The Computing and Information Science and Engineering Landscape: A Look Forward

Margaret Martonosi

NSF Assistant Director for Computer and Information Science and Engineering (CISE)

Research:
Planting trees now,
in order to
have shade in
the future

Seeing the Unseeable:
Computational Photography
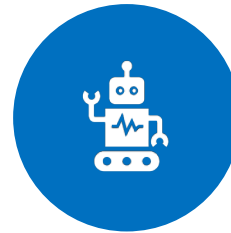
Elements of Computational Photography

SENSING AND DATA CAPTURE

COMPUTER GRAPHICS, RENDERING, VISION

EFFICIENT, TRACTABLE ANALYSIS ALGORITHMS

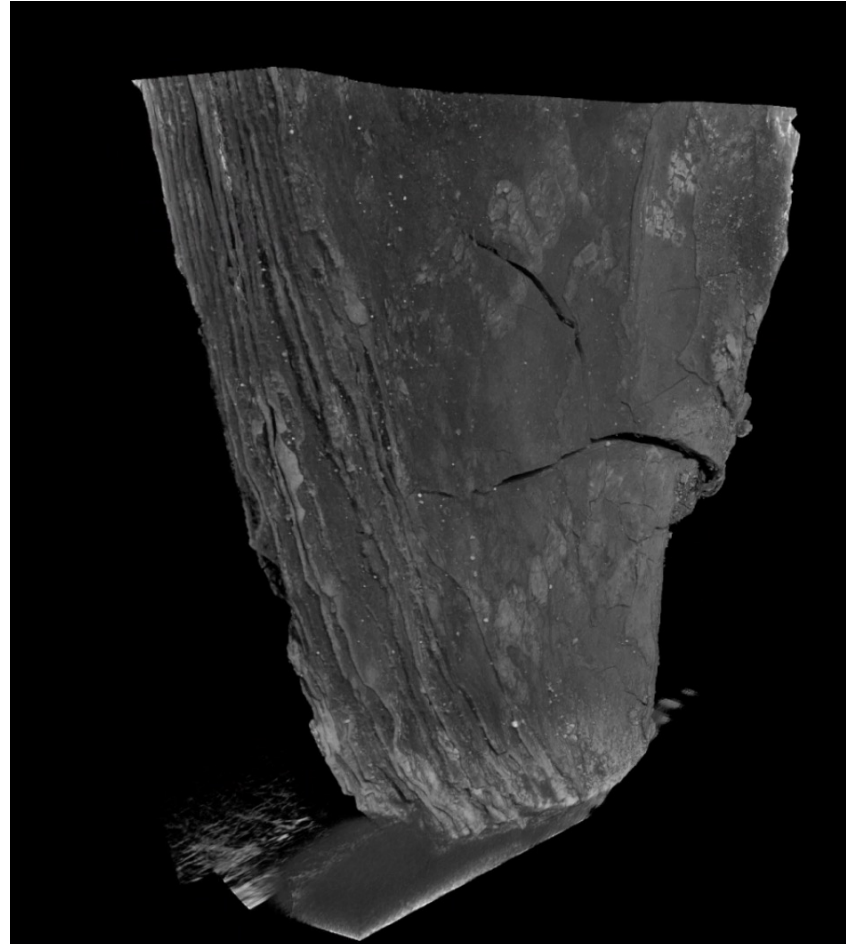**ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**

**SOCIOTECHNICAL ELEMENTS: PRIVACY, FAIRNESS**

Computational Imaging and Heritage Science:
How to read an ancient scroll without unrolling it?

- Carbonized scrolls from archeological sites
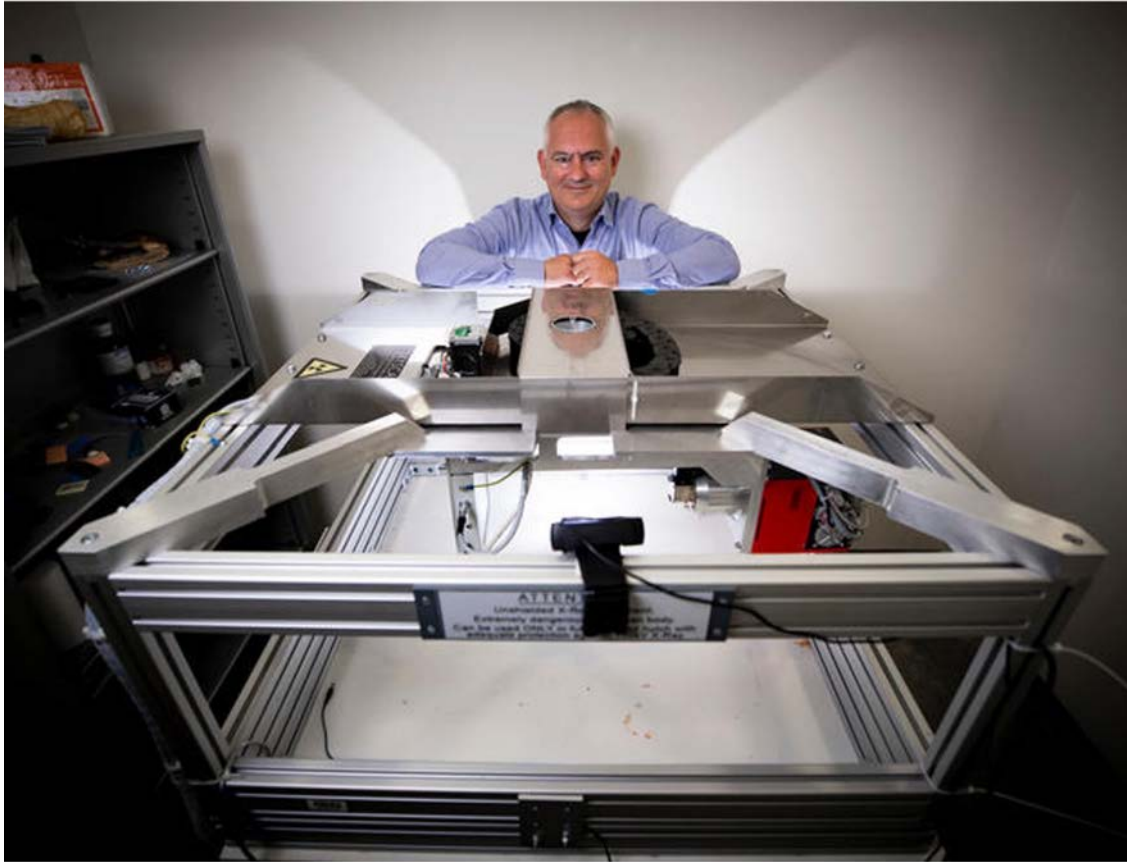
- Locate and map 2D surfaces from a 3D object

