THE UNIVERSITY OF CHICAGO

Departments of Computer Science, Mathematics, and Statistics

SCIENTIFIC AND STATISTICAL COMPUTING SEMINAR

KAUST Student Recruitment Talk

DAVID E. KEYES

Department of Applied Mathematics and Computational Science
King Abdullah University of Science and Technology (KAUST)

Paradigms for a 21st Century University

FRIDAY, February 1, 2013, at 4:30 PM
Ryerson 251, 1100 E. 58th Street

ABSTRACT

KAUST is a graduate research institution, founded in 2009 by King Abdullah of Saudi Arabia, with research thrusts in energy, environment, food, and water for a sustainable planet, and supporting thrusts in core capabilities (modeling, simulation, analytics, software, and hardware). As a 45-sq km international academic village on the shores of the Red Sea, created to be a 21st century "House of Wisdom" in the tradition of the ninth century *Bayt al Hikmah* that gave the world some of its modern mathematics, physics, chemistry, and medicine, KAUST has been endowed with world-class facilities and has recruited a world-competitive research faculty. KAUST awards degrees in Applied Mathematics and Computational Science, Bioscience, Chemical Science, Chemical and Biological Engineering, Computer Science, Earth Science and Engineering, Electrical Engineering, Environmental Science and Engineering, Marine Science, Materials Science and Engineering, and Mechanical Engineering. Currently, KAUST enrolls about 800 students from about 60 different countries. The language of instruction is English. KAUST is co-educational and is established upon principles of intellectual freedom, non-discrimination, and merit-based promotion. For Fall 2013, KAUST seeks ambitious, academically talented, and highly motivated doctoral and master's candidates in sustainable technologies and the enabling sciences from the worlds leading institutions to participate in discovery and translation into start-up enterprises. The founding Dean of KAUST's Mathematical and Computer Sciences and Engineering Division will present KAUST's programs and take questions about life in today's Middle East and about starting a university from scratch.

Organizers:
Lek-Heng Lim, Department of Statistics, lekheng@galton.uchicago.edu,
Ridgway Scott, Departments of Computer Science and Mathematics, ridg@cs.uchicago.edu,
Jonathan Weare, Department of Mathematics, weare@math.uchicago.edu.
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SCIENTIFIC AND STATISTICAL COMPUTING SEMINAR

SPECIAL SEMINAR

DAVID E. KEYES

Department of Applied Mathematics and Computational Science

King Abdullah University of Science and Technology (KAUST)

Large-scale Simulation in Science and Engineering: Digesting the Fruit, Replanting the Fields

FRIDAY, February 1, 2013, at 2:30 PM

Ryerson 251, 1100 E. 58th Street

Refreshments following the seminar, at 3:30pm, in Ryerson 255

ABSTRACT

High performance computing has transformed science and engineering, and become, itself, a science. The Scientific Discovery through Advanced Computing (SciDAC) program of the U.S. Department of Energy, among other campaigns of the past decade, has raised expectations and standards for predictive simulation as a tool of discovery, design, and decision support. The merger of the "third paradigm" of simulation for modeled systems with the "fourth paradigm" of data analytics independent of physical models has opened up exciting prospects of data assimilation and uncertainty quantification. These developments ride the dual trends of three orders of magnitude per decade in increased aggregate performance and three orders of magnitude per decade in decreased cost of installed flop/s. However, diverging exponentials in hardware subsystem performance now threaten to interrupt the steady progress in Computational Science and Engineering and require rethinking of models and reimplementation of algorithms. Much mathematics and software appears to be missing if emerging hardware is to be used near its potential, since our existing scientific computing code base has been assembled with a premium on squeezing out as many floating point operations as possible and improving the execution rate of those that remain. Instead, for reasons of energy efficiency and system acquisition cost, algorithms must now focus on squeezing out synchronizations, memory footprint, and memory transfers, including copies. High concurrency and power-efficient design of the individual cores put opposite pressures on algorithms: requiring simultaneously greater data locality and greater freedom to redistribute data and computation. After decades of algorithm refinement during a period of programming model stability, new programming models and new capabilities must be developed simultaneously, a process called co-design. We extrapolate current trends and describe some directions for exascale algorithms.

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