Institute for Computational & Mathematical Engineering

1. Who we are and what we do

2. Our vision for the next five years

3. Our strategic plan

ICME

AT THE INTERSECTION OF MATH, COMPUTING, AND ENGINEERING AND APPLIED SCIENCES

We train students and scholars in mathematical modeling, scientific computing, advanced computational algorithms

We collaborate closely with engineers and scientists to develop improved models and computational approaches

We help advance many engineering and scientific fields: aerodynamics, reservoir modeling, bio-engineering, uncertainty quantification, stochastics, optimization

Computational mathematics has become essential for scientific and engineering progress

"We want to hire all your graduates" (Jensen Huang)

HTTP://ICME.STANFORD.EDU

Degree granting institute (MS & PhD), anno 2004

Successor Scientific Computing & Computational Mathematics, anno 1970

Providing nearly 40 courses to Stanford

140 graduate students (half MS, half PhD)

One director, four staff members, 40+ associated faculty
from 14 departments and 4 schools

Proud occupant of the Huang Engineering Center

ICME STRENGTHS

Fulfills strong need for improved models and algorithms in many areas of engineering and science

Attracts very high quality of graduate students with strong mathematical and computational skills

Provides quality training in computational mathematics to a large number of undergrad and grad students

Creates environment for interdisciplinary approaches

Competitors at Harvard, Brown, UT Austin, Oxford, Princeton

ICME ATTRACTS UNIQUE STUDENTS TO SoE

Ph.D. students typically

- Have UG degrees in applied or computational mathematics (75-80% in last five years)
- Have a strong interest in engineering applications
- Are drawn by our interdisciplinary nature and do not feel at home in traditional disciplinary programs

Unique character of students a major draw to ICME for faculty

Many of our associated faculty rely on ICME students

MS students come from a wider range of backgrounds in the sciences and engineering

ICME FOSTERS INDUSTRIAL COLLABORATIONS

Silicon Valley (NVIDIA, Google, HP, Intel, …)

Aircraft industry, Movie industry, Energy companies,

Financial and management consulting, Biotech

National laboratories

ICME is an NVIDIA CUDA Center of Excellence

ICME COURSES (ALSO DISTANCE LEARNING)

Core graduate courses include:

- Theoretical and numerical differential equations

- Discrete mathematics

- Linear and nonlinear optimization

- Numerical linear algebra

- Stochastic methods

- Computer programming (C++, MPI, OpenMP, CUDA)

- Algorithms: design, implementation and parallelization

# ICME COMPUTE ENVIRONMENT

ICME provides to its students and faculty

- cloud compute environment

- Large GPU cluster

- specialized hardware for data-intense computations

Large scale high performance compute needs fulfilled through the public cloud (Amazon EC2), as well as national labs

We offer many specialized training courses in collaboration with industry and vendors (Cuda, Hadoop, Amazon EC2)
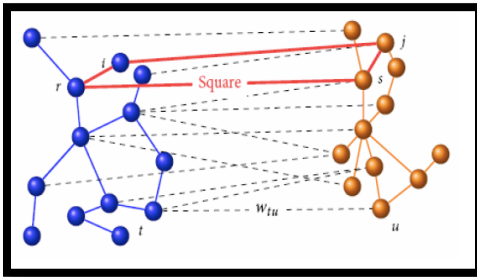
ICME is a NVIDIA CUDA Center of Excellence

Environmental fluid flow
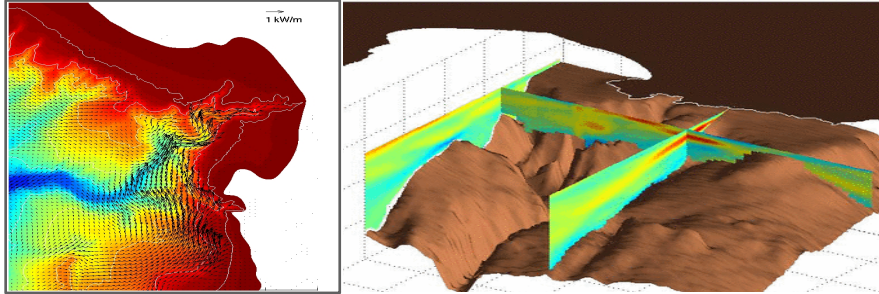
Ocean dynamics (tides & waves, pollutant transport, tidal turbines)
Ground water modeling and remediation
Mitigation harmful impacts of oil and gas recovery
http://suntans.stanford.edu

Search engines, data mining, networks

Optimization of page ranking algorithms
Virtual librarian for massive digital archives
Multi-lingual searching for the World Digital Library
Mining Twitter for socio-cultural trends
http://cads.stanford.edu

Uncertainty Quantification
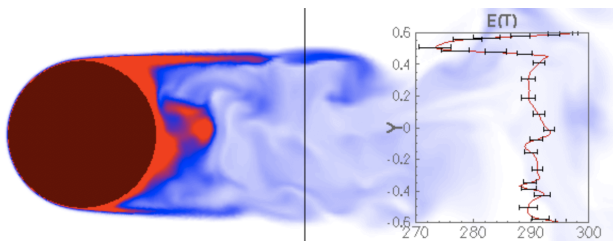
Impact of variability, randomness in numerical simulations
Limitations of mathematical models of complex systems
Behavior of multi-physics models
http://uq.stanford.edu

ICME

COMPUTATIONAL CONSULTING
FREE TO STANFORD AND WIDER COMMUNITY

Run by advanced grad students, advised by faculty members

Expertise includes matrix solvers, numerical simulation, optimization strategies, graph theory, software design

5-10 consultants solve 15-30 problems each quarter

Consulting gives students exposure to wealth of problems

Students may take consulting for credit.

http://csquared.stanford.edu

Recent progress & developments

Strengthening the C in ICME
- Computer system upgrades (research oriented)
- New fundamental programming series
- Short courses in collaboration with industry

Center of Excellence NVIDIA

Initiated collaboration with Mathworks & Agilent

Strengthening of graduate level education

Open Day, Bay Area Scientific Computing Day, summer schools

Vision & mission for next five years

Strengthen our reputation of world leader in ground breaking and fundamental research in computational mathematics

Establish new research initiatives in critical scientific and engineering fields

Maintain our reputation of world leader in graduate education

Strengthen our undergraduate education at Stanford

Help promote computational mathematics as an important and exciting discipline

ICME

WORLD LEADER IN RESEARCH

Initiate faculty billets, joint with critical departments,
   including mathematics, CS, earth sciences, medicine

Maintain the very high quality of our graduate students

Ensure a regular stream of internationally renowned visitors

Establish/maintain strong collaborations with best researchers
   inside and outside of Stanford

Grow research directions

Initiate new initiatives in areas of research that are critical
Including:

    Field of medicine

        Genome research

        Cancer and other life-threatening diseases

        Surgery training and real-time assistance

    Earth & environment

        Climate modeling

        Energy production

        Pollution remediation and prevention

        Geo-engineering

ICME