Virginia Math Bulletin

Issue 3 Volume 1 June 2016

View from the Chair

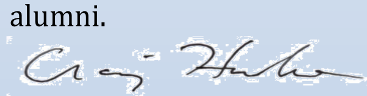
The articles in this newsletter reflect the tremendous activity we had in the department during the academic year. It was an amazing year for us. The year began by welcoming to the department three new faculty: Thomas Koberda, Paul Bourdon, and Aseel Farhat. In the winter and spring we had an extremely active hiring season. As a result, five new faculty will be joining the department in 2016-17. Jennifer Morse comes as a Full Professor in Combinatorics, Julia Bergner as an Associate Professor in Algebraic Topology, and Juraj Foldes (PDEs), Francesco Di Plinio (Harmonic Analysis), and Sara Maloni (Low-Dimensional Geometry) join us as Assistant Professors. We welcome new post doctoral fellows: Axel Saenz-Rodriguez in Probability, and Ramanujan Santharoubane in Topology. We also welcome new staff member Allison Boese.

This year marked the start of anticipated changes in our undergraduate program as well. Our Distinguished Majors Program was reorganized and revitalized into a more robust experience. Under the direction of Paul Bourdon, our new Director of Lower Divisional courses, next year we will be beginning our movement toward smaller and more interactive Calculus classes. Two of our graduate students, Peter Bonventre and Katelynn Kochalski, will be helping to change the way we teach our Math 1310 courses next Spring. Our major program continues to be robust and challenging. This year we had what may be a record of nine of our majors being elected to Phi Beta Kappa.

Work on Kerchof Hall continues. Last summer the front of Kerchof was completely redone, while this summer we have many offices being renovated.

Our faculty sustains its excellence. Leonid Petrov won the Moscow Math Prize, while Ben Webster has been promoted to Associate Professor, won the Cory Family Teaching Award, and was a Kavli Fellow – the only pure mathematician invited to attend the Kavli Symposium at the National Academy of Sciences. Karen Parshall was elected to the important Nominating Committee of the American Mathematical Society and next year puts another hat on, becoming Chair of the History Department.

Please enjoy reading about these successes and changes, as well as other articles on "Citizen Science", on John Berman's experiences helping train the U.S. Olympiad team last summer, about the activities of our Math Club, about our distinguished lecture series in the Institute of Mathematics, and about the activities of our alumni.



Craig Huneke
Marvin Rosenblum Professor of Mathematics

Supporting Us

The Mathematics Department is grateful for the generous support of its alumni and friends. The Department welcomes gifts annually to address its most urgent needs, as well as to the endowment which provides funding in perpetuity. To learn about how you can make a difference by supporting the Mathematics Department, please contact Liz Blaine at lblaine@virginia.edu or (434) 924-6156. To make a gift online, please visit http://giving.virginia.edu/mathematics

Student Awards

Edwin E. Floyd Prize in Mathematics

April 2016

The 2016 Edwin E. Floyd Prize in Mathematics was given to Peter Dillery. The prize is awarded to second- or third-year students who show exceptional promise in mathematics.

E. J. McShane Prize in Mathematics

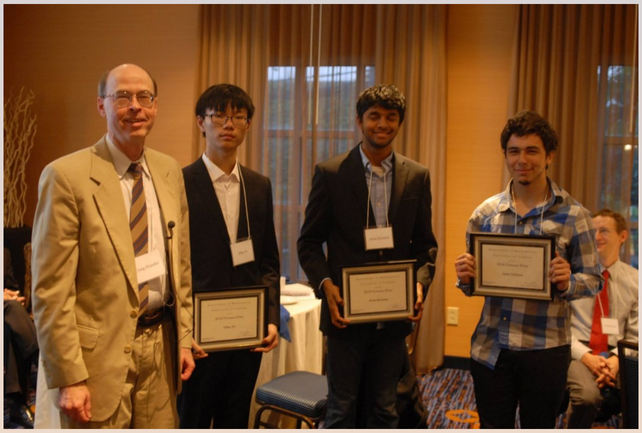
April 2016

The 2016 E. J. McShane Prize in Mathematics was given to Alexander Grieser for his achievements in mathematics.

William Lowell Putnam Mathematical Competition Award

April 2016

The 2016 William Lowell Putnam Mathematical Competition Award was given to Sifan Ye, Juan Velasco, and Arun Kannan for their outstanding scores on the exam. Congratulations!