PI: Prof. Brent Seales

University of Kentucky

Computational Imaging and Heritage Science: How to read an ancient scroll without unrolling it?

L-003
(colorized)

L000

L001

L002

L003

1 cm
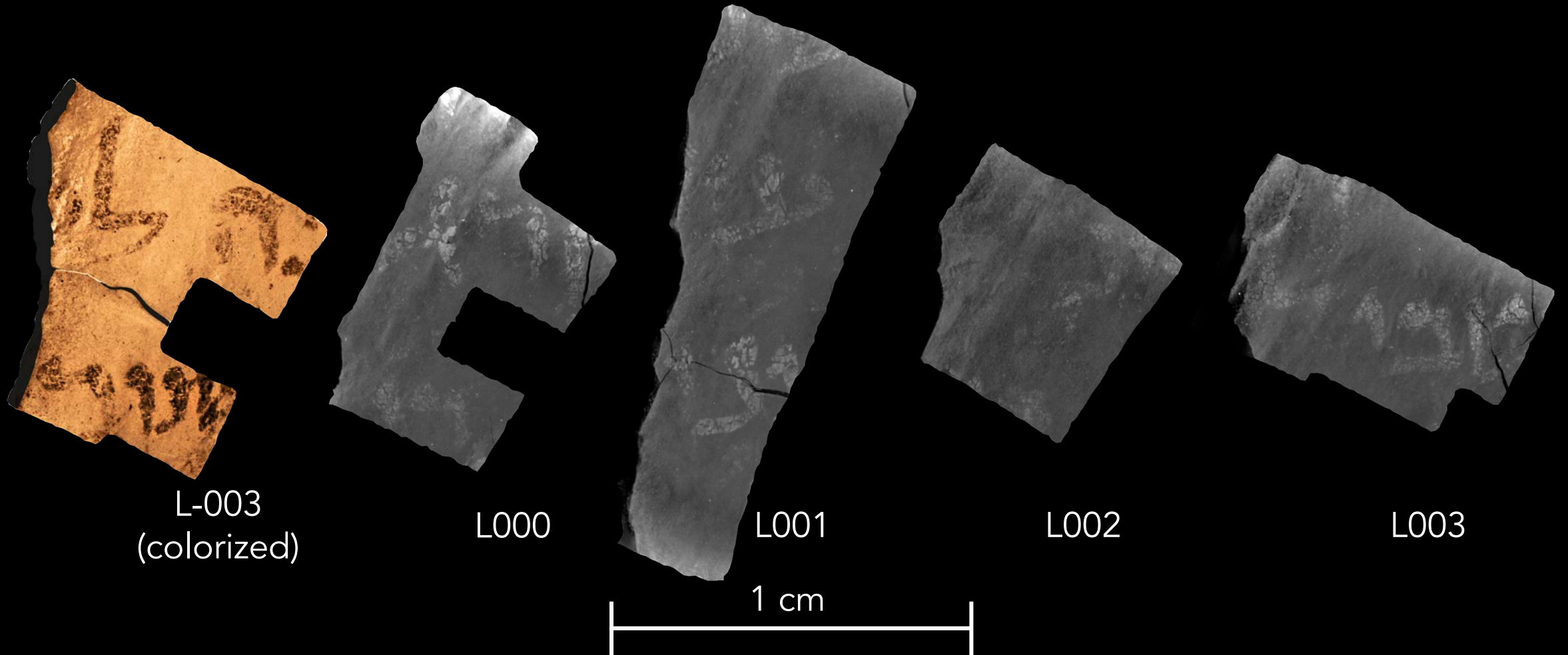
New Beginnings: NSF MSR-1 Infrastructure Support for Heritage Science at University of Kentucky

New Beginnings: Bouman 2021 NSF CAREER Awardee

CISE Organization and "Core" Programs

Manish Parashar
Office Director

Kevin Thompson
Acting Deputy Office Director

Gurdip Singh
Division Director

Behrooz Shirazi,
Acting Deputy Division Director

Office of Advanced Cyberinfrastructure (OAC)

- Data/Software
- Leadership and Advanced Computing
- Networking/Cybersecurity
- Learning and Workforce

Computing & Communication Foundations (CCF)

- Algorithmic Foundations
- Communications and Information Foundations
- Software and Hardware Foundations
- Foundations of Emerging Technologies

CISE Leadership

Margaret Martonosi,
Assistant Director

Joydip Kundu,
Deputy Assistant Director

Computer & Network Systems (CNS)

- Computer and Network Systems
- Education and Workforce Development

Information & Intelligent Systems (IIS)

- Human-Centered Computing
- Information Integration and Informatics
- Robust Intelligence

Walter Cleveland II,
Division Director

Funda Ergun,
Acting Deputy Division Director
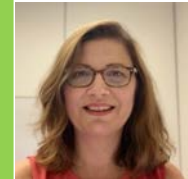
Henry Kautz,
Division Director

