The Computing Community Consortium

Dr. Erwin Gianchandani Director, Computing Community Consortium Computing Research Association

NIH Biomedical Information Science & Technology Initiative (BISTI) April 7, 2011









The Computing Research Association

What is the CCC?

Possible synergistic directions?

The Computing Research Association

Over 220 department/lab members

Arizona State University - CSE Auburn University - CSSE Ball State University - CS Boston College - CS Boston University - CS Bowdoin College - CS Bowling Green State University - CS Bradley University - CS Brandeis University - CS Brigham Young University - CS Brown University - CS Bryn Mawr College - MCS Bucknell University - CS California Institute of Technology - CS California Polytechnic State University - CS California State University, Chico - CS Carnegie Mellon University - CS Case Western Reserve University - EECS City University of New York, Graduate Center - CS Clemson University - CS Colgate University - CS College of William & Mary - CS Colorado School of Mines - MCS Colorado State University - CS Columbia University - CS Cornell University - CS Cornell University - ECE Dalhousie University - CS Dartmouth College - CS DePaul University - CS Drexel University - CS Drexel University - IST Duke University - CS Emory University - MCS Florida Atlantic University - CSE Florida Institute of Technology - CS Florida International University - CS Florida State University - CS Florida State University - IS George Mason University - CS George Washington University - CS Georgia Institute of Technology - CSE Georgia Southern University - IT Georgia State University - CIS Georgia State University - CS Grinnell College - MCS Harvard University - CS Harvey Mudd College - CS Hofstra Universyt - CS Illinois Institute of Technology - CS Illinois State University - ACS Indiana University - CS Indiana University - I Iowa State University - CS Iowa State University - ECE

Johns Hopkins University - CS Johns Hopkins University - SI Juniata College - IT & CS Kansas State University - CIS Kent State University - CS Lafayette College - CS Lehigh University - CSE Long Island University - ICS Louisiana State University - CS Loyola University, Chicago - CS Massachusetts Institute of Technology - EECS Miami University - CS McMaster University - CE&S Michigan State University - CSE Michigan Technological University - CS Mississippi State University - CS Montana State University - CS Montclair State University - CS National University of Singapore - CS/IS Naval Postgraduate School - CS New Jersey Institute of Technology - CCS New Mexico State University - CS New York University - CS North Carolina State University - CS Northeastern University - CIS Northwestern University - ECE Nova Southeasern University - CS Oakland University - CSE Ohio State University - CSE Ohio University - EECS Oklahoma State University - CS Old Dominion University - CS Oregon Health & Science University - CSE Oregon State University - EECS Pace University - CSIS Pennsylvania State University - CSE Pennsylvania State University - IST Polytechnic University - CIS Pomona College - MCS Portland State University - CS Princeton University - CS Purdue University - CS Purdue University - ECE Rensselaer Polytechnic Institute - CS Rice University - CS Rochester Institute of Technology - CS Roosevelt University - CS&T Rutgers University, Busch Campus - CS Saint Louis University - MCS Santa Clara University - CE Simon Fraser University - CS Singapore Management University - IS Southern Illinois University, Carbondale - CS Southern Methodist University - CSE Southern Polytechnic State University - CSE

Stanford University - CS State University of New York, Albany - CS State University of New York, Binghamton - CS State University of New York, Stony Brook - CS Stevens Institute of Technology - CS Swarthmore College - CS Syracuse University - IS Temple University - CIS Texas A&M University - CS Texas State University - CS Toyota Technological Institute at Chicago - CS Tufts University - CS Tulane University - EECS Union College - CS University at Buffalo - CSE University at Buffalo - IS University of Alabama, Birmingham - CIS University of Alabama, Tuscaloosa - CS University of Alberta - CS University of Arizona - CS University of Arkansas - CSCE University of Arkansas at Little Rock - I University of Calgary - CS University of California, Berkeley - EECS University of California, Berkeley - IMS University of California, Davis - CS University of California, Irvine - ICS University of California, Los Angeles - CS University of California, Riverside - CSE University of California, San Diego - CSE University of California, Santa Barbara - CS University of California, Santa Cruz - CE University of California, Santa Cruz - CS University of Central Florida - CS University of Chicago - CS University of Cincinnati - ECECS University of Colorado, Boulder - CS University of Delaware - CIS University of Denver - CS University of Florida - CISE University of Georgia - CS University of Hawaii - ICS University of Houston - CS University of Houston - ECE University of Idaho - CS University of Illinois, Chicago - CS University of Illinois, Urbana Champaign - CS University of Illinois, Urbana Champaign - ECE University of Iowa - CS University of Kansas - EECS University of Kentucky - CS University of Louisiana at Lafayette - CACS University of Louisville - CECS University of Maine - CS University of Maryland - CS