Nine Majors have been elected into Phi Beta Kappa

Congratulations to:

Peter Dillery, Stephanie Gulley, Ji Won Kim, Honglei Li, Hexuan Liu, Megan Marcellin, Yingze Song, Qi Tang, and Boya Yang!

As the oldest and most distinguished honor society in the country, Phi Beta Kappa offers membership to less than one percent of all undergraduates. Many of the leading figures in American history and culture have begun their careers with election to the society, including seventeen presidents of the United States. As a result, membership is a remarkable accomplishment, both for the student who achieves it and the faculty and staff whose support and guidance has led to this milestone.

Department Transitions

Benjamin Webster

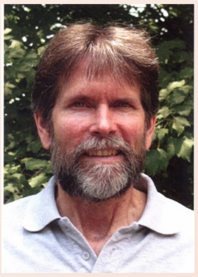
Associate Professor

Ben Webster has been promoted from Assistant to Associate Professor of Mathematics. Ben completed his PhD at UC Berkeley in 2007 under the guidance of Nicolai Reshetikhin. He then held positions at the Institute for Advanced Study, MIT, the University of Oregon, and Northeastern University, before joining the faculty at UVa. He's been awarded an NSF CAREER grant, a Sloan Fellowship, and fellowships to travel to France and Australia, and recently received the Cory Family Teaching Award from UVA (see page 7). Ben's research is on the intersection between geometry, algebra and topology. Each of these fields has profound applications in the others, so geometric intuition can lead to algebraic machinery which constructs topological invariants.

Particular examples of his recent work include constructing homological knot invariants whose Euler characteristics are known polynomial knot invariants, conjectures on the relationship between the representation theory of quantizations of the Higgs and Coulomb branches of certain physical gauge theories and giving new proofs of a conjectured description of the analogues of Kazhdan-Lusztig polynomials for both Cherednik and Lie superalgebras. He co-organized a conference in May 2016 at UVA on related topics, and has previously organized conferences in Paris, Montreal and Boston. Ben has served as a mentor for graduate students in under-represented groups in the UVA Mentoring Institute and for the Association for Women in Mathematics. He also serves on the AMS Committee on Publications and Web Advisory Group, and is a board member of MathOverflow, a successful question-and-answer site for research mathematics.

Paul Bourdon

Director of Lower Division Courses



A mathematician whose published work includes a graduate text on harmonic function theory; a research monograph on cyclic phenomena for composition operators; and articles in Physical Review, the Journal of the American Mathematical Society, and the Journal of Functional Analysis, Paul Bourdon will direct the calculus program and serve as a mentor for the department's graduate-teaching assistants. His research interests include operator theory (especially composition operators acting on spaces of analytic functions), function theory (analytic & harmonic), and quantum-information theory related to superdense coding with partially entangled quantum particles. He has published more than 50 papers and books, and his research has been supported through four grants and two research-opportunity awards from the National Science Foundation. In 2000, Bourdon received the John Smith Award for Distinguished Teaching of Mathematics, conferred by the MD-VA- DC Section of the Mathematical Association of America. Bourdon earned a Ph.D. in mathematics from the University of North Carolina at Chapel Hill (1985) and a bachelor's degree in mathematics and physics from Washington and Lee University (1981). He has held appointments at Michigan State University, W&L, and the University of Tennessee, Knoxville.

Department Transitions

Aseel Farhat

Whyburn Instructor

As a Zorn Postdoctoral Fellow at Indiana University the last three years, Aseel Farhat taught courses on differential equations, calculus, linear algebra, analysis, and graduate partial differential equations. She also worked as a graduate research assistant at the Los Alamos National Laboratory's Center of Nonlinear Studies in 2012 after completing her Ph.D. in mathematics at the University of California, Irvine that year. Farhat's research interests include nonlinear partial differential equations, fluid dynamics, geophysical models of oceans and the atmosphere, dynamical systems, data assimilation algorithms, and harmonic analysis. Her work has been published in the Journal of Mathematical Physics, the Journal of Communications in Mathematical Physics, the Journal of Communications in Information and Systems, the Journal of Communications on Pure and Applied Mathematics, Physica D: Nonlinear Phenomena Journal, and the Journal of Mathematical Fluid Mechanics. Her academic honors include the Connelly Award for Excellence in Research and Teaching (2012) and a Graduate Dean's Dissertation Fellowship (2011) at the University of California, Irvine, as well as the Mousa Nasser Fellowship for Excellent Physics Students (2002-05) at Birzeit University in Palestine. Farhat earned her bachelor's degree in physics at Birzeit (2005), where she also received a master's degree in scientific computing (2007). In addition to her Ph.D., Farhat completed her M.S. in mathematics at UC Irvine.

