max Planck Institute for Mathematics in the Sciences	Fall 2024
Max Hill	University of California, Riverside	Fall 2024
Joshua Justison	Iowa State University	Fall 2024
Nicholas Barvinok	Georgia Institute of Technology	Spring 2025
Dániel Garamvölgyi	Alfréd Rényi Institute	Spring 2025
Matthias Himmelmann	University of Potsdam	Spring 2025
Alison La Porta	Lancaster University	Spring 2025
William Sims	University of Florida	Spring 2025
Jack Southgate	University of St. Andrews	Spring 2025

ICERM Institute Postdoctoral Fellows and Associates (9 months w/benefits; funds for research travel):

Name	Previous Institution	ICERM Semester Program
Maize Curiel	University of Hawai'i at Mānoa	2024-2025: focus on Fall 2024
Dimitrios Diamantidis	Indiana University, Bloomington	2024-2025: focus on Fall 2024
Sungsik Kong	University of Wisconsin, Madison	2024-2025: focus on Fall 2024
Zeyuan He	University of Cambridge	2024-2025: focus on Spring 2025

Tracking Former Postdocs (Institute and Semester)

ICERM Research Fellows are supported with a salary for one semester. ICERM expects that these postdoctoral fellows will be on leave from, or have deferred the start of, another position. The institute makes every effort to keep in touch with its postdoctoral alumni in order to track their professional growth.

ICERM-funded postdocs ***(to date)***	**Period of Stay**	**Current Institution**
Emre Esenturk	Fall 2011	Jesus College, University of Oxford
Jeffrey Haack	Fall 2011	Los Alamos National Laboratory
Andong He	**Fall 2011**- Spring 2012	Passed away in 2016
Ahmed Kaffel	Fall 2011	University of Wisconsin-Milwaukee
Daniela Tonon	Fall 2011	Università degli Studi di Padova
Dongming Wei	Fall 2011	Nazarbayev University
Cecile Armana	Spring 2012	University Marie et Louis Pasteur
Anupam Bhatnagar	Spring 2012	Google
Alon Levy	Fall 2011 – **Spring 2012**	NYU | The Marron Institute
Bianca Viray	Spring 2012	University of Washington
Xiaoguang Wang	Spring 2012	Virginia Tech
Daniel Cargill	Fall 2012	Lockheed Martin
Arnab Ganguly	Fall 2012	Louisiana State University
Peng Hu	Fall 2012	Shanghai Luoshu Investments
Hao Ni	Fall 2012	University College London
Aaron Smith	**Fall 2012** - Spring 2013	University of Ottawa
Julio Andrade	Fall 2012 - **Spring 2013**	University of Exeter
Kwangho Choiy	Spring 2013	Southern Illinois University
Zajj Daugherty	Spring 2013	Reed College
Martina Lanini	Spring 2013	Università di Roma Tor Vergata
Ben Salisbury	Spring 2013	Central Michigan University
Ryan Greene	Fall 2013	KairoBit
BoGwang Jeon	Fall 2013	POSTECH Mathematics Institute
Rodolfo Rios-Zertuche	Fall 2013	UiT The Arctic University of Norway
Giulio Tiozzo	**Fall 2013** – Spring 2014	University of Toronto
Anastasiia Tsvietkova	Fall 2013	Rutgers University
Emily Kyle Fox	Spring 2014	University of Texas at Dallas
Danupon Nanongkai	Spring 2014	Max Planck Institute for Informatics
Amanda Redlich	Spring 2014	University of Massachusetts Lowell
Charalampos Tsourakakis	Spring 2014	Boston University
Grigory Yaroslavtsev	Fall 2013 - **Spring 2014**	Independent Researcher
Ali Ahmed	Fall 2014	Information Technology University (Lahore); Director of CACTuS; CEO of

		Qult Technologies; CTO of TierMax AI
Ulas Ayaz	**Fall 2014** – Spring 2015	Google Hausdorff Center for Mathematics, University of Bonn
Jacqueline Davis	Fall 2014	Unknown
Pawel Siedlecki	Fall 2014	University of Warsaw
Li Wang	Fall 2014	University of Minnesota
Tyler Helmuth	Spring 2015	Durham University
Marcin Lis	Spring 2015	Vienna University of Technology
Emily Russell	Fall 2014 – **Spring 2015**	Google
Xuan Wang	Spring 2015	Databricks
Samuel Watson	Spring 2015	RelationalAI
Olga Balkanova	Fall 2015	Steklov Mathematical Institute of Russian Academy of Sciences
Sandro Bettin	Fall 2015	University of Genova
Edgar Costa	Fall 2015	Massachusetts Institute of Technology
Anna Medvedovsky	**Fall 2015** – Spring 2016	Max Planck Institute for Mathematics
James Weigandt	**Fall 2015** – Spring 2016	Lorain County Community College
Abel Farkas	Spring 2016	Flow Színház - Flow Theatre
Marta Canadell Cano	Fall 2015 – **Spring 2016**	Wallapop
Nishant Chandgotia	Spring 2016	Tata Institute of Fundamental Research
Zhiqiang Li	Spring 2016	Peking University; Beijing International Center for Mathematical Research
Polina Vytnova	Spring 2016	University of Surrey
Hannah Alpert	**Fall 2016** – Spring 2017	Auburn University
Chaim Even-Zohar	Fall 2016	Technion - Israel Institute of Technology
Isaac Mabillard	Fall 2016	Google
Greg Malen	Fall 2016	Skidmore College
Jose Alejandro Samper	Fall 2016	Pontificia Universidad Católica de Chile
John Wiltshire-Gordon	Fall 2016	RetroacDev R&D Tax Credit Automation Software
Sergey Dyachenko	Fall 2016 – **Spring 2017**	University at Buffalo
Seok Hyun Hong	Spring 2017	POSCO Research Institute
Cecilia Mondaini	Spring 2017	Drexel University
Olga Trichtchenko	Spring 2017	Western University
Xuecheng Wang	Spring 2017	Tsinghua University
Xiaoqian Xu	Spring 2017	Duke Kunshan University
Mario Bencomo	**Fall 2017** – Spring 2018	California State University, Fresno
Wei Li	Fall 2017	DePaul University
Shixu Meng	Fall 2017	Virginia Institute of Technology
Yimin Zhong	Fall 2017	Auburn University
David de Laat	Spring 2018	Delft University of Technology

