

## Research Trends in NSF and JST-NSF Collaboration Opportunities

A View from the Directorate for Computer and Information Sciences and Engineering (CISE) at the

US National Science Foundation (NSF)

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2<sup>nd</sup> JST-NSF International Joint Symposium on Big Data, AI, CPS, and SCC for a New Society







## **CISE programs address national priorities**



**Big Data & Al** 



Cybersecurity



Robotics & Manufacturing



Understanding the Brain



Advanced Cyberinfrastructure Cyber Physical Systems Smart Communities Computer Science Education Advanced Wireless Research

"To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense..."

## **NSF Big Ideas**



" ... 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."



## Harnessing the Data Revolution (HDR)

Enabling 21<sup>st</sup>-century science, engineering, and education to move toward effective use of digital data to advance discovery

- Fundamental research in data-centric mathematics, statistics and computational, and computer science
- Fundamental research on data-centric algorithms and systems
- Data-driven research in all NSF research domains
- Data-centric, science-driven, research cyberinfrastructure (CI) ecosystem
- Creation and nurturing of a 21st-century data-capable workforce

science

# Includes CISE investments in the following programs: BIGDATA, DIBBs, TRIPODS

## **Research** across all NSF Directorates

**Systems** 

foundations

data-centric algorithms,

systems



Theoretical foundations

mathematics. statistics,

computer & computational

## Harnessing the Data Revolution (HDR)

#### **TRIPODS:**

#### Transdisciplinary Research in Principles of Data Science

 Bringing together statistics, mathematics, theoretical computer science communities to develop theoretical foundations of data science through integrated research, training activities
 CISE, MPS **BIGDATA:** Critical Techniques, Technologies and Methodologies for Advancing Foundations and Applications of Big Data Sciences and Engineering

- Foundations: fundamental techniques, theories, methodologies, technologies
- Innovative Applications: applicationdriven novel techniques, methodologies, technologies
- CISE, BIO, EHR, ENG, GEO, MPS, SBE
- AWS, Google Cloud, Microsoft Azure

#### **DIBBs:** Data Infrastructure Building Blocks

- Robust, shared data-centric cyberinfrastructure capabilities
- accelerating interdisciplinary research in areas stimulated by data
- CISE (OAC) and other directorates



#### Cyberinfrastructure 5

#### Systems & applications

## Work at the Human-Technology Frontier: Shaping the Future

A bold initiative to catalyze interdisciplinary science and engineering research to...

- understand and build the humantechnology partnership;
- design new technologies to augment human performance;
- illuminate the emerging sociotechnological landscape; and
- foster lifelong and pervasive learning with technology



## **The Human-Technology Frontier**

#### **Cyber Physical Systems (CPS):**

Deeply integrating computation, communication, and control into physical systems

- develop core system science for complex cyberphysical systems in multiple application areas
- CISE, ENG
- DHS, DOT, NASA, NIH, USDA

## **NRI-2.0: Ubiquitous Collaborative**

**Robots:** Developing the next generation of collaborative robots to enhance personal safety, health, and productivity

- accelerate development and use of collaborative robots
- CISE, EHR, ENG, SBE
- DOD, DOE, USDA





## **The Human-Technology Frontier**

#### Smart & Connected Communities (S&CC):

#### improving quality of life for all

- interdisciplinary, integrative research to improve understanding, design, sustainability of intelligent infrastructure
- engaging local residents, stakeholders, government across rural, coastal, urban, border communities
- CISE, EHR, ENG, SBE

#### Smart and Connected Health (SCH): transforming

healthcare knowledge, delivery, and quality of life through IT

- safe, effective, efficient, patient-centered, proactive, predictive health and wellness technologies
- CISE, ENG, SBE
- Joint with NIH

#### **Cyberlearning and Future Learning Technologies:**

expanding and transforming learning and educational opportunities and outcomes for learners and workers of all ages

- technologies to enable lifelong learning, including adult re-training
- CISE, EHR, ENG, SBE





## Work at Human Technology Frontier – Workshops and Research Coordination Networks

Understand and build the human-technology partnership	Design and develop new technologies to augment human performance	Illuminate the emerging socio-technological landscape	Foster lifelong and pervasive learning through technology
Making "The Future of Work" Work: A Convergence Workshop on Experiments in Tech Work-Maker Culture, Co-working, Cooperatives, Entrepreneurship & Digital Labor	RCN: Enhancing small and mid-level farm viability through a systems-based research network: Linking technology and sustainable development and practice	Future Workforce Implications of Autonomous Trucks: Workshop on the Sociotechnical Research Challenges, Benefits, and Opportunities	Convergence Research about Multimodal Human Learning Data during Human Machine Interactions
From Making to Micro- Manufacture: Reimagining Work Beyond Mass Production	A Workshop Shaping Research on Human- Technology Partnerships to Enhance STEM Workforce Engagement	RCN: Converge Research on the Socio Technological Landscape of Work in the Age of Increased Automation	Converging Human and Technological Perspectives in Crowdsourcing Research

## **Artificial Intelligence**

Transformative science that holds promise for tremendous societal and economic benefit with potential to revolutionize how we discover, work, learn, and communicate

- CISE core research programs:
  - Cyber-human Systems
  - Robust Intelligence
- Cross-directorate programs:
  - BIGDATA
  - NRI-2.0: Ubiquitous Collaborative Robots
  - Cyber Physical Systems
  - Smart & Connected Communities
  - Smart and Connected Health
  - Collaborative Research in Computational Neuroscience
- CISE Expeditions in Computing
- AI+X: ML as a new horizontal



## Future AI Research and Development Strategies

Al advances possible through: the availability of <u>big data</u> which provided raw material for dramatically <u>improved</u> <u>machine learning approaches and algorithms</u>; which in turn relied on the capabilities of <u>more powerful</u> <u>computers</u>