Thomas Koberda

Assistant Professor

Thomas Koberda was a National Science Foundation Postdoctoral Fellow at Yale University for two years before being awarded a J. Willard Gibbs Assistant Professorship in Yale's Department of Mathematics in 2014. Koberda's research focuses on geometric group theory and low-dimensional topology. In particular, he is interested in mapping class groups of surfaces, in diffeomorphism groups of manifolds, Artin groups, and the topology of hyperplane arrangements.

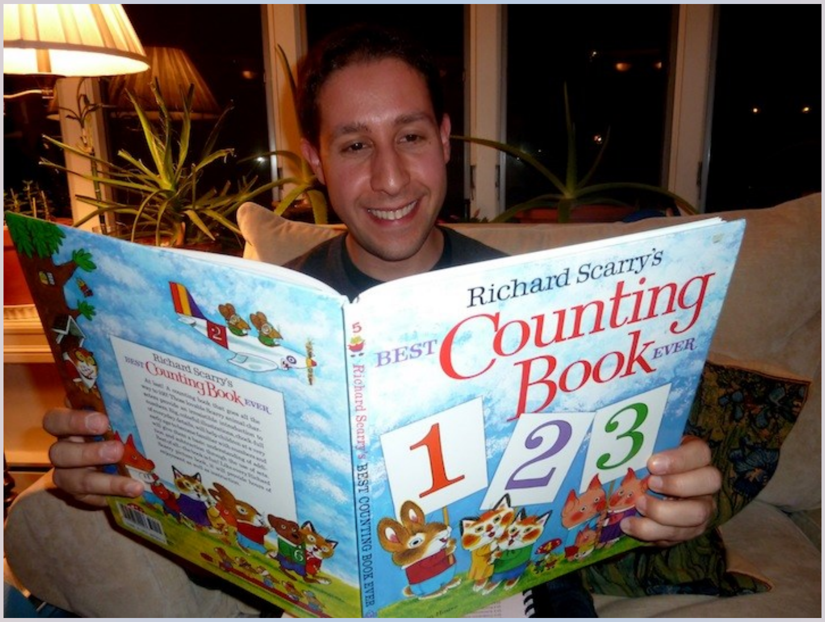
His published works include a paper in *Geometric and Functional Analysis* ("Right-angled Artin groups and a generalized isomorphism problem for finitely generated subgroups of mapping class groups," December 2012) and a joint paper scheduled for publication in Geometry & Topology ("Anti-trees and right-angled Artin subgroups of planar braid groups," co-authored with Sang-hyun Kim).

Koberda received his Ph.D. in mathematics from Harvard University (2012). He also received his master's in mathematics from Harvard (2008) and graduated with honors from the University of Chicago with a B.S. in mathematics.

Math Club

Our active undergraduate math club is organized by Andrew Obus and Leonid Petrov. This year, the club had an array of speakers and other activities. Aside from U.Va. math professors (and one undergraduate --- Bradley Zykoski), speakers came from the University of Chicago (Aaron Silberstein), the University of British Columbia (David Brydges), UCSD (Todd Kemp), JMU (Cassie Williams), and MIT (Alexey Bufetov). The topics ranged from boarding an airplane efficiently (by our very own Leo Petrov), to elliptic curve cryptography (by JMU's Cassie Williams), to what it mathematically means for someone to be the "11th most liberal senator" (by Jon Kropko from the U.Va. Politics department). Students and faculty learned that the standard airplane boarding method is in fact beaten by random boarding, that the difficulty of "dividing by integers" on elliptic curves makes them ideally suited for cryptography, and that "liberalness/conservativeness" in the present-day US can be measured mathematically from voting records with only the slightest preconceived notion of what the terms actually mean!

The math club activities culminated with an "Integration Bee," with questions written by first-year student Benjamin Keigwin in which first-year student Arun Kannan was crowned "Master of Integrals."