Wendy Nilsen,
Acting Deputy Division Director

Major CISE-wide and Multi-Directorate Initiatives

Office of Advanced Cyberinfrastructure (OAC)

Computing & Communication Foundations (CCF)

Computer & Network Systems (CNS)

Information & Intelligent Systems (IIS)

CISE-wide Initiatives
Expeditions in Computing
Broadening Participation in Computing Plans
CISE Community Research Infrastructure (CCRI)
CISE MSI Research Expansion
Principles and Practice of Scalable Systems (PPOSS)

Sample Multi-Directorate Initiatives that CISE Leads
National AI Research Institutes
Secure and Trustworthy Cyberspace (SaTC)
Cyber-Physical Systems (CPS)
Predictive Intelligence for Pandemic Prevention (PIPP)
Smart & Connected Communities (S&CC) /Civic Innovation Challenge (CIVIC)

NSF CISE by the numbers, FY 2021

24% success rate

$1,022M — FY 2021 enacted budget

7,248 proposals

461 Panels

1,740 awards

19,321 people supported

373 institutions supported

8,164 senior researchers

1,460 other professionals

581 postdoctoral associates

6,162 graduate students

2,954 undergraduate students
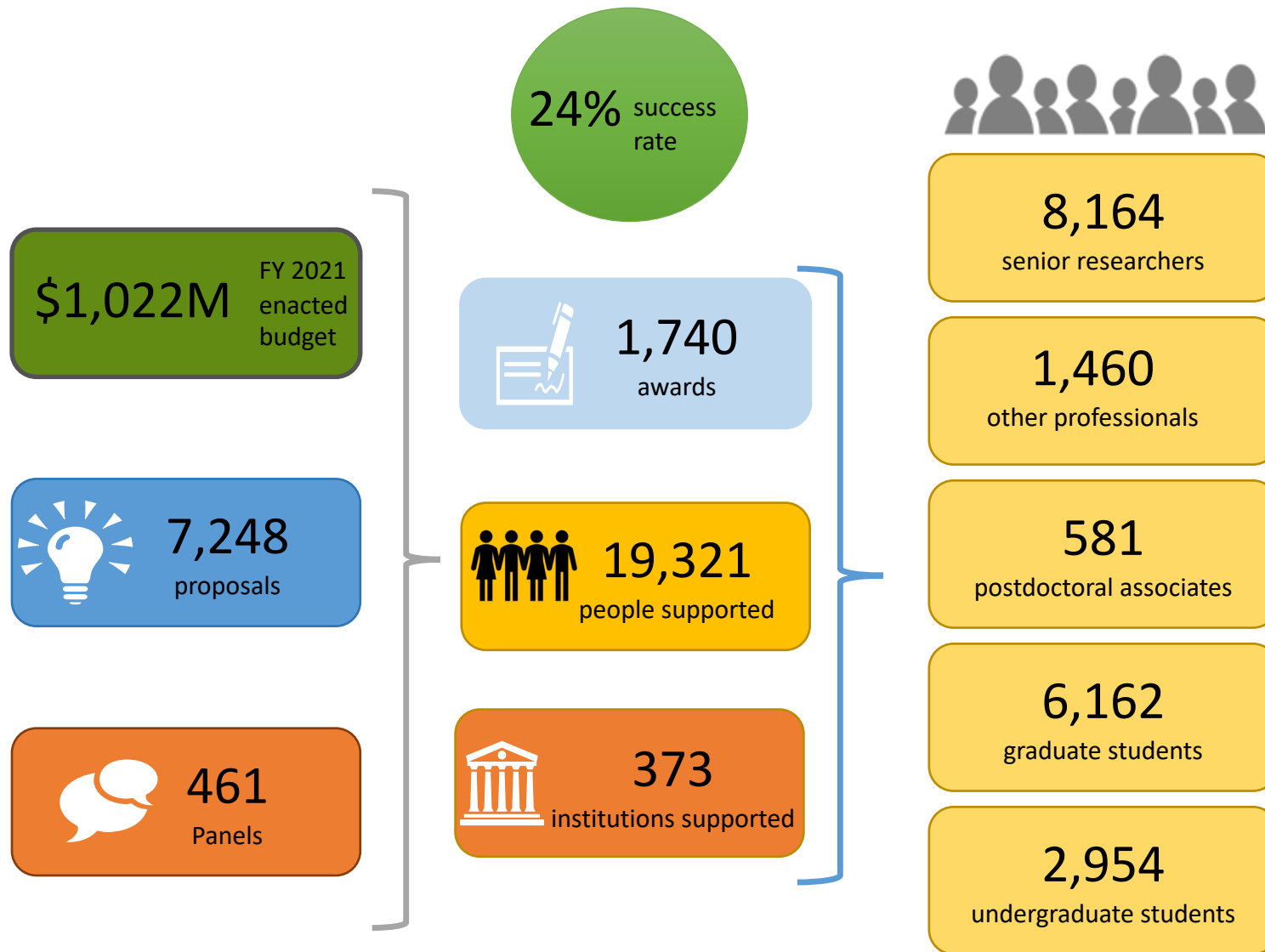
NSF funds > 87% of federally-funded academic CS research in the US.

(*Source: NCSES*)

If you had a billion dollars a year, what research would you spend it on?
What trees would you plant?

And, how much more could we do with more?

Today…

- Technical Themes
- "How to get there": Programs, Infrastructure, People…
- Q&A

CISE in a Post-Moore World: Seismic Shift...

- **<u>Challenge</u>**: Across many different topic areas, a fundamental need to design new interface layers & design practices.

- **<u>Opportunity</u>**: Sweeping change across many CISE research topics.

- **<u>Rethink</u>** Hardware, Software, Curriculum...

