

For New SIAM President, The I's Have It

As green energy technologies mature and cloud computing transforms our digital world, and as new materials upend our manufacturing and healthcare industries, SIAM finds itself at an unprecedented crossroads. We have the unique opportunity, as the world's foremost organization for applied mathematics and computational science, to lead in cutting-edge interdisciplinary research and, working with industry, in the development and use of innovative technologies. By acting as a principal facilitator in bridging academia—where fundamental and applied research thrives—and industry—where real-world applications flourish—SIAM can do its part to respond to key challenges now facing society.

While SIAM's central activities remain healthy and strong, I believe we need to reenergize and reinforce our efforts with what I call the two I's of SIAM: Partnering with *industry* and deepening our *international* (and particularly student) network. During SIAM past president Nick Trefethen's term, the SIAM Industry Committee was revitalized, a clear signal of where we are headed. Though this undertaking remains in the early stages—after all, SIAM's 14,000

members include just six from Google and none from Apple—increasing ties with successful, real-world practitioners must be a critical part of the SIAM mission. This will not only help disseminate the meaningful research conducted by our members, and supported by our excellent journals, books, and conferences, but will also encourage more flow-through between academia and industry. Such constant conversation between the two is essential, particularly in informing and driving future applied research.

On the international front, we can look to Nick Trefethen, a fellow at Balliol College at Oxford University, for inspiration. Under his tenure, SIAM added the 100th student chapter to its worldwide collection. SIAM remains the only truly international society for industrial and applied mathematics and computational science. But geographic (and, yes, disciplinary) barriers persist, demanding to be torn down. SIAM must continue its efforts to better connect the world's leading mathematicians, computational scientists, statisticians, and other STEM researchers, while also striving to attract new scientists from the next generation; we can do this in part by increasing the number and visibility of SIAM student chapters throughout the world. With just five chapters in fast-growing Asia, one in

FROM THE SIAM PRESIDENT

By Irene Fonseca



Model next-generation international community-builders: Members of the Heidelberg Student Chapter of SIAM joined with students from the Hanoi University of Science and Technology to organize the workshop Model-based Parameter Estimation & Optimum Experimental Design, held in Hanoi in March 2012. Shown here are participating students (from left) Nguyen Phuong Anh, Nguyen Quang Thuan, Holger Diedam, Kathrin Hatz, and Dennis Janka.

the Middle East, and two in Latin America, the potential for growth in this area is staggering. This is also true for the general SIAM membership, in Asia and China in particular, where former president Doug Arnold made an important push in 2009.

Lastly, I pledge to continue Nick Trefethen's vital effort to streamline SIAM's world-class journals, especially the time it takes to assess and revise manuscripts. SIAM publications are crucial to our global reach and our members' scholarship.

Growing SIAM's industrial and inter-

national partnerships and presence will take some time, to be sure, but this is an opportunity we do not want to miss. We can look to the European Commission's ambitious Europe 2020 growth agenda, which also calls for tackling tough challenges through excellence in research, innovations in industry, and the nurturing of a new generation of minds. What I propose for SIAM over the next two years is no less ambitious, but just as necessary to prepare us for the exciting future that awaits our discipline and SIAM.



New SIAM president Irene Fonseca sees the five SIAM student chapters in Asia as an inspiration for the creation of many others. Shown here, members of the Chinese Academy of Sciences SIAM Student Chapter, including Zaikun Zhang (left), the group's first president, met in 2011 with then SIAM president Nick Trefethen.



In May 2012, the Rochester Institute of Technology SIAM Student Chapter presented an exhibit at the ImagineRIT innovation fair. The three-part exhibit included a segment on mechanical strategies for Quoridor, a segment on basic ideas and terminology of game theory, and a flow chart about the choices open to two warring factions as their conflict evolved. Pictured are (from left) Bryan Ek, Manuel Lopez (faculty adviser), Erin Crossen, Justin Pearson, Charlene DiMeglio, Lauren Kelley, and Evan Witz.

Adaptive Inexact Newton Methods: A Posteriori Error Control and Speedup of Calculations

By Alexandre Ern and Martin Vohralík

Systems of nonlinear algebraic equations arise in numerous applications of scientific computing. Iterative linearizations, with the Newton method as a prominent example (see, for example, [5]), are extensively used for the approximate solution of such systems. At each step of an *exact Newton method*, a system of linear algebraic equations needs to be solved. To alleviate the computational burden, the solution of this linear system can be approximated, typically by employing some early stopping criterion within an iterative linear algebraic solver. This is the essence of the so-called *inexact Newton method*. A crucial question is when the linear algebraic solver should be stopped. Is it possible to speed up the calculation with a suitably chosen algebraic stopping criterion? Answers via a priori limit theory have been suggested (see [1] and the references therein).

The situation becomes more intricate when the system of nonlinear algebraic equations results from the discretization of

some nonlinear partial differential equation. In this context, three sources of error are inevitable: *algebraic error*, linked to the linear algebraic solver, *linearization error*, linked to the linearization iteration, and *discretization error*. It is then natural to envisage an early stopping criterion for the Newton iteration itself. Intuitively, converging the iterative linear and nonlinear solvers to machine precision does not seem to be necessary. Devising stopping criteria for both solvers so as to balance the three error components is not straightforward and, to our knowledge, such criteria have relied to date essentially on heuristics.

In [3], following [2, 4], we identified and estimated separately the three error components via the theory of a posteriori error estimates for nonlinear diffusion PDEs. Within this theory, we have used equilibrated flux reconstructions, originating in the pioneering work of Prager and Synge [6]. The twofold advantage of this approach is to deliver guaranteed, fully computable error estimates, a key issue for the conception of practical stopping criteria, and to allow for

a unified theory encompassing most discretization schemes. We then devised and analyzed stopping criteria stipulating that there is no need to continue with the algebraic solver iterations once the linearization or discretization error components start to dominate, and no need to continue with the linearization iterations once the discretization error component starts to dominate. We call the resulting algorithm an *adaptive inexact Newton method*.

To illustrate the idea, we consider the following nonlinear diffusion PDE: Find $u : \Omega \rightarrow \mathbb{R}$ such that

$$\begin{aligned} \nabla \cdot \sigma(u, \nabla u) &= f & \text{in } \Omega, & \quad (1a) \\ u &= 0 & \text{on } \partial\Omega, & \quad (1b) \end{aligned}$$

where $\Omega \subset \mathbb{R}^d$, $d \geq 2$, is a polygonal (polyhedral) domain (an open, bounded, and connected set), $f : \Omega \rightarrow \mathbb{R}$ a given source term, and $\sigma : \mathbb{R} \times \mathbb{R}^d \rightarrow \mathbb{R}^d$ the nonlinear flux function. We let $u_h^{k,i}$ be a numerical approximation of u obtained on a computational mesh of Ω , at the linearization step k and

See *Inexact Newton* on page 4

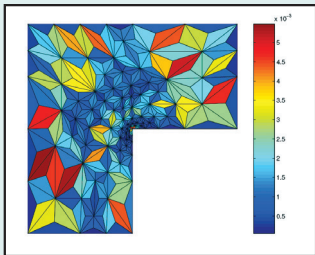
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1 For New SIAM President, The I's Have It



1 Adaptive Inexact Newton Methods: A Posteriori Error Control and Speedup of Calculations



4 Math, Sustainability, and Planet Earth



5 The (Admittedly Beautiful) Conservation Laws of Financial Economics

Economist Robert Shiller “chides his professional colleagues for being too easily seduced by (perceived) beauty, and insists that truth need not always be beautiful,” reviewer James Case writes. In particular, “conservation laws of financial economics are only as valid as their underlying assumptions, and their relevance to the real world remains debatable.”

