The Computing Community Consortium

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

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

Overview

- The Computing Research Association
- What is the CCC?
- Possible synergistic directions?

The Computing Research Association

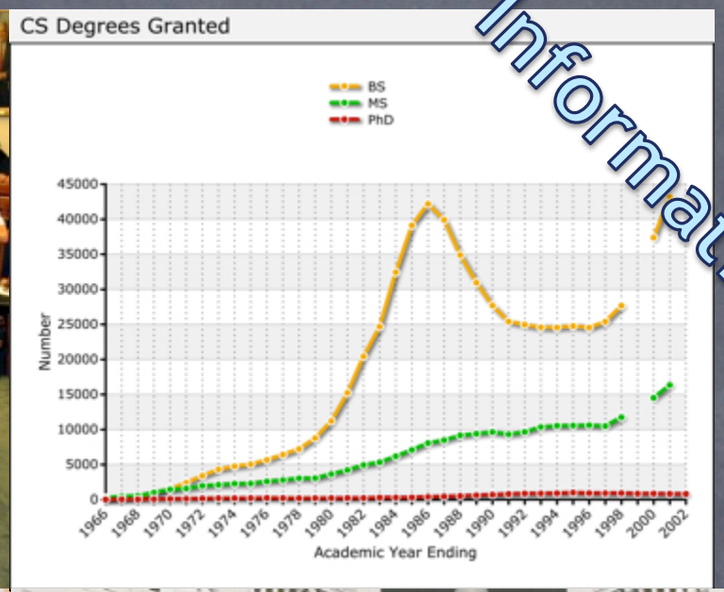
Over 220 department/lab members

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
West Virginia University - CSEE
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



Mission + 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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Government Affairs

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CRA-W CDC

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CRA-W
CDC

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Mission + activities

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

The Computing Community Consortium

Concerns in the mid-2000s...

- NSF leaders and computing research leaders had 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:
  - Ed Lazowska, Chair
  - Susan Graham, Vice-Chair
  - Erwin 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
  - Beth Mynatt
  - Fred Schneider
  - Margo Seltzer
- Terms ending 2012
  - Stephanie Forrest
  - Chris Johnson
  - Anita Jones
  - Frans Kaashoek
  - Ran Libeskind-Hadas
  - Robin Murphy
- Rotated off
  - Greg Andrews, 2009
  - Bill Feiereisen, 2011
  - Dave Kaeli, 2011
  - Dick Karp, 2010
  - John King, 2011
  - Peter Lee, 2009
  - Andrew McCallum, 2010
  - Karen Sutherland, 2009
  - Dave Waltz, 2010

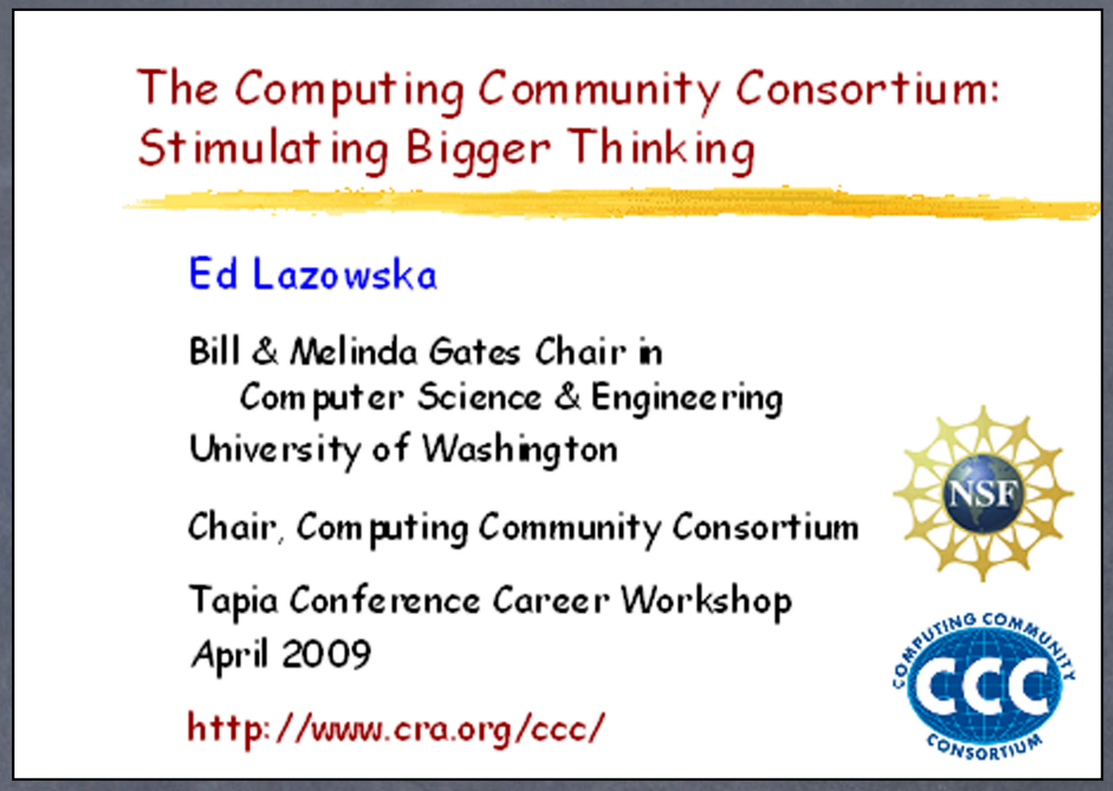
Meets three times a year, including once in DC
Funded at $2M/year for three years

Communicating about computing...

...to the community, to the public, etc.

Communicating about computing...

- 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/

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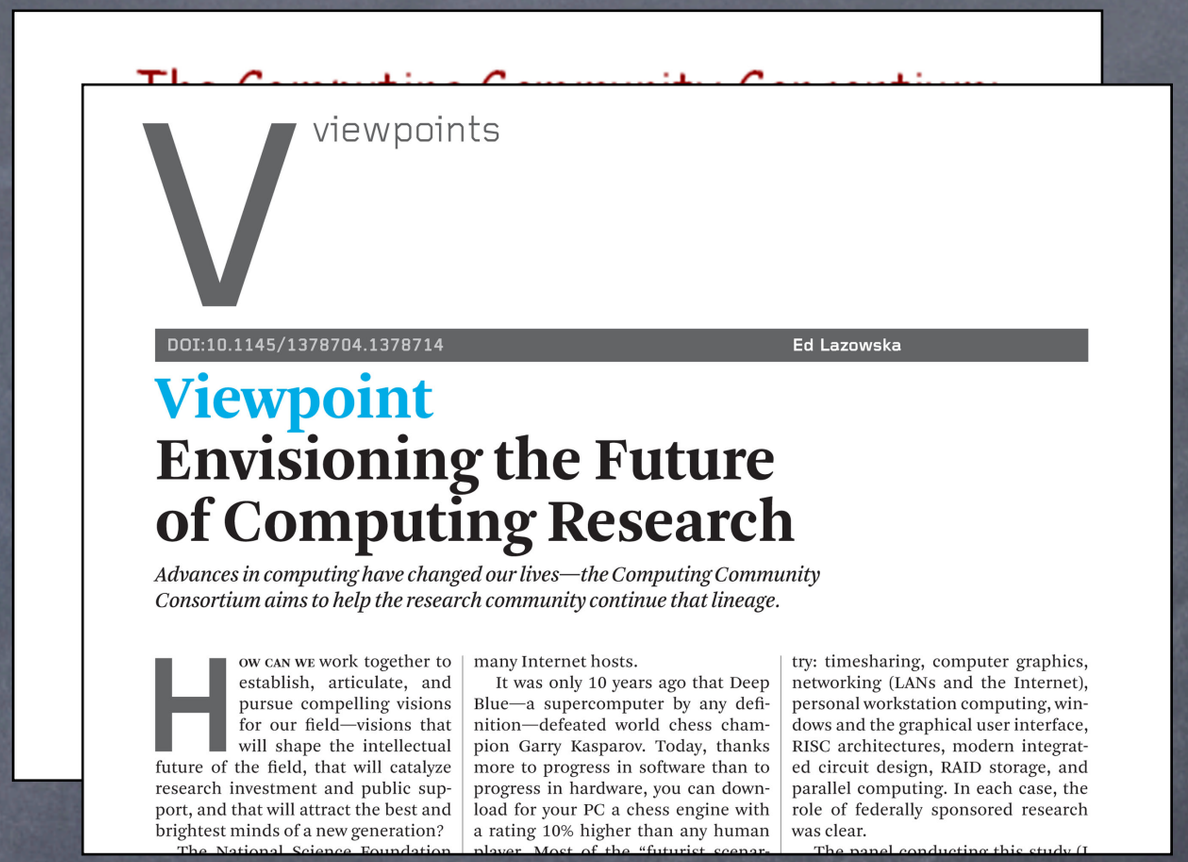
Communicating about computing...