Andrew Obus studies number theory

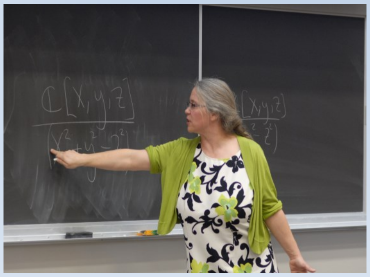
Virginia Mathematics Lecture Series

In 2014, the IMS established the Distinguished Lecture Series ``Virginia Mathematics Lectures.'' This year, Ian Agol (UC Berkeley), and – most recently – Karen Smith (University of Michigan) presented the lectures. These lectures were given to an enthusiastic audience which included undergraduate and graduate students, faculty members, and guests from other departments and institutions.

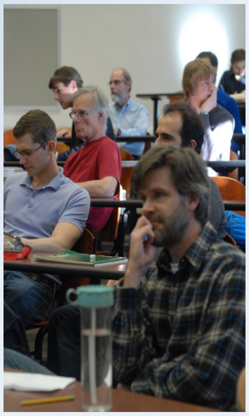
Spotlight: Ian Agol

In October 2015 Ian Agol (Professor of Mathematics at the University of California - Berkeley and Visiting Distinguished Professor at the Institute for Advanced Study in Princeton) gave a series of three lectures, the Virginia Mathematics Lectures, on his proof of the famous Virtual Haken Conjecture. This conjecture was formulated by William Thurston in 1982, and its resolution is a remarkable culmination of work by many mathematicians in the subject of 3-dimensional topology. The goal of 3-dimensional topology is to classify 3-dimensional shapes, rigorously mathematically defined as "manifolds". Agol's theorem states that every 3-dimensional manifold M has a "finite cover" (a mathematical notion which means a new manifold made from M by unraveling a certain collection of loops) contains an essential surface without self-intersections. The reason (explained by German mathematician Wolfgang Haken in the 1960s) why this is important is that such surfaces may be used to cut the three-dimensional shape into smaller pieces which are easier to study. For his work on this conjecture Agol was awarded the 2013 Veblen Prize of the American Mathematical Society and the 2016 Breakthrough Prize in Mathematics. These lectures were accompanied by a workshop on geometric group theory.

Spotlight: Karen Smith



Karen Smith is the Keeler Professor of Mathematics at the University of Michigan. She gave three lectures on the uses of characteristic p methods in algebraic geometry, specifically on the classification of singularity types using numerical invariants coming from reduction to characteristic p. This method involves studying the singularities of algebraic varieties over the complex numbers by representing the varieties as the set of zeroes of polynomial equations, reducing the coefficients of these equations modulo prime numbers p in a suitable sense, then studying their sets of solutions over finite fields as one varies the primes p. The Frobenius homomorphism taking elements to their pth powers plays a fundamental role. Smith introduced the concept of Frobenius splittings and showed how it influences the study of singularities and can be used to study cluster algebras.



Faculty Awards and Honors

Leonid Petrov Discusses his Series of Works, *Combinatorics of Branching Graphs and Probabilistic Models*, for which he Won the 2015 Moscow Math Society Prize

In several past decades, Probability Theory has been widely successful in analyzing complicated random systems modeling numerous real-world phenomena, from spectra of heavy nuclei to shapes of melted crystals and growing bacteria colonies. A significant part of these developments is made possible by applications in a probabilistic context of ideas and methods from more abstract areas of Mathematics, such as Representation Theory or Algebraic Combinatorics. Applying these ideas, I am exploring a rich zoo of complicated random systems by means of concise exact distribution formulas. These formulas allow to approach asymptotics of these special random systems (as time or size of the system goes to infinity).
A historically first example of applying exact formulas to study randomness is the De Moivre-Laplace theorem from the 1700s, which states that the coin-tossing frequencies can be approximated using the famous bell-shaped curve (the normal, or Gaussian, distribution). More than 100 years later, this exact computation was followed by the general Central Limit Theorem allowing to use normal approximations in much more general situations. In the recent 10 years, a similar program was completed (by two groups led by Terence Tao and Horng-Tzer Yau) for distributions of spectra of random matrices. Here one starts from exact computations in the Gaussian case, and then expands the asymptotic results to general distributions of entries of the matrices. Systems I am interested in are similar to random matrix models, but are discrete, which leads to even stronger ties to algebraic structures. Despite the specialty of the approach using exact formulas, above examples provide hope that the asymptotic behavior observed via exact computations should be universal, i.e., it should also occur in large classes of "similarly looking" random systems which do not necessarily admit exact formulas.