- Principles and Practice of Scalable Systems (PPoSS) [NSF 22-507]
  - January deadlines (Jan 23, 2023)
  - First large awards just announced

https://www.nsf.gov/pubs/2022/nsf22507/nsf22507.htm

Seismic Shift → NSF Programs

Foundations of Emerging Technologies (FET) → Core programs cluster in CCF
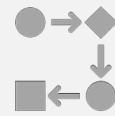
Principles & Practice of Scalable Systems (PPoSS)

Secure and Trustworthy Cyberspace (SaTC)

Quantum and Advanced Wireless and …

Technical Themes

- **CISE in a Post-Moore World: The Seismic Shift**
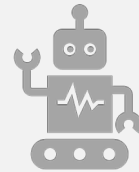
- **Transcendence of Artificial Intelligence**

- **CISE's Sociotechnical Frontier**

2023 AI Research Institutes

Use-inspired

- Cybersecurity
- Cognitive Foundations
- Decision-Making
- Climate-Smart Agriculture
- Trustworthy
- Education

Foundations
- Learning, abstraction, and inference
- Reasoning, uncertainty, causality
- Agents and multiagent systems
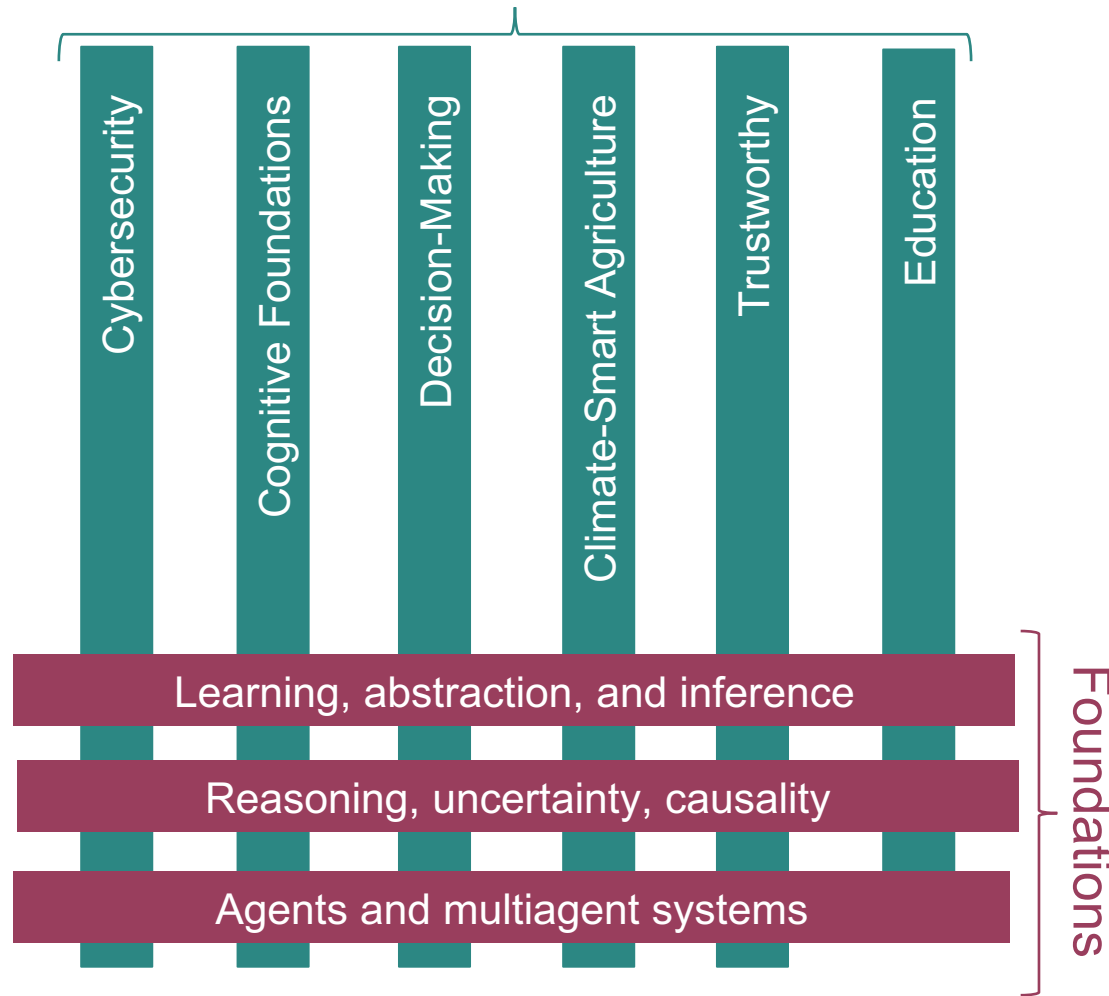
National hubs for universities, government, industry and nonprofits to advance AI research and education

- $20M over five years per Institute

- First round: 7 AI Institutes announced Aug 2020

- Second round: 11 more institutes announced July, 2021

- Third round solicitation now in process: 22-502

  - Pre-proposals were due Jan 14, 2022

USDA · NIST · IES · U.S. DEPT OF DEFENSE · accenture · amazon · Google · intel · IBM

NSF-LED NATIONAL AI RESEARCH INSTITUTES

★ LEAD ORGANIZATION   ■ PRINCIPAL ORGANIZATIONS   ● PARTNERS/COLLABORATORS

The U.S. National Science Foundation (NSF) announced a $220 million investment in eleven new Artificial Intelligence (AI) Research Institutes, building on the first round of seven AI Institutes totaling $140 million funded last year. (The default map view below shows all awards combined).

FY20 and FY21 Awards:
18 Institutes spanning 40 states

The map reflects the approximate location of the Institutes' lead and principal organizations (staffing and/or activity), as well as their initial funded and unfunded partners.
Note: Partners and collaborators related to an Institute may be represented with a single plot due to space limitations.

