Theory, Simulation & Computation (ADTSC)
CCS Division

A partial listing of ISTI Interactions

CRP Project (LANL/UCSC): Cosmic Calibration - Statistical Modeling of Dark Energy
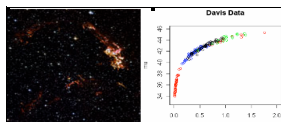
We propose to work on the problem of calibrating the parameters of computer code used for simulation of physical phenomena. We explore statistical methods based on a Bayesian approach implemented with Sampling Importance Resampling (SIR).

LANL (CCS) Collaborators/mentors: David Higdon, CCS-6

Related Papers/presentations

- Paper: Simulations and Cosmological Inference: A Statistical Model for Power Spectra means and Covariances, January 2010
- Paper: The Case for Deep, Wide-Field Cosmology
- Presentation: Cosmic Calibration - Statistical Modeling for Dark Energy (for UCSC Engr Days), May 2008
- Presentation: Discriminating Theoretical Models of Dark Energy, August 2009
- Presentation: ISSDM Day: Comic Calibration - Statistical Modeling for Dark Energy, October 2009
- Presentation: Cosmic Calibration - Statistical Modeling for Dark Energy, April 2010

Related Proposals

- Proposal: NSF: III Medium Collaborative Research Statistical and Feature Comparisons for Large Scale Simulations, February 2009
- Proposal: NSF Cosmic Calibration: Meeting the Precision Cosmology Challenge, May 2009
- Proposal: LDRD ER: Venturing Beyond the Cosmological Constant, April 2009
- Proposal: LDRD DR: Cosmological Signatures of Physics beyond the Standard Model: Petascale Cosmology Meets the Great Surveys, March 2009
- Proposal: NSF Understanding Uncertainties in Petascale Applications, October 2008
- Proposal: NSF Probabilistic features in petascale data with uncertainty, April 2009
- Proposal: LDRD ER: Venturing Beyond the Cosmological Constant, April 2009
- Proposal: NSF: Understanding Uncertainties in Petascale Applications, October 2008
- Proposal: DOE ASCR: Probabilistic Features in Petascale Data with Uncertainty, April 2009

CRP Project: (LANL/MIT): Dynamics of the Hog1 Signaling Pathway through Stochastic Modeling and Single Molecule mRNA Counting

LANL (CCS) Collaborators/mentors: Brian Munsky, CCS-3

CRP Project (LANL/UCSC/Ohio State/LLNL): Exascale Data Management in File Systems

Today's file systems use interfaces largely conforming to POSIX IO, a standard that was designed in the mid-1960s when high-end file systems stored less than 100MB. Today's high-end file systems in super-computing environments and search engine and social network companies are up to 7-9 orders of magnitude larger, resulting in numbers of data items for which POSIX abstractions are quite inadequate. With the advent of exascale systems this inadequacy will continue to grow worse. We propose to coalesce the functionality of data analysis, management, and file systems by extending file systems with data management services, including declarative querying, distributed query planning and optimization, automatic indexing, a common data model for most scientific file formats, and provenance tracking that spans multiple layers of abstraction. These services are optimized for predictability, throughput, and low latency while minimizing data movement and power consumption. We will leverage important insights gained by both the file system and the database communities. However, the sheer amount of data managed by file systems and their associated access patterns require a design very different from current database management systems.

LANL (CCS) Collaborators/mentors: James Ahrens, CCS-7

CRP Project (LANL/Ohio State University): Multi-threaded and Multi-purpose parallel Rendering on Multi-Core Computers

The goal of this project is to research the area of multi threaded and multi-process parallel rendering on multi-core computers as part of LANL's investigation into using supercomputers for parallel visualization. We are evaluating the practical feasibility of visualization on large memory, multi-CPU, high bandwidth connected nodes.

LANL (CCS) Collaborators/mentors: John Patchett, James Ahrens, CCS-7

Related Proposals

- Proposal: NSF: III Medium Collaborative Research Statistical and Feature Comparisons for Large Scale Simulations, February 2009

CRP Project (LANL/Ohio State University): Many-core Accelerated User-programmable Rendering

This project addresses the challenge of analyzing and visualizing extremely large data sets. The approach taken is to accelerate data analysis and visualization computations using "on-the-fly" compiled code for today's high-performance processors. We will concentrate on execution of the code on large-scale, distributed memory, parallel computer systems. In addition to the complexities of supporting these larger systems this work requires the compositing of imagery generated by the distributed rendering tasks.