8 Well Served by Service

Returning Careers columnist David Keyes finds enrichment and deep satisfaction in professional service. On review panels: “Few events past a thesis defense occasion the free-wheeling, wide-ranging discussion of fresh ideas among experts who are committed to the importance of the occasion. Few better illustrate the superiority of the whole to the sum of its parts.”

7 Professional Opportunities

MacArthur Fellow Excels at Connecting the Seemingly Unrelated

Among the 23 new fellows named by the MacArthur Foundation in 2012 is Daniel Spielman of Yale University. In the article that follows, Shanghua Teng of the University of Southern California draws on his longtime collaboration with Spielman to give readers of SIAM News a glimpse of some of the problems Spielman has taken on to date in his widely ranging, highly interdisciplinary work in the theory of computing.

The 2012 group included a second SIAM member—Maria Chudnovsky of Columbia University, who has joint appointments in the Departments of Industrial Engineering and Operations Research and Mathematics and works in graph theory and combinatorial optimization. A focus of her research, according to the MacArthur citation, is on a deepening of “the connections between graph theory and other major branches of mathematics, such as linear programming, geometry, and complexity theory.”

MacArthur fellows, who receive no-strings \$500,000 awards, are selected on the basis of “extraordinary originality and dedication in their creative pursuits,” along with “a marked capacity for self-direction.”

Dan Spielman is a visionary and a pioneer. A prescient scholar, he has built an exceptional record in discovering fundamental research topics and areas, as well as ways to answer outstanding questions that have challenged researchers for years. He is a gifted problem solver, resourceful in making conjectures that set up promising leads. He is also a fabulous mathematical writer and educator, and his talent for making complicated concepts simple has helped give a general audience an appreciation for our field.

Unexpected Connections

Dan’s work has fundamentally transformed nearly all aspects of the theory of computing—from communication to optimization, from complexity theory to algorithm design and analysis, from graph algorithms to numerical methods. In fact, many of his landmark achievements resulted from his extraordinary ability to connect seemingly unrelated disciplines, and therefore have simultaneously advanced multiple areas of computing.

As a PhD student in the MIT mathematics department, for example, Dan began to use techniques from coding theory in designing the nearly linear-size holographic proofs sought by researchers in complexity theory. But in an amazing turn of events, he not only successfully applied coding theory to complexity theory, he also discovered a breakthrough algorithm, using concepts from theoretical computer science and discrete mathematics, such as expanders and superconcentrators; this work fundamentally elevated the state of the art in coding theory. His papers “Expander Codes” (with

Mike Sipser) and “Linear-Time Encodable and Decodable Error-Correction Codes” have initiated a new generation of error-correction codes, such as erasure correction codes, that are more suitable than classic codes for modern Internet applications. For a subsequent work, “Improved Low-Density Parity-Check Codes Using Irregular Graphs,” he and co-authors Michael Luby, Michael Mitzenmacher, and Amin Shokrollahi received the 2002 Information Theory Society Paper Award. This family of codes has been used in the Digital Video Broadcasting Standard.

Since 1995, when he completed his PhD thesis—which won the ACM best Doctoral Dissertation Award for contributions in complexity and information theory—Dan has gradually shifted his focus to algorithm design and analysis. I have been very fortunate to be one of his collaborators in this exciting journey. Significant accomplishments along the way include smoothed analysis, a Laplacian solver, and maximum flow approximation; the majority are thoughtfully covered in the four articles listed at the end of this article.

Expanding on those essays in the rest of this article, I focus on a piece of Dan’s earlier work and the critical role it played in his 15-year effort to close the gap between theory and practice in algorithm design and analysis.

A Bridge Between Numerical and Combinatorial Thinking

Back in 1995, Dan was drawn to work of Fielder that established a connection between the connectivity of a graph and the second-smallest eigenvalue of its Laplacian matrix, and to work of Donath and Hoffman that used eigenvectors for partitioning graphs. At the time, spectral graph partitioning was widely popular; it was used in scientific computing, and was demonstrated experimentally to work extremely well in a wide range of applications, including image segmentation, VLSI design, sparse matrix computation, combinatorial optimization, and parallel processing. However, the quality of the partition that the spectral methods should produce on graphs from these important applications had eluded more rigorous analysis.

Intrigued by this algorithm at the intersection of graph theory and matrix theory, Dan dedicated himself to the development of “numerical thinking” for graph-theoretical problems and “combinatorial thinking” for numerical problems. Indeed, he was fascinated by this algorithm: It was an elegant method based on linear algebra and physical intuitions; it used a continuous method to solve a discrete problem; and it was a suc-

cessful practical heuristic whose theoretical performance analysis was still lacking.

Applying differential geometry and Brouwer’s fixed point theorem, Dan’s work established a novel connection between graph eigenvalues and graph embedding in Euclidean space. This connection proved a spectral theorem for planar graphs that, together with the famous discrete Cheeger’s inequality, showed that spectral methods can be used to find partitions as good as those that can be achieved with the classic Lipton–Tarjan planar separator theorem. It also proved a similar statement for finite-element meshes, thus providing the first mathematical analysis of the amazing practical performance of spectral partitioning methods in domains that include scientific computing, image processing, and VLSI design.

Like many creative thinkers, Dan celebrates his major breakthroughs as the beginning of new research paths, rather than as the end of the pursuits. His work has not only provided the avidly sought answer to the question of why the spectral partitioning method works for planar-like graphs and finite-element meshes, but has also been a launch pad for him. This research instigated a long trek that achieved three landmark results connecting numerical thinking and combinatorial thinking:

- smoothed analysis of algorithms and its application to the simplex algorithm for linear programming and Gaussian elimination for linear systems;
- spectral graph sparsification and a nearly linear-time algorithm for solving Laplacian and symmetric diagonally dominant linear systems; and
- the electrical flow framework for maximum flow approximation.

Each of these results built on Dan’s insightful observations, his perseverance, and his foresight in mapping the direction of the explorations. He is never willing to let opportunities, however small, pass by without understanding what they could inspire. As an example, intrigued by the classic Steinitz connection between three-connected planar graphs and the convex polytopes in three dimensions, he painstakingly advanced the aforementioned research in spectral analysis of planar graphs in several directions—to the mathematical study of high-dimensional polytopes and the smoothed analysis of the performance of the simplex algorithm for linear programming, to the development of spectral sparsification and the Laplacian solver, and then to an electrical-flow-based algorithm for approximating the maximum flow in a graph. The essays listed below highlight these accomplishments.

Congratulations to Dan! We look forward to watching as his lively mind, uncanny talent in selecting research directions, ability to break interdisciplinary barriers, and courage to work on challenging problems lead him to the next big thing.

For Further Reading

- “The Work of Daniel A. Spielman,” by Gil Kalai (<http://www.icm2010.in/wp-content/icmfiles/laudaions/nevanlinna.pdf>).
- “The Mathematical Work of Daniel Spielman,” by Michel X. Goemans and Jonathan A. Kelner (<http://www.ams.org/notices/201109/rtx110901288p.pdf>).
- “The Simplex Solutions,” by Megan Vandre (<http://www.technologyreview.com/news/401951/the-simplex-solution/>).
- “The Network Solutions,” by Erica Klarreich (<http://simonsfoundation.org/features/feature-articles/mathematics-and-physical-science/network-solutions/>).



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What Does SIAM Offer its Industrial Members?

By Thomas Grandine

Most SIAM members are aware of the published benefits of individual membership in SIAM: subscriptions to *SIAM News* and *Review*, discounts on books, journals, and conferences, and opportunities for networking and enhanced visibility in the applied mathematics and computational sciences community. Through these publications and activities, SIAM membership provides access to cutting-edge research. Membership also confers eligibility to vote in SIAM elections.