Benjamin Webster Receives Cory Family Teaching Award

Congratulations to Associate Professor Benjamin Webster. He was named as one of two recipients of

this year's prestigious Cory Family Teaching Award, and joins David Sherman (2013) among the award recipients from the Mathematics department. The Cory Family Teaching Awards are designed to reward and incentivize excellence in teaching among junior faculty. Since 2013 and continuing through 2017, two junior faculty members are chosen as recipients and honored at Fall Convocation. Each recipient is awarded $25,000 thanks to the generosity of Mr. and Mrs. Charles R. Cory. Well done, Ben!

Graduate Experiences

John Berman Discusses Coaching the Team that Won the International Mathematical Olympiad

I first got involved in math competitions in 7th grade. I was at a small middle school of 50 students, and my math teacher encouraged me to come to MATHCOUNTS meetings. At the regional competition that spring, I surprised myself by winning 1st place. I realize now that I came from a small region of Eastern North Carolina, and certainly would not have done so well even in Raleigh or Charlotte, but at the time I was extremely excited by this performance. I assumed it meant I could get in the top 10 at the state level competition. When the state competition came around, I got 44th place. What I took out of the back-to-back success and disappointment was an enthusiasm for math competitions and a drive to improve. The next year, I got 2nd place in the North Carolina state competition, and by the summer after 12th grade, I was traveling to Germany to compete in the International Math Olympiad (IMO) as one of a six-person team from the US.

John Berman (right) with the IMO team

I have been closely involved in the IMO training ever since then, returning to the IMO as an observer in 2013 (Colombia) and 2014 (South Africa). This year, the IMO was in Thailand, and for the first time, I was able to go as Deputy Leader, the second-in-command of the US team. This also involved helping the team leader, who is a math professor at Carnegie Mellon University, to run a month-long training program in Pittsburgh. At the training program, there are about 50 students, taught by a collection of graders and instructors who have been through the program before. The top 6 students then attend the IMO. At the IMO, about 500 students from 100 different countries compete to solve 6 very difficult problems in 9 hours.

Technically, the problems require no background beyond high school mathematics, but in practice, competitors train for years before they can solve even one problem. This year, the US surpassed expectations by coming in 1st place for the first time since 1994, beating out China and South and North Korea. Most importantly, everyone had a great time and made new international friends.

I have enjoyed being a part of so many diverse mathematical communities, from Charlottesville and North Carolina to MIT and the international level. Here in Charlottesville, I try to give back to the community in the ways that meant the most to me as a student. Last year, I worked with local middle and high school math clubs and math teams, and I volunteered at the regional MATHCOUNTS competition, the same competition where I got started back in middle school. I have also been involved with Tai Melcher in outreach to middle school classrooms. This year, I will be helping to run the Putnam training for UVA undergraduates. The Putnam is the premiere college-level math competition in the US. In short, I'm looking forward to an exciting year for the UVA and Charlottesville-area math community!

For an example of one of the problems, see our Problem Corner (page 13).

Recent PhDs

Scott Alexander Atkinson
[Advisor: David Sherman]
Convex Sets Associated to C-Algebras*

Gonzalo Bley Delgado
[Advisor: Lawrence Thomas]
Estimates on Functional Integrals of Non-Relativistic Quantum Field Theory, with Applications to the Nelson and Polaron Models

Alessandro De Stefani [Advisor: Craig Huneke]
Homological Methods, Singularities, and Numerical Invariants

Daniel E. Franz [Advisor: Mikhail Ershov]
Quantifying the Residual Finiteness of Linear Groups

Stephen R. Hardy [Advisor: David Sherman]
Pseudocompact C-Algebras*

Hankyung Ko
[Advisor: Brian Parshall] (*Sum 16*)
Representations of quantum groups at roots of unity and their reductions mod p to algebraic group representations

Chun Ju Lai [Advisor: Weiqiang Wang]
Affine Quantum Symmetric Pairs: Multiplication Formulas and Canonical Bases

Bryce A. Terwilliger
[Advisor: H. Christian Gromoll]
Tandem Queues with Identical Service Times in Heavy Traffic

Joshua Schwartz
[Advisor: Andrei Rapinchuk] *(Sum 15)*
Weekly Commensurable Zariski-Dense Subgroups of Algebraic Groups Defined Over Fields of Positive Characteristic

Alumni Activities

Turbulence Games

Turbulence—both `bad' and `good'—is omnipresent in the world surrounding us. On one hand, understanding the genesis and dynamics of a turbulent wake behind a large plane is key in maintaining safety of the airspace in the proximity of an airport. On the other hand, turbulent mixing may be desirable, an example being designing more efficient drug delivery systems.