University of Maryland, Baltimore Co - CSEE University of Maryland, Baltimore Co - IS University of Massachusetts, Amherst - CS University of Massachusetts, Boston - CS University of Michigan - EECS University of Michigan - I University of Michigan, Dearborn - CIS University of Minnesota - CSE University of Minnesota, Duluth - CS University of Mississippi - CIS University of Missouri, Columbia - CS University of Missouri, Rolla - CS University of Montana - CS University of Montreal - CS University of Nebraska at Omaha - CS/IST University of Nebraska, Lincoln - CSE University of Nevada, Las Vegas - CS University of Nevada, Reno - CSE University of New Brunswick - CS University of New Hampshire - CS University of New Mexico - CS University of New Mexico - ECE University of North Carolina at Chapel Hill - CS University of North Carolina at Chapel Hill - SILS University of North Carolina, Charlotte - IT University of North Dakota - CS University of North Texas - CS University of Notre Dame - CSE University of Oklahoma - CS University of Oregon - CIS University of Pennsylvania - CIS University of Pittsburgh - CS University of Pittsburgh - IS University of Puget Sound - MCS University of Rochester - CS University of South Alabama - CIS University of South Carolina - CSE University of South Florida - CSE University of Southern California - CS University of Southern California - EES University of Tennessee, Knoxville - CS University of Texas, Arlington - CSE University of Texas, Austin - CS University of Texas, Dallas - CS University of Texas, El Paso - CS University of Toronto - CS University of Tulsa - MCS University of Utah - CS University of Virginia - CS University of Washington - CSE University of Washington - I University of Washington, Bothell - CS University of Washington, Tacoma - CSS University of Waterloo - CS University of Wisconsin, Madison - CS

University of Wisconsin, Milwaukee - EECS University of Wyoming - CS Utah State University - CS Vanderbilt University - EECS Virginia Commonwealth University - CS Virginia Tech - CS Wake Forest University - CS Washington State University - EECS Washington University in St. Louis - CS Wayne State University - CS Wayne State University - CS West Virginia University - CS Western Michigan University - CS Williams College - CS Worcester Polytechnic Institute - CS Wright State University - CSE Yale University - CS York University - CS

Sun Microsystems (Sponsoring Member) Microsoft Corporation (Sustaining Member) IBM Research (Supporting Member)

Accenture Technology Labs Argonne National Laboratory Avaya CA Labs Computer Science Research Institute, Sandia National Labs Fraunhofer Center for Experimental Software Engineering Fujitsu Laboratories of America Google Hewlett-Packard Company IDA Center for Computing Sciences Intel Corporation Lawrence Berkeley National Laboratory Los Alamos National Laboratory Lucent Technologies, Bell Labs McAfee Research Mitsubishi Electric Research Labs National Center for Atmospheric Research NCSA NEC Laboratories America NTT DoCoMo USA Labs Pacific Northwest National Laboratory Panasonic Information & Networking Technologies Lab **Ricoh Innovations** San Diego Supercomputer Center SAP Labs SRI International Telcordia Technologies



Core activities





- Strengthen research and education in the computing fields
 - working to influence policy that impacts computing research
 - encouraging the development of human resources
 - contributing to the cohesiveness of the professional community
- Collect and disseminate information about the importance and state of computing research



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CDC

CCC

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CRA-W @ encouraging the development of human resources

contributing to the cohesiveness of the professional community

Collect and disseminate information about the importance and state of computing research



CCC

The Computing Community Consortium

Concerns in the mid-2000s.

- Similar deep concerns about computing:
 - Failure to articulate and coalesce around exciting research visions in computer science that could galvanize the public, policymakers, researchers, and students
 - Need to groom the future leadership of the field
 - Decrease in student interest

"Led to the need for a "CCC"."

- Increased focus by NSF leaders and computing research leaders in academia & industry
- A Computing Community Consortium solicitation & proposal
 - "[NSF] will support the CCC as a community proxy responsible for facilitating the conceptualization and design of promising infrastructure-intensive projects..."
 - The purpose of the CCC is to provide a voice for the national computing research community. The CCC will facilitate the development of a bold, multi-themed vision for computing research and education... [communicating] that vision to ... major stakeholders."