Vision: National AI Research <u>Network of Networks</u>

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International AI Partnerships

AI Institutes: Lead + funded collaborators

MSI/Equity Connectors

AI Institutes: Lead + funded collaborators

Online Community.
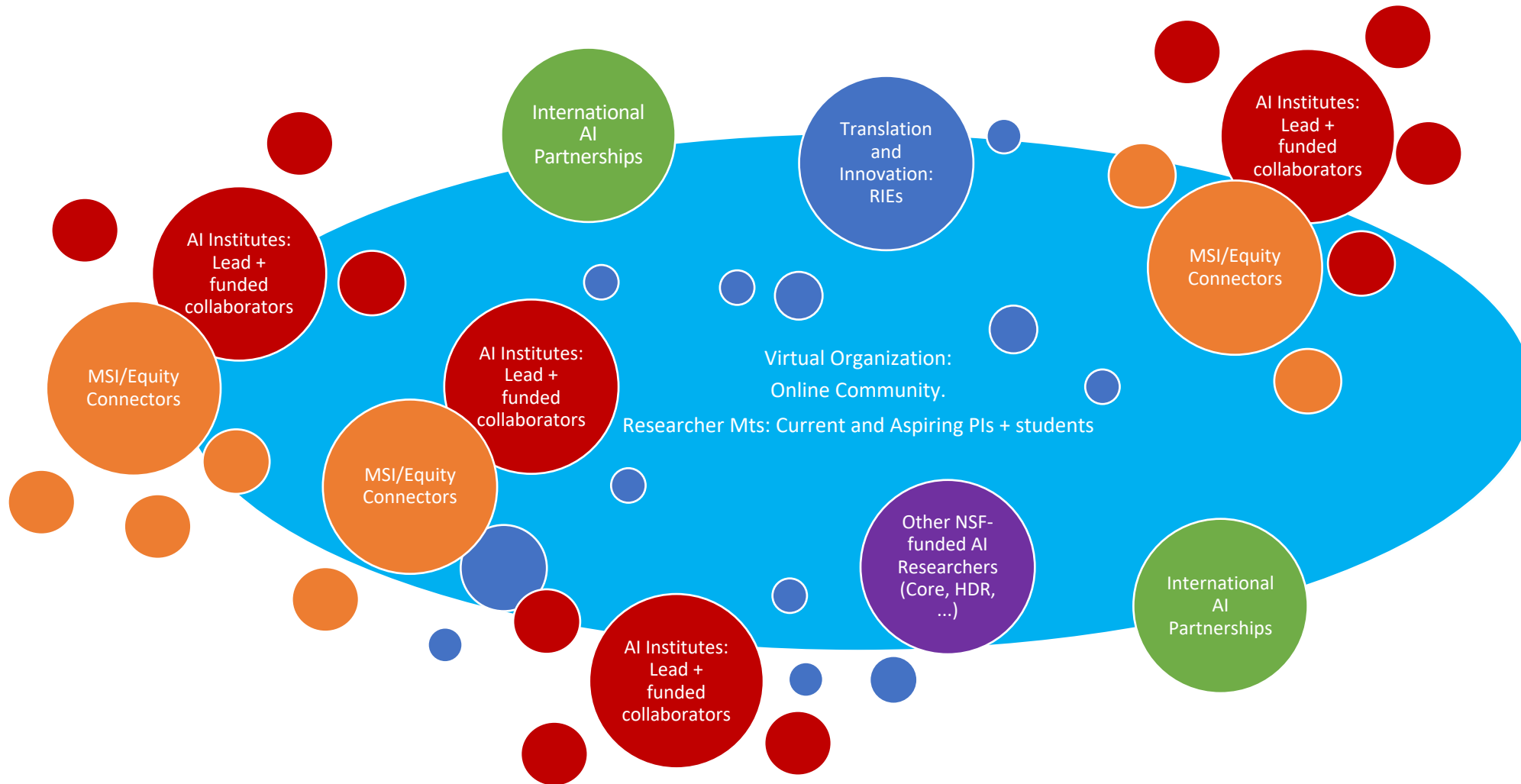
International AI Partnerships

NSF 22-046

Dear Colleague Letter: International Collaboration Supplements in National Artificial Intelligence Research Institutes

February 16, 2022

Dear Colleagues:

With this Dear Colleague Letter (DCL), NSF invites requests for supplemental funding from existing awardees of the National Artificial Intelligence (AI) Research Institutes program (NSF 20-503, NSF 20-604) to add a new — or strengthen an existing — international dimension to their award. International collaboration should advance efforts to achieve the goals of the institute as outlined in the existing NSF award. Supplemental funding requests should represent mutual benefit and true intellectual collaboration with international partners.

NSF 22-031

Dear Colleague Letter: Special Guidelines for Submitting Collaborative Proposals under National Science Foundation (NSF) and Natural Sciences and Engineering Research Council of Canada (NSERC) Collaborative Research Opportunities in Artificial Intelligence and Quantum Science

December 16, 2021

Dear Colleagues:

The U.S. National Science Foundation (NSF) and the Natural Sciences and Engineering Council of Canada (NSERC) have signed a Memorandum of Understanding (MOU) on Research Cooperation. The MOU provides an overarching framework to encourage collaboration between U.S. and Canadian research communities and sets out the principles for developing jointly supported activities. The MOU provides for an international collaboration arrangement whereby U.S. researchers may receive funding from NSF and Canadian academic researchers may receive funding from NSERC.