- Presentations
- Articles



viewpoints

DOI:10.1145/1378704.1378714 Ed Lazowska

Viewpoint

Envisioning the Future of Computing Research

Advances in computing have changed our lives—the Computing Community Consortium aims to help the research community continue that lineage.

How can we work together to establish, articulate, and pursue compelling visions for our field—visions that will shape the intellectual future of the field, that will catalyze research investment and public support, and that will attract the best and brightest minds of a new generation?

The National Science Foundation

many Internet hosts.

It was only 10 years ago that Deep Blue—a supercomputer by any definition—defeated world chess champion Garry Kasparov. Today, thanks more to progress in software than to progress in hardware, you can download for your PC a chess engine with a rating 10% higher than any human player. Most of the "futurist scenar-

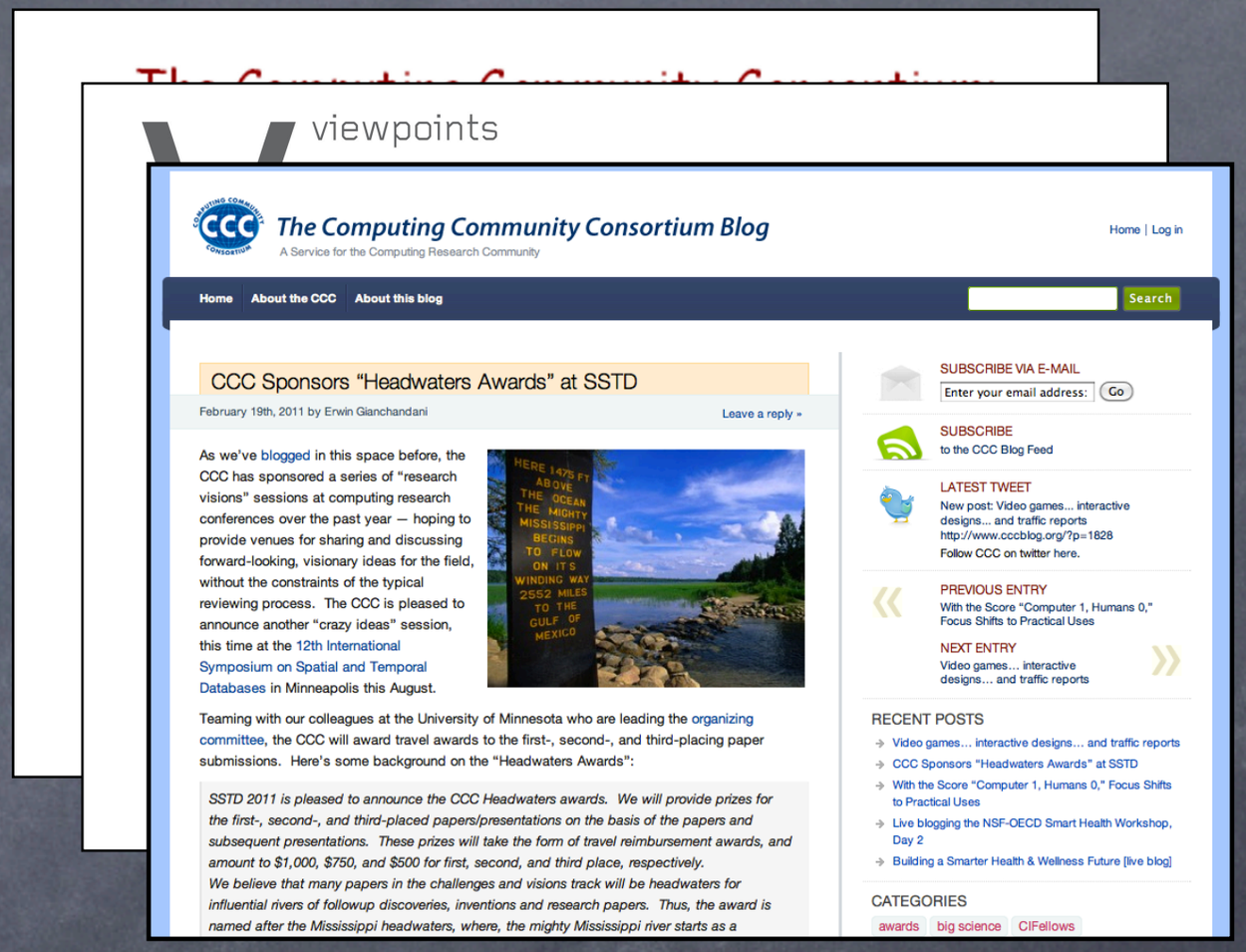
try: timesharing, computer graphics, networking (LANs and the Internet), personal workstation computing, windows and the graphical user interface, RISC architectures, modern integrated circuit design, RAID storage, and parallel computing. In each case, the role of federally sponsored research was clear.

The panel conducting this study (I

...to the community, to the public, etc.

Communicating about computing...