Maria Dostert	Spring 2018	Munters
Philippe Moustrou	Spring 2018	Université Toulouse Jean Jaurès
Yu Guang Wang	Spring 2018	Shanghai Jiao Tong University; University of New South Wales
Wei-Hsuan Yu	Fall 2017 – **Spring 2018**	National Central University
Daniel Bernstein	Fall 2018	Tulane University
Papri Dey	Fall 2018	University of California, Santa Cruz
Mareike Dressler	Fall 2018	University of New South Wales
Kathlén Kohn	Fall 2018	KTH Royal Institute of Technology
Sara Lamboglia	Fall 2018	Goethe-Universität
Dane Wilburne	Fall 2018	The MITRE Corporation
Marilyn Vazquez	Fall 2018 – **Spring 2019**	Simpson College
Shubhendu Trivedi	Fall 2018 – **Spring 2019**	Massachusetts Institute of Technology
Guangyao Zhou	Spring 2019	Google DeepMind
Gabriel Dorfsman	Fall 2019	St. Lawrence University
Alba Málaga Sabogal	**Fall 2019** – Spring 2020	University of Lorraine
Michael Musty	Fall 2019	Faraday
Martin Skrodzki	Fall 2019	Delft University of Technology
Steve Trettel	Fall 2019	University of San Francisco
Gregory Darnell	Fall 2019 – **Spring 2020**	Apple
Davide Palitta	Spring 2020	University of Bologna
Jemima Tabeart	Spring 2020	Eindhoven University of Technology
Michael Schneier	Spring 2020	University of Pittsburgh
Min Wang	Spring 2020	University of Houston
Stefan Czimek	**Fall 2020** – Spring 2022	Leipzig University
Martin Licht	Fall 2020	Swiss Federal Institute of Technology Lausanne
Jacob Lange	Fall 2020	University of Texas at Austin
Caroline Mallary	Fall 2020	Unknown
Zachary Nasipak	Fall 2020	University of Southampton
Brendan Keith	Fall 2020	Brown University
Sunita Chepuri	Spring 2021	University of Puget Sound
Netanel Friedenberg	Spring 2021	Tulane University
Sean Griffin	Spring 2021	University of Vienna
Daoji Huang	Fall 2020 – **Spring 2021**	Institute for Advanced Study
Gleb Nenashev	Spring 2021	St. Petersburg State University
Louise Gassot	**Fall 2021** - Spring 2022	Mathematics Institute of Rennes (IRMAR)
Amirali Hannani	Fall 2021	KU Leuven
Kyle Liss	Fall 2021	Duke University
Anastassiya Semenova	**Fall 2021** - Spring 2022	University of Washington

Annalaura Stingo	Fall 2021	École Polytechnique France
Jiaqi Yang	**Fall 2021** - Spring 2022	Clarkson University
Antonio Alfieri	Spring 2022	Stony Brook University
Lei Chen	Spring 2022	University of Maryland
Jonathan Johnson	Spring 2022	Oklahoma State University
Sudipta Kolay	Fall 2021-**Spring 2022**	SAS: Data and AI Solutions
Nancy Scherich	Fall 2021-**Spring 2022**	Elon University
Hannah Turner	Spring 2022	Stockton University
Yvon Verberne	Spring 2022	University of Western Ontario
Alexandros Eskenazis	Fall 2022	Sorbonne University
Fushuai Jiang	Fall 2022	University of Maryland
Michael Roysdon	**Fall 2022**-Spring 2023	Case Western Reserve University
Masana Naga Vempati	Fall 2022	Louisiana State University
Katarzyna Wyczesany	Fall 2022	University of Leeds
Sudan Xing	Fall 2022	University of Arkansas at Little Rock
Sean Kafer	Spring 2023	Georgia Institute of Technology
Chiara Meroni	Spring 2023	Swiss Federal Institute of Technology
Bento Natura	Spring 2023	Columbia University
Nimita Shinde	Fall 2022-**Spring 2023**	University of Kansas Medical Center
Shixuan Zhang	Fall 2022-**Spring 2023**	Texas A&M University
Robyn Brooks	Fall 2023	University of Utah
Tom Burns	Fall 2023	Cornell University SciAI Center
Vasiliki Liontou	Fall 2023	University of Bologna
Marissa Masden	**Fall 2023**-Spring 2024	University of Puget Sound
Nikola Milićević	Fall 2023	Pennsylvania State University
John Carter	Spring 2024	Rensselaer Polytechnic Institute
Sijing Liu	Fall 2023-**Spring 2024**	Worcester Polytechnic Institute
Henry von Wahl	Spring 2024	Friedrich Schiller University Jena
Yukun Yue	Spring 2024	University of Wisconsin Madison
Maize Curiel	**Fall 2024**-Spring 2025	TBD
Dimitrios Diamantidis	**Fall 2024**-Spring 2025	TBD
Marina Garrote López	Fall 2024	KTH Royal Institute of Technology
Max Hill	Fall 2024	University of Hawai'i
Joshua Justison	Fall 2024	University of Wisconsin
Sungsik Kong	**Fall 2024**-Spring 2025	TBD
Nicholas Barvinok	Spring 2025	TBD
Dániel Garamvölgyi	Spring 2025	Alfréd Rényi Institute
Zeyuan He	Fall 2024-**Spring 2025**	TBD
Matthias Himmelmann	Spring 2025	Technical University of Braunschweig
Alison La Porta	Spring 2025	Lancaster University

William Sims	Spring 2025	TBD
Jack Southgate	Spring 2025	Whole Life Consultants Limited

Graduate Students

Support for Graduate Students

The research semester program budget typically includes partial support for a cohort of graduate students. Applicants include graduate students working with visitors to the program, as well as students who intend to attend without an advisor. Graduate students must arrange for a letter of recommendation from their advisor to be sent separately. The graduate student applications are prioritized by the semester program organizing committee (1 - Would make a contribution to this program; 2 - Desirable for this program but not high priority; 3 - High priority, important for the success of the program). The prioritized list is subsequently reviewed by the Deputy Director overseeing the development of that particular program. Final decisions are made by the Directors. The ability to provide a mentor for each graduate student in residence is a factor in the decision.

Training and Mentoring Programs

Before a semester program starts, ICERM attempts to assign a mentor to all postdocs and graduate students. The institute provides all senior mentors with written guidelines that spell out their responsibilities and the responsibilities of mentees. Currently, the assigned ICERM Deputy Director coordinates these efforts and works with the members of the Program Organizing Committee assigned to be responsible for mentorship.

The mentoring program for the Institute Postdoctoral Fellows necessarily includes a plan for the "off semester" when these postdocs are "in residence" at ICERM while there is no active research program in their area. In most cases, postdocs are matched with mentors at Brown in Math, Applied Math, or Computer Science in order to continue their ICERM research.

ICERM Postdoctoral Participant and Mentor list by Semester Program

Postdoc	**Mentor**	**Program/How Supported**
Maize Curiel	H. Banos	Fall 2024 Institute Postdoc (NSF Funds)
Dimitrios Diamantidis	J. Rhodes	Fall 2024 Institute Research Associate (NSF Funds)
Marina Garrote López	J. Chifman	Fall 2024 Semester Postdoc (NSF Funds)
Max Hill	J. Rhodes	Fall 2024 Semester Postdoc (NSF Funds)
Joshua Justison	M. Jones	Fall 2024 Semester Postdoc (NSF Funds)
Sungsik Kong	E. Allman	Fall 2024 Institute Postdoc (NSF Funds)
Nicholas Barvinok	J. Bowers and B. Connelly	Spring 2025 Semester Postdoc (NSF Funds)
Dániel Garamvölgyi	S. Gortler and T. Nixon	Spring 2025 Semester Postdoc (NSF Funds)
Zeyuan He	M. Sitharam and S.Gortler	Spring 2025 Institute Postdoc (NSF Funds)
Matthias Himmelmann	M. Himmelmann	Spring 2025 Semester Postdoc (NSF Funds)

Alison La Porta	T. Nixon and S. Tanigawa	Spring 2025 Semester Research Associate (NSF Funds)
William Sims	M. Sitharam and B. Connelly	Spring 2025 Semester Postdoc (NSF Funds)
Jack Southgate	T. Nixon and B. Jackson	Spring 2025 Semester Postdoc (NSF Funds)

Roundtable Discussions

To prepare graduate students and postdocs better for their future careers, the institute also organizes regular roundtable discussions with long-term visitors, Brown faculty, and Directors, that in the course of each semester, cover the following topics:

- Preparing job applications
- Writing and submitting papers
- Writing grant proposals
- Ethics in research as required by NSF – mandatory, attendance is taken
- Job opportunities in industry and government labs

Peer-to-Peer Discussions

During semester programs, there are regularly scheduled postdoc-graduate student seminars, expressly limited to junior researchers. This gives participating postdocs and graduate students an opportunity to discuss research topics and any other issues openly, without senior people present. The format is completely flexible. For example, it could feature talks by postdocs or graduate students on their current research or provide an opportunity to read and report on papers, or give an introduction to upcoming talks in other seminars. The group could even ask a senior participant to give a tutorial lecture and then follow up with a discussion session afterwards.