- 1. Make long-term investments in AI research
- 2. Develop effective methods for human-AI collaboration
- 3. Understand and address the ethical, legal, and societal implications of AI
- 4. Ensure the safety and security of AI systems
- 5. Develop shared public datasets and environments for AI training and testing
- 6. Measure and evaluate AI technologies through standards and benchmarks
- 7. Better understand the national AI R&D workforce needs



Recommendation 1: Develop an AI R&D implementation framework

Recommendation 2: Study the national landscape for creating and sustaining a healthy AI R&D workforce

#### A Vision for Research Cyberinfrastructure

Architecting an open national data infrastructure



Increasing interdisciplinary sharing

### NSF Cyber Physical Systems Research Model

- Abstract from sectors to more general principles – and apply these to problems in new sectors
- Thriving CPS community over 350+ current funded researchers
- Multiple agency participation (DHS, DoT, NASA, NIFA, and NIH)
- Investment
  - Over \$300M cumulative
  - 350+ awards
- Over \$40M in awards for each of FY14 -FY17
- Program and research of global Interest
  - Multiple emerging collaborations



#### A Long-term Research and Education Agenda for Smart & Connected Communities



Growing an international inter- and multidisciplinary, multisector research and education community

# Smart and Connected Communities Builds on History of NSF Research Investments

- Integrative Research
- Community Engagement
- Experimentation / Pilots
- Evaluation and Assessment
- Responsive to priorities in economic growth, prosperity, improvement of quality of life



Education and Workforce Training

## Smart and Connected Community Research Model

- Scientific and engineering foundations that will enable smart and connected communities to bring about new levels of economic opportunity and growth, safety and security, health and wellness, and overall quality of life.
- Integrative research projects that pair advances in technological and social dimensions with meaningful community engagement.
- Aligned in spirt with Society 5.0



## **Partnerships: Many dimensions**

Partnerships **build capacity**, **leverage resources**, **increase the speed of translation** from discovery to innovation



- Joint NSF/industry research solicitations: Intel (5), SRC (5), VMware (1)
- Research infrastructure: PAWR: Platforms for Advanced Wireless Research, cloud credits for BIGDATA, (AWS, Google, Microsoft)
- Individual project-based:
  I/UCRC, Intrans, GOALI

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- NSF-BSF (Israel): CCF and CNS core, SATC
- US-Japan: JUNO, Disaster recovery, interest in BIGDATA, ML
- NSF-Finland: WIFUS
- NSF-India: S&CC
- NSF-Netherlands: privacy
- NSF-Brazil: cybersecurity
- NSF-France, Germany, Israel: CRCNS

## **Partnerships: Many dimensions**

Partnerships **build capacity**, **leverage resources**, **increase the speed of translation** from discovery to innovation



- Cyber Physical Systems (CPS): DHS, DOT, NASA, NIH
- National Robotics Initiative (NRI): DARPA, NASA, NIH, USDA
- Smart and Connected Health (SCH): NIH
- Collaborative Research in Computational Neuroscience (CRCNS): NIH

all joint with other NSF directorates

## Value-Added for Partnerships and Collaborations

- Partnership: relationship between organizations, to achieve common goals together, with benefits to all partners
  - Common Goals: build capacity, leverage resources, increase the speed of translation from discovery to innovation, and enhance opportunity for collaborations to achieve these goals
  - Other value-added activities: communication and understanding between agencies
- Collaboration: a process among (teams of) research scientists to achieve a common objective. Valued added
  - <u>Accelerate progress</u> by working with people, ideas, infrastructure
  - <u>Create "better" outcomes</u> (e.g., more robust solutions to program, solutions that scale to realistic cases, more trustworthy software ...)
  - <u>Affect a broader impact</u> (e.g., results reach more people, or are more enduring)
  - Add <u>critical expertise</u> to a project
  - Provide <u>unique training and research experiences</u> for students
  - Provide access to and sharing of unique resources





## JST and NSF Partnership

## Building on Aligned Missions, History, Common Investments

- Missions Aligned
  - Both create intellectual knowledge to promote the progress of science
  - Both acknowledge the broader impact of knowledge to society
- History (partial) of Interactions
  - 2014: Release of Solicitation on Big Data and Disaster joint funding opportunity
  - 2016: JST-NSF International Joint Symposium on Big Data, AI, IoT and Cybersecurity for a New Society, Tokyo, Japan
  - 2017: DCL on NSF- JST Collaborative Research
    - NSF Big Data, CPS, SCC
    - JST Advanced Core Technologies for Big Data Integration: Team-Oriented Research (<u>CREST</u> <u>Program</u>) and Individual Research (<u>PRESTO Program</u>) and Advanced Application Technologies to Boost Big Data Utilization for Multiple-Field Scientific Discovery and Social Problem Solving: Team-Oriented Research (<u>CREST Program</u>)
    - Japan Workshop Enabling Global Collaborations in Big Data Research at IEEE Conference
- Common Investments: Big Data, AI, Cyber Physical Systems, others



## Quo Vadis

- First goal achieved creating collaborations amongst NSF and JST funded researchers –"Seeding many opportunities to see what blossoms"
- Next goal –Build on the collaboration to create impactful research project / program with significant benefits to Japan and US and leverage joint funding --- "Planting a flag"
  - Project submitted to current NSF solicitation (e.g. NSF 18-520 Smart and Connected Communities, CPS, or other) including proposers from US matched with proposers from Japan. Project has to leverage JST funding
  - New program based on bilateral solicitation modelled after several existing with SaTC, Neuroscience requires senior level discussion and planning
- Think big, impact and leverage



## What is the collaboration path to achieve significant impact and leverage?

Thank you