In thinking about my more than 30 years of SIAM membership, I realize that I've taken advantage of several additional benefits not usually included in the standard list. Perhaps the most important is the role that SIAM can play as a conduit for mathematical technology. SIAM fosters personal connections between its members that enable them to form important symbiotic relationships. In the most successful cases, industrial members of SIAM are able not only to access important

research, but also to form bi-directional pipelines through which that technology can be pumped directly into their companies—in the form of usable software, computational aids, and test suites. Through the same pipeline, the industrial partners can return new applications and problem formula-

tions, along with data on algorithmic performance, computational bottlenecks, and domain of applicability, to their academic counterparts. This feedback influences research directions, ensuring that the pump is primed for subsequent infusions of new technology. In the best cases, the pipeline plays a prominent role in the preparation of academic grant proposals that grow from industrial partnerships.

These symbiotic relationships lead to another important advantage for SIAM members within their own companies. Because technical employees are often trained not as mathematicians, but as engineers and scientists in other disciplines, they tend to participate in activities of technical societies other than SIAM. For example, The Boeing Company sends hundreds of employees to the annual American Institute of Aeronautics and Astronautics conference, but typically only one or two to the SIAM Annual Meeting. This relative vacuum creates a golden opportunity for motivated employees who do attend SIAM meetings to differentiate and promote their skills within their own organizations, equipping themselves with unique abilities and professional connections that are useful to their companies. In other words, SIAM helps create an environment rich with opportunities for significant career development and success.

Employees who successfully differentiate their own mathematical skills within their companies can offer the companies, in turn, a means for differentiating their products and services within the marketplace—thereby leveraging the benefits at a still higher level. One example of this is the introduction of Gorilla Glass* by

*<http://www.engadget.com/2012/10/24/coming-touts-1-billion-gorilla-glass-devices/>.

Coming years earlier than would have been possible otherwise, mathematical modeling having permitted the elimination of much of the usual start-up experimentation. Gorilla Glass, moreover, is only one of the mathematically leveraged high-tech components of the modern marvel that is the cell phone.

SIAM membership offers its industrial members a sounding board for technical ideas. Over a period of decades, I have applied an industrialized version of a metric used by Nick Trefethen to assess the value of conferences; in the ideal case, he wrote in *SIAM News* (July/August 2011), the idea for a new paper would emerge from every conference he attended. For a very long time, I have used a similar metric, keeping track of good ideas from conferences that can be brought to bear on problems at Boeing. I do not recall attending a single SIAM conference that did not generate at least one such idea, and many have produced several. Because these ideas can have such a significant impact on Boeing's products and services, a single idea usually justifies

For a very long time, I have been keeping track of good ideas from conferences that can be brought to bear on problems at Boeing. . . . Because these ideas can have such a significant impact on Boeing's products and services, a single idea usually justifies the time and expense of an entire week at a conference.

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One important resource that industrial mathematicians do not have access to is graduate students. By building bridges between industrial mathematicians and graduate programs in important areas, SIAM facilitates access of this type. As a graduate student in 1985, I met Dave Ferguson, a Boeing employee, at a SIAM conference in Albany. Our casual conversation eventually turned into a job application and interview, and I joined Boeing less than a year later. That relationship, fostered by SIAM through informal conference activities, shaped my career in profound ways.

Beyond their value as potential new employees, graduate students are central to many SIAM-sponsored community service opportunities for industrial members—including career fairs, workshops, colloquia, and other outreach activities. Exposure to graduate students and their faculty in an enthusiastic setting provides validation for the choices many of us have made in our careers, re-energizing, reinvigorating, and, most of all reminding us that we have some of the coolest jobs in the world.

Finally, SIAM offers the potential for travel and adventure. Early in my career, it never occurred to me that my professional contacts would lead to opportunities to collaborate and share research results all over the world. I have learned many amazing things and met many fascinating people. I did not anticipate early on all that 30 years of SIAM membership might lead to, but it's clear in hindsight that it's one of the best long-term investments I've ever made.

Thomas Grandine, a senior technical fellow in flight sciences technology at The Boeing Company, is SIAM's vice president for industry.

Summer 2013 Research Opportunities for Undergraduates

Undergraduates who are looking for summer research opportunities are encouraged to visit the National Science Foundation's "Search for an REU Site" web page at http://www.nsf.gov/crssprgm/reu/reu_search.cfm and click on the "Mathematical Sciences" link.

Students can also find links to research opportunities in the mathematical sciences that have been identified by *SIAM News* press time, funded both by NSF and by other institutions, on the SIAM website at <http://connect.siam.org/?p=2869> and <http://www.siam.org/students/resources/fellowship.php>.

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What's New at SIAM?

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- 2012 *SIAM Report on Mathematics in Industry*
- *SIAM Connect*—SIAM's online source for news on conferences, members, the community, prizes and awards, research, science policy and funding, and students
- *SIAM Presents*—online recordings of invited presentations and prize lectures from selected SIAM conferences
- SIAM ebooks available for purchase by your institution
- *Careers in the Math Sciences* columns that appear in *SIAM News* archived online
- Student chapters in China, Germany, England, Scotland, and Wales
- SIAG/NWCS prize Martin Kruskal Lecture
- SIAM Activity Group on Data Mining and Analytics



SIAM offers a variety of benefits that grow with the member, from conferring identity as an applied mathematician for a young person, to enabling connections and professional development for a growing career, and ultimately, providing fulfilling opportunities for service. The latter opportunity really begins at any career stage.

— David E. Keyes,
Dean of the Division
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and Engineering,
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Inexact Newton

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algebraic solver step i . Up to higher-order terms on the right-hand side, our a posteriori error estimate takes on the general form

$$J_u(u_h^{k,i}) \leq \eta^{k,i} \leq \eta_{\text{disc}}^{k,i} + \eta_{\text{lin}}^{k,i} + \eta_{\text{alg}}^{k,i} \quad (2)$$

for a suitable error measure $J_u(u_h^{k,i})$. Here, the overall estimator $\eta^{k,i}$ as well as the estimators of the three error components $\eta_{\text{disc}}^{k,i}$, $\eta_{\text{lin}}^{k,i}$, and $\eta_{\text{alg}}^{k,i}$ are fully computable. Our stopping criteria can be formulated for the linear and nonlinear solvers, respectively, as

$$\begin{aligned} \eta_{\text{alg}}^{k,i} &\leq \gamma_{\text{alg}} \max\{\eta_{\text{disc}}^{k,i}, \eta_{\text{lin}}^{k,i}\}, \\ \eta_{\text{lin}}^{k,i} &\leq \gamma_{\text{lin}} \eta_{\text{disc}}^{k,i}, \end{aligned} \quad (3)$$

where the values of the parameters γ_{alg} and γ_{lin} are set by the user, typically to a small percentage. From a mathematical viewpoint, an important result is that, under our stopping criteria, there exists a generic constant C such that, up to higher-order terms on the right-hand side,

$$\eta_{\text{disc}}^{k,i} + \eta_{\text{lin}}^{k,i} + \eta_{\text{alg}}^{k,i} \leq C J_u(u_h^{k,i}), \quad (4)$$

which is called efficiency and, together with (2), proves the equivalence of the error measure $J_u(u_h^{k,i})$ with our estimates. Moreover, as C is independent of the mesh size h , the domain Ω , and the nonlinear function σ , the a posteriori error estimate is robust. The bounds (2) and (4) are established for an error measure $J_u(u_h^{k,i})$ based on a dual norm of the difference between the exact flux $\sigma(u, \nabla u)$ and the approximate flux $\sigma(u_h^{k,i}, \nabla u_h^{k,i})$. In numerical results for the nonlinear p -Laplace equation, that is, $\sigma(u, \nabla u) = -|\nabla u|^{p-2} \nabla u$ for a real number $p > 1$ in (1), $J_u(u_h^{k,i})$ is very close to the Lebesgue norm of the flux difference $\|\sigma(u, \nabla u) - \sigma(u_h^{k,i}, \nabla u_h^{k,i})\|_{q, \Omega}$, with $q = p/(p-1)$. This error measure is important from a physical viewpoint, as the underlying PDE expresses a conservation principle by means of a balance law for the fluxes. The derivation of a posteriori error estimates for alternative error measures, e.g., in a goal-oriented setting, is an active area of research.