ICERM makes all of its resource materials for its Graduate Students and Postdoctoral Fellows available to the general public on its website, which can be found at:
https://icerm.brown.edu/pds/

Summer Undergraduate Research Program

Summer@ICERM is an eight-week summer research program for 16-20 undergraduates. Students work in small groups, typically in pairs, supervised by faculty advisors and assisted by TAs. In addition to research projects, the program includes topical mini-courses and colloquium-style lectures given by invited speakers. Students present their findings at a symposium at the end of the program.

1. Solicitation of Proposals

ICERM solicits and recruits proposals from faculty nationwide. Faculty organizers and TAs are required to be in residence for a minimum of six of the eight weeks, especially the first and last week of the program.

2. Future Proposal Selection
Programs are selected from proposals submitted to ICERM in an open competition. Successful programs typically have a significant computational component. Proposals are reviewed and prioritized by the Education Advisory Board, which usually offers substantive feedback to the proposers.

3. Application Process
Undergraduates apply to the program through MathPrograms.org and participants are selected from a talented pool of students currently enrolled in U.S. universities and colleges. A small number of international participants may also be admitted.

4. Applicant Selection
Undergraduate participants are selected by the Summer@ICERM faculty organizers and the selections are finalized by ICERM Director(s). We seek students whose academic and professional trajectory might be changed through a summer at ICERM. Cohorts include students from R1 research institutions, comprehensive universities, and liberal arts colleges. To ensure a diverse group of applicants, ICERM advertises widely. We seek the following dimensions when evaluating candidates: interest and initiative, aptitude and preparation, ability to create an inclusive and supportive environment, perseverance, and potential for the program to influence future trajectory.

Financial Decisions for Program
Faculty and TAs receive a stipend and travel support, and faculty also get partial or full support for lodging. Undergraduate participants funded by ICERM receive a stipend, travel funds within the United States, meals, and accommodation in a Brown dormitory.

Summer@ICERM 2024: Mathematical Models to Predict, Prepare, and Prevent
Jun 10 - Aug 2, 2024

Organizing Committee:
Amanda Harsy Ramsay, Lewis University
Adam Schultze, Lewis University
Brittany Stephenson, Lewis University
Cara Sulyok, Lewis University

Program Description
Mathematical modeling allows researchers to address questions and test hypotheses that may not be feasible to study otherwise. The Summer@ICERM 2024 faculty advisors will present a variety of research projects centered around approaches to using mathematical modeling for making predictions and determining associated preparations and necessary preventions in the fields of epidemiology, precision nutrition, and sports analytics. Faculty will guide the development of appropriate models and computational tools that can aid in answering fundamental questions in these fields.

During the eight-week program, students will be introduced to the research topics through interactive lectures. Afterward, students will work on their projects in assigned groups of two to four, supervised by faculty advisors and aided by teaching assistants. Students will meet daily; give regular talks about their findings; attend mini-courses, guest talks, and professional development seminars; and practice coding. Students will learn how to collaborate mathematically while working closely with their teams to write a paper detailing their results.

2024 Proposed Research Project Topics

1. Ordinary Differential Equation Models of Disease Transmission and Control in Long-Term Care Facilities
2. Agent-Based Models to Evaluate Precision Nutrition Interventions through a Socioeconomic Lens
3. Predictive Modeling and Analysis of Sports Using Linear-Algebra-Based Models

2024 Summer@ICERM Cohort

The Summer@ICERM 2024 program had a cohort of 18 students and 4 graduate student teaching assistants. All of them were funded through the NSF.

Student Name	Institute	Funding Source
Mia Adler	Pomona College	ICERM
Alli Brophy	Winthrop University	ICERM
Joshua Brown	Ursinus College	ICERM
Yutong Bu	Emory University	ICERM
Andres Castellanos	Sonoma State University	ICERM
Zachary Cheesman	Bowdoin College	ICERM
Priscilla Doran	Bryan College	ICERM
Natsuka Hayashida	Brown University	ICERM
Bryce Iversen	Sonoma State University	ICERM
Kristen Joyner	University of Tennessee	ICERM
Journey Keen	University of Tennessee	ICERM
Anh-Thai Le	Yale University	ICERM
Ford McDill	Wesleyan University	ICERM
Grace Moberg	Colby College	ICERM
Danielle Murphy	University of California, Berkeley	ICERM
Tiffanie Ng	Kenyon College	ICERM
Benjamin Orman	Grinnell College	ICERM
Will Paz	Miami University	ICERM

Here follows a sample of the most substantive comments from Summer@ICERM participants:

Some Participant Comments for “Describe the highlight of this program”:

- *Definitely getting to meet great faculty and teammates! Some interactions with researchers at the conferences was also really valuable. Exposure to different areas of research, technology, and mathematics has definitely changed my life.*
- *The entire thing. Meeting awesome people, learning more about mathematics and research, learning more about myself, and everything in between.*

- *The highlight of this program was being able to work with some amazing and supportive professors in an area of research I had never been exposed to before.*

Summer@ICERM 2024 Scientific Outcomes to Date

Final Student Presentations

- **Local and Global Approaches for Improving American Football Rankings**
  - Journey Keen, University of Tennessee, Knoxville
  - Anh-Thai Le, Yale University
- **A Mathematical Model of Clostridioides difficile Transmission in Long-Term Care Facilities**
  - Priscilla Doran, Bryan College
  - Natsuka Hayashida, Brown University
  - Kristen Joyner, University of Tennessee, Knoxville
  - Grace Moberg, Colby College
- **Money Bull: An Analysis of Ranking Methods on Rodeo**
  - Mia Adler, Pomona College
  - Ford McDill, Wesleyan University
  - Tiffanie Ng, Kenyon College
  - Will Paz, Miami University
- **Predictive Modeling of English Club Soccer Using Ranking and Forecasting Methods**
  - Josh Brown, Ursinus College
  - Yutong Bu, Emory University
  - Zachary Cheesman, Bowdoin College
  - Benjamin Orman, Grinnell College
- **Stochastic Simulations of C. difficile Spread in Assisted Living Facilities**
  - Alli Brophy, Winthrop University
  - Andres Castellanos, Sonoma State University
  - Bryce Iversen, Sonoma State University
  - Danielle Murphy, University of California, Berkeley

Posters Presented at JMM 2025

- **Local and Global Approaches for Predicting Week-to-Week NFL Outcomes**
  - **Abstract:** Despite the popularity of the National Football League (NFL), it is difficult to rank teams throughout the season with predictive power. Even though ranking methods by Massey and Keener are mathematically elegant, extending such models to predict team performance lacks structural information about past performances. This research first proposes a global model, using only score differentials and point spreads for predicting week-to-week NFL team outcomes and rankings. To identify inconsistencies in our ranking system, we apply the Hodge theorem (via HodgeRank) to analyze uncertainties in pairwise rankings. We then introduce a local model, incorporating individual player ratings into a gradient-boosting model to weigh overall team strength. We assess the models' generated predictions based on straight-up and spread wins, with accuracy compared to models recorded by The Prediction Tracker. We show how both

models complement each other, serving as promising methods for predicting NFL games.
    - **Presenting Authors:** Journey Keen, Ahn-Thai Le
- **A Mathematical Model of *Clostridioides difficile* Transmission in Long-Term Care Facilities**
    - **Abstract:** *Clostridioides difficile*, also known as *C. difficile*, is a prevalent cause of infectious diarrhea in United States healthcare facilities. Spread through the fecal-oral route and primarily through contact with spores on contaminated surfaces, *C. difficile* can cause severe diarrhea, stomach pain, and colitis. Most individuals can mount an effective immune response, but older populations, immunocompromised individuals, and those taking antibiotics have an increased risk of being colonized by *C. difficile*. While many mathematical models have been developed to understand *C. difficile* transmission in hospital-based settings, few studies have considered the context of long-term care facilities.