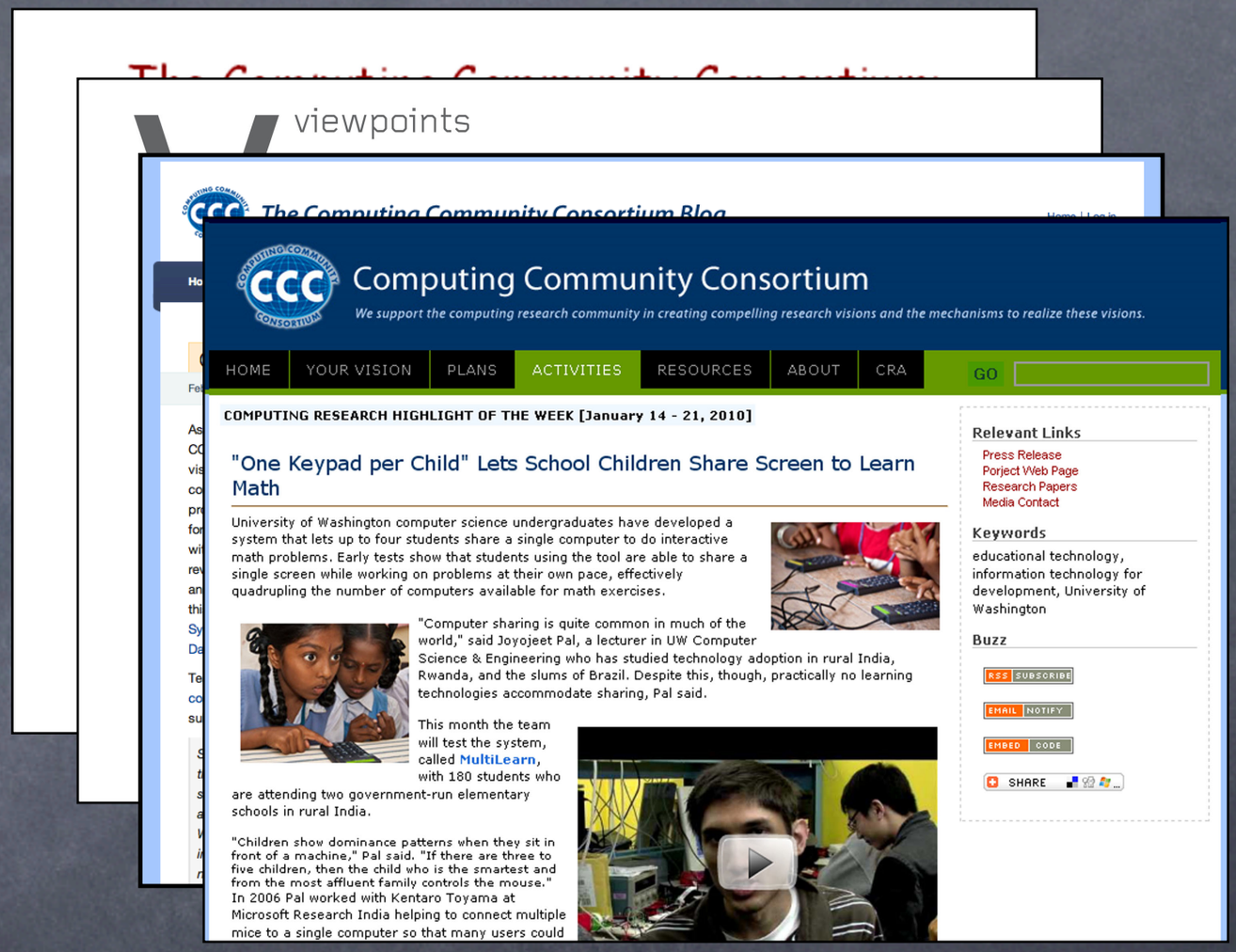
- Presentations
- Articles
- CCC Blog



...to the community, to the public, etc.

Communicating about computing...

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



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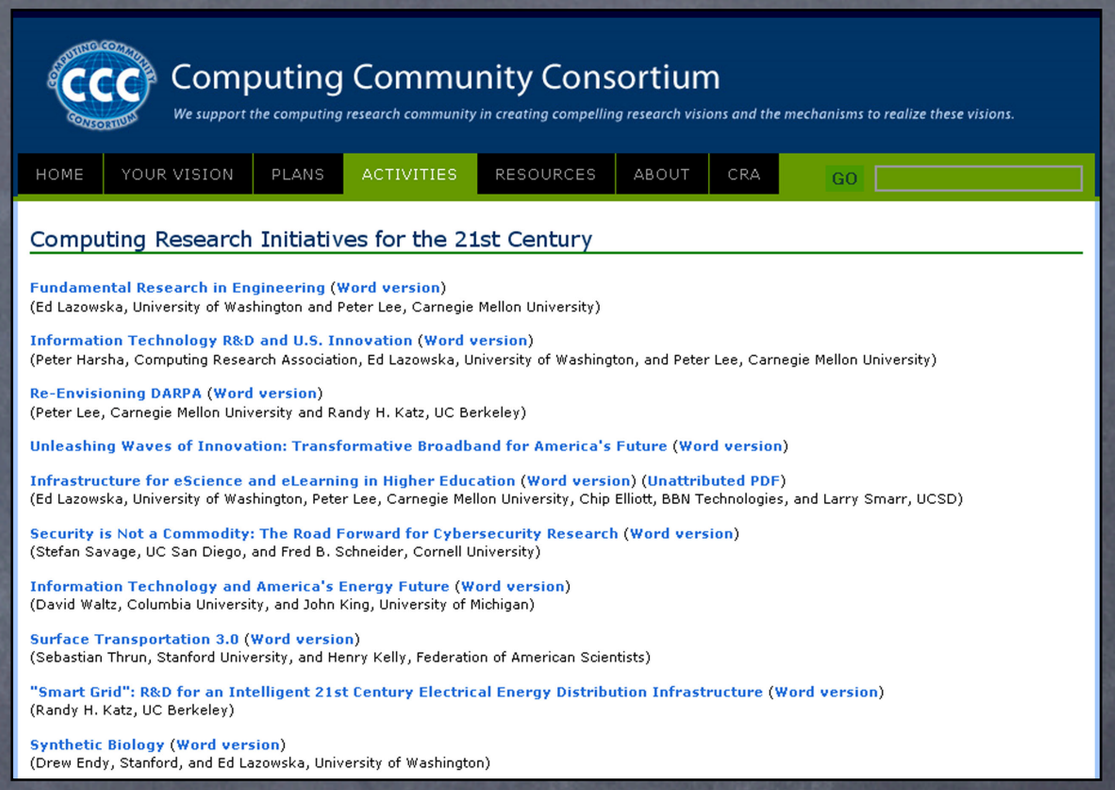
Outreach to Federal agencies

- "Transition Team" white papers



Computing Community Consortium

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 | GO

Computing Research Initiatives for the 21st Century

Fundamental Research in Engineering (**Word version**)
(Ed Lazowska, University of Washington and Peter Lee, Carnegie Mellon University)

Information Technology R&D and U.S. Innovation (**Word version**)
(Peter Harsha, Computing Research Association, Ed Lazowska, University of Washington, and Peter Lee, Carnegie Mellon University)

Re-Envisioning DARPA (**Word version**)
(Peter Lee, Carnegie Mellon University and Randy H. Katz, UC Berkeley)

Unleashing Waves of Innovation: Transformative Broadband for America's Future (**Word version**)

Infrastructure for eScience and eLearning in Higher Education (**Word version**) (**Unattributed PDF**)
(Ed Lazowska, University of Washington, Peter Lee, Carnegie Mellon University, Chip Elliott, BBN Technologies, and Larry Smarr, UCSD)

Security is Not a Commodity: The Road Forward for Cybersecurity Research (**Word version**)
(Stefan Savage, UC San Diego, and Fred B. Schneider, Cornell University)

Information Technology and America's Energy Future (**Word version**)
(David Waltz, Columbia University, and John King, University of Michigan)

Surface Transportation 3.0 (**Word version**)
(Sebastian Thrun, Stanford University, and Henry Kelly, Federation of American Scientists)

"Smart Grid": R&D for an Intelligent 21st Century Electrical Energy Distribution Infrastructure (**Word version**)
(Randy H. Katz, UC Berkeley)