Figure 1 shows a comparison of results for the exact, inexact, and adaptive inexact Newton methods in the example of a nonlinear p -Laplace equation, with discretization by the Crouzeix–Raviart non-conforming finite element method, Newton linearization, and a conjugate gradient linear solver with diagonal preconditioning. The behavior of the overall error measure $\|\sigma(u, \nabla u) - \sigma(u_h^{k,i}, \nabla u_h^{k,i})\|_{q, \Omega}$ as a function of the number of degrees of freedom is quite similar for the three methods. This means that our early stopping criteria do not influence the overall error. What differs is the

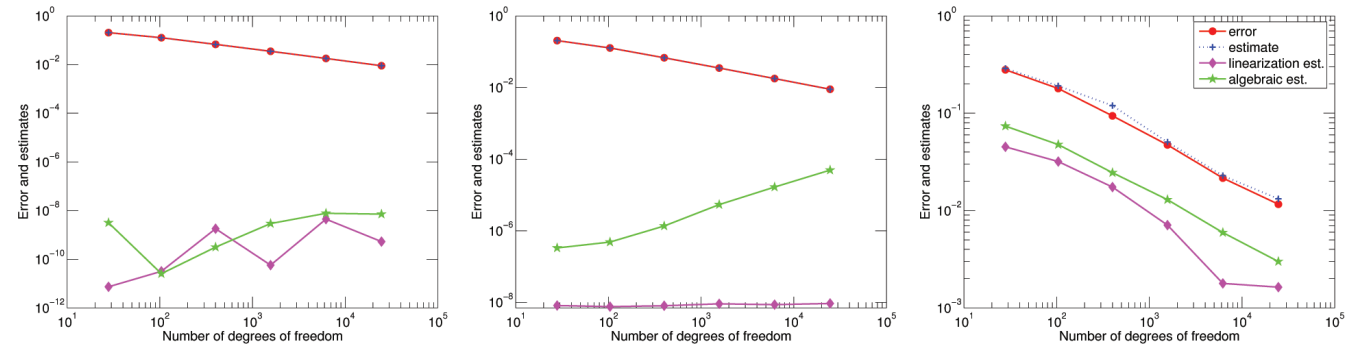


Figure 1. Error and estimates on a series of uniformly refined meshes with the exact Newton (left), inexact Newton (middle), and adaptive inexact Newton (right) methods.

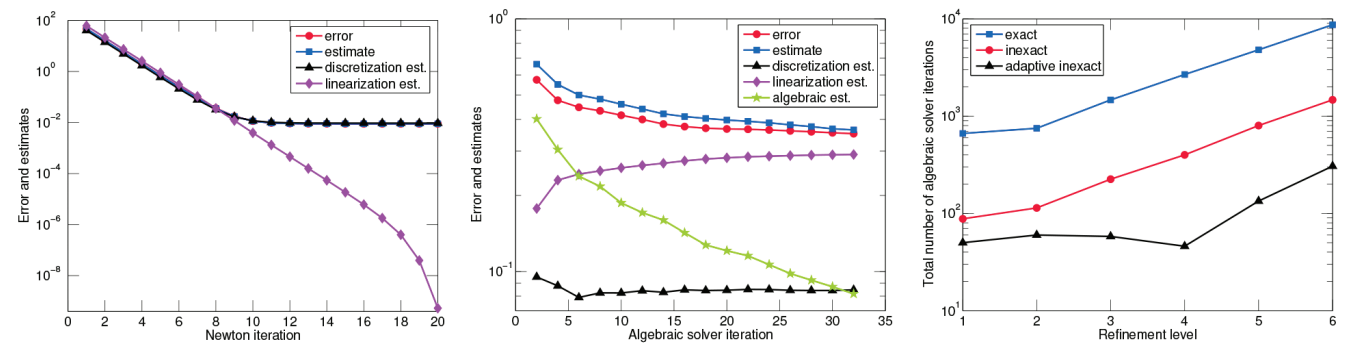


Figure 2. Error and estimates as a function of: Newton iterations, 6th-level uniformly refined mesh (left); preconditioned conjugate gradient iterations in the 8th Newton step on the 6th-level uniformly refined mesh (middle); and total number of linear solver iterations per uniform refinement level (right).

level below which the “side” (algebraic and linearization) errors are forced to decrease; in our approach, the user specifies this by means of (3). We used $\gamma_{\text{alg}} = \gamma_{\text{lin}} = 0.3$.

The left panel of Figure 2 provides further insight into the dependence of the error and of our estimates on the Newton iterations. The error and all but the linearization estimates start to stagnate after the linearization error ceases to dominate. Whereas the exact Newton method (with a convergence criterion of 10^{-8}) needs 20 iterations, we can safely stop after 11 iterations in our approach. The middle panel of Figure 2 presents similar plots for the CG iterations. Our adaptive algorithm stops after 32 iterations, whereas the exact method (with a convergence criterion of 10^{-8}) needs about 650 iterations. The total number of algebraic solver iterations required per refinement level is displayed in the right panel of Figure 2. On the last mesh, the inexact Newton method achieves a sixfold speedup compared with the exact Newton method (8690 vs. 1470 iterations). Our adaptive inexact Newton method achieves a further fivefold speedup (306 vs. 1470 iterations).

In Figure 3, we illustrate our adaptive inexact Newton method in conjunction with adaptive mesh refinement, still for the nonlinear p -Laplace equation. With local, elementwise stopping criteria, the predicted error distribution typically matches the actual one quite nicely, as illustrated in Figure 3. The figure also shows the adaptive mesh refinement triggered by a corner singularity.

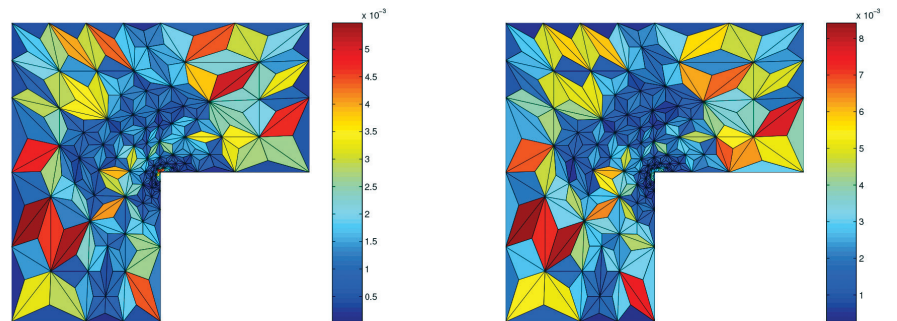


Figure 3. Estimated (left) and actual (right) error distribution, 5th-level adaptively refined mesh.

This stems from a theoretical result asserting the local efficiency of our estimates that is formulated by means of a mesh-localized version of (4).