...And NSF asked CRA to create it

To catalyze the computing research community to consider such questions

- To envision long-range, more audacious research challenges
- To build momentum around such visions
- To state them in compelling ways
- To move them towards funded initiatives
- To ensure "science oversight" of large-scale initiatives
- A "cooperative agreement" with NSF
 - Close coordination

The CCC --- a broad-based Council

• Leadership:

- ø Ed Lazowska, Chair
- Susan Graham, Vice-Chair
- Servin Gianchandani, Director
- Andrew Bernat, CRA Executive Director

• Terms ending 2014

- Deborah Crawford
- Gregory Hager
- John Mitchell
- Bob Sproull
- Josep Torrellas
- Terms ending 2013
 - Randy Bryant
 - Lance Fortnow
 - Hank Korth
 - Eric Horvitz
 - ø Beth Mynatt
 - Fred Schneider
 - Margo Seltzer

- Terms ending 2012
 - Stephanie Forrest
 - Ohris Johnson
 - Anita Jones
 - Frans Kaashoek
 - Ran Libeskind-Hadas
 - Ø Robin Murphy

Rotated off

- Greg Andrews, 2009
- Bill Feiereisen, 2011
- Ø Dave Kaeli, 2011
- Ø Dick Karp, 2010
- John King, 2011
- Peter Lee, 2009
- Andrew McCallum, 2010
- ø Karen Sutherland, 2009
- Dave Waltz, 2010

Meets three times a year, including once in DC Funded at \$2M/year for three years

Presentations

The Computing Community Consortium: Stimulating Bigger Thinking

Ed Lazowska

Bill & Melinda Gates Chair in Computer Science & Engineering University of Washington

Chair, Computing Community Consortium

Tapia Conference Career Workshop April 2009

http://www.cra.org/ccc/

Presentations Articles

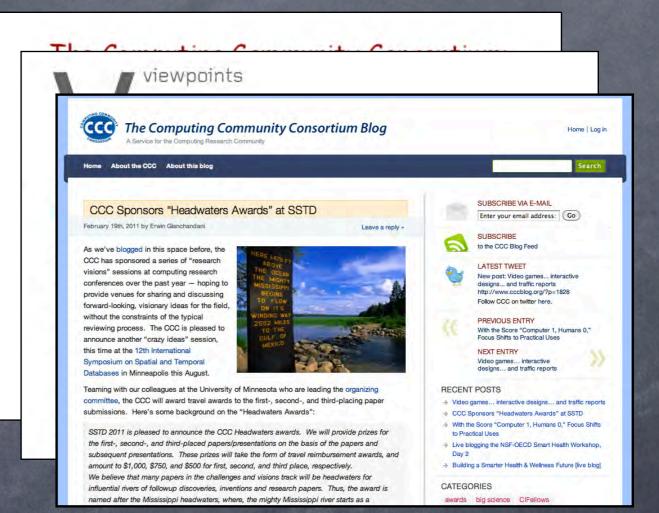


port, and that will attract the best and load for your PC a chess engine with

pursue compelling visions Blue-a supercomputer by any defifor our field-visions that nition-defeated world chess chamwill shape the intellectual pion Garry Kasparov. Today, thanks RISC architectures, modern integratfuture of the field, that will catalyze more to progress in software than to ed circuit design, RAID storage, and research investment and public sup- progress in hardware, you can downbrightest minds of a new generation? a rating 10% higher than any human was clear.

try: timesharing, computer graphics, networking (LANs and the Internet), personal workstation computing, windows and the graphical user interface, parallel computing. In each case, the role of federally sponsored research

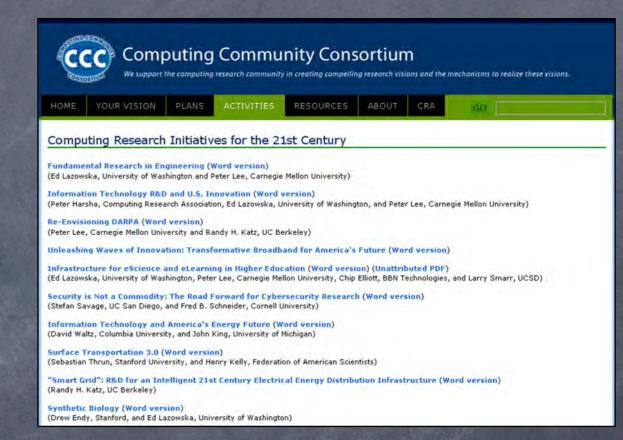
Presentations
Articles
CCC Blog



Presentations
Articles
CCC Blog
Computing Research "Highlight of the Week"