      Using a system of ordinary differential equations, our mathematical model represents *C. difficile* transmission in assisted living facilities, with their interactive nature and high-risk factors. The equations include four resident classes (susceptible, colonized, diseased, and quarantined) and three pathogen environmental reservoirs (high-traffic areas, low-traffic areas, and healthcare worker hands) to simultaneously capture the movement among classes and track the number of spores on these environmental reservoirs, including how they contribute to disease spread. Data from the Emerging Infections Program at the Centers for Disease Control and Prevention was used for parameter estimations, and sensitivity analyses were performed to quantify the impact of varying these parameters and their impact on incidence. Mitigation strategies such as frequent disinfection, increased handwashing compliance, and a lower ratio between residents and healthcare workers had the greatest impact on reducing the incidence of *C. difficile*.
        - **Presenting Authors:** Priscilla Doran, Natsuka Hayashida, Kristen Joyner, Grace Moberg
        - **Authors:** Austin Kind, Matthew Senese, Brittany Stephenson, Cara Sulyok
- **Mathematics and Sports: Mentoring Undergraduate Research at Summer@ICERM**
    - **Abstract:** The intersection of sports and mathematics offers a wide range of research opportunities, allowing students to apply mathematical concepts to real-world scenarios and uncover patterns in sports data. In this talk, we will share examples of how these opportunities were explored in the Summer@ICERM 2024 NSF-REU (Research Experience for Undergraduates) program hosted at Brown University. In particular, we look at the program from the perspective of a graduate student teaching assistant who was also a participant in Summer@ICERM 2023, highlighting the benefits and challenges of mentoring and conducting these projects, as well as lessons learned from these experiences.
        - **Presenting Author:** Iris Horng
- **Money Bull: Analyzing the Application of Ranking Methods to Rodeo**

    - **Abstract:** Drawing millions of fans each year and surpassing even golf and tennis in sporting event attendance in the United States, the rodeo stands as one of North America's most unique and iconic sports. Despite having vast numbers of participants and spectators, there has been little mathematical work published on the rodeo ranking system, strategy, or other common topics covered in sports analytics. In this research, we examine various ranking systems of bareback riding in the largest rodeo organization in America, the Professional Rodeo Cowboys Association (PRCA). Due to a wide range of rodeo prize pools with no observable pattern for how they are set, the PRCA's use of total earnings as the primary measure of ranking may not accurately represent rider skill. We explore alternative methods of comparing bareback riders by extending classical linear algebraic ranking methods -specifically Colley, Massey, Keener, and PageRank- to rank PRCA bareback riders based on performance data. We assess the effectiveness and predictive power of these standard methods. Ultimately, we find that these linear algebra models serve as a more holistic ranking system, each of which favors aspects such as average earnings, average total score, and average rider score.
        - **Presenting Author:** Mia Adler
        - **Author:** Ford McDill, Tiffanie Ng, Will Paz
- **Predictive Modeling of Lower-Level English Club Soccer Using Crowd-Sourced Player Valuations**
    - **Abstract:** In this poster presentation, we examine the capabilities of different mathematical models to accurately predict various levels of the English football pyramid. While existing work has largely focused on top-level play in European leagues, our work analyzes teams throughout the entire English Football League system. We use weighted Colley and Massey ranking methods which incorporate player valuations from the widely-used website Transfermarkt to predict game outcomes. Our initial analysis found that lower leagues are generally more challenging to forecast. However, after removing dominant outlier teams from the analysis, we found that top leagues were just as difficult to predict as lower leagues. We also extended our findings using data from multiple German and Scottish leagues.
        - **Presenting Authors:** Joshua Brown, Yutong Bu, Zachary Cheesman, Benjamin Orman
- **Stochastic Simulations of *C. difficile* Spread in Assisted Living Facilities**
    - **Abstract:** *Clostridioides difficile*, also known as *C. difficile*, is a bacteria commonly found in healthcare settings. It spreads via touch through the environment through colony-forming units of spores found on surfaces. Studies have shown individuals with an advanced age are more likely to become colonized or diseased with *C. difficile*. The death rate from *C. difficile* has been reported to be one in 11 people, with mortality in relation to the disease increasing with age.

Multiple mathematical models, including agent-based models (ABMs), have been used to study the spread of *C. difficile*. These models have primarily studied *C. difficile* transmission in hospital settings while few models have examined this transmission in long-term care facilities, such as assisted living facilities (ALFs). Residents in ALFs require care from staff for many activities of daily living. However, unlike in hospital settings where patients are often isolated, residents often have a more social and active environment in ALFs due to their ability to visit the dining room and other common areas with residents and visitors. Since the level of social activity present in ALFs is much higher than in hospitals, model simulations of the spread of *C. difficile* will differ greatly between the two settings when considering the shared common spaces in ALFs and how residents interact with such spaces and each other. Our ABM accounts for these social behaviors, as well as the different assistance needs of residents in an ALF, the contamination on various surfaces, and the impact of healthcare workers and visitors as transmission vectors. In particular, we study how residents in ALFs are exposed to *C. difficile*, and how various cleaning, hand hygiene, and staff protocols can be leveraged to mitigate the spread of this disease.

- **Presenting Authors:** Alli Brophy, Andres Castellanos, Bryce Iversen, Danielle Murphy
- **Authors:** Austin Kind, Matthew Senese, Brittany Stephenson, Cara Sulyok

Articles and Publications

- **"From Chalkboard to Scoreboards: Applying Math to Sports at Summer@ ICERM"**
  - Featured in the June/July 2025 issue of *MAA Focus*, pp. 33-34
  - **Authors:** Mia Adler, Josh Brown, Audrey Bu, Tiffanie Ng
- **"Inside the Front Office: A conversation with Will Cousins of the Tampa Bay Rays"**
  - Featured in the June/July 2025 issue of *MAA Focus,* pp. 35-36
  - **Author:** Will Paz

The Evaluation Process: Measure to Evaluate Progress

Current Program Evaluation

ICERM continues to work with Strategic Research Group (SRG), an external evaluation company, to build upon its current survey data.

ICERM automates its survey reporting, using templates that display particular variables of interest across participants and over time. In this way, ICERM can easily recognize a pattern of program strengths in certain areas and may be able to tailor aspects of its programs to successfully equip individuals for a thriving and influential research career.

ICERM also successfully creates two and five-year follow-up surveys that are customized to a single participant instead of distributing a broad and generalized survey to all participants. An

example of how customized surveys are being used at the institute is the generation of publication lists for each participant. When the survey is sent, Qualtrics reads the unique identification number of the participant stored in the panel database and generates a list of publications previously collected by ICERM staff and assigned to that specific identification number. Then, the surveyed participant is able to identify the publications that can be attributed to his or her time at ICERM. This novel incorporation of a participant-specific generated publication list has been useful in understanding how influential ICERM programs are to one's research career long-term.

Measure impact across subgroups

Qualtrics cloud-based software not only aids in creating customizable surveys for participants, but also serves as a platform for analyzing data according to different subgroups of participants e.g., gender, job title, race/ethnicity.