In conclusion, we advocate that only the necessary number of algebraic solver iterations at each linearization step, and only the necessary number of linearization iterations should be carried out within an adaptive inexact Newton method. This typically leads to important computational savings, further increased with the addition of mesh adaptivity, thereby paving the way to a complete adaptive strategy. The driving force is a posteriori estimates that ensure a guaranteed and robust error upper bound. More details on our approach can be found in [3].

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Alexandre Ern is a professor of scientific computing at Ecole des Ponts ParisTech, Université Paris-Est, and an associate professor of numerical analysis and optimization at Ecole Polytechnique. Martin Vohralík is a senior researcher at INRIA Paris-Rocquencourt.

Mathematics Awareness Month - April 2013

Mathematics of Sustainability

Balancing needs and seeking solutions for a complex changing world

To learn more about the connections between mathematics and sustainability, visit www.mathaware.org

Joint Policy Board for Mathematics: American Mathematical Society, Mathematical Association of America, Society for Industrial and Applied Mathematics, American Statistical Association

Math, Sustainability, and Planet Earth

As this issue of *SIAM News* goes to press, preparations for the celebration of Mathematics Awareness Month in April have produced impressive results. So far, five essays on this year’s theme, Mathematics of Sustainability, have been posted at www.mathaware.org.

The organizing committee members for Math Awareness Month 2013 are Victor Donnay of Bryn Mawr College (chair), Thomas Pfaff of Ithaca College, Catherine Roberts of Holy Cross College, and Mary Lou Zeeman of Bowdoin College. Each is the author or a co-author of one of the essays.

Like all the activities, the essays are directed mainly to mathematically (and environmentally) inclined students at the high school and early university level. As Donnay, Pfaff, and Roberts point out in the opening essay on the role of math in addressing issues of sustainability in a complex changing world:

“At present, 50% of the world’s population live in cities. . . . City planners are looking at the overall systems that support life in a city (transportation, water supplies, storm water management, trash) and considering the benefits of creative green approaches. To prevent future catastrophic flooding, such as occurred during Hurricane Sandy, should New York City build a huge sea wall for protection or revive its coastal wetlands which reduce storm surges naturally? . . . Planners and engineers have to do the math and determine how well the various approaches will work and how much they will cost.”

In an essay on resource management, Colin Clark of

the University of British Columbia asks: “How can we manage a given renewable resource, such as a marine fish population, or a forest, in a sustainable way? And what forces tend to prevent sustainable harvesting? Can we identify an ‘optimal’ harvest strategy, in some sense, and how could it be implemented? These questions have been, and probably must be addressed by using mathematical models.” Clark concludes by presenting a simple model.

Zeeman and co-authors Thomas Eisner, Lynn Fletcher, Jason Hamilton, and David McCobb contributed an essay titled “Empower Your Students: Bring a State of the Planet Course to Your School.” In it, they briefly describe State of the Planet, a multidisciplinary course developed by graduate students and faculty at Cornell. The course, which “was an instant success among students,” is about “how we can address the global crises we collectively face.” The authors describe the original course vision and offer implementation tips, including: “Note that the vision is extremely robust, and can be given whatever slant works for you at your school, from mathematical analysis of climate data to inspiring behavior change through the arts.”

Also at *SIAM News* press time, the U.S. launch of the international Mathematics of Planet Earth 2013 was under way in San Diego, at the Joint Mathematics Meetings. Reports on MPE13-related sessions at JMM, along with articles on activities of the mathematical institutes in Canada and the U.S. that support MPE13, will appear in forthcoming issues of *SIAM News*.

The (Admittedly Beautiful) Conservation Laws of Financial Economics

Finance and the Good Society. By Robert J. Shiller, Princeton University Press, Princeton, New Jersey, 2012, 304 pages, \$24.95.

Robert J. Shiller is the Arthur M. Okun Professor of Economics at the Cowles Foundation for Research in Economics, and a professor of finance at the International Center for Finance at Yale. He is, in the opinions of many, the most deserving economist still without a Nobel Prize.

In this, his most recent book, Shiller both concedes the need for financial reform and expresses doubt that the good society, however defined, can exist without a prosperous financial sector. His warning to the growing number who would nationalize the banks, bomb Wall Street, and/or impose an inordinate regulatory burden on financial activity, is simple: Don't throw the baby out with the bath water.

Shiller's basic message is not new. At most times, he says, there is both a supply of money available for investment and a demand for such money from would-be entrepreneurs. The purpose of the financial sector is twofold: identify the worthiest projects and steer the available funds to them. The phrase "picking winners," which came into vogue during the Reagan administration, is still heard on late-night TV. Shiller seeks to flesh out his message by explaining how the various financial actors contribute to the well-being of society.

To that end, he devotes the first part (18 chapters/130 pages) of his book to explaining what various participants in the financial process actually do, from CEOs, investment managers, and bankers of various descriptions, to policy makers in charge of

stabilizing the economy, trustees, and philanthropists. Most of this material, although familiar to those already involved in the financial process, will be enlightening to some.

The second part of the book (12 chapters, 100 pages) is more diverse and eclectic. The first chapter thereof, Finance, Mathematics, and Beauty, may be the most interesting to the SIAM community. In it Shiller concedes that the hypocrisy and manipulation that pervade financial capitalism may sometimes obscure the beauty both of the system itself and of theories explaining it. Yet he insists that the beauty is real, and seeks to describe some of it.

In so doing, he quotes mathematician Hermann Weyl to the effect that "beauty is bound up with symmetry," and physicist Leon Lederman to the effect that "comprehending the universe means understanding its symmetries." Symmetries in nature find their most obvious expression in the conservation laws that govern—in appropriate circumstances—mass, energy, linear and angular momentum, and so forth. The same can be said of symmetries in economics, and specifically in financial economics. The Black-Scholes formula for the price of a European option, asserting that the values of certain portfolios are unchanged by (suitably random) fluctuations in the prices of the component assets, is one example of a conservation law in finance.

The so-called Modigliani-Miller theorems of corporate finance, which assert that it often makes no difference whether a firm borrows or issues additional shares of stock to raise funds needed for expansion, are another example of value conservation in economics. There again, certain values

and returns on investment turn out to be transformed by financial activity in such a way that their total value is exactly conserved.

A somewhat more controversial principle, dubbed "Ricardian equivalence" by Harvard economist Robert Barro, holds that government spending to stimulate the economy is little more than a trick, as savvy taxpayers will know that any such expenditure must be followed by increased taxes to discharge the debt, thereby shifting the pain of an economic slowdown onto future generations. This too is a conservation law—it asserts that society can choose to endure the pain of an economic downturn immediately or can postpone it at least temporarily, but cannot alter the magnitude (severity) of the pain.

Shiller chides his professional colleagues for being too easily seduced by (perceived) beauty, and insists that truth need not always be beautiful. In particular, the (admittedly beautiful) conservation laws of financial economics are only as valid as their underlying assumptions, and their relevance to the real world remains debatable. This is particularly true of the appealing efficient markets hypothesis, which asserts that the prices generated by financial markets furnish, at any given time, the best possible estimate of the present value of any potential investment. The EMH has been disproven many times over—never more convincingly than by Shiller himself in his best-selling *Irrational Exuberance*—yet refuses to die.

In Shiller's opinion, the survival of this and other "beautiful" but easily disproven generalizations makes it easier for still other unsubstantiated beliefs to influence public policy. In expressing that opinion, he reminds his audience that the marketplace of (scientific) ideas—perhaps more than any other market—is ruled by "the law of the jungle," often described as "survival of the fittest." As facts come to light, explanatory hypotheses are proposed and tested. A hypothesis that fails even one test must be either modified or discarded, no matter how many previous tests it may have passed. Thus, any undiscarded hypothesis is necessarily a survivor. One that has survived extensive testing becomes a potential "law of nature." Over time, potential laws of nature gain acceptance as actual laws

of nature, though such acceptance is ultimately provisional. No science can adhere to so lofty a standard at all times, but—in Shiller's carefully considered opinion—economic science falls unacceptably short.