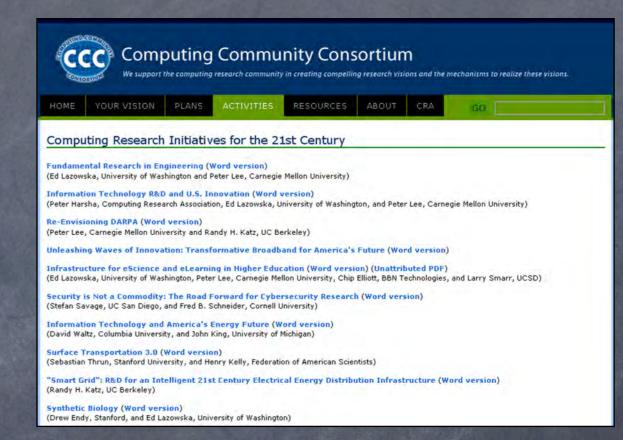
Transition Team white papers



"Transition Team" white papers

- Sensed and seized an opportunity to influence Federal science policy through the Presidential Transition Team
 - I9 papers produced in late 2008 & early 2009
 - 30 separate authors
 - Many highly influential:
 - Re-envisioning DARPA -- Peter Lee, Randy Katz
 - Infrastructure for eScience & eLearning/Unleashing waves of innovation -- Ed Lazowska, Peter Lee, Chip Elliott, Larry Smarr
 - Security is not a commodity -- Stefan Savage, Fred Schneider
 - Synthetic biology -- Drew Endy, Ed Lazowska
 - Big-data computing -- Randy Bryant, Randy Katz, Ed Lazowska
 - The ocean observatories initiative -- John Delaney, John Orcutt, Robert Weller
 - Ocyber-Physical Systems -- Janos Sztipanovits, Jack Stankovic

Transition Team white papers



 Transition Team" white papers
 Library of Congress Symposium



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- Transition Team
 white papers
- Library of Congress
 Symposium
- Landmark Contributions by Students in Computer Science"

The LIBRARY of CONGRESS

Landmark Contributions by Students in Computer Science Version 11: September 15, 2009

There are many reasons for research funding agencies (DARPA, NSF, etc.) to invest in the education of students. Producing the next generation of innovators is the most obvious one. In addition, though, there are an impressive number of instances in our field in which undergraduate and graduate students have made truly game-changing contributions in the course of their studies.

The inspiring list below was compiled by the following individuals and their colleagues: Bill Bonvillian (MIT), Susan Graham (Berkeley), Anita Jones (University of Virginia), Ed Lazowska (University of Washington), Pat Lincoln (SRI), Fred Schneider (Cornell), and Victor Zue (MIT).

We solicit your suggestions for additional student contributions of comparable impact – post them on the Computing Community Consortium blog, http://www.cccblog.org/2009/08/28/landmark-contributions-by-students-in-computer-science/, or send them to Ed Lazowska, lazowska@cs.washington.edu.

Leadership development

Leadership development

 Computing Innovation Fellows (CIFellows)

CRA 🍈 😳

Computing Innovation Fellows Project

Home CRA CCC CISE

The 2009 Computing Innovation Fellows have been selected!

View the press release with the names of the 2009 Fellows and their Mentors, ${\ensuremath{\mathcal{C}}}$

Congratulations to everyone who was selected for a CIFellow award! Thank you for your interest in CIFellows. The response has been tremendous! For up-to- the-minute news on the progress of the selection process, check out the forum.

In the light of the response that the CIFellows has received, we have set up a courtesy website where employers can post available postions suitable for new computing PhD's. This site is available at http://cifellows.org/opportunities.

An additional courtesy site has been set up for computing PhD's to post their profiles and availability. This website is available at http://cifellows.org/profiles. We encourage employers and candidates to make use of these complimentary services.

The Computing Community Consortium (CCC) and the Computing Research Association (CRA), with funding from the National Science Foundation, announce a program for new PhD graduates to obtain one-to-two year postdoctoral positions

CIFellows Project overview

- Established in 2009 with NSF/ CISE funding
- Provides recent Ph.D.s in computer science (and allied fields) post-doctoral positions
- Positions span one to two years
- Goal is to retain new Ph.D.s in research & teaching during difficult economic times
- 60 CIFellows funded in 2009
 - If are leaving by the end of year I, most with permanent positions, many with tenure-track faculty appointments
 - 41 are continuing for a second year
- Additional 47 CIFellows funded in 2010