SRG continues to assist ICERM with using the Qualtrics data analysis tools to better understand how the institute's programs impact different subgroups of researchers in both the immediate i.e., program exit surveys and intermediate-/long-term i.e., two- and five-years after program participation. Qualtrics also provides the opportunity to analyze longitudinal data, which will be helpful in the analysis of certain programs over time. Ultimately, these analyses will provide information as to how ICERM can alter programs to benefit different types of participants who may be at various points in their research career.

Measure long-term outcomes

Since 2014, ICERM has been administering an intermediate - i.e., two-year follow-up survey to past semester program participants. Using the unique identification numbers and in-survey data analyses as described above, these surveys measure the attributable impact of participation in ICERM research programs by gathering data on published papers, invited talks, and funded or pending grant proposals. These follow-up surveys help us understand the far-reaching impact of ICERM's research programs over time.

To boost survey response rates during this reporting cycle, the SAB suggested the program organizers send a "heads up/please respond" email to their program's long-term participants prior to putting the follow-up surveys in the field. This request resulted in an increased response rate (from an average of 50% for the two-year-follow-up and 36% for the five-year-follow-up to 52% and 55%, respectively).

A central tenet of ICERM is that networking, collaboration, and engagement with computational tools promote career growth that would not be possible without engagement with its programs.

With SRG's help, the institute developed a longitudinal comparison report using a program's exit survey, as well as its 2 and 5-year follow-up survey. In this way, ICERM can connect participant data across surveys (with the use of unique IDs) and generate a more holistic narrative of ICERM's impact over a longer period of time. The results from this report are meant to showcase

ICERM's long-term impact on participant careers and their continued perceptions of their time at the institute. Notably, this report examines:

- trends in employment over time
- professional talks
- grant funding submitted and received
- collaborations

The challenge is having high enough response rates for the collected data to draw meaningful conclusions.

The SAB is interested in seeing details about a program's long-term impact. It reviews outcomes of past programs in its annual meeting, to focus attention on the potential long-term outcomes of programs it reviews. The challenge in the coming year is to pare down the massive quantity of information collected to something more concise. ICERM will endeavor to simplify and streamline its survey instruments, with a view toward what is needed for formative evaluation (in director-manager meetings) and summative evaluation (led by ICERM's boards).

ICERM continues to play a large role in gathering and updating participant information for the two and five-year follow-up surveys. Specifically, one question provides participants with a list of their papers, pre-prints, or reports published since their participation at ICERM (or, in the case of the five-year follow-up, since their initial two-year survey). Participants then have the opportunity to include/update publications resulting from their participation in an ICERM program or event. ICERM is responsible for finding and compiling these publications for each participant. Additionally, before implementing each survey, ICERM continues to be involved in editing and testing the survey in order to have an end product that will most effectively provide data aligned with its goals.

It is important to note here that although ICERM has hired SRG as its external evaluation company to aid in reaching their evaluation goals, the institute still plays a vital role in the data collection and survey distribution process. In addition, at weekly management meetings, survey results are reviewed and discussed so that improvements can be made as appropriate.

Note: Exit survey summaries for core programs run during this reporting cycle (May 1, 2024 through April 30, 2025) can be found in Appendix H.

Reported Scientific Outcomes/Projects Initiated

In the past, the Director sent a request to all long-term participants asking for updates on their research projects and/or publications that arose during, or were enhanced by, participation in an ICERM program. With the advent of ICERM's 2-year and 5-year follow-up survey for each of its semester programs, scientific outcomes have begun to be collected much more systematically and consistently. In general, the response rate for all survey types has remained steady over the past four years, when ICERM first began tracking response rates.

Since the 2021 Board of Trustees Meeting, ICERM has presented publication information collected in these surveys somewhere to highlight accomplishments of ICERM programs and

participants. Over the past year a project was carried out which resulted in publications being added to the program's website that the author(s) attended. Semester programs now include listings as soon as ICERM is made aware of an attributable publication to the program and a database has been made to manage the information. So far over 1200 publications have been added to the related program pages. In the coming year the goal is to have similar upgrades to the Summer@ICERM and Collaborate@ICERM pages.

Note: A list of publications attributed to an ICERM program since the 2023-2024 annual report can be found in Appendix I.

Future Plans for Evaluations

Based on the feedback from ICERM's Scientific Advisory Board, ICERM has started to take steps to modify the current evaluation summary format. The goal is to provide quickly comprehensible data points and highlight standout responses from the open ended questions. This would effectively streamline the summary from the current format which can quickly grow to several pages. Further ICERM hopes that by having this done in-house will allow for more flexible responsiveness to the needs of the SAB and the participants taking the surveys. The 2 and 5 year follow up surveys were used as a test and the initial responses were good. With some additional staffing, plans are in development to expand upon this momentum to manage more aspects in-house and survey more of the groups. Additionally, ICERM has adopted in person exit interviews with program organizers to help fulfill its reporting duties to the NSF. These interviews focus on workshop high points, specific scientific outcomes, and any new avenues for research suggested during programs.

Corporate and Academic Sponsorship

Several math institutes currently funded by the NSF employ corporate and university-sponsored programs with tiered memberships. ICERM launched its own unique corporate and academic sponsorship programs in 2011.

The Corporate Sponsorship program has a $5,000 annual membership fee. To date, ICERM has received $92,500 in corporate sponsorship funds.

The Academic Sponsorship has an annual membership fee of $1,500 for domestic memberships with small graduate student programs, $3,000 for domestic membership with large graduate student programs, and $5,000 for international membership. To date, ICERM has received $99,375 in academic sponsorship funds. Academic sponsors have included:

- Cornell University, Department of Mathematics
- Indiana University, Bloomington, Department of Mathematics
- Korea Advanced Institute of Science and Technology, Dept. of Mathematical Sciences
- Michigan Tech, Department of Mathematical Sciences
- Worcester Polytechnic Institute, Mathematical Sciences Department

External Support

The institute staff works to develop new sources of support for its programs. Associate Director of Finance and Administration, Jenna Sousa, has duties which include managing both public and private grants, managing the proposal process and ensuring that follow-up reporting is completed. Director Brendan Hassett and Associate Director Jenna Sousa manage relations with the institute's sponsoring corporations and serves as a liaison to Brown's Division of Advancement, which unites Alumni Relations, Development, Corporate and Foundation Relations in a single, focused organization.

In addition to the funding provided by the NSF, ICERM receives substantial in-kind financial support from Brown University. The Director is released from teaching, and two Deputy Directors are released from half of their teaching responsibilities. In addition, ICERM is not charged for the use and maintenance of its building or for custodial care.

Other Funding Support received in 2024-2025

Additional Grants	*Amount*
American Mathematical Society Epsilon Fund *(for GoGetMath@ICERM)*	$ 7,000.00
Math *f*or America *(for GoGetMath@ICERM)*	$ 10,000.00
MathWorks *(for GoGetMath@ICERM)*	$ 3,000.00
PPL Foundation *(for GoGetMath@ICERM)*	$ 6,350.00
Sub-total	**$ 26,350.00**
University Funding Support	
University Research Committee	$ 75,000.00
Sub-total	**$ 75,000.00**
Sponsor Support	
Academic Sponsors	$ 5000.00
Corporate Sponsors	$ 0.00
Individual Sponsors	$ 3,000.00
Sub-total	**$ 8,000.00**
TOTAL	**$ 109,350.00**

Outreach Activities

Public Lectures

ICERM has gained a reputation for providing the Brown community and the general public with an excellent public lecture series. These lectures attract a broad audience, from high school students on up.