Shiller maintains that, despite its many shortcomings, regulated financial capitalism serves the common good better than any known alternative, and is capable of further improvement via—among other things—democratization. The public, he suggests, needs to participate more widely in financial activity, and to become more conversant with the fundamentals of risk and reward. For only when they understand the financial system well enough to participate in it with confidence born of sustained success will the middle and working classes cease to suspect that the economy is run by and for a power elite.

James Case writes from Baltimore, Maryland.

BOOK REVIEW

By James Case

The public needs to participate more widely in financial activity, and to become more conversant with the fundamentals of risk and reward.

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NJIT
New Jersey's Science & Technology University

Tenth Conference on Frontiers in Applied and Computational Mathematics (FACM '13)

May 31- June 2, 2013
New Jersey Institute of Technology
Newark, New Jersey

Program: The tenth FACM conference will be broadly focused on mathematics applied to problems in science and technology, including wave propagation and electromagnetics, fluid dynamics and biology, with additional sessions on applied statistics and biostatistics. Plenary speakers will include Professors Daniel Heitjan (University of Pennsylvania) statistics; Pam Cook (University of Delaware) fluid dynamics; Xiao-Jing Wang (Yale) mathematical biology and Yvon Madaay (Pierre & Marie Curie University, Paris) waves. The first nine FACM conferences were major events in applied and computational mathematics, and the responses to them were enthusiastic (see <http://m.njit.edu/Events/FACM13/> for links to previous conference programs).

Local Organizers: Daljit S. Ahluwalia and Jonathan Luke (Co-Chairs), Linda Cummings, Ji Meng Loh, Horacio Rotstein, Catalin Turc and Michael Siegel.

Sponsored and Supported by: Department of Mathematical Sciences, NJIT; Center for Applied Mathematics and Statistics, NJIT; and the National Science Foundation.

Travel Awards: Applications are solicited for contributed talks from postdoctoral fellows and graduate students. Selected applicants will receive full support for travel. Other contributed papers for the conference will be presented as posters. Funds are available for partial support of travel expenses for graduate students, postdoctoral fellows, and junior faculty poster presenters. The deadline for all applications and submission of titles and short abstracts is April 15, 2013.

Contact: See the FACM '13 website for full details: <http://m.njit.edu/Events/FACM13/>. Local contact: Susan Sutton, Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, NJ 07102, USA; email: suttons@njit.edu; tel.: 973-596-3235.

NEW JERSEY INSTITUTE OF TECHNOLOGY
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THE EDGE IN KNOWLEDGE



What's Your Problem?

Problem Ideas Being Sought for High School Math Modeling Competition

Helping to challenge the next generation of mathematicians is critical, and that is what Moody's Mega Math (M^3) Challenge aims to do. You can help and impact thousands!

In 2012, nearly 5,000 high school students in the eastern U.S. participated in and submitted solutions to an open-ended, realistic, math-modeling problem presented to them in the M^3 Challenge, an Internet-based, applied math contest that occurs annually in March. Organized by SIAM, the contest poses a problem that students, working independently in teams of 3–5, must solve in just 14 hours.

Last year's problem dealt with determining the best regions in the U.S. for establishing high speed passenger rail lines. In previous years, students tackled other timely issues such as persistent drought, the census, the stimulus package and job creation, energy independence, Social Security solvency, and choosing stocks for maximum gain (see below right). Coming up with great problem ideas year after year is not easy, and that's where we're hoping you can help.

SIAM is looking for ideas for problems to be used in upcoming M^3 Challenges

Required problem characteristics:

- Accessibility to 11th and 12th graders
- Suitability for solution in 14 hours
- Possibility for significant mathematical modeling
- Topic of current interest involving interdisciplinary problem solving and critical thinking skills (e.g., humanitarian or environmental concerns, social media or online community challenges, economic or financial problems)
- Availability of enough data for a variety of approaches and depth of solutions (without easy answers found on the web)
- Problem broken down into parts with some simpler than others so that all teams can make some progress
- References identified to help get students started

Please submit problem statement idea in the format of previous Challenge problems.

Problem structure

Within the problem statement, there should be three questions for teams to answer:

- Question One: The warm up — every serious team can answer.
- Question Two: The guts — framed so that every team can have some success and many teams can cover it well.
- Question Three: The discriminator — many teams can do something, while only a few will have striking results.

**Submit problem statements via uploaded file at
m3challenge.siam.org/problem/submitproblems.php
or via email to montgomery@siam.org.**

Idea submissions or additional information needed?



Contact:
Michelle Montgomery
Project Director
Moody's Mega Math Challenge
montgomery@siam.org
<http://m3challenge.siam.org>



Society for Industrial and Applied Mathematics
3600 Market Street, 6th Floor
Philadelphia, PA 19104 USA
215-382-9800

High schools located in the following states are eligible to participate in M^3 Challenge 2013: Alabama, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, Washington D.C., West Virginia, and Wisconsin.



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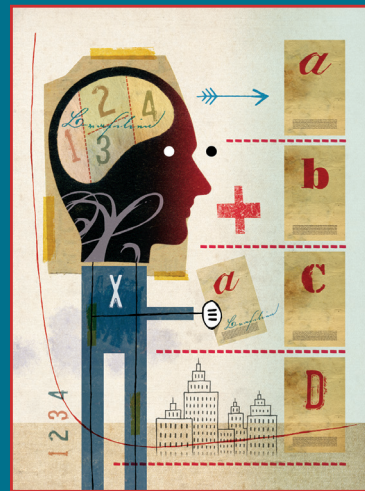
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The National Association of Secondary School Principals has placed this program on the NASSP National Advisory List of Student Contests and Activities for 2011–2013.



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Previous problems

2006: Solving the Social Security Stalemate

2007: Beat the Street!

2008: Energy Independence Meets the Law of Unintended Consequences

2009: \$787 Billion: Will the Stimulus Act Stimulate the Economy?

2010: Making Sense of the 2010 Census

2011: Colorado River Water: Good to the Last Acre-Foot

2012: All Aboard: Can High Speed Rail Get Back on Track?

Future topics

We are open to any topic!

Of particular interest are problems based on timely, relevant, big issues facing the U.S. and the rest of the world.

Honoraria

- Problems found suitable to add to the M^3 problem reserve "bank" receive \$150.
- Problems selected to be used as "the" Challenge problem get an additional sum, up to \$1,000.

Professional Opportunities

Send copy for classified advertisements to: Advertising Coordinator, SIAM News, 3600 Market Street, 6th Floor, Philadelphia, PA 19104-2688; (215) 382-9800; fax: (215) 386-7999; marketing@siam.org. The rate is \$2.70 per word (minimum \$325.00). Display advertising rates are available on request.

Advertising copy must be received at least four weeks before publication (e.g., the deadline for the April 2013 issue is February 28, 2013).

Advertisements with application deadlines falling within the month of publication will not be accepted (e.g., an advertisement published in the April issue must show an application deadline of May 1 or later).

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Graduate Fellowships
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Since 1959, the GFD program has brought together graduate students and researchers from a variety of fields sharing a common interest in the nonlinear dynamics of fluids. The program dates for 2013 are June 17–August 2. The 2013 program commences with two weeks of principal lectures on “Buoyancy-Driven Flows,” given by Paul Linden. Daily lectures by staff and visitors, on a wide range of GFD and related topics, will follow.