Computing Innovation Fellows Project

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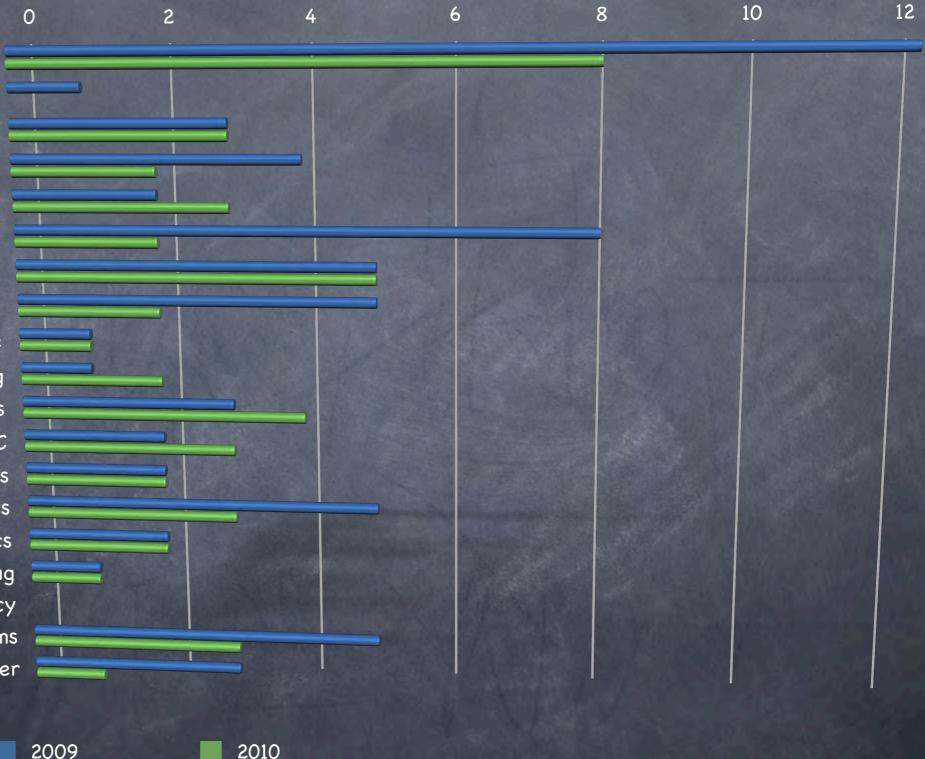
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2009 & 2010 CIFellows Projects

AI/machine learning/robotics/vision Communications/signal processing CS education/ed tech Databases/data mining Graphics/visualization Hardware/architecture Human-computer interaction Security/privacy/cryptography Information systems/information science Mobile/embedded computing Networks/operating systems Numerical/scientific computing/HPC Programming languages/compilers Scientific/medical informatics Social computing/social informatics Software engineering Technology policy Theory/algorithms Other



Leadership development

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Leadership development

- Computing Innovation Fellows (CIFellows)
- Leadership in Science Policy Institute



RESOURCES

NetSE Cyber Physical Systems Robothan XLaver Global Development Architecture

YOUR VISION

Big Data Computing Theoretical CS EDTECH Ope HealthIT SEES IT Interactive Tech

CRA

ABOUT

CCC Leadership in Science Policy Institute

PLANS

Overview

N

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As part of its mission to develop a next generation of leaders in the computing research community, CRA's Computing Community Consortium (CCC) announces the CCC Leadership in Science Policy Institute (LISPI), intended to educate a small cadre of computing researchers on how science policy in the U.S. is formulated and how our government works. We seek nominations for participants.

LiSPI will be centered around a one-day workshop to be held on Monday, November 7, 2011 in Washington, DC.

LiSPI will feature presentations and discussions with science policy experts, current and former Hill staff, and relevant agency and Administration personnel about mechanics of the legislative process, interacting with agencies, advisory committees, and the federal case for computing.

Here is a list of Sessions and Speakers

LiSPI participants are expected to:

Content is still being added to this site. Please check back periodically. The last change was made on: March 30, 2011.

Logistics

Date: November 7, 2011 Location: Hyatt Regency Capitol Hill, Washinton, DC

Participation in the workshop will include breakfast and lunch at the workshop, as well as a reception with workshop speakers and other interested guests at the conclusion of the meeting. Hotel accommodations for two nights (before and after the workshop) as well as

Visioning for the future

Visioning for the future

Research visions sessions at conferences...

Computing Community Consortium CCC³

We support the computing research community in creating compelling research visions and the mechanisms to realize these visions.

HOME YOUR VISION PLANS ACTIVITIES RESOURCES ABOUT CRA

Research Visions

Call for Visionary Conference Tracks

The Computing Community Consortium (CCC) is sponsoring an initiative to bring special "Challenges and Visions" tracks to leading computer science research conferences. The goal of this initiative is to help conferences reach out beyond the usual research papers that present completed work and to seek out papers that present ideas and visions that can stimulate the research community to pursue new directions.

Conferences may request CCC sponsorship of such tracks along with a CCC grant that provides for prize money for the top 3 papers (first prize \$1000, second prize \$750, and third prize \$500, to be awarded as travel grants). (See below for details about selecting and awarding these prizes.)

Papers in a "Challenges and Visions" track should be open-ended, possibly "outrageous" or "wacky", and present new problems, new application domains, or new methodologies that are likely to stimulate significant new research. The CCC is seeking papers (roughly 4 pages in length) so that the ideas can be referenced after the conference is over.

After the conference, the CCC will post links to the track papers on its Challenges and Visions web page and help disseminate these ideas broadly in the computer science research community.

Requests for CCC sponsorship should include information on the conference and a proposed list of program committee members for the track. We provide below a prototype call for papers and suggestions regarding the review process. Proposals should be sent to Erwin Gianchandani, the CCC Director, at erwin@cra.org.