Various *coherent vortex structures* are observed at *all scales*, from spiral galaxies to solar wind phenomena to hurricanes and tornadoes to tea leaves spiraling in a cup to quantized vortex motion in Helium II.

Some of the more famous artistic renditions of the vortex phenomena include Leonardo da Vinci's drawings of eddy motion in the study for the elimination of rapids in the river Arno, a woodblock print *The Great Wave off Kanagawa* by Katsushika Hokusai and a painting of *Starry Night* by Vincent van Gogh.

On the scientific side, large-scale computational simulations of turbulent flows confirm that the regions of intense fluid activity organize in coherent vortex structures. Developing a *rigorous theory* of turbulence consistent with the experiments, computational simulations and the phenomenology, and identifying the role that the *geometry of the flow* plays in the theory of *turbulent cascades* and *turbulent dissipation* in 3D incompressible, viscous fluid flows, modeled by the 3D Navier-Stokes (NS) equations, has been a grand challenge in the mathematical fluids community since the foundational works of Kolmogorov, Onsager and Taylor in the 1930s-1950s period. Richard Feynman described turbulence as "the most important unsolved problem of classical physics."

The seed for the *Turbulence Games* was planted in Fall 2014 and Spring 2015 when then undergraduate Janet Rafner took two semesters of MATH 4993, Independent Study, with math professor Zoran Grujic.

After completing her study, Rafner was eager to test her design talents and scientific visualization skills, catalyzed while she was on a summer internship with the French research team Le Physique Autrement (Physics Reimagined), lead by Julien Bobroff, within the realm of turbulent flows. In a summer 2015 REU-type project, under the guidance of Grujic, she produced a storyboard for scientific visualization of the two fundamental ways in which the coherent vortex structures emerge in turbulent flows: a flow past an obstacle and vortex shedding off the boundary. This was done with an eye on producing detailed visualizations using *Maya* animation software, and with the end-goal of bringing the secret life of turbulent entities closer to the public.

In the fall of 2015, Rafner carried the project over the Atlantic to Denmark, as a part of her Fulbright Fellowship research in collaboration with Rikke Schmidt Kjaergaard, the head of iNANO Visualization Lab at Aarhus University. An immersion in the science and art & design communities of Aarhus and Copenhagen, and keeping in touch with Grujic, recently sparked the project *Gamification of turbulent flow*, A.K.A. the Turbulence Games.

This project is best viewed as a part of a greater movement for *citizen science*-based research and will be in conjunction with the Niels Bohr Institute (NBI) and ScienceAtHome, a large-scale crowdsourcing project based in Aarhus University. ScienceAtHome transforms open science problems into games and invites citizens of all possible backgrounds to play them. People worldwide spend *three billion hours a week* playing games. By turning science into games, researchers can tap into that resource; the gameplay ultimately translates into scientific data, shining a new light on the problem in view.

Turbulence Games are based on the recent mathematical work by Grujic and collaborators on the interplay between the mechanisms of *vortex stretching* and *locally anisotropic diffusion* as the main physical cause of the phenomenon of turbulent dissipation. Incidentally, this approach also provides a new avenue to better and *more geometric* understanding of the problem of possible formation of singularities in the 3D NS model (one of the *Millennium Prize Problems*).

A key facet in this novel theory is the scale of *local linear sparseness* (LLS) of the *regions of intense vorticity* (RIV), and it would be very useful to have solid computational results revealing the value(s) (in an appropriate average sense, as anything in turbulence) of its *scaling exponents*. Within the realm of the state-of-the-art of the computational fluid dynamics, simulating the RIV is feasible; unfortunately, a purely algorithmic identification of the scaling exponents of LLS does not seem to be.

The great wave off Kanagawa by Hokusai

The computational barrier and human's innate abilities in pattern recognition is why the Aarhus-NBI-UVA research team proposed a *gamification approach* to the problem, based on visualization of the RIV via Maya animation software, within Unity development platform. The game will utilize the data imported from the computational simulation of the RIV to be performed by the NBI group for modeling of complex phenomena, simulating a fully developed 3D NS turbulent flow on a periodic box with the Reynolds number of the order of 1000. (This would provide much higher resolution and accuracy compared to the output that would have been generated using the NS solver already incorporated in Maya.)

