Applied Computer and Information Science (ACIS)

A Proposal for ISC-2 Planning

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Allen D. Malony, Andrzej Proskurowski, John Conery, Matt Sottile

Vision

Scientific discovery in the 21th century will be driven by the application of computing innovations and technologies. Computational modeling, data analysis, and informatics are the new tools of modern science, and they will be the fundamental building blocks for any integrative science initiative. Indeed, the future competitiveness and productivity of research institutions may well be determined by how effectively computer science and practice is incorporated in its research and education mission. By building core competencies in computational, data, and information sciences, referred to collectively as "Applied Computation and Information Science" (ACIS), the University of Oregon has an opportunity to amplify integrative science initiatives across all science areas. ACIS (pronounced *axis*) will serve as a bridge for translating computer science knowledge and technology to address such challenges as robust numerical modeling, complex data analytics, large-scale information management, and high-resolution, multi-dimensional visualization. However, it is important for ACIS engagement to have close presence with domain scientists to promote interactions and cyber-enabled discovery and innovation.

We propose that any ISC-2 plan include support for three important ACIS components: 1) faculty, scientists, and students working in the ACIS core competencies, 2) cyber innovation labs for interactive problem solving with domain scientists, and 3) scientific computing, network, and storage infrastructure. More specifically, we propose to locate the Neuroinformatics Center (NIC) and the Computational Science Institute (CSI) in the ACIS space and to plan the 'cyberlab' as a shared high-tech environment for brainstorming and instruction. The scientific computing facility is proposed at a high-end (in terms of space) to accommodate significant computing power and storage capacity, yet with flexible configuration in mind to allow upgrades long term. Here it is also important to plan for power and cooling. High-speed networking is proposed throughout the building with high-bandwidth connection to the campus network backbone.

The ACIS plans for ISC-2 complement the other ISC-2 proposals in support for scientific computing and informatics expertise applied to domain science, as well as for the high-performance computing (HPC), storage, and visualization resources needed for scientific research. ACIS implementation will also be an enabler for the Integrated Science Complex as a whole, and we envision strong connection being made with nanoscience and microtechnologies research activities in ISC-1. ACIS is a vision supported by the Department of Computer and Information Science (CIS). It will both guide CIS research and education in computational science and informatics, and be a catalyst for CIS integration in UO's cyber-enhanced science future.

Scientific Connections

Elements of ACIS are already functioning in the University of Oregon. However, human and computing resources are disperse on campus and are not connected in ways that could leverage expertise and capabilities. Nevertheless, there are important and successful projects that demonstrate ACIS potential. As examples, those involving computer science faculty include research in genomics and bioinformatics (Conery), computational paleontology (Stevens), neuro ontologies and gene databases (Dou), assistive technology research for cognitive impairment (Fickas), and neuroinformatics (Malony, Sottile). For the ACIS proposal, we focus on the Neuroinformatics Center and the Computational Science Institute as key contributers for ISC-2.

The NIC is a core component of the Brain, Biology, and Machine Initiative (BBMI) focused on the problem of dynamic neuroimaging and processing of neurological information. Research projects include development of EEG signal analysis tools, physics-based computational models of human head electromagnetics, automated MR image segmentation, cortical surface extraction, and neurological ontologies. High performance computing plays a significant role in the research. A grid of parallel computers, large-scale storage resources, and visualization devices (the *ICONIC Grid*) was developed for use by NIC researchers and university research partners. This was the result of a successful proposal to the NSF Major Research Instrumentation program. The NIC is applying its work to the analysis of human brain activity in normal function and in disorders including epilepsy, hematoma, and traumatic brain injury. It is developing internet-based telemedicine capabilities to provide remote sites with a point-of-presence for its advanced brain analysis services.

