Research and Education Programs in NSF Office of Advanced Cyberinfrastructure

Office of Advanced Cyberinfrastructure Division (OAC)
Computer and Information Science & Engineering (CISE)
National Science Foundation

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George Mason, Sept 2018
NSF Office of Advanced Cyberinfrastructure

Program Staff

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- Amy Walton
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- Rajiv Ramnath (Part-Time)
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- Stefan Robila

- Bill Miller
  Science Advisor
  (On Detail)

- Beth Plale
  Science Advisor
  Public Access

- Alejandro Suarez
  Cooperative Agreements

- Scott Sellars
  AAAS S&T Policy Fellow

Join NSF/OAC: Multiple Program Officer openings

* IPA Appointment
CISE/OAC – Transforming the Frontiers of Science & Society

Foster a cyberinfrastructure ecosystem to transform computational- and data-intensive research across all of science and engineering

– Cyberinfrastructure Research & Research Cyberinfrastructure

CI-Enabled Instrumentation
Computing Resources
Data Infrastructure
Gateway, Hubs, and Services
R&E Networks, Security Layers
Coordination & User support
Software and Workflow Systems
Pilots, Testbeds

Cloud Resources & Services

People, organizations, and communities
CISE/OAC – Transforming the Frontiers of Science & Society

Computing
- Advanced resources and services at all scales – MRI (clusters); Innovative HPC; Leadership Class; XSEDE coordination and user services; Research

Data
- Data Building Blocks (DIBBS) Program

Software
- Software Infrastructure for Sustained Innovation (SI2)

Networking & Cybersecurity
- Campus Cyberinfrastructure (CC*), International Research Network Connections (IRNC), Cybersecurity Innovation for CI (CICI)

Learning & Workforce Devel
- Training-based Workforce Development for Advanced Cyberinfrastructure (CyberTraining), CAREER, CRII, OAC Core

Emerging Opportunities
- Cyberinfrastructure for Emerging Science and Engineering Research (CESER), Public Access
Planning for the Future CI Ecosystem

Key Drivers

- Changing application landscape & workload profile
- Changing technology, services landscape
- Increasing availability of (exp., obs.) data
- Growing role of ML, data-driven approaches
The NSF Big Ideas

**RESEARCH IDEAS**

- Harnessing Data for 21st Century Science and Engineering
- Work at the Human-Technology Frontier: Shaping the Future
- Windows on the Universe: Multi-messenger
- Quantum Leap: Leading the Next Quantum Revolution
- Navigating the New Arctic
- Understanding the Rules of Life: Predicting Phenotype

**PROCESS IDEAS**

- Mid-scale Research Infrastructure
- NSF 2026
- Growing Convergence Research at NSF
- NSF INCLUDES: Enhancing STEM through Diversity and Inclusion

“... bold questions that will drive NSF's long-term research agenda -- questions that will ensure future generations continue to reap the benefits of fundamental S&E research.”

Big Ideas => Big Cyberinfrastructure Challenges & Opportunities
Harnessing the Data Revolution (HDR)

Research across all NSF Directorates

Theoretical foundations
TRIPODS

Systems foundations
data-centric algorithms
systems: BIGDATA; OKN

Data-intensive research
across all science & engineering
TRIPODS+X

Advanced cyberinfrastructure
Accelerating data-intensive research.
CSSI;
Scalable data-driven CI DCL;
Midscale infrastructure (Midscale RFI)

Educational pathways
Innovations grounded in
an education-research-based framework
NASEM study on data science at the undergraduate level; NSF Research Traineeships; GRFP
LWD: Communities of Concern

**CI Contributors**
Cyber Scientists
to develop new capabilities

**CI Professionals**
Professional Staff
to deploy & support new capabilities

**CI Users**
Area Scientists
to exploit new capabilities

OAC: Communities of Concern
Learning and Workforce Development

Student Research Training
- REU SITES
- NRT

Training/Workforce Development
- CyberTraining NSF 18-516
- Deadline Jan, 2019

Faculty Research
- CRII
- CAREER
- Expeditions

OAC-Core Research Program
- New Solicitation NSF 18-567
- Deadline Nov 15, 2018
• Program Goals
  – Advanced Cyberinfrastructure (CI) research to impact the future capabilities of research CI
    • New knowledge in design, development, and utilization of robust research CI
  – Research career paths of cyber scientists/engineers
    • Computer as well as Computational and Data-driven Science and Engineering
OAC Core Research Program

• Translational research
  • Spanning design to practice
  • All aspects of advanced cyberinfrastructure

• Possible other characteristics:
  • Multi-disciplinary,
  • extreme-scale,
  • driven by science and engineering research,
  • end-to-end, or
  • deployable as robust research CI
OAC Core Research Program