Prior Vision Tracks

- A Outrageous Ideas and Visions (OIV) session, at the 5th Biennial Conference on Innovative Data Systems (CIDR). January 2011, Asilomar, CA - CCC Blog Post - Session Information Page
- * Research Vision session, at the 9th Symposium on Operating Systems Design and Implementation (OSDI), October 2011, Vancouver, BC, Canada - CCC Blog Post
- Session Information Page

See the full list.

...And lots of "visioning activities"

Community visioning activities	Participants	Organizations	
Networking science & engineering	109	44	
Cyber-physical systems	100	47	
Robotics	141	79	
"Big data" computing	81	46	
Theoretical computer science	39	26	
Global development (ICT4D)	56	37	
Learning technologies	55	30	
Health information technology	121	102	
Cross-layer reliability	121	45	
Free and open source software	42	35	
Advancing computer architecture	In progress		
Interactive technologies	In progress		
Sustainability + IT	In progress		

Open RFP for community-driven visioning

"And lots of "visioning activities"

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Interactive technologies	In progress		ACM CHI
Sustainability + IT	In progress		ACM CHI

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Open RFP for community-driven visioning



A Roadmap for US Robotics From Internet to Robotics

Georgia Institute of Technology University of Southern California Johns Hopkins University University of Pennsylvania University of California, Berkeley Rensselaer Polytechnic Institute University of Massachusetts, Amherst University of Utah Carnegie Mellon University Tech Collaborative



4 meetings during summer 2008

Roadmap published May 2009

Extensive discussions between visioning activity leaders & agencies

Henrik Christensen Georgia Tech



EXECUTIVE OFFICE OF THE PRESIDENT OFFICE OF MANAGEMENT AND BUDGET WASHINGTON, D.C. 20503



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CRA

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES Peter R. Orszag Director, Offic ement and Budget John P. Holdren Director, Office of tience Technology Policy

July 21, 2010

BJECT: Science and Technology Priorities for the FY 2012 Budget

Scientific discovery, technological breakthroughs, and innovation are major engines for expanding the frontiers of human knowledge and are indispensable for promoting sustainable economic growth, improving the health of the population, moving toward a clean energy future, addressing global climate change challenges, managing competing demands on the environment, and safeguarding our national security.

This memorandum follows up on OMB Memorandum M-10-19 by outlining the Administration's science and technology (S&T) priorities for formulating FY 2012 Budget submissions to the Office of Management and Budget (OMB). These priorities for research and development (R&D) investments and other S&T investments build on priorities already reflected in the American Recovery and Reinvestment Act, the FY 2010 and 2011 Budgets, and key Administration policy guidance such as the President's Strategy for American Innovation. This memorandum also provides program guidance for S&T activities in Executive Departments and Agencies.

Prioritizing key S&T activities

THE DIRECT M-10-30

FROM

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Extensive discussions between visioning activity leaders & agencies

OSTP issues directive to all agencies to include robotics in FY 12 budgets

> Henrik Christensen Georgia Tech





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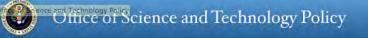
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FROM:

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RTD2: Research for Robotics

Posted by Tom Kalil and Sridhar Kota on September 15, 2010 at 03:09 PM EDT

In July, the heads of the Office of Management and Budget and the Office of Science and Technology Policy identified robotics as one of the Administration's R&D priorities for the President's FY2012 budget

Robotics is an important technology because of its potential to advance national needs such as homeland rity, defense, medicine, healthcare, space exploration, environmental monitoring and remediation, ortation, advanced manufacturing, logistics, services, and agriculture. Robotics is also nearing a tipping terms of its usefulness and versatility as technologies such as software, chips, and computer vision inue to improve

OSTP has been working with Federal agencies and the research community to identify concrete steps that the Administration can take to promote U.S. leadership in robotics

As part of this effort, five agencies teamed up to issue a joint solicitation for small business research for Robotics Technology Development and Deployment (RTD2). Small businesses can apply for research funding for a wide range of topics, including robot-assisted rehabilitation, robotics for drug discovery, and robots that can disarm explosive devices

Expect to see more to come in the months ahead from a newly energized and collaborative Federal robotics community

Tom Kalil is Deputy Director for Policy in the White House Office of Science and Technology Policy

Sridhar Kota is Assistant Director for Advanced Manufacturing in the White House Office of Science and Technology Policy

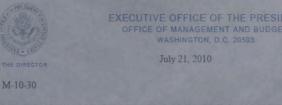
> Agencies begin rolling out robotics initiatives, beginning with RTD2



Henrik Christensen Georgia Tech



A Roadmap for US Robotics **From Internet to Robotics**



MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES Peter R. Orszag

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Roadmap published May 2009

Extensive discussions between visioning activity leaders & agencies

Trying to replicate success with learning technologies, through discussions with ED and NSF leaders