https://www.nsf.gov/pubs/2022/nsf22031/nsf22031.jsp

https://www.nsf.gov/pubs/2022/nsf22046/nsf22046.jsp

Technical Themes

CISE in a Post-Moore World: The Seismic Shift

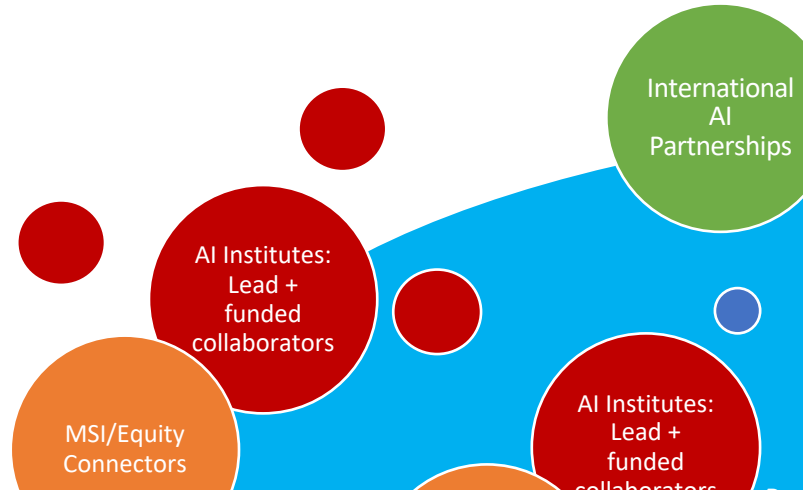Transcendence of Artificial Intelligence

CISE's Sociotechnical Frontier

CISE's Sociotechnical Frontier

- Cyber-Physical and Cyber-Human interactions increasingly shape our society and economy, at all levels and in many forms: Health, connectivity, community, fair access to trustworthy information...

- Reshape computation to "bake in" equity, fairness, security, trust, privacy, ...

Highlights

- DASS: Designing Accountable Software Systems
- CIVIC Innovation Challenge
- Project Overcome: Novel Broadband for Virtual Learning
- Fairness in AI
- Smart Health and Biomedical Research in the Era of Artificial Intelligence (SCH)
- NASEM Study on Ethics and Governance in Computing Research and Applications

CIVIC Innovation Challenge Awards

New Solicitation!
Deadline May 5, 2022

Track A

- Living in a changing climate: pre-disaster action around adaptation, resilience, and mitigation; and

- Interagency Partners

Track B

- Bridging the gap between essential resources and services & community needs.

- Interagency Partners

https://vimeo.com/404649740

https://nsfcivicinnovation.org

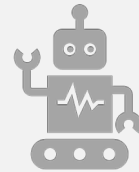https://beta.nsf.gov/funding/opportunities/civic-innovation-challenge-civic

Technical Themes

CISE in a Post-Moore World: The Seismic Shift

Transcendence of Artificial Intelligence

CISE's Sociotechnical Frontier

Priorities: AKA How to Get There?

- Budget and Program Portfolio
- Infrastructure
- People
- Partnerships

Platforms for Advanced Wireless Research (PAWR): Enabling At-scale Experimentation

POWDER

Salt Lake City, UT

Software defined networks and massive MIMO

COSMOS

West Harlem, NY

Millimeter wave and backhaul research

AERPAW

Raleigh, NC

Unmanned aerial vehicles and mobility

ARA

Ames, IA

Rural broadband

$100M public-private partnership with DOD, USDA NIFA, and >35 companies accelerating beyond-5G wireless research
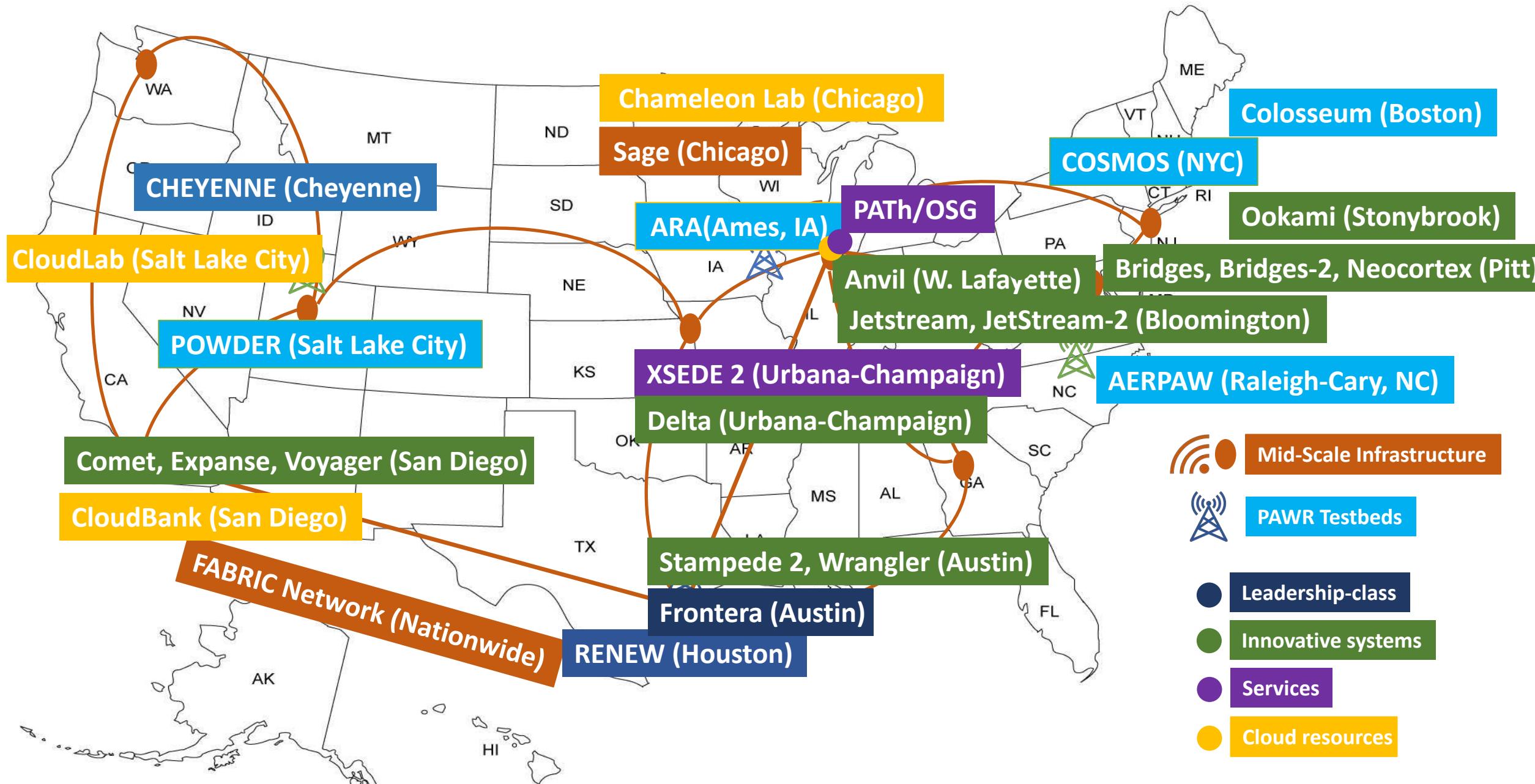
https://www.advancedwireless.org