During this reporting cycle, three public lectures were held:

- **"Mathematicians Helping Art Historians and Art Conservators"** with Dr. Ingrid Daubechies (May 2024)
- **"Count on Me to Write a Mathematics/Statistics Book"** with Dr. Kimberly Sellers (November 2024)
- **"AlphaGeometry: A Step Toward Automated Math Reasoning"** with Dr. Junehyuk Jung (March 2025)

GoGetMath@ICERM

For ten years, ICERM has been able to secure funding to run its well-received GoGetMath@ICERM program (formerly known as GirlsGetMath@ICERM). Since 2023, the program has been led by Amalia Culiuc, Lecturer in the Division of Applied Mathematics at Brown.

ICERM's founding program organizers (Katharine Ott and Amanda Tucker) have developed curricula for topics including cryptography, the game "Set", image processing, recommendation systems etc. An abbreviated, asynchronous version the program was made available to applicants as well as the general public during the pandemic. Videos of Ott and Tucker presenting a selection of modules related to the GoGetMath curriculum (as well as some downloadable activities) are still posted on ICERM's website.

GoGetMath was designed to motivate young students to consider careers in mathematics, computation, and quantitative fields, provides an affirming environment that encourages participants to explore, and invites them to excel in the mathematical sciences.

The program inspires 20-25 participants to love math by:

- demonstrating through hands-on activities, games, and computer simulations that the study of mathematics can be exciting, fun, and useful;
- introducing the high school participants to a variety of career opportunities for which sophisticated mathematical ability plays a key role, with an emphasis on the central role mathematics plays for success in STEM careers; and
- providing the participants with a support group of like-minded peers and mentors.

GoGetMath Broader Impact

The mentorship provided to the participants has been specifically designed by those with experience in outreach to meet a key set of needs identified by research as being most likely to make a difference in the way the girls view mathematics and STEM disciplines. The program

content is created by mathematicians who collectively have many years of experience as researchers and educators. It is crafted to be at the appropriate level for the participants, but at the same time challenging and practical. The topics are selected to showcase the beauty and depth of mathematics.

Thanks to funding from the JetBlue Foundation in 2018, ICERM developed a train-the-trainer opportunity for nine faculty who were interested in replicating the program at their home institutions. The observational training occurred during ICERM's summer 2019 GirlsGetMath program. The train-the-trainer participants were then given the opportunity to apply for start-up seed funds to run their own programs. The program was ultimately able to support five programs. The locations were Stonehill College in 2021, Colorado State University in 2022, Boston University in 2022, University of Michigan-Dearborn in 2022, and University of Central Oklahoma in 2022. The feedback at all locations was well received and most of the sites report planning to host programs in future years.

ICERM has developed methodologies for tracking program alumni annually in order to follow their educational interests – specifically, how many will go on to seek a college degree and if they choose to major in a STEM field.

EPSCoR

ICERM supports the National Science Foundation's EPSCoR mission: "to assist the NSF in its statutory function "to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education." EPSCoR goals are:

1. to provide strategic programs and opportunities for EPSCoR participants that stimulate sustainable improvements in their R&D capacity and competitiveness;
2. to advance science and engineering capabilities in EPSCoR jurisdictions for discovery, innovation and overall knowledge-based prosperity.

ICERM hosted 318 researchers from EPSCoR states in the 2024-2025 year.

Accepted ICERM participants from EPSCoR States (May 1, 2024 through April 30, 2025)

EPSCoR State	# of ICERM Participants
Alabama	3
Alaska	2
Arkansas	6
Delaware	7
Hawaii	13
Idaho	2

Iowa	15
Kansas	6
Kentucky	12
Louisiana	11
Maine	9
Mississippi	5
Missouri	16
Montana	1
Nebraska	4
Nevada	1
New Hampshire	10
New Mexico	8
North Dakota	4
Oklahoma	3
Rhode Island	125
South Carolina	16
Tennessee	20
Utah	17
Vermont	1
West Virginia	1
Total	**318**

Administration and Staff

The ICERM Directors who received funding from the NSF core grant during this reporting cycle were Caroline Klivans, Benoit Pausader, Jill Pipher, Kavita Ramanan, and Bjorn Sandstede. Brendan Hassett commits 100% time.

ICERM Staff

Events Team

Teresa Fitzsenry, Program Manager, hired October 2016: reports to the Associate Director of Finance and Administration. Responsible for the implementation of ICERM's scientific research programs; manages a program timeline and program guide for each program, adhering to all programmatic deadlines and budgets. Major responsibilities include coordinating the housing, coordinating all communications regarding the arrival and orientation of long-term and short-term visitors; sending and tracking invitations and applications, assisting with creating a program schedule.

Allison Foster, Program Coordinator, hired August 2024: reports to the Program Manager. Coordinates all logistical aspects of the fall semester/later summer programs and workshops. Acts as the main point of contact and customer support for ICERM visitors; sends and tracks speaker invitations, coordinates visitor housing, and enters participant data into ICERM's Cube database. Assist the Program Manager and Assistant Director with other activities, such as social media and other marketing, as needed.

Steven Freund, Program Coordinator, hired July 2022: reports to the Program Manger. Coordinates all logistical aspects of the fall semester/later summer programs and workshops. Acts as the main point of contact and customer support for ICERM visitors; sends and tracks speaker invitations, coordinates visitor housing, and enters participant data into ICERM's Cube database. Assist the Program Manager and Assistant Director with other activities, such as social media and other marketing, as needed.

Finance Team

Monique Bandaronek, Financial Coordinator, hired August 2024: reports to the Associate Director of Finance and Administration. Serves as primary point of contact for ICERM staff, program organizers, visitors, postdocs, students, vendors, and sponsor agencies for all financial transactions and related issues; reconciles the day-to-day financial activity for expenses supported by sponsored projects and University appropriated budgets.

Don Calitri, Grants and Financial Specialist, hired December 2023: reports to the Associate Director of Finance and Administration. Supports grant proposal submissions, general grant and financial management and reporting. Engages with intercampus departments to resolve issues that arise within financial, human resources, and grant domains.

IT Team

Erik Brunnenmeyer, IT Support Coordinator, hired September 2023: reports to the Director of IT. Provides A/V support for the institute's programs and events as well as technical support for program participants.

João Dos Santos, Senior Application Developer, hired March 2022: reports to the Director of IT. Performs application testing, development, and maintenance, including development/coding, testing, and ongoing maintenance of the department's front-end applications, back-end applications, java application servers, and databases.

Departed Staff Members and Directors

Vaishali Atiku, Application Developer, hired August 2023 and departed in April 2025: reported to the Senior Application Developer. Performed application testing, development, and maintenance, including development/coding, testing, and ongoing maintenance of the department's front-end applications, back-end applications, java application servers, and databases.

Halle Bryant, Communications Specialist, hired January 2023 and departed in January 2025: reports to the Assistant Director of Programs and Operations. Ensured that there was a robust communications strategy for the institute, and that all communications were executed in a professional manner in line with current best practices and trends. This position was responsible for managing social media platforms and marketing materials (print and digital, with a focus on a digital-first communications strategy). Collaborated with Brown University's department of Advancement to create opportunities for donor engagement and stewardship.

Leo Bunyea, Senior Systems Administrator, hired June 2024 and departed in June 2025: reported to the Director of IT. Managed and maintained software, systems, servers, and infrastructure necessary to support ICERM programs, and oversaw technical support.

Carly Seaman, Financial and HR Coordinator, hired March 2022 and departed in December 2024: reported to the Associate Director of Finance and Administration. Served as primary point of contact for ICERM staff, program organizers, visitors, postdocs, students, vendors, and sponsor agencies for all financial transactions and related issues; reconciled the day-to-day financial activity for expenses supported by sponsored projects and University appropriated budgets. Provided human resources guidance and support to the department.