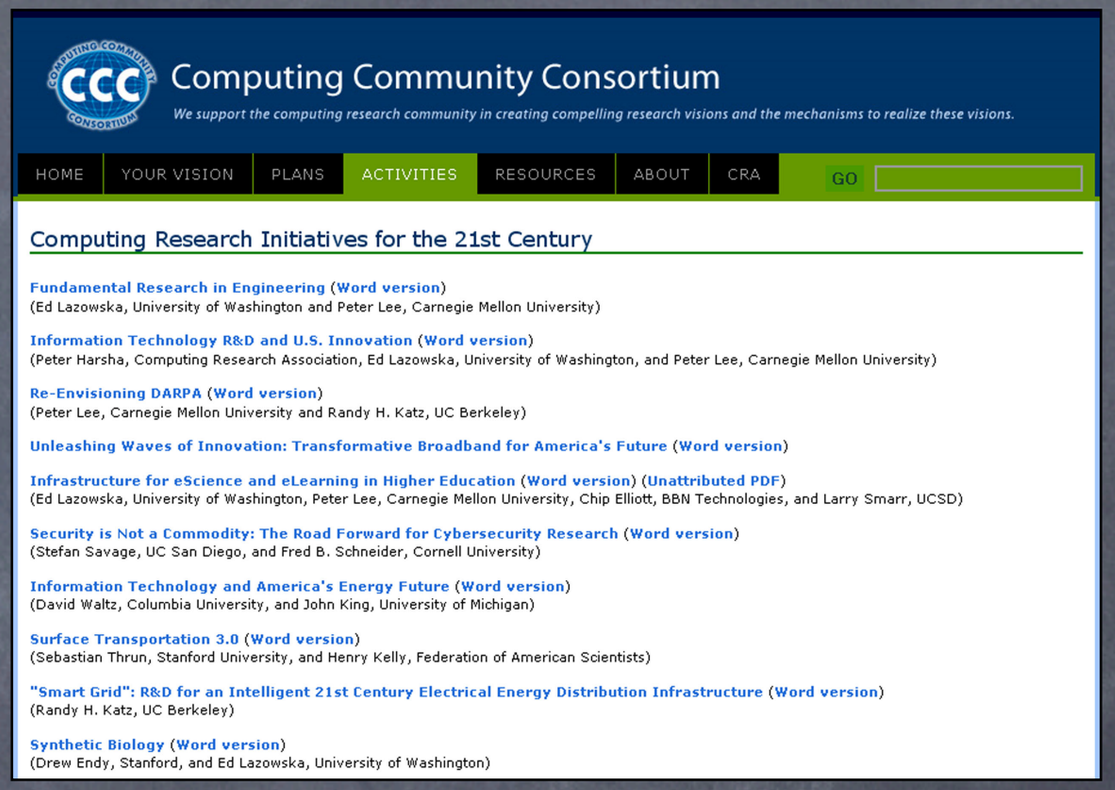
Synthetic Biology (**Word version**)
(Drew Endy, Stanford, and Ed Lazowska, University of Washington)

"Transition Team" white papers

- Sensed and seized an opportunity to influence Federal science policy through the Presidential Transition Team
  - 19 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
    - Cyber-Physical Systems -- Janos Sztipanovits, Jack Stankovic

Outreach to Federal agencies

- "Transition Team" white papers



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Outreach to Federal agencies

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- Library of Congress Symposium

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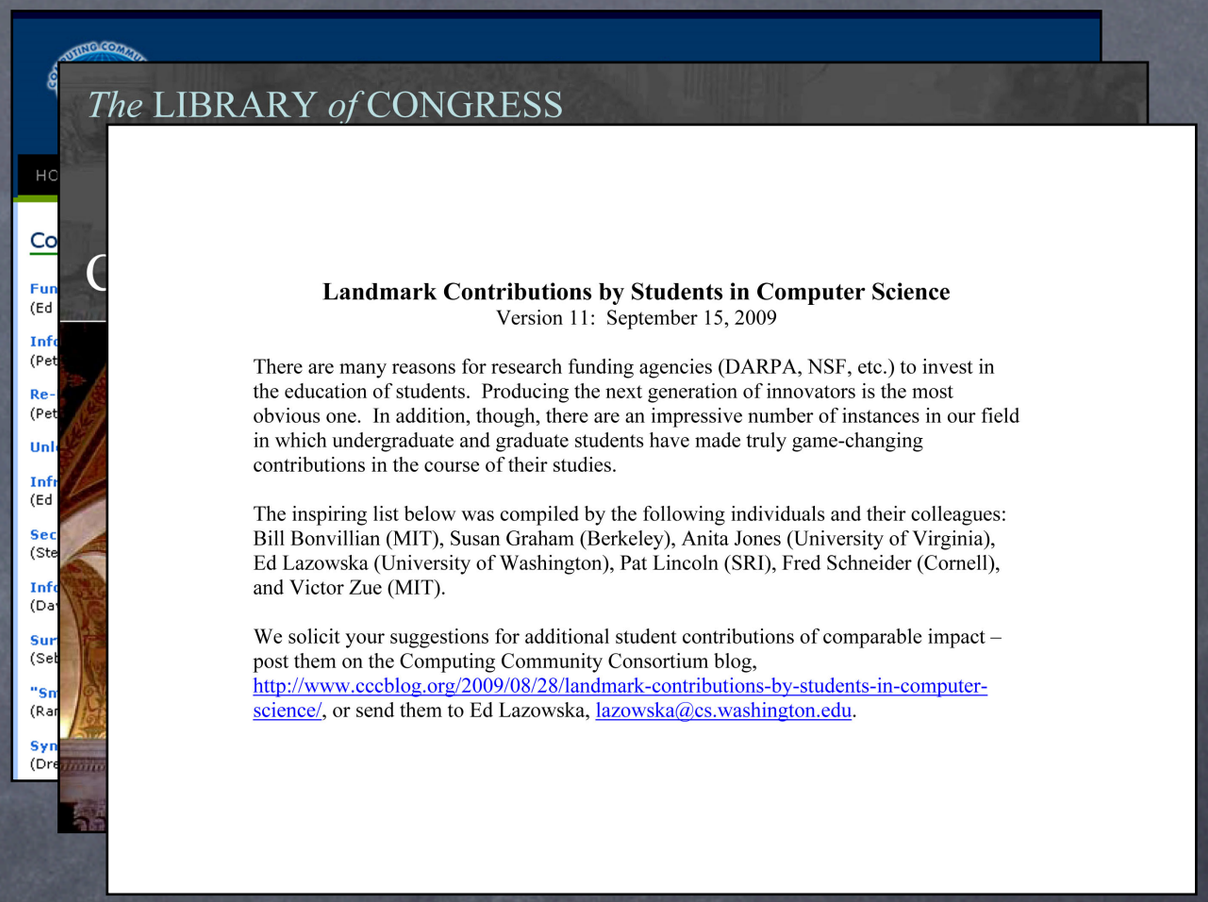
- "Transition Team" white papers
- Library of Congress Symposium
- "Landmark Contributions by Students in Computer Science"



Leadership development

Leadership development

- Computing Innovation Fellows (CIFellows)

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.

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.