The main point of this approach is to *replace* the purely algorithmic identification of the scale of LLS of the RIV with gathering the same information via the gameplay. Essentially, a player would traverse scenes of the 'turbulent world', each scene representing a visualization of an RIV, and identify the scaling exponents of LLS in process.

This seems to be well within the capabilities of the Unity 3D game engine, as the main data set would be essentially static (the data imported from the computational simulation of the RIV), and writing a dynamic script for verification of the correct choice of the scale with the real-time feedback should be feasible. The purpose of the initial levels (I - III) of the game would be to test and train players in identifying relevant scales in the context of the progressively more and more complex geometry (this part is also of interest to cognitive scientists studying the processes behind the reaction time and accuracy of a player when confronted with this type of spatiotemporal challenges). Players completing Level III will gain access to Level IV, offering high resolution RIV scenes, where hard scientific data will be collected from every gameplay. The Level I is currently being developed by a game designer from the Aarhus group.

Janet Rafner is a US Fulbright Fellow and visiting researcher at the Niels Bohr Institute, University of Copenhagen and at ScienceAtHome, a large-scale crowdsourcing project based at Aarhus University. She graduated in spring of 2015 from the University of Virginia and holds degrees in Physics and Studio Art. While at UVA Rafner was an officer for both the Society of Physics Students and Sigma Pi Sigma, the physics honor society. Her current work bridges domains of physics, mathematics, design, science communication, simulation modeling, ‘gamification,’ didactics, and science, technology, and society (STS).

At ScienceAtHome Rafner works on all things design related, co-maintains the ScienceAtHome website, and is currently developing physics visualizations. At the Niels Bohr Institute, Rafner, along with a fluid flow simulation group, is collaborating with UVA math professor Zoran Grujic on a project to create an innovative, computationally intensive video game to engage the public in the efforts of the mathematical fluids community to solve one of the Millennium Prize Problems: whether a singularity can form in a turbulent flow. Rafner has also curated ‘physics + design’ exhibitions at the Science Museum of Virginia and at the Niels Bohr Institute for Copenhagen’s Culture Night. She intends to pursue a career that integrates the arts and the sciences while continuing to find new ways to reimagine physics.

Janet Rafner

Spotlight on Alumni

The Math Majors dinner this Spring featured Dr. Berrien Moore as our guest speaker. Dr. Moore received his PhD from UVa under Marvin Rosenblum. He returned to talk about his journey from a PhD in mathematics to his current position at the University of Oklahoma as the Chesapeake Energy Corporation Chair in Climate Studies, Dean of the College of Atmospheric and Geographic Sciences, Director of the National Weather Center, and Vice President for Weather and Climate Programs. He spoke about the creation and dispersion of $CO2$ in the atmosphere and oceans. Dr. Moore joined the University of New Hampshire in 1969 and stayed there until 2008. Visits to the Woods Hole Oceanographic Institute played an important role in his transition from pure mathematician to his current interests in climate. He has published extensively on the global carbon cycle, biogeochemistry, remote sensing, environmental and space policy, and mathematics.

The Problem Corner

1. Given nine lattice points in three-space (that is, nine points with integer coefficients), prove that there is an interior lattice point (which does not have to be one of the nine) on at least one segment joining a pair of them.

2. (IMO, 2015) Determine all triples (a,b,c) of positive integers such that each of the numbers ab-c, bc-a, and ca-b is a power of 2 ($1 = 2^0$ is allowed).

3. (From MSRI) Two prisoners, A and B, know ahead of time of the task they will be asked to do, and develop a 100% strategy for succeeding. They cannot communicate in any way once the task has begun. What happens is the following. A enters a room in which the 52 cards of an ordinary deck are face up in a line on a table. A is allowed to take two of the cards and interchange them. A then leaves, and the warden turns the cards face down without disturbing their positions in the line. B enters the room. The warden announces a card selected at random. The task B must perform is turn the cards up one at a time (B can decide which card to turn up at any given point on the basis of what B has already seen). If the card is among the first 26 that B turns up, both prisoners go free. What is the strategy?

What are you Doing?

We'd like to hear from you!

You may complete the form below and return it to us:
Form [ctrl+click]: http://pi.math.virginia.edu/questionnaire.pdf
Facebook:[Ctrl+click].https://www.facebook.com/UVAMath

FAX: 434-982-3084
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