> robotics in FY 12 budgets

Agencies begin olling out robotics initiatives, beginning with RTD2

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Thursday, April 7, 2011

Health information technology

- Following ARRA, NSF asked CCC to organize workshop
- Computer scientists, systems engineers, social scientists, care practitioners
- Produced a report summarizing key research questions and directions



Connecting America for Better Health The Office of the National Coordinator for Health Information Technology

- From data to knowledge to action -- enabling evidence-based healthcare
- Empowering people -providers and consumers -improves healthcare quality
- Computer-based augmentation of human learning, reasoning, decision-making, and physical motion significantly enhances human capabilities
- Healthcare is a complex, large-scale, adaptive distributed evolving system

 The Importance of Collaborative Government Investment

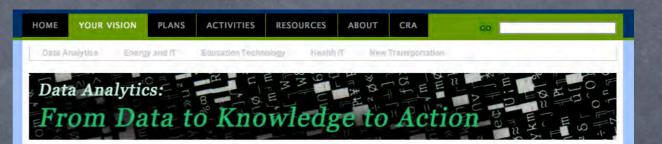
Sustainability + IT

- NSF/CISE recently asked CCC to run a workshop on sustainability
- Computer scientists, systems engineers, social scientists, sustainability scientists
- Produced a report summarizing key research questions and directions

- ø Defining sustainability
- Routine uses of CISE for sustainability
- CISE research to further sustainability
 - Big data
 - Modeling & simulation
 - Optimization
 - Intelligent systems
 - Cyber-physical systems
 - Human-centered & social computing
 - Privacy & security
 - Systems engineering & systems integration
 - Green IT
- The power of applied problems
- Collaboration & interdisciplinary research
- ø Education & workforce development
- The importance of collaborative Federal investment

Data analytics

- Overview
- eScience
- Healthcare
- Energy
- Education technology
- New Transportation
- Intelligence
- New Biology
- Robotics & emergency response



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Funding Opportunities

* NSF Cyber-Enabled Discovery and

Innovation (CDI) Program

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Overniew

Today, data available via the Internet, sensor networks, and new and higher resolution sensors across the sciences allow us to capture more data about people and the world than ever before - and the quantities of data available are accelerating. Coupled with recent advances in machine learning and reasoning, as well as rapid rises in computing power and storage, we are transforming our ability to make sense of these increasingly large, heterogeneous, noisy or incomplete datasets collected from a variety of sources; to visualize and infer important new knowledge from the data; and to guide action and policies in missioncritical situations, enabling us to make the best decisions. The pipeline of data --> predictive models --> decision analyses will transform many facets of our daily lives, from healthcare delivery to transportation to energy and the environment. These methods will be critical for Federal agencies tasked with protecting America from threats. And they have the potential to alter how we educate the next generation, how we interact with one another, and how we protect our personal privacy and security in an era of constant connectivity and unfiltered access. Ultimately, data analytics - enabling the transition from data to knowledge to action - is critical to address our nation's priorities and to ensure our nation's prosperity well into the 21st century

- White Papers From Data to Knowledge to Action: A Global Enabler for the 21st Century
- PDF | Word Enabling Evidence-Based Healthcare
- PDF | Word
- Enabling an Initiative in "New Biology" - PDF | Word
- Enabling 21st Century Discovery in Science and Engineering PDF | Word

Workshops/Conferences 🖌 Hadoop Summi

- March 25, 2008, Sunnyvale, CA
- A Data-Intensive Computing Symposium
- March 26, 2008, Sunnyvale, CA

Data analytics

Overview @ eScience Healthcare Energy Education
 Educatio New Trans Intelligenc New Bioloc Robotics & response

Systems biology: As the NAS report stated, "Improved measurement technologies and mathematical and computational tools have led to the emergence of a new approach to [address] biological questions termed 'systems biology' [that] strives to [integrate heterogeneous experimental data sets] and achieve predictive modeling [of biological systems]." Rather than pursuing the decades-old *reductionist* approach, interrogating individual components and reactions underlying a given system, systems biology attempts to *integrate* various biological structures and create predictive models representing systems-level functions and behaviors.

For example, in 2007, systems biologists published a genome-scale reconstruction of the human metabolic network³. This reconstruction catalogs all known gene, protein, and reaction relationships underlying human metabolism – the vital cellular process that is attributed to many human diseases – in a highly quantitative, structured, and chemically consistent manner. In other words, the reconstruction assimilates all existing experimental knowledge about the system, and enables a quantitative analysis of the "flows" through the network – much like a map of a highway system overlaid with quantitative data about traffic volumes. Nearly 1,500 genes spanning 2,000 proteins and 3,300 reactions were incorporated from nearly 1,600 different papers. The resultant *model* represents the set of all hypotheses about the network that have been reported in the literature to date and, in turn, can be used to *predict which genes are essential or inessential, and which ones are involved in mechanisms of chronic diseases like cancer and arthritis*. Ultimately, such a model *enables us to better understand the manifestation of human diseases and identify ideal drug targets to combat these illnesses*.