Fellows undertake a ten-week research project, delivering a lecture and a written report for a proceedings volume at the summer’s close. Fellows receive a stipend of \$5600 and a travel allowance. The application deadline is February 15, 2013.

Further information and applications can be found at: http://gfd.whoi.edu/gfd_fellowship.html.

Missouri University of Science and Technology

Department of Mathematics and Statistics

The Missouri University of Science and Technology invites applications for the position of chair of the Department of Mathematics and Statistics; assumption of the position will be in the fall of 2013.

Information about the department can be found at <http://math.mst.edu/>.

Applicants can find details about the position and the application process by clicking the academic position link at: <http://hraadi.mst.edu/hr/employment/>.

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Students (and others) in search of information about careers in the mathematical sciences can click on “Careers and Jobs” at the SIAM website (www.siam.org) or proceed directly to

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Worldwide Search for Talent

City University of Hong Kong is a dynamic, fast-growing university that is pursuing excellence in research and professional education. As a publicly-funded institution, the University is committed to nurturing and developing students’ talent and creating applicable knowledge to support social and economic advancement. Currently, the University has six Colleges/Schools. Within the next two years, the University aims to recruit **100 more scholars** from all over the world in various disciplines, including **science, engineering, business, social sciences, humanities, law, creative media, energy, environment**, and other strategic growth areas.

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Please send the nomination or application with a current curriculum vitae to Human Resources Office. **Applications and nominations will receive full consideration until the positions are filled.** Please quote the reference of the post in the application and on the envelope. Shortlisted candidates for the post of Assistant Professor will be requested to arrange for at least 3 reference reports sent directly by their referees to the Department, specifying the position applied for. The University reserves the right not to fill the positions. Personal data provided by applicants will be used strictly in accordance with the University’s personal data policy, a copy of which will be provided upon request.

The University also offers a number of visiting positions through its “CityU International Transition Team” for current graduate students and for early-stage and established scholars, as described at http://www.cityu.edu.hk/provost/cityu_international_transition.htm.

City University of Hong Kong is an equal opportunity employer and we are committed to the principle of diversity. We encourage applications from all qualified candidates, especially those who will enhance the diversity of our staff.

NJIT
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Assistant/Associate/Full Professor
Mathematical Biology: Genomics & Proteomics

Faculty Position available for September 1, 2013 hire.

The Department of Mathematical Sciences (DMS) at New Jersey Institute of Technology seeks candidates to fill a tenure-track/tenured position at the Assistant/Associate/Full Professor level in the general area of Mathematical Biology. The Department is particularly interested in candidates with a research focus on the development and application of mathematical techniques to further the understanding of the dynamics of gene, protein or cellular networks but will consider all areas of Mathematical Biology. Approaches combining deterministic and stochastic dynamics are of special interest.

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DMS offers BS, MS & PhD degrees, with tracks in the PhD program in Applied Mathematics, as well as Applied Probability & Statistics. DMS has an established record of interdisciplinary research accomplishment in Applied Mathematics as highlighted at our annual Frontiers in Applied & Computational Mathematics conference. For more information about DMS faculty and programs, visit <http://math.njit.edu>. Please apply online at njitjobs.com using posting # 0601243.

Required Documents: CV, Cover Letter, Teaching and Research Statements, Course Evaluations & 3 letters of reference. Please have letters of reference mailed or emailed to: Ms. Susan Sutton, Department of Mathematical Sciences, New Jersey Institute of Technology, 323 Dr. MUK Jr. Blvd., Newark, NJ 07102-1982; sutton@njit.edu.

At the university's discretion, the education and experience prerequisites may be accepted when the candidate can demonstrate to the satisfaction of the university an equivalent combination of education and experience specifically preparing the candidate for success in the position. NJIT is committed to diversity among its faculty, and applications from women and underrepresented minorities are encouraged. NJIT is an Equal Opportunity Employer M/F/V/D.

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THE EDGE IN KNOWLEDGE

Service

continued from page 8

mathematics divisions. That afternoon, or overnight, CSP members prepare brief position papers on priorities for support and advances from previous applied mathematics research. On the second day, committee members pair up and visit legislative staff—often those of their own Representatives in Congress, or of key legislators for science funding. They follow up with letters to agency representatives and legislators, and with news articles for SIAM’s membership.

Legislative staffers are often recent college grads—ambitious and eager, but generally having evaded math en route to their current jobs. Those who stay don’t learn more mathematics, except from people like us. My congressman’s senior staffer once greeted Linda Petzold and me by putting his feet up on his desk and informing us that earlier in the week lobbyists for medical research on various organs (heart, kidney, eye . . .) had stopped by to plead their cases; he challenged us to match them in importance. We replied by describing mathematical modeling and simulation research that was helping to enhance understanding of some of the same organs. This was not the kind of mathematics he had been shown in school. When it comes to community service, surprising amounts of fun and low-hanging fruit await!

Govern Thyself

Members of the SIAM Council decide on the sunrise and sunset of activity groups, conferences, journals, contests, prizes, and all kinds of initiatives, collaborations, and statements. SIAM members also join their counterparts from other professional societ-

ies in populating advisory committees to granting agencies. I remember the first time it dawned on me that I was writing text that might go into a future agency solicitation to which I (and hundreds of others) might apply. What a sobering fact to sleep on! Our systems for support of science have many flaws, but how wonderful is this feedback loop amidst all of the other forces and how important it is to maintain!

Self-initiated Contributions

Are agencies and professional societies not yet asking your advice because you are a little ahead of their domain? It is natural that new paradigms arise bottom-up, rather than top-down. Internet blogs, wikis, and open-source sites for distribution of codes, data sets, and technical tools are previously nonexistent forms of nonrefereed or lightly refereed service to the community that can potentially rapidly accelerate the transformation of a field. Only later are such contributions codified into supported programs and standards.

Following frontiersman Davy Crockett, “Make sure you’re right—then go ahead.”

Control your Expectations

Contributing technical expertise allows you to stay current in your own and nearby fields, to swell your Rolodex, to impress your colleagues and grant monitors, and to truly influence the direction of a field. However, some career cautions should be borne in mind vis-à-vis agency and society service. Don’t expect immediate gratitude—a little here, a little there, from different stakeholders, is hard to notice at first. Those in charge come and go. But you’re in the profession for the long haul, and thanks come over time. Don’t throw yourself into too much volun-

teer work too soon. It can be addictive! Research and teaching are more important for immediate advancement. There is time for agency and society interaction when your career is solidly established. But when asked, everyone who benefits from the system is expected to flex to participate.

What is a reasonable commitment for community service? If you have a grant from an agency, expect to be asked to serve on a panel or two per year, or to combine a panel and a batch of mail reviews. If your work is published in a journal, expect to be asked to review up to a few papers per year for that journal. Such service is not quid pro quo, however; follow your instincts, accepting invitations from those you respect, in areas to which you can contribute the most specialization. If you have not yet been asked to serve, do not panic. It is fine to make your willingness to serve known, but don’t target too finely—you could appear to have a private agenda. Ultimately, invitations will cascade. Don’t be too picky at first, but you will eventually have to prioritize.

There are many categories of service to consider, from the broadest forms of service to the community described above, to your employer, and, finally, to your closest circle.

Serving your Employer

Service to an employer can take a dizzying variety of forms in academia, perhaps fewer in industrial and national laboratories, where the diversity of the employers’ activities can be somewhat less. To begin, universities, corporations, and laboratories may have their own internal granting programs, for which the advice is similar to that given above.

