About the Institute

A $10 million anonymous donation plus matching funds of equal value from the Simons Foundation enabled Stony Brook University to establish a world-class Institute for Advanced Computational Science. The core mission of the institute is to advance the science of computing and its applications to solving complex problems in the physical sciences, the life sciences, medicine, sociology, industry and finance. In this endeavor, the Institute cooperates closely with the new Computational Science Center at Brookhaven National Laboratory, which specializes in large-scale data analysis. IACS firmly establishes the SBU-BNL partnership as a center of excellence in high-performance computing. Professor Robert Harrison, a distinguished expert in high-performance computing, has a joint appointment with BNL and is the Director of both IACS and the Computational Science Center at BNL.

IACS

Stony Brook University
Suite 230, Heavy Engineering
PH: 631-632-4629
iacs.stonybrook.edu
iacs@stonybrook.edu

Institute for Advanced Computational Science *presents*

GPGPU Workshop

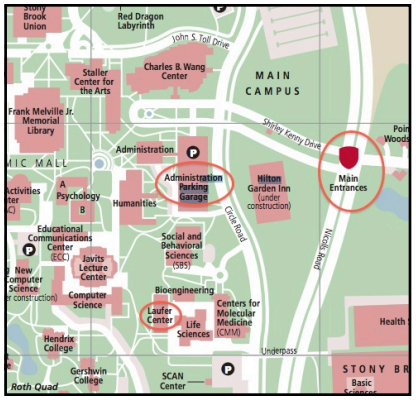
Friday, August 23
9am-5pm
Laufer Center, Room 101

Agenda

TIME	EVENT	ROOM	SPEAKER
9 AM	Programming with GPGPUs	Lecture 101	Dave Stampf
Noon	Lunch	IACS raw space (Other side of LC)	
1 pm	GPU Implementation of Lagrangian Particle Methods for Compressible Euler Equations	Lecture 101	Roman Samulyak
2 pm	GPU acceleration for medical imaging and visualization	Lecture 101	Wei Xu
3 pm	Survey of Techniques on Medical Imaging Computation	Lecture 101	Allen Tannenbaum
4 pm	GPUs versus CPUs	Lecture 101	Robert Harrison

Directions

The Laufer Center is located on West Campus between the Computer Science and the Life Sciences buildings. Parking is available in the Administration Garage which is accessible from the Main Entrance. See map at right for details.



David Stampf

Programming with GPGPUs

This workshop offers an introduction to Graphical Processing Units (GPU) used for General Purpose (GP) programming. It will include a tutorial on using CUDA (an API from Nvidia) on a linux system. Some experience with C (or Fortran) programming is expected.

BIO

David Stampf has worked at BNL since 1974 as an application programmer, systems programmer, network programmer, network designer, and project manager for the Protein Data Bank, he has worked with the ARM database team at BNL, ported the objectivity Object Database Management System to Linux for RHIC, worked for international teams in Moscow, and Vienna to support the safeguarding of nuclear material, assisted in the management of the Bluegene supercomputers and is currently working with porting codes to GPU systems. He received his BS in Applied Math from NYU, an MS in Computer Science from Polytechnic University, an MS in Astronomy from Swinburne University of Technology in Australia, and an MS in Applied Mathematics and Engineering from SBU.

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Roman Samulyak

GPU Implementation of Lagrangian Particle Methods for Compressible Euler Equations

The talk will start with an introduction to GPU memory hierarchy, CUDA programming model, and CUDA C/C++ API. Then new Lagrangian particle methods for solving hyperbolic PDE's, in particular Euler equations for compressible flow, and their GPU implementation will be discussed. By representing Lagrangian fluid cells with particles, as in smoothed particle hydrodynamics (SPH), the method avoids the mesh distortion problem of the original Lagrangian method and is suitable for the simulation of complex free surface flows. The main contribution of our method is the improvement of two major deficiencies of SPH: the dependence on a parameter called smoothening length, causing difficulties especially in the case of large density changes, and the presence of large linear errors of SPH differential operators. The parallelization of particle-based methods depends on the ability to find closest particle neighbors. Parallel octree-based neighbor search algorithms, their GPU implementation, and timing studies of particle codes will be discussed.

BIO

Roman Samulyak received his PhD in Applied Math from NJ Institute of Technology. His prior degree is in Mathematical Physics. He holds a joint appointment in AMS at SBU and the Computational Science Center at BNL. Samulyak's research interests include mathematical modeling and parallel numerical algorithms for multphysics systems and large scale simulations of processes in particle accelerators and nuclear fusion and fission devices. He has contributions in sharp interface magnetohydrodynamics and phase transitions, specialized PIC methods for electromagnetic systems of particles and fields, mesoscale models for brittle fracture, and Lagrangian particle/meshless methods for hyperbolic and elliptic PDEs.

Wei Xu

GPU Acceleration for Medical Imaging and Visualization

In this talk, several case studies will be presented to cover useful GPGPU acceleration strategies. First, we will present a simple non-linear image processing filter and its gradually improved versions of CUDA implementation. Then the optimization of the summation operator using shared memory will be shown. Finally, the application to Computed Tomography specifically for low-dose CT reconstruction will be discussed.

BIO

Wei Xu joined the Computational Science Center at BNL in 2013. She is currently working on a web-based data analysis workflow system for NSLSII. Before that, she received her Ph.D. Degree from Computer Science Department at Stony Brook University in 2012. Her research interests include high performance computing with both GPU acceleration and Multi-core parallel computing, Tomographic reconstruction methods, image processing and visualization.

Allen Tannenbaum

Survey of Techniques on Medical Imaging Computation

In this talk, we will discuss key problems in medical image computation, especially segmentation and registration. If one wants to apply these techniques intraoperatively where real-time processing is key, there is a need for parallel implementations. The GPU gives an ideal framework for this and is being used more and more for various medical computational purposes.

BIO

Allen Tannenbaum is professor of Computer Science and Applied Math at SBU. His research is in systems, image processing, medical imaging, computer vision, robust control, robotics, semiconductor process control, operator theory, functional analysis, cryptography, algebraic geometry, and invariant theory. He has authored or co-authored more than 450 research papers, four books and has four patents in computer vision and medical imaging. Dr. Tannenbaum has been an Associate Editor of several journals and has won several awards including the Kennedy Research Prize, George Taylor Research Award, IEEE Fellow, SICE Best Paper Award, Foams 2000 Best Paper Award, MICCAI Best Paper Award, and Hugo Schuck Award (Best Paper at ACC). He has given a number of plenary talks including at the American Mathematical Society, SIAM, IEEE CDC 2000, MTNS, and SCICADE.

Robert Harrison

GPUs versus CPUs

In this talk I try to get your expectations of performance gains from using GPUs over CPUs in line with reality. While some people claim to have seen in excess of 100-fold acceleration, a detailed analysis of the technology and software platforms suggests a reality that is significantly different indeed. Maybe you shouldn't fire that person who can't get the GPU to run faster than the CPU.

BIO

Robert Harrison is professor of Applied Math and the director of the Institute for Advanced Computational Science at SBU. He is also the head of the Computing Science Center at BNL. Dr. Harrison comes to Stony Brook from the University of Tennessee and Oak Ridge National Laboratory, where he was Director of the Joint Institute of Computational Science, Professor of Chemistry and Corporate Fellow. He has a prolific career in high-performance computing with over one hundred publications on the subject, as well as extensive service on national advisory committees.