Research Areas

• **Architecture & middleware for extreme-scale systems:**
  • Design, benchmarking, and analysis; storage, networks, and I/O;
  • Resource management, monitoring, fault tolerance, and cybersecurity

• **Scalable Algorithms and Applications:**
  • Numerical and high-performance scientific computing methods; Data, software and visualization; and Modeling and simulation

• **Advanced Cyberinfrastructure Ecosystem:**
  Programming languages, libraries, and environments; Tools; Sociotechnical aspects
OAC Core Research Program

- Part of CISE’s **coordinated core program** solicitations
- Only **Small** proposals in FY’19
  - Max $500K/award;
- Funding amount **$7.5M**
- Due **Nov 15, 2018**
- PI’s **strongly encouraged** to send 1-page project summary for further guidance:
  - Sushil Prasad; Vipin Chaudhary; Stefan Robila
- Webinar held on Aug 7
  - Slides, audio recording posted
    https://www.nsf.gov/events/event_summ.jsp?cntn_id=296101&org=CISE
Faculty Early Career Development Program (CAREER - NSF 17-537)

• Most prestigious award supporting junior faculty as a teacher-scholar
  • Outstanding research, education and the integration of education and research
    • Presidential Early Career Awards ...(PECASE) – 20 best
  • Number of OAC submissions doubled in FY16 and tripled in FY’17
    • 30 active OAC awardees; Deadlines: CISE: July 2019
• More open to non-tenure track faculty; Sr. personnel allowed
• Min $400K/5 years, typically $500K
Faculty Early Career Development Program (CAREER – contd)

- OAC encourages proposals that are either of
  - primary interest to OAC, or
  - secondary interest to OAC (add OAC in Cover Page)
- Dear Colleague Letter: ACI & CAREER (NSF 15-072)
- CAREER program page
  - http://www.nsf.gov/career
- CISE CAREER Proposal Writing Workshops
  - April 9, 2018, Alexandria: https://cisecareerworkshop.web.unc.edu/
    - Apply by March 10
Enabling infrastructure to support generation, assessment, and refinement of ad hoc models
- From voluminous, multidimensional, time-series observational data at scale
- Copes with the combinatorially explosive number of ways in which models can be realized

Well suited for analytics of data streams generated in Internet-of-Things and Smart Communities

Outreach: Computer Science STEM Camp for female high school students
Need for software infrastructure for statistical inference using complex, multiphysics models on modern supercomputers

Bring together GRINS, built on libMesh finite element library, with QUESO statistical library for inference of complex multiphysics FEM models

RUNTIME selection of parameters, statistical surrogate development, etc.

Developments major part of new CDSE Ph.D. program and new courses
Research areas of this CAREER project: Liang takes novel engineering Computational Fluid Dynamics techniques to study solar convection zone. Research interests of the PI have included (but is not limited to): High-Performance Computing, Computational Mathematics, Fluid Dynamics, Magnetohydrodynamics, Helioseismology, Astrophysics, Marine Hydrodynamics (Liang is also an ONR YIP awardee) and more . . .

Unique Features of this CAREER project:
• Novel engineering approaches of Computational Fluid Dynamics are being applied to study the Sun
• Substantial outreach activities for students to learn at the National Center for Atmospheric Research (including REU) and the George Washington University (including high-school summer programs).
CISE Research Initiation Initiative  
(CRII - NSF 17-552)

- Independent research for faculty or research scientists in their first three years (Pre-CAREER)
  - May not have any grant as PI; 2 chances;
  - New: Chair letter certifies lack of essential resources
  - Tenure-track or research science or education position

- OAC research focus:
  - Advanced CI research: Translational, Use-inspired, multidisciplinary, End-to-end,
  - Computational and data-intensive scientists in addition to computer scientists

- Award ~$175K/ 2 yrs;
- Deadline: Aug 2019
Goals of CISE Research Initiation Initiative (CRII - contd.)

• Start a research program and career
  – The PI need not have significant prior research results or maturity
  – Start a path toward research independence
  – Develop collaborations within or across research disciplines
  – Undertake exploratory investigations
  – Acquire and test preliminary data

• Broaden community of researchers
  – Reach underserved sub-communities, under-represented groups, nontraditional institutions
Overarching hypothesis: To initiate large-scale adoption of patient-specific simulations in clinical practice, next-generation imaging-through-analysis tools need to run autonomously in hospitals.

Research objectives: This CRII project re-thinks the process of how imaging data are transferred into simulations. Develops new strategies that enable fundamental advances in the way finite element methods can automatically interact with imaging data.