Computational biology: Whereas systems biology takes an integrative, systems-based approach, computational biology applies data mining, machine learning, graphics/visualization, and related computational techniques to specific biological questions. For instance, clustering algorithms have been applied to gene expression data to associate genes with similar functions. High-throughput gene expression assays are enabling us to measure the expression levels of thousands of genes simultaneously, across different conditions and over time. These assays result in incredibly large data sets: the expression of each gene requires multiple "probes," meaning that there are often 20 or more data elements per gene, and a routine experiment involving human cells measures 54,000 human gene transcripts concurrently. By clustering these data, we are able to make sense of the data and gain insight into gene function; genes that respond similarly to different stimuli are more likely to have related functions. Likewise, "compendium analyses" are used to study the mechanisms underlying drug function, by comparing the gene expression profiles of unknown drugs with databases of profiles of known drugs. Drugs with similar mechanisms are likely to have correlative gene expression footprints⁴.





Funding Opportunities * NSF Cyber-Enabled Discovery and Innovation (CDI) Program

Data analytics

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Nearly 2500 years ago, Hippocrates kicked off a revolution in healthcare by calling for the careful collection and recording of evidence about patients and their illnesses. This call—which first introduced the goal of sharing data among physicians to provide the best care possible for patients—established a foundation for the evolution of modern healthcare. Although 25 centuries have passed since Hippocrates' call, we have not yet attained the dream of true evidence-based healthcare. Large quantities of data about wellness and illness continue to be dropped on the floor, rather than collected and harnessed to optimize the provision of care. We are simply not yet doing the best that we can.

We now stand at the brink of a potential revolution in data-centric healthcare, enabled by advances in computer science. Such a revolution promises to enhance the quality of healthcare while cutting costs, and, more generally, enabling physicians to do the very best that is possible with realistically bounded healthcare resources. Doing the best that can be done with available resources aligns with the core promise that all physicians make when they solemnly raise their hand and recite the Hippocratic Oath upon receipt of their medical degree.

Enabling this vision of true evidence-based healthcare will require critical investments for translating key methods and insights into working systems, as well as for advances in core computer science research and engineering to address key conceptual bottlenecks and opportunities.





Funding Opportunities

* NSF Cyber-Enabled Discovery and
Innovation (CDI) Program

Collecting and analyzing data collected on health and illness promises to enhance the quality and efficacy of healthcare, and to enhance the quality and longevity of life. The collection and analysis of data can provide new insights about wellness and illness that can be operationalized. Data-centric methods allow us to transform *data* into *predictive models*. Predictive models can be used to generate forecasts with well-characterized accuracies about the future—or diagnoses about states of a patient that we cannot inspect directly. Such forecasts or diagnoses can be harnessed within procedures that generate recommendations for *actions in the world*, and decisions about *when it is best to collect more information about a situation before acting*, considering the costs and time delays associated with collecting more information to enhance a decision.

The pipeline of *data to prediction to action* can be used to automate or provide decision support for accurate triage and diagnosis, to generate well-calibrated predictions about health outcomes,

The value of the CCC

How necessary is it to have within the U.S. computing research community an organization designated to perform one or more of the following activities?

	0%	20%	40%	60%	80%	100%	
Bring the community together to discuss, prioritize, and envision future research needs		238		261		5 31	
Communicate these priorities and needs to the broader national community		353		217	7	<mark>91</mark> 13	
Develop visions and thinking for computing research that will galvanize the public, policymakers, researchers, and/or students		353		209		<mark>96</mark> 17	
Turn the priorities and visions developed within the community into funded research programs and/or instruments		325		234 9		<mark>97 1</mark> 8	
Generate excitement within and about computing research that attracts students of both genders and al ethnic groups into computing research careers	•	387		19	192 <mark>81</mark>		
Serve as a widely accepted catalyst and voice for the computing research community	e	201	27	/1	166	36	
Inculcate values of leadership and service in the computing research community by example, inclusion and mentoring Necessary and urgent	,	182	263 Jecessary		201	<mark>26</mark>	
 Helpful but not necessary 		 Necessary but not urgent Not at all necessary 					

--SRI International

Small, nimble organization Onique components to the mission

Provides a "leadership voice" for the community

Synergistic steps forward?

Number of places where computing can help with NIH mission and activities

- Modeling & simulation
- Robotics and cyber-physical systems
- Big data // data analytics
- Ways to get more computer scientists involved?
- Workshops that bring CS folks together with domain scientists?
- Getting the word out about NIH RFPs relevant for computer scientists?



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