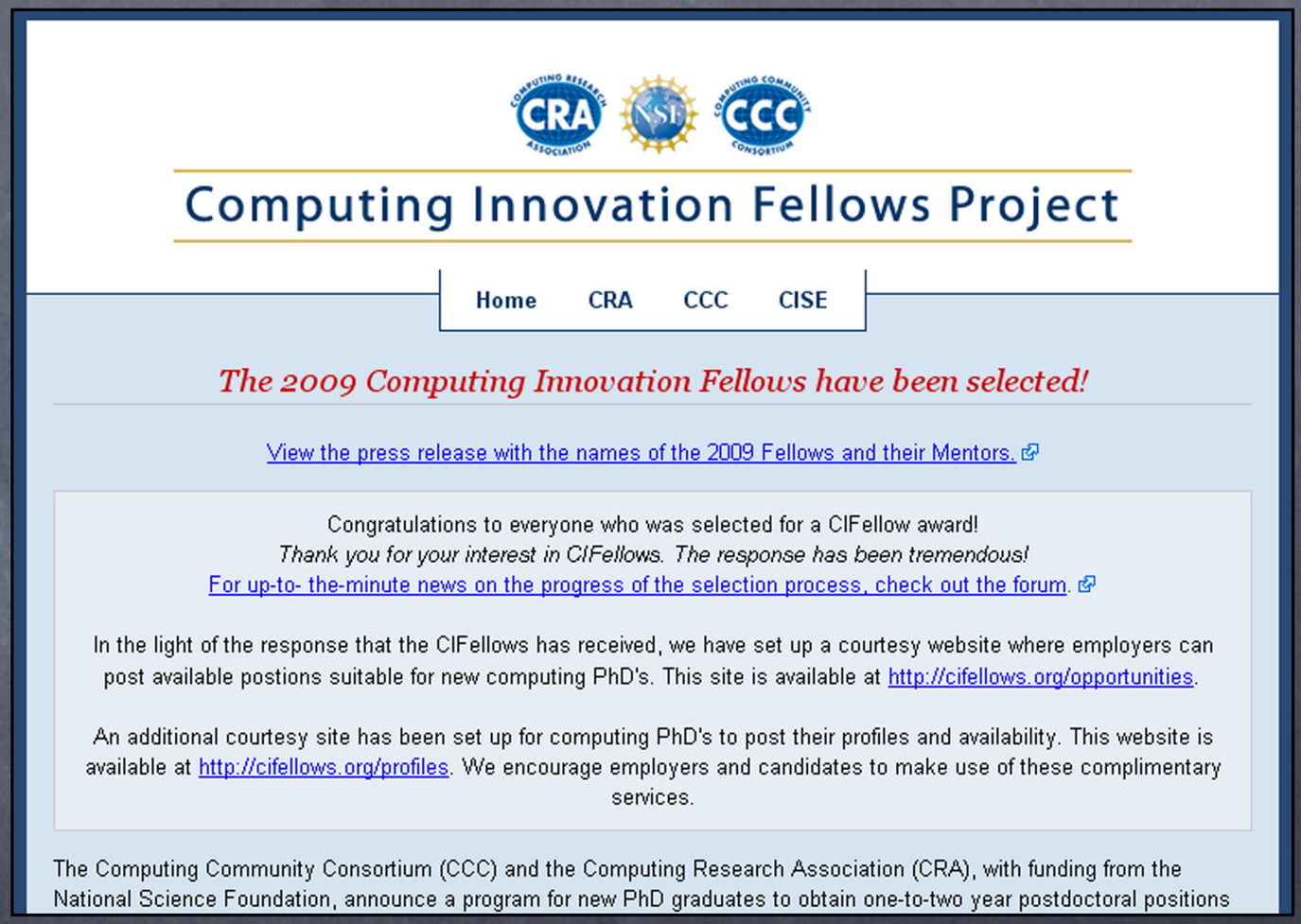
In the light of the response that the CIFellows has received, we have set up a courtesy website where employers can post available postions suitable for new computing PhD's. This site is available at http://cifellows.org/opportunities.

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.

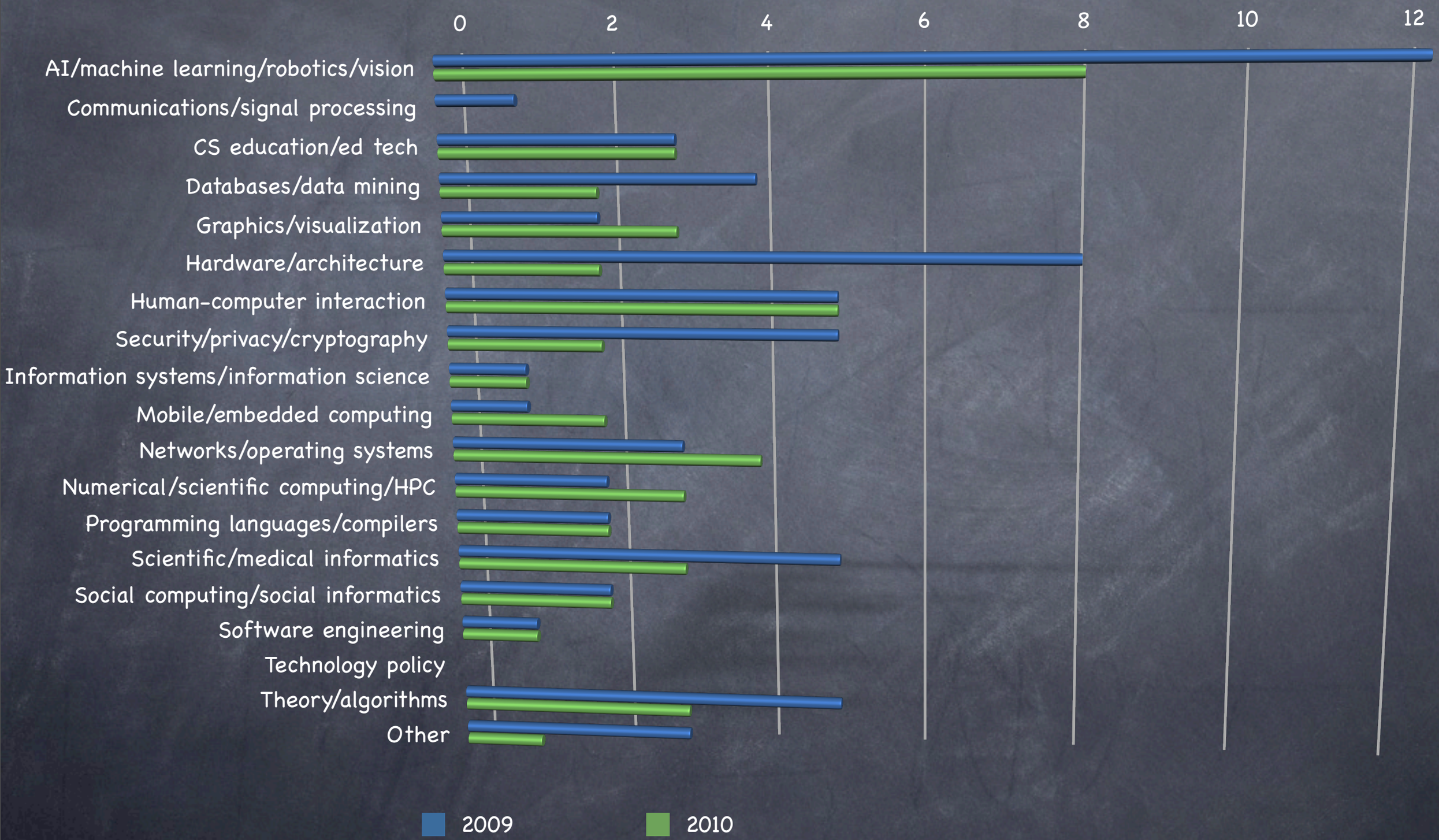
The Computing Community Consortium (CCC) and the Computing Research Association (CRA), with funding from the National Science Foundation, announce a program for new PhD graduates to obtain one-to-two year postdoctoral positions

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
  - 19 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



2009 & 2010 CIFellows Projects



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

Visioning for the future

Visioning for the future

- Research visions sessions at conferences...

...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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Yahoo!