Academic service is usefully categorized as university-wide or program-based, though the two have some activities in common. Both include committees for student recruiting, graduate admissions, faculty recruiting, faculty promotion and tenure, library or facility acquisition, curriculum review, qualifying examinations,

thesis evaluation, student chapter advising, conflicts of interest, intellectual property, university development, student prizes, faculty prizes, alumni relations, publicity, international programs. Many of the same considerations regarding career cost, career benefit, and priority described for community service apply here as well, except that the community is much smaller and typically has a much longer memory.

Serving your Circle

The smallest circle of service is within a department or group of students and post-docs. Here, the dominant service is mentoring and career counseling. The interactions are more intense and typically lifelong. The needs and the unique roles required to fulfill them are more obvious than for community and institutional service. The most important items on the career checklist are balance and priority. Your students and junior colleagues are more uniquely dependent on your time than, say, SIAM or NSF, but rewards from service come from all levels, from all sectors, and at diverse timescales. Practice on activities with low stakes, by volunteering to judge undergraduate poster contests or science fairs, or by organizing single-day campus-wide or regional technical symposia.

Diversify for experience. Specialize for effectiveness. But don’t miss out!

David Keyes has contributed to more than a dozen U.S. agency reports on computational mathematics or computational science and engineering and has served on two NSF advisory committees. He is the inaugural dean of the Division of Computer, Electrical and Mathematical Sciences and Engineering at the King Abdullah University of Science and Technology. Keyes is the 2011 recipient of SIAM’s Prize for Distinguished Service to the Profession.

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Well Served by Service

Service is always listed third in the academic career-development triad: research, teaching, and service. Though typically the last area emphasized and cultivated, whether in academic, government, or industrial careers, service is richly varied and rewarding. Service can create a sense of community that is far more diverse than the community you might experience as a specialized researcher. Too strong and too early an emphasis on service can rob you of the concentration and dedication required to advance your career. But many types of service are broadening and perspective-building. Too weak or too late an involvement in service can lead to narrowing and even burnout. No general article can prescribe the type, schedule, or level of service that is appropriate for a particular reader, but we hope this one might encourage junior colleagues to consider new possibilities—perhaps as a volunteer with SIAM.

Peer Review: Privilege and Responsibility

I often emerge from review panels marveling at the unanimously converged on rank of the proposals left on the board—and its modest correlation with the rank on the spreadsheet I had studiously prepared beforehand. What transpired in between was an almost magical process called peer review—a practice of obvious significance to the proposers, but also of great stretching for the reviewers. The dinner following a well-run panel is a high moment: Friends who were strangers a day before celebrate a group achievement requiring wisdom, candor, vulnerability, and prolonged concentration from each that has identified new talent, offered constructive feedback, and highlighted technical paths forward. Few events past a thesis defense

occasion the free-wheeling, wide-ranging discussion of fresh ideas among experts who are committed to the importance of the occasion. Few better illustrate the superiority of the whole to the sum of the parts.

The contract between society and its research scientists and technologists has evolved during the post-World War II era to depend upon a strong engagement of scientists with society. This was not always so, but never before in history have so many—as much as 1.7% of the population—been scientists or engineers! Earlier, science was typically the realm of the well-to-do or the monastic—very rare members of the species who were free from concerns of making ends meet. Today, economically competitive societies need to grow researchers and developers more systematically, and we tax ourselves to accomplish this, spending as much as 2.5–3% of our GDP on R&D. Societies dispense much of this support through competitive processes.

In the U.S. and most G-20 countries, applied and computational mathematicians are expected to earn support for their research from granting agencies or from centralized discretionary corporate or laboratory programs. While most development and some research support is dispensed top-down according to short-term goals, the majority of basic research support is awarded by peer review. A high level of expertise and careful separation of interests are required for a peer review system to work well, and the human effort required by the system has to come from researchers themselves, whether as volunteer fractional-time reviewers of proposals or as paid full-time (at least for some term) managers of the process.

Members of the SIAM community are vital across the globe to agencies that support research in the mathematical sciences, staffing panels as described above or working solo to prioritize investments. Volunteers do the majority of the technical work accomplished by these organizations, facilitated by generally lean executive staffs. Voluntary participation is essential to the intellectual health of the profession and to the various specialties within it. Participation of many volunteers diversifies the perspectives and keeps the work relatively light (in the long view) for each one.

Proposals

Agency service can take many forms, including reviews, panels, and site visits; resource-allocation boards (for computer time, beamline time, etc.); and advisory boards, report-writing panels, and workshops, wherein grantors set their strategies. What agencies are we talking about? In the U.S., many government agencies support some aspect of research and training in the mathematical sciences: DHS, DoD, DOE, DoEd, DOT, NASA, NIH, NIST, NOAA, NSA, NSF, and USDA, to name a dozen. Many states in the U.S. also conduct peer review of technology incubator proposals. Of course, some peer review takes place across national boundaries; this is especially important when too many investigators within one country are too interconnected in a particular campaign to provide impartial review.

Publication

If proposal review is “upstream,” peer review surfaces again “downstream” of the research endeavor, in the publication of results. Service to journals includes editing and reviewing. SIAM journals are among the top ranked globally in applied and computational mathematics, and maintaining their standards and scope would be impos-

sible without the approximately 10,000 reviews of the approximately 4000 papers submitted by the community each year.

Conferences

Peer review is also required in running conferences. SIAM conferences are intentionally rather light on selectivity compared to most, favoring networking and exchange over conferring prestige. Still, a lot of expert judgment is required in setting the themes and populating the podiums for each of the dozen or so conferences SIAM holds in a year.

Reap What You Sow

Peer review provides major indirect rewards. Your field prospers and polices itself. Strong participation as a volunteer engenders a favorable reputation for you within budget offices and editorial offices, and with other stakeholders. Your personal reputation as a contributor grows with your participation in individual and panel reviews. Influential colleagues come to know you and your judgment and can subsequently review you well in turn. Your technical knowledge deepens and broadens, and your “street smarts” in championing, proposing, and executing future research grow. You also become more valuable in the eyes of enlightened employers.

Lobbying for the Health of the Discipline

Another form of service to agencies and professional societies is lobbying—where the societies meet the agencies. SIAM has an extremely well-run Committee on Science Policy, made up of about two-dozen SIAM researchers. Twice yearly, committee members converge on Washington for two days, hosted by our lobbying organization, Lewis-Burke.

On the first day, the CSP hears from invited guests, usually heads of agency

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IPAM Institute for Pure and Applied Mathematics

Los Angeles, CA

GRADUATE SUMMER SCHOOL: COMPUTER VISION

July 22 - August 9, 2013



Organizing Committee: Don Geman (Johns Hopkins University), Fei Fei Li (Stanford University), Deva Ramanan (University of California, Irvine), Stefano Soatto (University of California, Los Angeles), Alan Yuille (University of California, Los Angeles)

Scientific Overview

The summer school will involve leaders from Computer Vision and experts from Mathematics, Statistics, Engineering and Computer Science who are interested in Vision. Computer Vision is a rapidly developing interdisciplinary field with an increasing number of practical applications such as automated cars, visual surveillance, and aids for the visually impaired. Its main goal is the automatic understanding and interpreting of images and image sequences.

The school will present the core techniques in Computer Vision, illustrate the large range of visual tasks they can be applied to, and describe the conceptual and theoretical foundations that underlie them. These techniques include filtering, geometry, differential equations, harmonic analysis, probabilistic methods, machine learning, and many more. The school will describe real world applications and discuss interactions with related disciplines such as image processing, machine learning, and biological vision.

Participation

This summer school will provide a rare opportunity for researchers in the mathematics, statistics, computer science, and engineering sciences to learn about recent research directions and future challenges in this area. Funding is available to support graduate students and postdoctoral researchers in the early stages of their career, as well as more senior researchers interested in undertaking new research in this area. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. The application is available online, and is due March 31, 2013.

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