ICERM PI and Director Biographies

Brendan Hassett (Director) joined the Brown faculty the summer of 2015 as a Professor of Mathematics. He assumed the directorship of ICERM in July 2016. Brendan received his Ph.D. from Harvard in 1996 and then spent four years at the University of Chicago before joining the faculty at Rice University in 2000. He was the chair of the mathematics department at Rice from 2009 to 2014. He has also held visiting positions at the Mittag-Leffler Institute in Stockholm, the Chinese University of Hong Kong, and the University of Paris. Brendan's research focus is algebraic geometry - the study of geometric objects that are defined as solutions to polynomial equations. Brendan has written 70 research papers and has authored or co-edited eight books. His work has been recognized with a Sloan Research Fellowship, a National Science Foundation CAREER award, and the Charles W. Duncan Award for Outstanding Faculty at Rice. He is a Fellow of the American Mathematical Society.

Mathew Borton was one of ICERM's first employees, hired in December 2010. As the Director of Information Technology, he brings big-picture, strategic development skills to the institute. He oversees all daily IT/technology related operational activities and ensures IT security and stability. He acts as the liaison to the Brown University's IT community. Besides supporting the scientific activities within the institute, his responsibilities include overseeing the support of administrative IT and A/V equipment, and the development and support of key web interfaces and databases. Mat received his BS in Information Technology and his MS in Technology – Information Security, both from Purdue University.

Jeffrey Hoffstein is Professor of Mathematics and Chair of the Mathematics Department (through June 2024) at Brown University, as well as an ICERM Consulting Associate Director. He received his PhD in mathematics from MIT in 1978. After holding postdoctoral positions at the Institute for Advanced Study, Cambridge University, and Brown University, Jeff was an

Assistant and Associate Professor at the University of Rochester. He came to Brown as a full professor in 1989. His research interests are number theory, automorphic forms, and cryptography. Jeff has written over seventy papers in these fields, co-authored an undergraduate textbook in cryptography, and jointly holds 10 patents for his cryptographic inventions. He was a co-founder of Ntru Cryptosystems, Inc., which was acquired by Qualcomm.

Misha Kilmer is a William Walker Professor of Mathematics at Tufts University and an ICERM Deputy Director. She has a secondary appointment in the Department of Computer Science at Tufts University and a co-PI of Tufts TRIPODS Institute. She has been a Tufts Data Intensive Studies Center (DISC) Faculty Fellow since January 2021. In 2019, Prof. Kilmer was named a Fellow of the Society for Industrial and Applied Mathematics (SIAM) "for her fundamental contributions to numerical linear algebra and scientific computing, including ill-posed problems, tensor decompositions, and iterative methods." She served as Chair of the Tufts Department of Mathematics from 2013 to 2019. She is a 2001 recipient of the Tufts Undergraduate Initiative in Teaching Award and was promoted directly from Assistant to Full Professor in 2005.

Caroline Klivans is an Associate Professor of Applied Mathematics at Brown University and an ICERM Deputy Director Emerita. As Deputy Director of ICERM from 2020-2024, her responsibilities included overseeing semester programs and other institute activities such as summer programming and special events, assisting in solicitation and development of programs and workshops, and with grant proposals to support institute activity. Prior to becoming a Deputy Director, she served as an ICERM Associate Director from 2015-2020, where her focus was on the Institute's mentoring and professional development programs for students and postdoctoral fellows. Caroline received a BA degree in mathematics from Cornell University and a PhD in applied mathematics from the Massachusetts Institute of Technology. Before coming to Brown, she held positions at MSRI and the University of Chicago. Her research is in algebraic, geometric and topological combinatorics.

Benoit Pausader is a Professor of Mathematics and Chair of the Mathematics Department (since July 2024) at Brown University and a co-PI on the ICERM grant. Benoit received his Ph.D. from the University of Cergy-Pontoise. He has held appointments at New York University, the Centre National de la Recherche Scientifique in France, and at Princeton. His current position at Brown marks his second appointment to the Brown faculty; from 2008-2011 he was appointed as a Tamarkin Assistant Professor. Benoit studies partial differential equations, especially equations coming from physics such as the nonlinear Schrodinger equation, the Euler-Maxwell system, the Water Wave system. He has been the recipient of two grants from the National Science Foundation, was named a Sloan Research Fellow in Mathematics in 2014 and a Simons Fellow in 2021.

Jill Pipher is the Elisha Benjamin Andrews Professor of Mathematics at Brown University and ICERM's founding Director Emerita. She served as Brown University's Vice President for Research through June 2024. Jill served as Chair of the Mathematics Department 2005-2008. Jill received her Ph.D. from UCLA in 1985 and came to Brown as an Associate Professor in 1990 from the University of Chicago. Her research interests include harmonic analysis, partial differential equations and cryptography. She jointly holds four patents for the NTRU encryption

and digital signature algorithms and was a co-founder of Ntru Cryptosystems, Inc., now named OnBoard Security. Her awards include an NSF Postdoctoral Fellowship, Presidential Young Investigator Award, Mathematical Sciences Research Institute Fellowship, and an Alfred P. Sloan Foundation Fellowship. She served as President of the Association for Women in Mathematics in 2011-2013, was a National Women's History Month 2013 Honoree, and also served as president of the American Mathematical Society from 2019-2020. She was honored to deliver the 2014 ICM lecture, and the 2016 Brown University Presidential Faculty Award lecture. Jill is a Fellow of the American Mathematical Society, a SIAM Fellow, and a member of the American Academy of Arts and Sciences.

Kavita Ramanan is the Roland George Dwight Richardson University Professor of Applied Mathematics at Brown University. She served as Deputy Director of ICERM in 2020. Kavita works on probability theory, stochastic processes and their applications. She has made fundamental contributions to the study of reflected processes, large deviations theory, high-dimensional probability and applications to asymptotic convex geometry. She has also developed novel mathematical frameworks for the analysis of stochastic networks, Markov random fields and interacting particle systems, which arise as models in a variety of fields ranging from operations research and engineering to statistical physics and neuroscience. Her work combines tools from several fields including discrete probability, stochastic analysis and partial differential equations. She also has four patents to her name. Kavita is an elected fellow of multiple societies including the AMS, SIAM and AAAS. She has received several honors for her research. She was awarded the Erlang prize in 2006 for "outstanding contributions to applied probability" by the INFORMS Applied Probability Society, and a Medallion from the Institute of Mathematical Sciences in 2015. She was a recipient of a Simons Fellowship in 2018, a Guggenheim Fellowship in 2020, a Distinguished Alumna Award from IIT Bombay in 2020, the Newton award in 2020 from the Department of Defense for "transformative ideas" during the COVID-19 pandemic, and a Distinguished Research Achievement Award from Brown University in 2021. She was also named a member of the American Academy of Arts and Sciences in 2021.

Bjorn Sandstede is Alumni-Alumnae University Professor of Applied Mathematics. He studied mathematics at the University of Heidelberg and received his PhD in 1993 from the University of Stuttgart. After holding postdoctoral positions at the Weierstrass Institute in Berlin and at Brown University, he was a faculty member at the Ohio State University from 1997-2004, before moving in 2004 to the University of Surrey in England. In 2008, he joined the Division of Applied Mathematics at Brown University. Bjorn received an Alfred P Sloan Research Fellowship in 2000, was awarded the first JD Crawford Prize of the SIAM Activity Group on Dynamical Systems in 2001, received a Royal Society Wolfson Research Merit Award in 2004, the Elsevier Jack Hale Award, and Brown's Philip Bray Award for Teaching Excellence and the Graduate School Faculty Award for Advising and Mentoring. He was selected as a Fellow of the Society for Industrial and Applied Mathematics.

