

CSE 2011: SIAG/CSE Holds Milestone Meeting in Reno

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CSE11, the latest iteration of the biennial SIAM Conference on Computational Science and Engineering, was held in Reno, Nevada, February 28–March 4. With around 850 attendees, the conference has nearly doubled since its inception 11 years and 6 conferences ago. Even more important than the strong numbers is the healthy mix of student, industrial, government, academic, and international participants.

From the beginning, this conference series has showcased innovations in the field and defined new directions. The success of CSE11 confirmed the value of the meeting as a forum for the exchange of views on new mathematical methods and computational techniques for challenging applications.

The themes highlighted here are the topics covered by the eight invited speakers, beginning with Thomas Zacharia, who opened the meeting with a plenary talk on extreme-scale computing and its potential impact on scientific discovery. Zacharia's talk set the tone for a series of



J. Tinsley Oden, 2011 recipient of the SIAM /ACM Prize in Computational Science and Engineering, accepted the certificate and check that accompany the prize from SIAG/CSE chair Kirk Jordan (second from left) and Richard Hanson (far right, representing ACM) during the conference in Reno. The prize, given for outstanding work in the use and development of mathematical/computational tools and methods for problems in science and engineering, recognized Oden's "impact on the development of finite element methods." After a rapid rundown of Oden's many other contributions to the CSE community, including his role as founding director of the Institute for Computational Engineering and Sciences at the University of Texas at Austin, an astonishing catalog of books and journal papers, and an impressive number of PhD students, Jordan concluded, "I don't know where he finds the time." Among Oden's students is Andrea Hawkins-Daarud (shown here at left), who finished a PhD under his supervision in May; a finalist in the BGCE prize competition, she gave a talk on her research at the conference. Photo by Susan Whitehouse.

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contributions on the exploitation of new architectures, from multicore and GPU architectures to exascale systems. In many ways, attention to emerging architectures was a driver for much of the CSE11 program, necessitating discussions of methods development and enlarging the scope and demands of application areas.

In a plenary presentation on lattice Boltzmann formulations and kinetic approaches for complex fluid flow, Li-Shi Luo offered an example of the suitability of certain methods for high-performance architectures and an instance in which large-scale computing has shaped new perspectives for nano- and multi-scale fluid dynamics. The sessions that followed pushed several mathematical methodologies into large-scale simulations and underscored the need to utilize the full potential of the formulations in these nano-, micro-, and multi-scale applications.

Several trends that have been emerging over the past few SIAM CSE conferences were a strong presence at CSE11. Tamar Schlick presented an example in biomedical computing in a plenary talk, with a review of expectations and products of biomolecular modeling and simulation over the past two decades. Schlick's analysis revealed that the impact and potential of computing in new fields are often unclear, with early unrealistic expectations followed by disappointment and a fall in popularity before the computational methodology is mature enough to become a full partner with experiment. That history and a few success stories in the field are the subject of an upcoming article in SIAM News. The current general interest in biomedical computing was reflected in subsequent minisymposia on widely ranging aspects of the field.

Simulation results with high fidelity require the incorporation of uncertainties in parameter values, geometry, and initial and boundary conditions, as well as in the model itself. It is clear that uncertainty quantification has become a major trend in CSE, a claim that was supported by the more than a dozen minisymposia in the area. The topics of the talks ranged from rigorous work in stochastic analysis to engineering approaches for large-scale real-world applications. In fact, the growth in UQ research has been so rapid that SIAM recently created an activity group in the area; plans are under way for the group's first conference, which is scheduled for 2012 in Raleigh, North Carolina, where it will coincide with SAMSI's 2011–12 program on UQ.

The explosion of data in many fields, from both measurements and simulation results, is driving the

development of methods for data and information mining. In a talk on the subject, Vipin Kumar offered perspectives on the important impact of data mining in climate and earth sciences, and highlighted a number of key challenges in CSE, from theory to implementation. As the information and computational sciences continue to mature together, this theme will be increasingly prominent at future CSE conferences.

While many of the research talks were focused on large-scale, high-performance computing environments, the widespread success of CSE is also attributed to the power of personal computing, which has made simulation a more easily accessible tool than ever. A natural consequence is that methods and applications in traditional scientific and engineering disciplines continue to attract wide interest among conference participants. Simplification of partial differential equation models, through approaches like the reduced basis method, is an important step for making simulation models even more applicable to real-life design problems in industry. In an invited talk Alfio Quarteroni addressed such complexity-reduction approaches and their promise in diverse fields.

Invited speaker Lori Diachin pointed out that progress in CSE comes not only with the development of methods, applications, and architectures, but also through advances in system, application, and library software. Diachin's description of the Interoperable Tools for Advanced Petascale Simulations project highlighted this aspect of the field and pointed to the immense programming scope of massive computations. The tasks become even more daunting as computing moves to the exascale level, as described in Gerhard Wellein's plenary talk. Not only will hardware need to change significantly as the power law emerges as a real roadblock, but software infrastructures, programming paradigms, and numerical libraries will also need to adapt in order to take advantage of the computational potential of exascale systems.

Another important advance since the last conference is the accessibility of GPU acceleration in computational simulation. These traditional graphics components have matured into real computing units, driving new types of methods (e.g., high-order) and applications (e.g., fluid flow and electromagnetic wave propagation). Moreover, CSE is having a profound impact on the graphics community, as evident in Mark Sagar's plenary talk on cutting-edge approaches in the film industry (some of which are featured in an article on page 8).

CSE11 was an exciting milestone for the community. The level of participation, the new research directions, and the new application areas make it clear that CSE continues to play a major role in scientific discovery and the engineering design process. In response, SIAM Journal on Scientific Computing has extended its scope to cover papers in CSE, as well as on scientific software and high-performance computing. The expanded scope makes the journal a natural choice for the papers of many conference participants and others working in CSE. In particular, the journal now welcomes high-quality papers describing new computational approaches to challenging scientific or engineering problems. The development of new fundamental algorithms is still a major focus for SISC, but with the extended scope the journal also encourages submissions whose novelty lies in the way standard algorithms and building blocks are composed to attack complex physical problems. Successful methodologies for complex problems are often accompanied by new developments in programming techniques, software tools, and strategies for utilizing upcoming architectures; the SISC editors encourage the submission of papers on these important emerging topics.

As the largest of the SIAM activity groups, SIAG/CSE has tripled its membership, to more than 2000, in the last 8 years; about 58% of the members are students. These are exciting numbers for CSE, and an indication that CSE13 will be a worthy follow-up to CSE11. Karen Willcox and Hans Petter Langtangen are the co-chairs of the organizing committee for the conference.

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