LANL (CCS) Collaborators/mentors: Pat McCormick, CCS-7; Daniel Livescu, CCS-2

### CRP Project: (LANL/MIT): Optimal Experimental Design for Penetrating Imaging

LANL (CCS) Collaborators/mentors: Frank Alexander, CCS-DO; John Hogden, CCS-3

CRP Project: (LANL/MIT): Model Reduction and Robustness Analysis for Computationally Efficient, High Fidelity Inference in Complex Physical Processes

Modern tools of semi-definite programming (in particular, the public domain SeDuMe program) can be used successfully in black-box identification of significantly nonlinear circuits, providing performance superior to the existing methods. A Polynomial Optimization Toolbox, was successfully designed and implemented to enable efficient realization of nonlinear system optimization algorithms. An analytical study of highly structured dynamic programming tasks associated with the design of reduced complexity digital signal processing systems was performed.

LANL (CCS) Collaborators/mentors: Michael Wall, CCS-3; Frank Alexander, CCS-DO

### CRP Project (LANL/UCSC): Sensing Human Shape and Motion
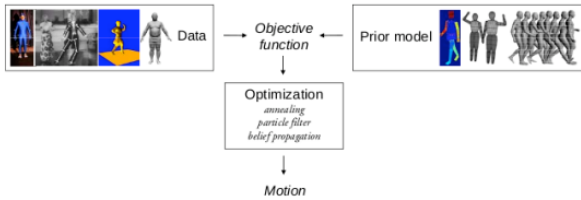
The research objective of this proposal is to measure human body shape and motion without augmenting the subject. The hypothesis is that replacing traditional cameras with high accuracy 3D shape measurement devices and utilizing a carefully constructed prior model of human surface shape are the critical factors that have been missing from prior attempts to meet this goal. The long-term accuracy targets are shape to 1mm and motion to 1deg.

LANL (CCS) Collaborators/mentors: Sriram Swaminarayan, CCS-7

Related Presentations

♦ Presentation: ISSDM Day: Eye Tracking for Blob Tracking, October 2009
♦ Presentation: 2010 ISSDM Day: Eye Tracking for Personalized Photography, October 2010

CRP Project (LANL/MIT): Statistical Physics for Computing and Communications
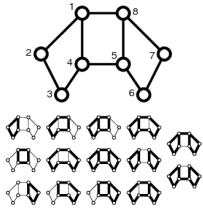
This project exploits methods from statistical physics to provide fundamental advances in computing and communication systems. The intersection of computer science, information theory and statistical physics has seen a recent explosion of activity, resulting in new algorithms and new methods of analysis. Discrete computational challenges including constraint satisfaction, error correction and communication network performance have benefited from techniques and insights offered by statistical physics. Physics, at the same time, has been significantly enriched by approaches from discrete **computation, such as message-passing algorithms.**

LANL (CCS) Collaborators/mentors: Leonid Gurvits, CCS-3; Howard Barnum, CCS-3; Stephan Eidenbenz, CCS-3; Hristo Djidjev, CCS-3

Related Proposals

♦ NSF Optimization of Complex Systems: Methodology and Applications, November 2008
♦ DOE ASCR in Office of Science Proposal: Dynamic Programming, Graphical Models, and Inference for Problems in Large Scale and Multi-Agent Optimization, June 2009
♦ Proposal: NSF Optimization of Complex Systems: Methodology and Applications, November 2008

CRP Project (LANL/UCSC): Understanding Multi-scale Multi-streaming Events in Cosmological Simulations

The science goal of this project is to seek a better understanding of the multi-streaming phenomenon in the universe. The specific aim is to
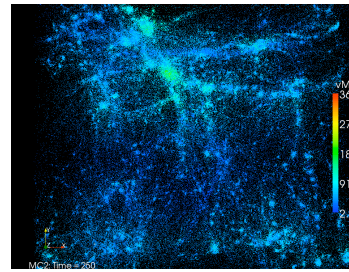
develop tools that will analyze, extract and visualize multi-streaming events from cosmological simulations.