Jenna Sousa, Associate Director of Finance and Administration, hired May 2014: reports to the Director. Jenna has over fifteen years experience in higher education and was in student affairs before coming to ICERM. Oversees program staff and financial staff, providing project

management, logistical oversight, and human resources guidance for ICERM's complex portfolio of research programs and events. She also directs the long-range and day-to-day financial and administrative activities that support ICERM's mathematical programs and 1,000+ international scientific researchers annually, including grant proposal submissions, grant management, and reporting. She works closely with the Directorate, is involved in management planning sessions for the Institute, and serves as the primary financial advisor and administrative risk manager.

Nathaniel Whitaker is a Professor Emeritus at the University of Massachusetts Amherst. As Associate Director of ICERM, he provides supervision and support to current research programs, assists in the development of future events, and is involved in strategic institute planning. From 2018 to 2024, he was chair of the Department of Mathematics and Statistics at UMass Amherst, which he first joined in 1987. He has also held positions as a Visiting Research Professor at L'École Normale Supérieure de Lyon and Interim Dean of the College of Natural Sciences at UMass Amherst. Nathaniel's research primarily focuses on the development of numerical algorithms for applied differential equations using finite difference methods, spectral methods and nonlinear optimization. He is regularly selected as a member of key academic and national mathematics initiatives, including two recent National Science Foundation committees of visitors (in 2017 and 2020) and several steering committees of the AMS and SIAM. Nathaniel has received numerous awards throughout his career for his sustained work on mathematics outreach. In 2024, he was named a SIAM Fellow in recognition of his outreach efforts and notable academic contributions to fluid mechanics and applied mathematics.

Ulrica Wilson is an Assistant Professor of Mathematics at Morehouse College. As ICERM's Associate Director, she provides leadership in meeting institutional goals. She plays a significant role in the development of institute policies and procedures, participation in national meetings and conferences, and partnerships involving government, academia, and the private sector, focusing on ICERM's connections with MSI's, non-R1 institutions, and US-based researchers. Ulrica's primary research has been in noncommutative ring theory and combinatorial matrix theory. Throughout her career, she has integrated opportunities to address inequities in the mathematical workforce. Over a decade of experience includes directing the Enhancing Diversity in Graduate Education EDGE Program and Research Experience for Undergraduate Faculty REUF workshops at AIM and ICERM. Ulrica was recently named as a 2019 AWM Fellow for her work supporting the professional development of women pursuing careers in the mathematical sciences.

Facilities

ICERM is located on the 10th and 11th floors of 121 S. Main Street, in a Brown owned building in downtown Providence, RI. Visitors to ICERM are within a 10-minute walking distance of the Brown campus, the train station, major hotels, and a variety of restaurants and historic sites.

The space includes a 120-seat lecture hall, a 20-seat seminar room, a 20-seat conference room, an administrative suite, office space for 40-45 visitors, two kitchens, and three large collaborative areas.

IT Resources

ICERM's information technology group's mission is to provide the necessary tools for research, collaboration, and information dissemination required by the institute's participants and to support the administrative staff. This is accomplished by providing flexible systems that can be quickly reconfigured to meet research needs and efficient administrative tools that allow the institute's staff to maintain operational excellence. The goal is to provide participants with a wide variety of tools to experiment with and allow them to sample options that may not be otherwise familiar in order to maximize potential avenues for research. ICERM's IT team works with program organizers to tailor technical offerings to support their vision.

Work Stations

ICERM provides virtual desktop systems to all semester program participants using a browser-based noVNC connection to the Center for Computation and Visualization. Most visitors to ICERM bring their own endpoint devices. ICERM supplies monitors, keyboards and mice for each desk. The IT group maintains a small pool of laptops available for participant use on a temporary basis, as well as an array of cables, connectors and adapters.

Applications are distributed based on the needs of the current program and researcher requests. The majority of the applications provided to users will leverage existing Brown license agreements but the IT team supports participant sharing of software developed through our programs.

Web Based Tools

ICERM provides an evolving suite of web-based tools for collaboration and to assist research. ICERM uses Zoom Meeting to facilitate virtual workshops and the software is available for smaller presentations and participant working groups. They also have access to a dedicated Slack workspace for text-based messaging. ICERM offers participants licensed access to Overleaf, a collaborative web based LaTeX editor. Access to Jupyter notebooks and CoCalc are available on request.

All previous talks and papers generated in the course of semester programs are archived and available for download and review via the website.

Multimedia Resources

ICERM has state of the art audio/visual capabilities. The 120-seat lecture hall features dual projection screens, a centrally controlled AV system capable of displaying multiple media types, and a lecture capture system with an auto-tracking camera for recording presentations and streaming to the web. The room is Zoom-capable to facilitate hybrid in-person/remote activities. A smaller meeting room is equipped with a Zoom video conferencing system and includes a digital media projection system. A seminar room on the 10th floor provides multimedia presentation capability and is also Zoom capable. ICERM also has an auxiliary portable AV system to make use of large spaces without integrated AV equipment. Digital signage screens throughout the institute are used to display important information to visitors and can be independently used as a peripheral display from a laptop.

Live Streaming

ICERM provides live, real-time video streaming of Workshop talks, special events, and tutorial sessions given in the lecture hall.

Video Archives

ICERM digitally records semester and Topical Workshop talks and special lectures in High Definition using the Panopto lecture capture system. Presentations are then archived and made available for viewing on ICERM's website along with a PDF copy of the presenter's slides, when available.

Data Collection and Reporting

ICERM has a visitor management system called Cube to collect and report on participant data. It collects demographic, financial, and scheduling data for all ICERM visitors. External-facing features include ICERM's participant application and organizer information systems. ICERM public calendars, webpages, video archives, and publication listings refer to data held in Cube.

ORCID iD

ICERM collects ORCID iDs from NSF-funded participants. The following message is conveyed: *In order for the NSF's Division of Mathematical Sciences to effectively evaluate math institutes, it requires that funded participants provide their Open Researcher and Contributor ID (ORCID) identifier. Only those participants who furnish their ID to ICERM may be supported with award funds.*

Brown Computing Resources

ICERM participants are invited to use other IT resources available at Brown. Chief among these is the high-performance computing cluster hosted by the Center for Computation and Visualization. ICERM provides exploratory access accounts to all long-term participants and to workshop participants on an as needed basis with approval from the Director. Accounts can be upgraded to premium level with access to higher resource limits upon request and with approval from the director.

Participants are also welcome to use the Digital Scholarship Lab at the Rockefeller Library. This room incorporates a high-definition video wall for large-scale visualization and collaboration.

CCV makes other services available to ICERM participants, including access to consultants for code creation and optimization and an immersive display environment.

APPENDICES

Appendix A: Fall 2024 Semester Program and Workshop Participant Lists
Appendix B: Spring 2025 Semester Program and Workshop Participant Lists
Appendix C: 2024-2025 Topical Workshops: Participant Lists
Appendix D: Minutes from Board of Trustees Meeting

Appendix E: Minutes from Scientific Advisory Board Meetings
Appendix F: Minutes from Education Advisory Board Meeting
Appendix G: 2024 MIDs Meeting Minutes
Appendix H: Survey Summaries May 1, 2024-April 30, 2025
Appendix I: Publications since last ICERM report
Appendix J: ICERM Participant Data Report (NSF Required)