NSF, ONC, NLM, NIST, AHRQ

Canada GRAND, ACM CHI

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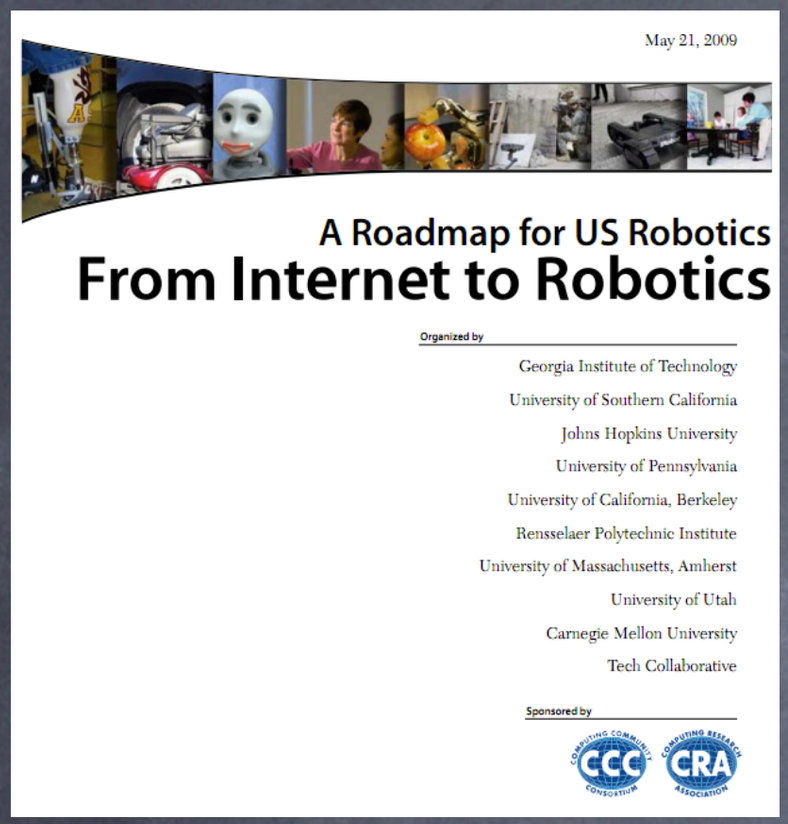
Open RFP for **community-driven** visioning

Robotics as an example



May 21, 2009

A Roadmap for US Robotics

From Internet to Robotics

Organized by

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

Sponsored by

CCC Computing Community Consortium
CRA Computing Research Association

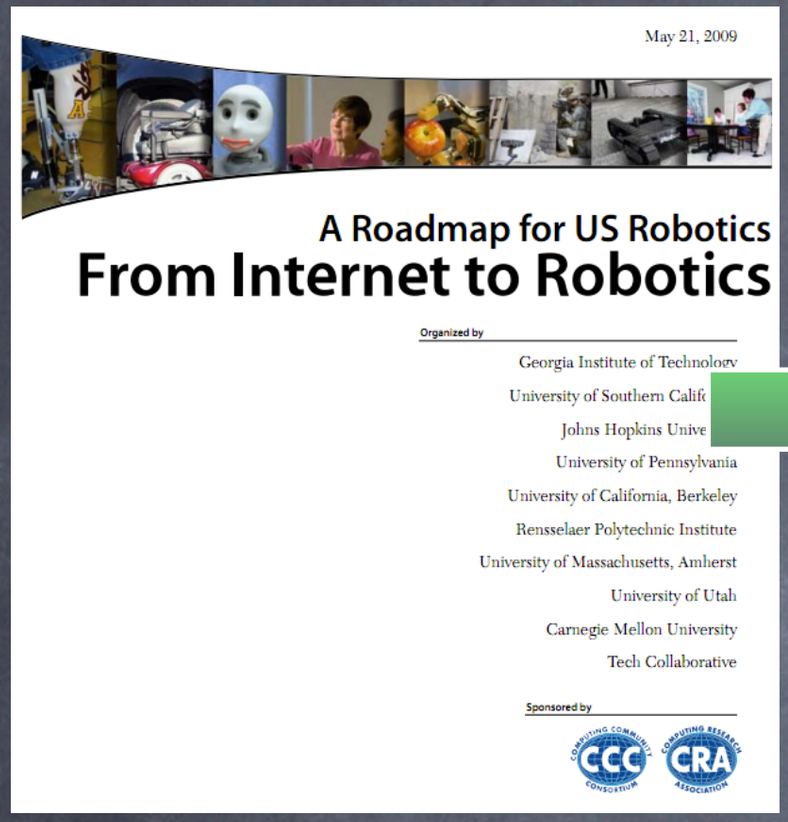
4 meetings during summer 2008

Roadmap published May 2009

Extensive discussions between visioning activity leaders & agencies

Henrik Christensen
Georgia Tech

Robotics as an example



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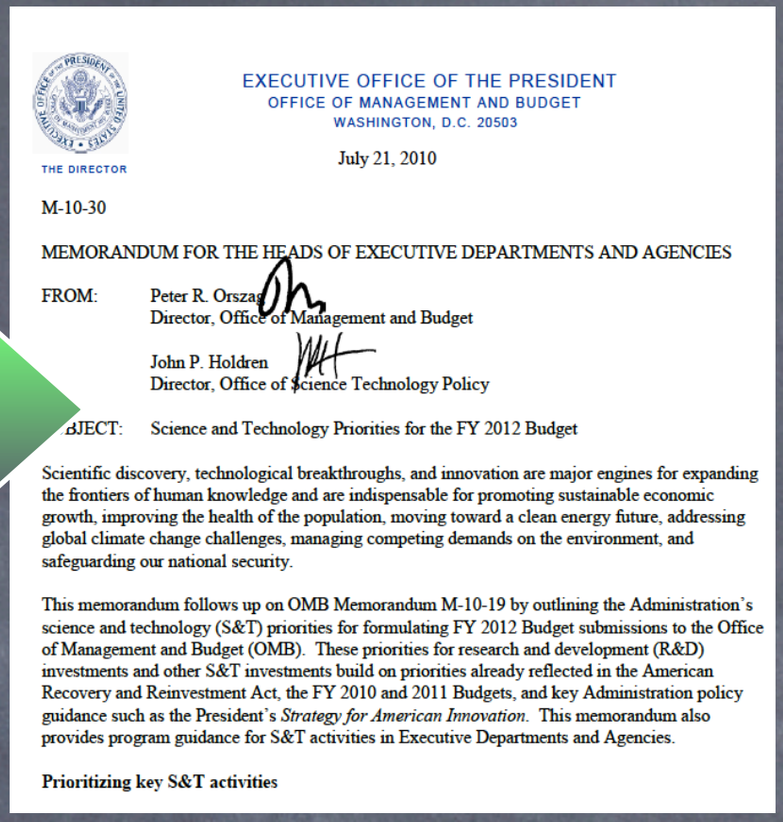
4 meetings during summer 2008

Roadmap published May 2009

Extensive discussions between visioning activity leaders & agencies



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

THE DIRECTOR

July 21, 2010

M-10-30

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: Peter R. Orszag
Director, Office of Management and Budget

John P. Holdren
Director, Office of Science Technology Policy

SUBJECT: 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.

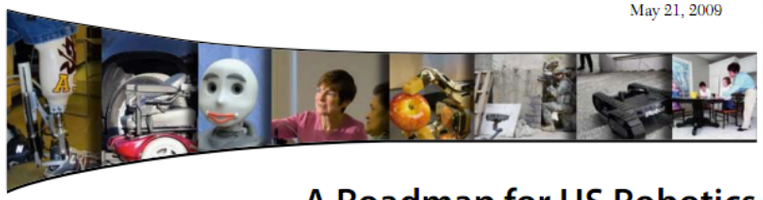
This memorandum follows up on OMB Memorandum M-10-19 by outlining the Administration's science and technology (S&T) priorities for formulating FY 2012 Budget submissions to the Office of Management and Budget (OMB). These priorities for research and development (R&D) investments and other S&T investments 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

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

Henrik Christensen
Georgia Tech

Robotics as an example



May 21, 2009

A Roadmap for US Robotics
From Internet to Robotics

Organized by

Georgia Institute of Technology
University of Southern Calif
Johns Hopkins Unive
University of Pennsylvania
University of California, Berkeley
Rensselaer Polytechnic Institute
University of Massachusetts, Amherst
University of Utah
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Office of Science and Technology Policy

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RTD2: Research for Robotics

Subscribe

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 ...curity, defense, medicine, healthcare, space exploration, environmental monitoring and remediation, ...rtation, 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 ...tinue 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!