Established in 1995 by CIS (Conery, Cuny, Malony) and other UO science faculty, the history of CSI pre-dates that of BBMI. The mission was to create an intellectual community interested in computational science under an institute framework that would support computational science research projects and initiatives at UO. Several research efforts took place under the CSI rubric, including seismic tomography for mid-ocean ridges, neural modeling of chemotaxis in C. elegans, mutational meltdown in evolutionary science, coupling of hydrology and land models, and parallel performance tools for scalable HPC systems. CSI was also successful in winning two NSF infrastructure awards in support of computational science activities. In recent years, the CSI has been dormant in an organizational sense, since projects spawned off as more individual interactions, and critical mass in the developing intellectual community was not sufficiently achieved.

We believe there is now substantial interest computational science and existing intellectual resources to contribute to core ACIS competencies. The NIC alone has strengths in computational physics, image analysis, signal analysis and applied mathematics. The Performance Research Laboratory (PRL) in the NIC has expertise in parallel software development, parallel peformance analysis, and high-performance computing systems. The NIC is presently supported by the "BBMI Applied" TATRC contract and PRL has over $1M in contracts from the DOE and NSF. Unfortunately, the NIC is remotely located in the Riverfront Research Park, making it difficult to leverage its expert resources conveniently by other science groups. In a synergistic sense, the CSI brings an intellectual mission and organizational resources to the ACIS vision. CSI could directly serve as a home for ACIS scientists and staff working with ISC research projects.

Space Requirements

The proposed ACIS space plan for presence in ISC-2 is shown below:

ACIS offices			
NIC staff	5 private offices	150 sq. ft. per unit	750 sq. ft. total
CSI staff	5 private offices	150 sq. ft. per unit	750 sq. ft. total
Shared staff	4 two-person offices	250 sq. ft. per unit	1000 sq. ft total
ACIS engagement			
Cyberlab	interactive development / brainstorming environment	500 sq. ft.	500 sq. ft. total
ACIS computing			
Shared facility	computational, networking, storage, power, cooling	7,500 sq. ft.	7,500 sq. ft. total

The ACIS office space for the NIC would accommodate the present staff with some room for growth. We envision the CSI office space being filled by research scientists contributing to ACIS core competencies and involved with ISC-related projects. While these offices may be filled by ISC project scientists, it is our intention that the staff add to ACIS competencies and be willing to promote CSI educational initiatives. The shared offices will support programming staff and graduate students.

The goal of the cyberlab is to provide a rich environment for domain science engagement, problem solving, and prototype development. It will be fully apportioned with high-technology hardware and software tools. The intention is to foster ACIS brainstorming and interaction.

The ACIS computing facility represents a high-end space allocation for all ISC-2 computing and storage needs combined, plus associated power and cooling. This space should be designed to be highly configurable to meet a variety of resource needs. Computer machine room design specialists should be hired for this purpose.

Leveraging Opportunities

There are significant opportunities leveraging major programmatic funding in ACIS-oriented initiatives. The NSF has a major program in Cyber-enabled Discovery and Innovation (CDI) and the DOE is in the second phase of funding the Scientific Discovery through Advanced Computing (SciDAC) program. Computational science, data modeling and analysis, and informatics will continue to be important competencies to leverage in future scientific proposals to almost all research agencies. There are also opportunities for major infrastructure support for computational resources. We believe high-performance computing tools for science will be attractive to donors and high-tech industry grant programs, such as the IBM Shared University Research (SUR) program.

Responsiveness to Space Allocation

The ACIS proposal brings together human resources contributing to core scientific computing and informatics competencies for purposes of ISC-2 science objectives. The plan is centered around relocating the NIC, as an existing successful ACIS component, to be in closer proximity to BBMI activities in the ISC-2 space. In addition, the plan establishes a CSI presence in ISC-2 to promote consolidation of computational science interests and expertise. The ACIS proposal supports shared scientific computing and storage facilities, and will contribute expertise to the planning and design of this infrastructure.

Responsiveness to Scientific Criteria

We view ACIS as an important vision for University of Oregon. It is a core part of interdisciplinary science initiatives and will be a key determinant of integrative science success. The ACIS proposal for ISC-2 is the first step towards realizing these goals.