NSF-funded Research Resources and Testbeds

https://www.cloudbank.org

New NSF Program!

POSE: Pathways to Enable Open-Source Ecosystems

- Purpose of the program is to:
  - harness the power of open-source development for the creation of new technology solutions to problems of national and societal importance.
  - fund new open-source ecosystem (OSE) managing organizations, each responsible for the creation and maintenance of infrastructure needed for efficient and secure operation of an OSE based around a specific open-source product or class of products.

- **Full proposal deadlines: May 12 (Phase1); October 22 (Phase II)**

- **More information:** https://beta.nsf.gov/funding/opportunities/pathways-enable-open-source-ecosystems-pose

Priorities:
AKA How to Get There?

Budget and Program Portfolio

Infrastructure

People

Partnerships

Vision: Broadening Participation in Computing

- Goal: Measurable progress towards diversifying the CISE research community
- Goal: CISE research proposals include a meaningful plan to broaden participation in computing
- **Approach: Individual PIs include BPC plans for Medium (and larger) proposals in Core, CPS, SaTC**
- Key Concept: Individual PIs plug into departmental and national plans and expertise
- Increase collaboration, coordinate efforts, broaden expertise

Vision: Broadening Participation in Computing

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- Approach: Individual PIs include BPC plans for Medium (and larger) proposals in Core, CPS, SaTC

- **Key Concept: Individual PIs plug into departmental and national plans and expertise**

- **Increase collaboration, coordinate efforts, broaden expertise**

Individual PI Plans and efforts	Department and Campus-Level Resources and Plans
Individual PI Plans and efforts	
Individual PI Plans and efforts	
Individual PI Plans and efforts	National-Level Resources and Plans
Individual PI Plans and efforts	
Individual PI Plans and efforts	

BPCnet RESOURCE PORTAL provides resources for CISE PIs

- **https://bpcnet.org**
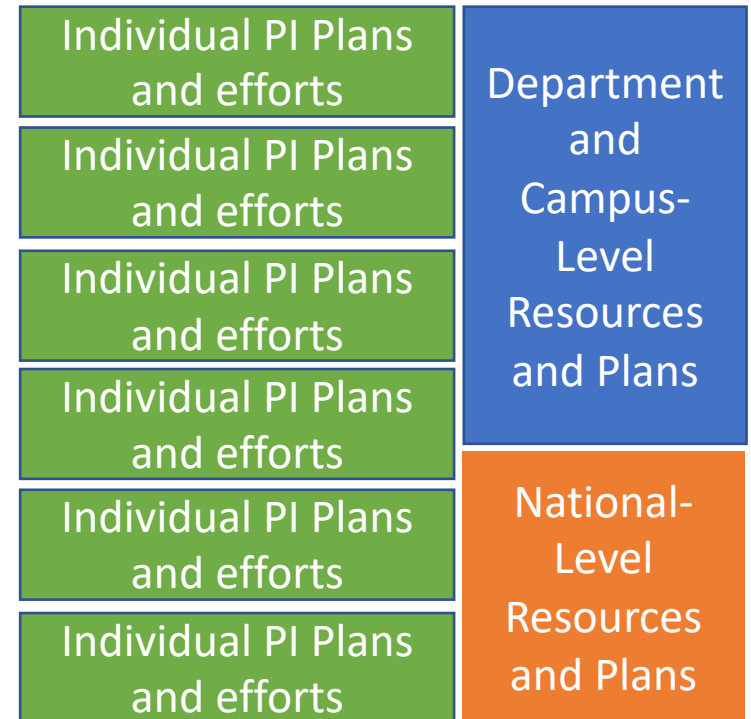
- Developed and curated by CRA, NCWIT

- Best and promising practices: Evidence-based and vetted resources
  - Not just **What** but **How**
  - Departmental data and teaching efforts

- Departmental and Individual BPC Plan Workshops
  - + Ongoing 1-1 Consulting Office Hours
  - Vetting, Hosting Departmental Plans in a Single Library