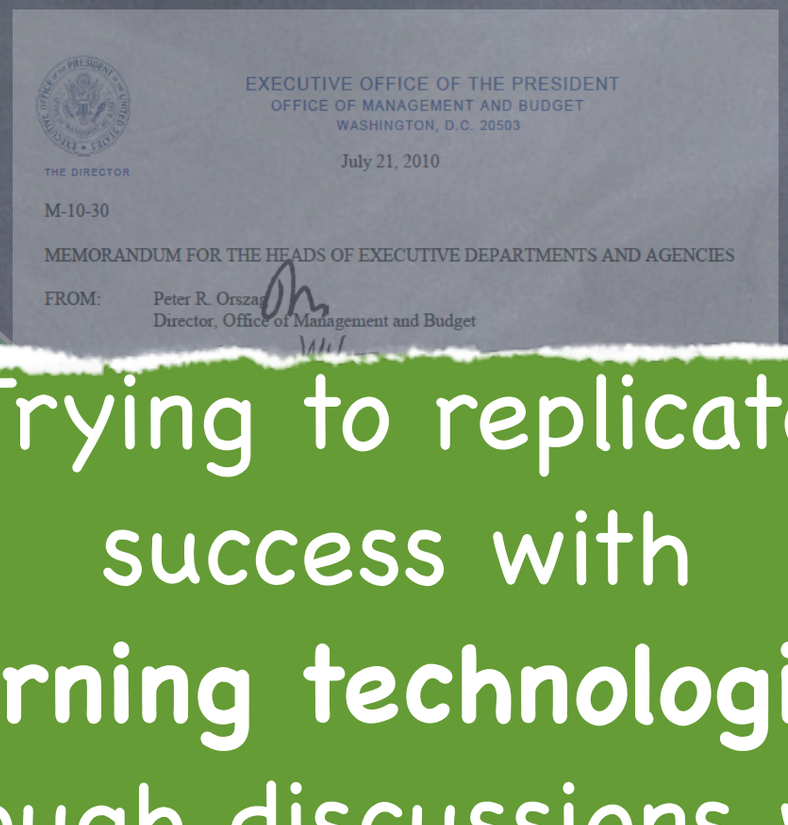
Tom Kalil is Deputy Director for Policy in the White House Office of Science and Technology Policy

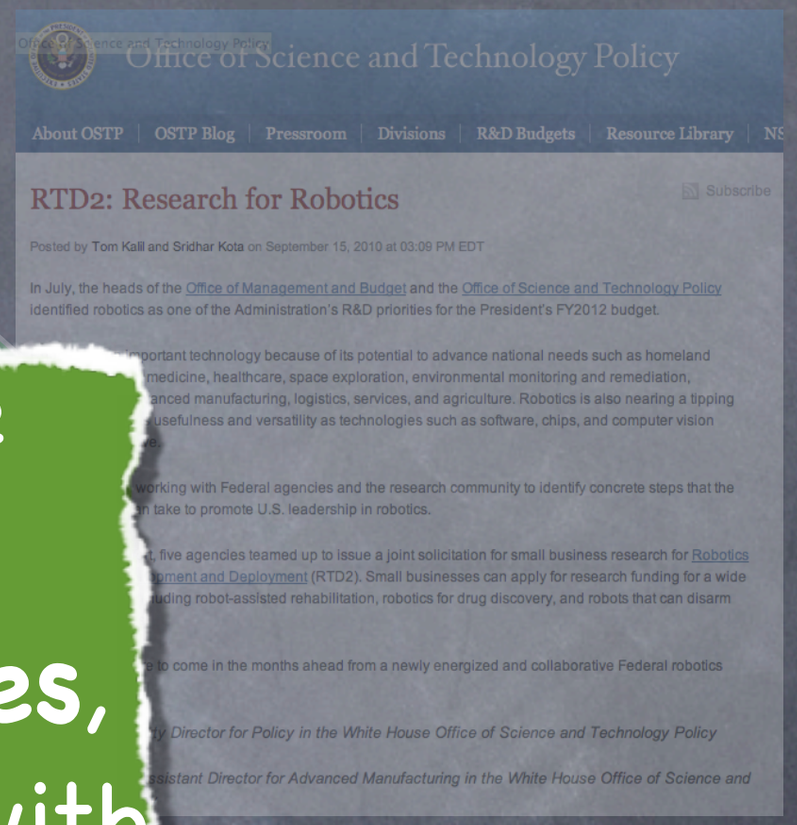
Sridhar Kota is Assistant Director for Advanced Manufacturing in the White House Office of Science and Technology Policy