LANL (CCS) Collaborator/mentor: James Ahrens, CCS-7

Related Proposals

♦ Proposal: Visualizing Multi-Streaming Behavior in the Universe for UC FEE, August 2008

CRP Project (LANL/Ohio State): Video Image Segmentation and Tracking

We are using an active PTZ camera data collection to study patterns and trends in outdoor scenes over long durations. Data is collected in a persistent manner using multiple cameras and locations at different times of day and day of week. The video images are used to track the trajectories of people and extract common pathways and routes by clustering and segmenting the trajectories.

LANL (CCS) Collaborator/mentor: Sriram Swaminarayan, CCS-7

CRP Project (LANL/Ohio State): Wireless Physical Layer Security, From Theory to Practice I

Development of methods to exploit the wireless medium to enhance the security of wireless networks. Development of experimentally validated security protocols to enhance the secrecy capacity of wireless networks by utilizing novel noise forwarding strategies to inject jamming signals to impair eavesdroppers.

LANL (CCS) Collaborator/mentor: Stephen Eidenbenz, CCS-3

CRP Project (LANL/Ohio State): Wireless Physical Layer Security, From Theory to Practice II

Development of methods to exploit the wireless medium to enhance the security of wireless networks. Development of experimentally validated security protocols to enhance the secrecy capacity of wireless networks by utilizing novel noise forwarding strategies to inject jamming signals to impair eavesdroppers.

LANL (CCS) Collaborator/mentor: Stephen Eidenbenz, CCS-3

CRP Project (LANL/Ohio State): Wireless Sensor Networks

We are creating a clone of the OSU testbed capability in a long-running outdoor surveillance testbed at LANL. The project will address energy efficiency concerns, in particular, maximizing efficiencies across routing and MAC.
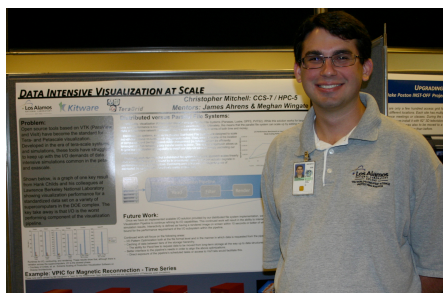
LANL (CCS) Collaborator/mentor: Stephen Eidenbenz, CCS-3

RESEARCH PROPOSALS

♦ LDRD-DR Optimization and Control Theory for Smart Grids, June 2009 (Marian Anghel, CCS-3; Nandakishore Santhi, CCS-3)
♦ LDRD-DR: Data to Knowledge at Scale: The Power of Data-Intensive SuperComputing (LDRD-DR Preproposal #20100029DR), January 2009 (James Ahrens, Scott Pakin, Jonathan Woodring, CCS-7; Chung-Hsing Hsu, CCS-1; David Higdon, James Gattiker, Joanne Wendelberger, CCS-6)
♦ LDRD- DR: Data to Knowledge at Scale: The Power of Data-Intensive SuperComputing (LDRD-DR Full Proposal #20100029), March 2009 (James Ahrens, Scott Pakin, Jonathan Woodring, CCS-7; Chung-Hsing Hsu, CCS-1; David Higdon, James Gattiker, Joanne Wendelberger, CCS-6)
♦ LDRD-DR Full Proposal: Building the Astroinformatics Competency: Finding, Interrogating, and Understanding Cosmic Explosions, April 2010 (James Ahrens, CCS-7)
♦ DOE ASC: Co-Design for Advanced Architectures and Critical Technologies Toward Exascale Computing, April 2010 (Paul Henning, CCS-7)
♦ LDRD: Co-Design for Advanced Architectures and Critical Technologies Toward Exascale Computing, April 2010 (Paul Henning, CCS-7)

COMPUTING AND INFORMATION TECHNOLOGY STUDENT MINI SHOWCASE

In its second year, the annual showcase provides a unique opportunity for students in the computing and information technology fields to present their research. The intent is to broaden students' expertise and prepare them for careers in their fields. This is an excellent forum for staff to interact and to learn about the breadth of projects in the area of IS&T at the Laboratory and for students to network and make professional contacts. A subset of CCS 2010 participants is listed below. The full listing of participants and abstracts may be found at http://institute.lanl.gov/isti/summer-school/mini-showcase/.