Individual PI Plans and efforts	
Individual PI Plans and efforts	Department and Campus-Level Resources and Plans
Individual PI Plans and efforts	
Individual PI Plans and efforts	
Individual PI Plans and efforts	National-Level Resources and Plans
Individual PI Plans and efforts	
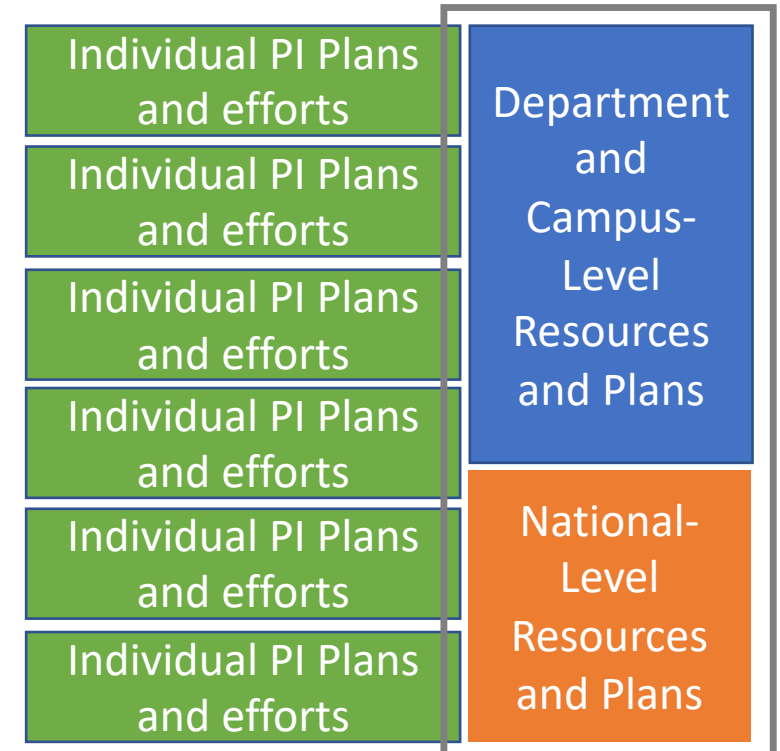
A few bits of advice...

Skills

Be ready to learn **new technical tricks** and topics

Be ready to work on your **oral and written communication skills**

Find **strategies for time-management** and context-switching that **work for you.**

People

Be a **good colleague** and enjoy the fun of working with good colleagues.
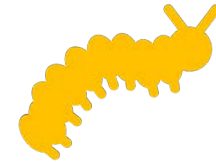
Ask for **feedback and advice** from a lot of people... Then integrate it and **make it your own**.

Everyone needs **several mentors**

Keep connected to your friends / colleagues as you progress

Mindset

Get some sleep!

Find the fun in this adventure. There's a lot of fun to be found.

You BELONG here!
We need you!
Welcome!

2022 CISE CAREER Proposal Writing Workshop (Virtual)

April 4-5, 2022

(Registration will open and Agenda will be available in early March)

Some Facts:

- Annual event started in 2011 with 50 participants, 200+ attended last year's workshop

- Expect to accommodate 250 participants in 2022

- Participants have access to sample successful CAREER proposals

Highlights of the Workshop

- **Day 1:**

- CISE Program Directors answers questions on CAREER solicitation

- Past CAREER awardees discuss dos and don'ts on how to prepare a successful proposal

- Participants attend Group Meeting with CISE Program Directors from Program Clusters

- **Day 2:**

- Participant sign up (in their primary research area) for One-on-One meeting with CISE Program Directors

https://cisecareerworkshop.web.unc.edu/

NSF Funding Opportunities in CISE Topic Areas: Slide 1 of a 2-slide Primer: The Core Programs

Core Programs:
Small (no deadlines, now $600K) + Medium.

Notes and Recent Changes:
CCF FET
CNS unified core programs (formerly CSR + NeTS)
IIS: HCC (new name)
OAC: Core (new)

Office of Advanced Cyberinfrastructure (OAC)

• Data/Software
• Leadership and Advanced Computing
• Networking/Cybersecurity
• Learning and Workforce

Computing & Communication Foundations (CCF)

• Algorithmic Foundations
• Communications and Information Foundations
• Software and Hardware Foundations
• Foundations of Emerging Technologies

CISE directorate

Computer & Network Systems (CNS)

• Computer and Network Systems
• Education and Workforce Development

• Human-Centered Computing
• Information Integration and Informatics
• Robust Intelligence
• Foundational Research in Robotics (joint with ENG)

NSF Funding Opportunities in CISE Topic Areas:
Slide 2 of a 2-slide Primer: Beyond the Core

Other CISE Programs

- CISE-MSI Research Expansion
- Principles and Practices of Scalable Systems
- Formal Methods in the Field
- Designing Accountable Software Systems

Multi-directorate Programs led by CISE

- Secure and Trustworthy Cyberspace
- Cyber-physical Systems
- National AI Research Institutes
- Smart Health and Biomedical Research in the Era of Artificial Intelligence (SCH)
- Smart and Connected Communities
- Civic Innovation Challenge (CIVIC)
- National Robotics Initiative
- Research on Emerging Technologies for Teaching and Learning
- Collaborative Research on Computational Neuroscience

Early-Career

- CAREER
- CISE Research Infrastructure Initiation Award (CRII)

Programs Led by Other Directorates but of Interest to CISE

- Designing Materials to Revolutionize and Engineer our Future
- SemiSynBio
- Future Manufacturing
- Spectrum Innovation Initiative
- Sustainable Regional Systems
- Neural and Cognitive Systems
- ExpandQISE

Education & Workforce

- Computer Science for All
- Computing in Undergraduate Education
- BPC Alliances
- Data Science Corps

Infrastructure

- Major research Instrumentation (MRI)
- Mid-Scale Research Infrastructure – Size classes 1 ($6-20M) and 2 ($20-100M)
- CCRI – CISE Community Research Infrastructure
- Cyberinfrastructure for Sustained Scientific Innovation (CSSI)
- Campus Cyberinfrastructure (CC*)

Entrepreneurship and Translation

- Pathways to Enable Open Source Ecosystems (POSE)
- Convergence Accelerator
- I-Corps, SBIR/STTR
- Industry/University Cooperative Research Centers (IUCRC)
- CISE InTrans supplements, CISE Transition-to-Practice opportunities