Agencies begin rolling out robotics initiatives, beginning with RTD2

Henrik Christensen
Georgia Tech

Robotics as an example





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

4 meetings during summer 2008

Roadmap published May 2009

Extensive discussions between visioning activity leaders & agencies

agencies to include robotics in FY 12 budgets

Agencies begin rolling out robotics initiatives, beginning with RTD2

Henrik Christensen
Georgia Tech

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

- 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

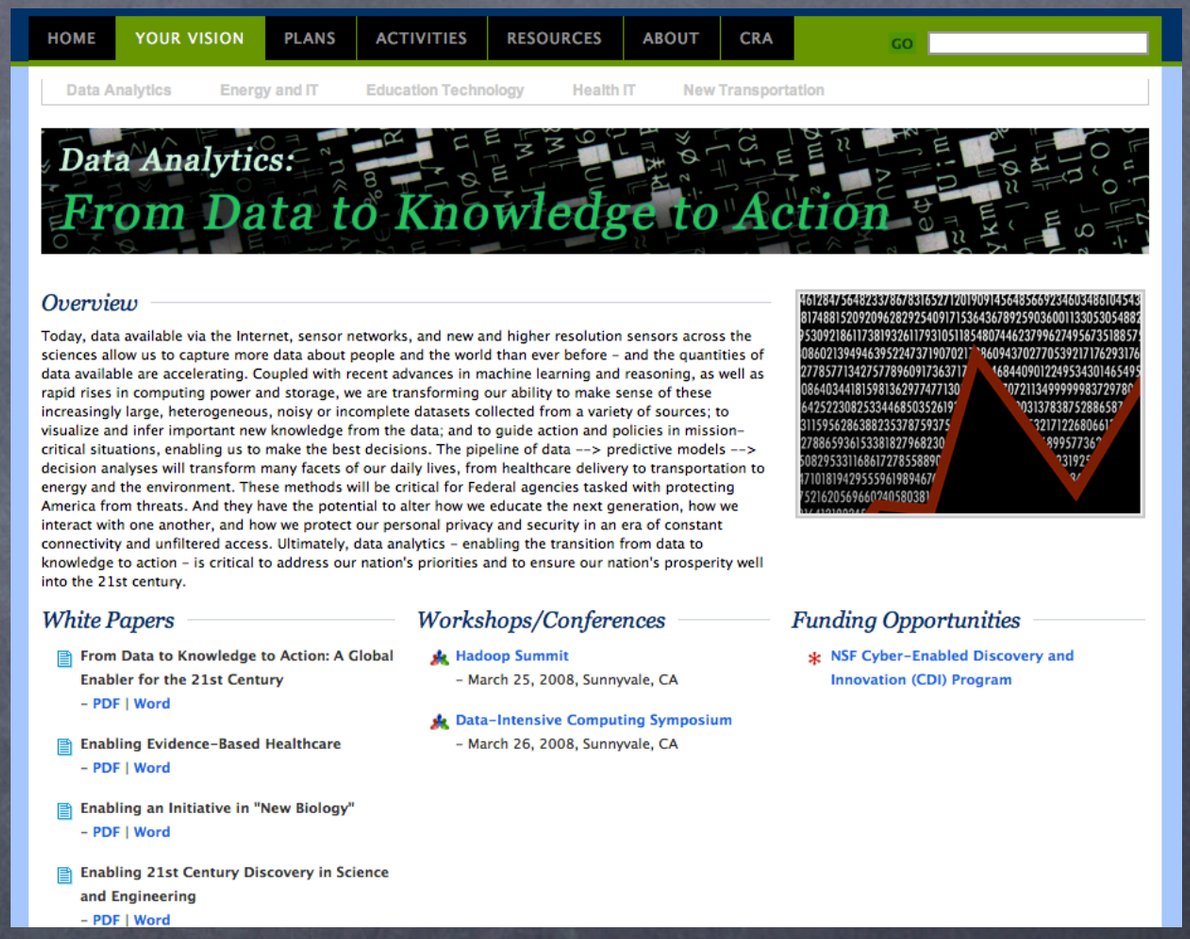
Sustainability + IT

- 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

- 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
- 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



Data analytics

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- Intelligenc
- New Biolog
- 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 network[3]. 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 footprints[4].

Data analytics

- Overview
- eScience
- Healthcare
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- Robotics & response

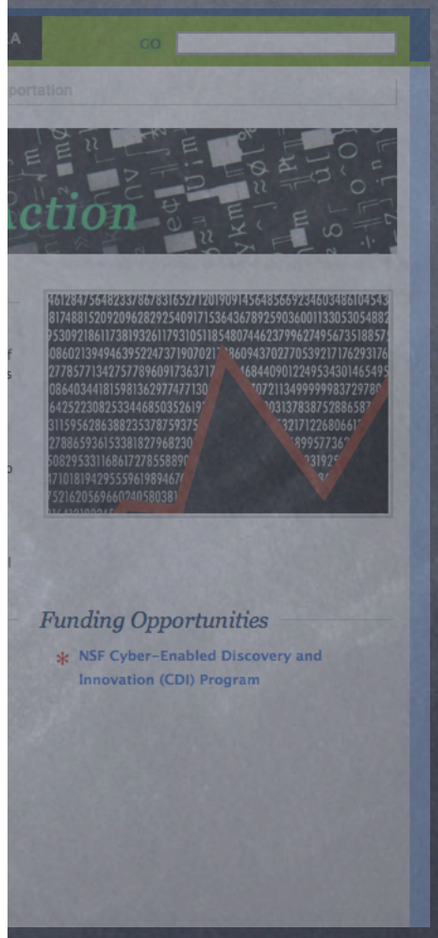
Nearly 2500 years ago, Hippocrates kicked off a revolution in healthcare by calling for the careful collection and recording of evidence about patients and their illnesses. This call—which first introduced the goal of sharing data among physicians to provide the best care possible for patients—established 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.

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.

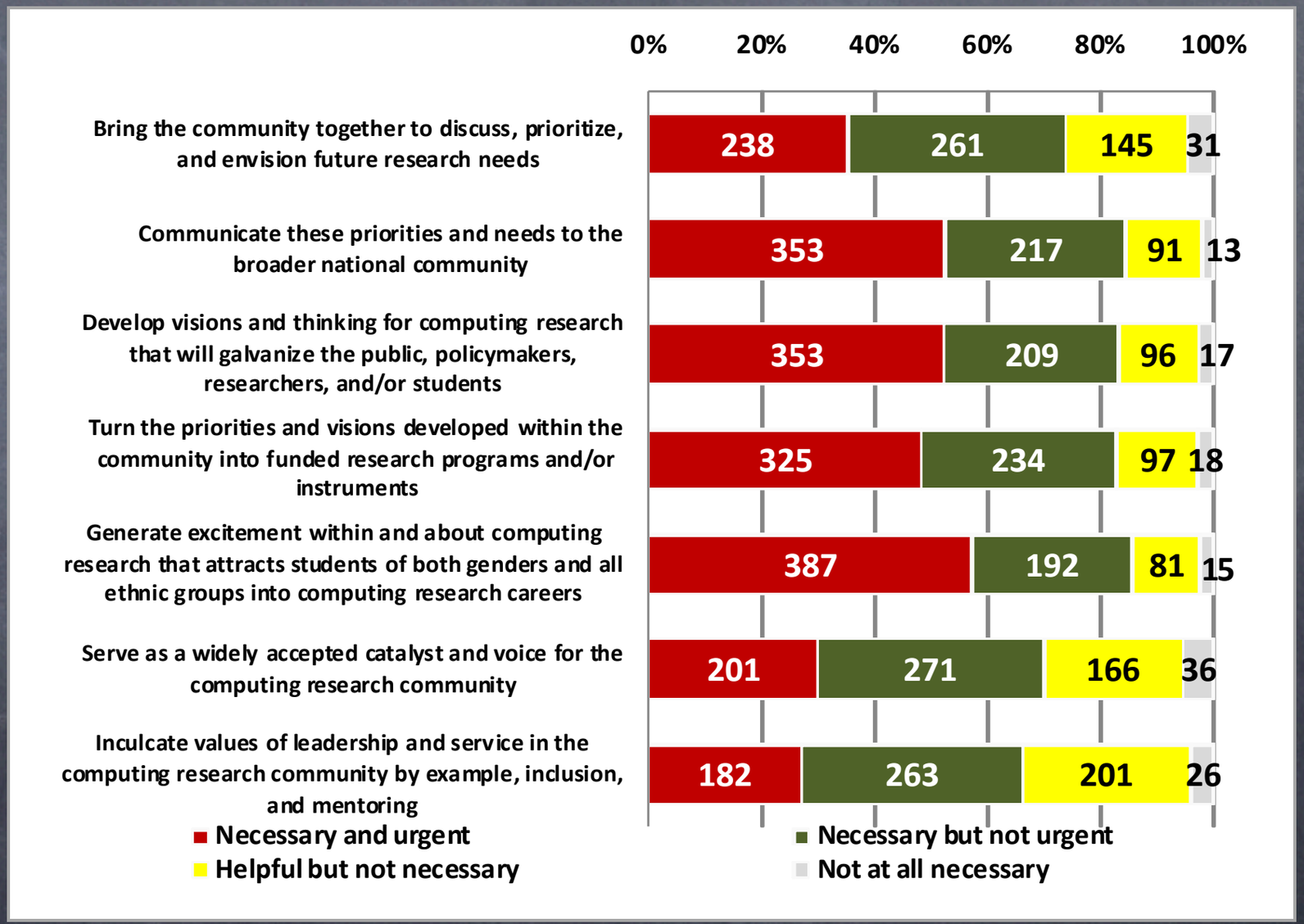
The pipeline of *data to prediction to action* can be used to automate or provide decision support for accurate triage and diagnosis, to generate well-calibrated predictions about health outcomes,



The value of the CCC

- Small, nimble organization
- Unique components to the mission
- Provides a "leadership voice" for the community

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?



--SRI International

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?

Questions?

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- Phone: (202) 266-2936
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