Impact: Closer integration of patient-specific predictive simulation in clinical decision-making, significantly accelerating transformation of healthcare from reactive and hospital-centered to preventive, proactive, and evidence-based.

Autonomous perfusion analysis based on MRI of the liver (prototype)
Research Experiences for Undergraduates (REU - NSF 13-542)

• Active research participation by undergraduate students
• \textbf{REU Sites} are based on independent proposals
  • \textbf{REU Supplements}: component of new or continuing proposals
    • $8K/student for up to 2 students
• Deadline: August 2019 (4\textsuperscript{th} Wed)
• Typically up to $360K/3yr
Research Experiences for Undergraduates (REU – Contd.)

School hosts summer cohort for undergrad research

- Coherent intellectual focus to research topics
- At least half the students are from institutions other than the host institution
- At least half from schools with limited research potential
- Research mentoring and support
- Social activities
- Professional development, grad school prep
Research areas of this site: The intellectual focus of the program is EcoInformatics, which unites theory and methods of informatics (e.g. computer science, mathematics, statistics, and engineering) with disciplines involving ecosystems (e.g. ecology, geography, geomorphology, botany, environmental sciences and management). Students work in teams to explore challenging natural resource management problems, extensive databases and complex ecosystem models, and new technologies for measuring ecosystems.

Site active since: 2006

Unique Features of the Site: Combines field data collection with the application and development of informatics algorithms

Desirée Tullos
REU Site: EcoInformatics Summer Institute
Oregon State University & HJ Andrews Experimental Forest, OR
http://agsci.oregonstate.edu/eisi
desiree.tullos@oregonstate.edu
Training-based Workforce Development for Advanced Cyberinfrastructure (CyberTraining)
NSF 18-516
(replaced NSF 17-507)

Submission Deadline: Jan, 2019
Overarching Goals

- **Overarching Goal:**
  - *prepare, nurture and grow* scientific research workforce
  - *ensure* broad adoption of CI tools, methods, and resources
  - *integrate skills* into educational curriculum/instructional material fabric in
    - advanced cyberinfrastructure (CI) +
    - computational and data science and engineering (CDS&E)
    - spanning undergraduate and graduate courses.

- **Innovative, scalable training and education** programs addressing
  - Emerging needs and Unresolved bottlenecks
  - Multidisciplinary communities
  - Undergrads, grad students, instructors, faculty, research CI professionals
NSF-wide Participation

• CISE/OAC - Office of Advanced Cyberinfrastructure – lead
  – Sushil K Prasad
  (Includes BD Hub)
• CISE/CCF Computing and Communication Foundation
  – Almadena Chtchelkanova
• EHR/DGE - Division of Graduate Education
  – Victor Piotrowski
• ENG - Directorates of Engineering
  – Joanne Culbertson, ENG/CMMI
  – Ronald Joslin, ENG/CBET
  – Anthony Kuh, ENG/EECS
• GEO - Directorate for Geosciences
  – Eva Zanzerkia
• MPS - Directorate for Mathematical & Physical Sciences
  – Bogdan Mihaila

• Intent: stimulate co-funding between OAC and one or more domains
FY 18: Award Framework

• Award Budget
  – $500K per award and up to 3 years in duration
  – About 25 awards made in FY 16 and FY 17

• Communities of Concern:
  – CI Professionals (CIP), CI Contributors (CIC), CI Users (CIU)

• Consult OAC + other Cognizant Program Officers
  – At least one month in advance of the submission deadline
  – Mention consultation in the Project Summary

• Interested in serving in review panels?
Example Projects

• CI-professionals:
  – Training and certification of CI Professionals in cybersecurity technology and management for advanced CI-enabled research;
  – working with natural science researchers for advanced visualization, or for supporting scientific gateways;

• CI Contributors:
  – Training geoscience students to develop scalable software
  – Training the next generation of researchers on the NHERI DesignSafe Cyberinfrastructure with holistic computational models for future, adaptive buildings;

• CI Users:
  – Instructor training for computational science literacy across STEM disciplines in minimum core topics
  – Software and data literacy for natural science students
Other LWD Opportunities within OAC

- **INTERN DCL (NSF 17-091)**
  - Non-academic Graduate Student Research $50K/student

- **EAGERs ($300K), Workshops ($50K), RCNs**
  - Seed Exploration of Research, Training and Education, Broadening Participation
  - Students, Post-Docs, Faculty, CI Professionals

- **Student Travel Grants**
- **Discuss with me and other OAC Program Officers**
- **To subscribe to OAC Mailing List:**
  Send an email to:
  OAC-ANNOUNCE-subscribe-request@listserv.nsf.gov
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