♦ **Title: Data Intensive Visualization at Scale**
Christopher Mitchell, University of Central Florida
Mentor: James Ahrens (CCS-7)
♦ **Title: Upgrading the IMMS Access Grid System**
Jake Poston, New Mexico Tech
Mentor: Cindy Sievers (CCS-7)

STAFF DEVELOPMENT AND RETENTION AND ORGANIZATIONAL OUTREACH ACTIVITIES

Cluster and Network Summer Institute Guest Lectures:
♦ SI2010 Guest Lecture: "Visualization of Petascale Data: Data-Intensive Computing on Numerically-Intensive Supercomputers," James Ahrens (CCS-7)
♦ SI2008 Guest Lecture: Christoph Teuscher (CCS-3)

Mentor Opportunity
♦ Mentor of Student for dissertation: Exploring Multistreaming in the Universe (James Ahrens, CCS-7)
♦ Mentor of Student for thesis: Stability-Preserving Model Reduction for Linear and Nonlinear Systems arising in Analog Circuit Applications (Frank Alexander, CCS-DO)
♦ Mentor of Student for dissertation: Designing Physical Primitives For Secure Communication In Wireless Sensor Networks (Frank Alexander, CCS-DO; Stephen Eidenbenz, CCS-3)
♦ Mentor of Student for thesis: Simulation-Based Approximate Solutions of Large-Scale Linear Least Squares Problems and Applications (Frank Alexander, CCS-DO)

Seminars/presentations/lectures
♦ Craig Rasmussen, CCS-7 Presentation: Visual Language Recognition with a Feed-Forward Network of Spiking Neurons, April 2010
♦ Craig Rasmussen, CCS-7 Presentation: PetaVision: A Software Framework for Constructing General Synaptic Networks at the Petascale, 2010
♦ Christoph Teuscher, CCS-3 Presentation: Computers as we Know Them, July 2008
♦ John Hogden, CCS-3 Presentation: A blind algorithm for recovering articulator positions from acoustics, March 2009
♦ Kroc Lukas, CCS-3 Paper: Tracking particles by passing messages between images, arxiv:0909.4256, April 2010

UCSC Graduate Classes are offered through ISTI (for credit toward a graduate degree in computer science or for professional development):
♦ Ingo Steinwart, CCS-3 Taught UCSC Winter 2010 graduate course: Advanced Machine Learning
♦ Sunil Thulasidasan, CCS-3: Attended FA2006 course: Analysis of Algorithms
♦ Tatiana Djidjeva, CCS-3
   • Attended Spring 2008 course: Advanced Topics on Computer Systems
   • Attended FA2008 course: Database Systems I: Principles of Database Systems
   • Attended FA2008 course: Analysis of Algorithms
   • Attended Winter 2009 course: E-Business Technology and Strategy
   • Attended Spring 2009 course: Advanced Computer Security
♦ Latchesar Ionkov, CCS-1 (currently HPC-5)
   • Attended course: Analysis of Algorithms, fall 2006
   • Attended course: Distributed Systems, spring 2007
   • Attended course: Principles of Database Systems, fall 2007
   • Attended course: Parallel Processing, winter 2008
   • Attended course: Advanced Operating Systems, fall 2006
   • Attended course: Computer Architecture, fall 2008
   • Attended course: Computer Networks, fall 2008
   • Attended course: Programming Languages and Environments, winter 2009
   • Attended course: Sensor Networks, winter 2009
   • Attended course: Coalescing Analysis & Storage, fall 2010
   • Sean Blanchard, CCS-1 (currently HPC-5)
   • Attended course: Advanced Operating Systems, fall 2006
   • Attended course: Coalescing Analysis & Storage, fall 2010
♦ Lee Nau, CCS-1: Attended course: Analysis of Algorithms, fall 2008
♦ Hugh Greenberg, CCS-1 (currently HPC-5)
   • Attended course: Advanced Computer Security, spring 2009
   • Attended course: Coalescing Analysis & Storage, fall 2010

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