# Humans in the CPS Loop: Research Priorities

## JST International Moonshot Symposium

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# How to think about this challenge?

One possible approach: look back to 1980.

- Predictable then: continuing improvement in computing and storage performance/cost

  ...along with changes driven by that – e.g., personal mobile communication

- Not predictable:  societal changes

  - Ongoing collection and concentration of data about human activity by large actors

  - Breakdown of trust in information

# The Future of Work at the Human-Technology Frontier (FW-HTF)

*Shaping the development and use of technologies to improve the quality of work, while also increasing productivity and economic growth*

## Research Themes:

- Building the human-technology partnership

- Augmenting human performance

- Illuminating the socio-technological landscape

- Fostering lifelong learning

References
Erik Brynjolfsson and Andrew McAfee(2014), The Second Machine Age, W W Norton & Co Inc, ISBN-10:0393239357
The Economist(2015), Jan 3
The National Academies of Science, Engineering, and Medicine(2017), Information Technology and The U.S. Workforce: Where Are We and Where Do We Go from Here?, National Academies Press, ISBN-10:9780309454025

# What will it take to achieve the targets?

- Innovation and Discovery
- Engineering
- Capacity (people, industries)
- Infrastructure
- Trust



## Also: Expect disruption from unforeseen directions!

# US Research and Development Priorities

NSF Programs support National Priorities, including <u>Industries of the future</u>:

1. Artificial Intelligence

   "Continued American leadership in AI is of paramount importance to ... shaping the global evolution of AI in a manner consistent with our Nation's values, policies, and priorities" – White House Executive Order on AI, February 2019

2. Advanced Wireless

   "Departments and agencies should support the development and deployment of advanced communications networks by prioritizing R&D consistent with the National Spectrum R&D Strategy." – FY2021 R&D Budget Priorities Memo, August 2019

3. Quantum Information Systems (QIS)

   National Quantum Initiative Act, became law January 2019, directs NSF to "(A) Support basic interdisciplinary QIS research; and (B) support human resources development in all aspects of quantum information science and engineering."

# National Artificial Intelligence (AI) Research Institutes

New Multi-year, multi-agency national initiative

- Initial partners: NSF, Dept. of Agriculture-National Institute of Food & Agriculture, Veterans Administration, Dept. of Transportation – Federal Highway Administration, Dept. of Homeland Security – Science & Technology

Goals:

- Significantly advance research in AI and accelerate the development of transformational, AI-powered innovation.
- Grow a workforce of future AI researchers and practitioners.
- Create national nexus points for universities, federal agencies, industries and nonprofits.

# National Artificial Intelligence (AI) Research Institutes

- Institute Scale (up to $20M/project): allowing researchers to focus on larger-scale, longer-term research.

- This solicitation: approximately $120M in grants in 2020 to fund *planning grants* and up to six *research institutes in specific areas* in order to advance AI research.
  - NSF anticipates repeating this funding opportunity in future years, subject to availability of funds.

# National AI Institutes: Background

**National Priorities**



Strategic Priority 1: Make long-term investments in AI research

**@NSF**



Convening of Potential Partners
May 29, 2019

# Institute Potential Discussed at May 2019 "Convening"

- Breadth and scale of challenges demand multi-disciplinary, multi-institutional collaborative efforts

- Sustained investment: in-depth, extended focus; prototyping, living labs; longer time horizons

- Nurture the next generation of talent

- Facilitate accelerated transition of innovations into many economic sectors

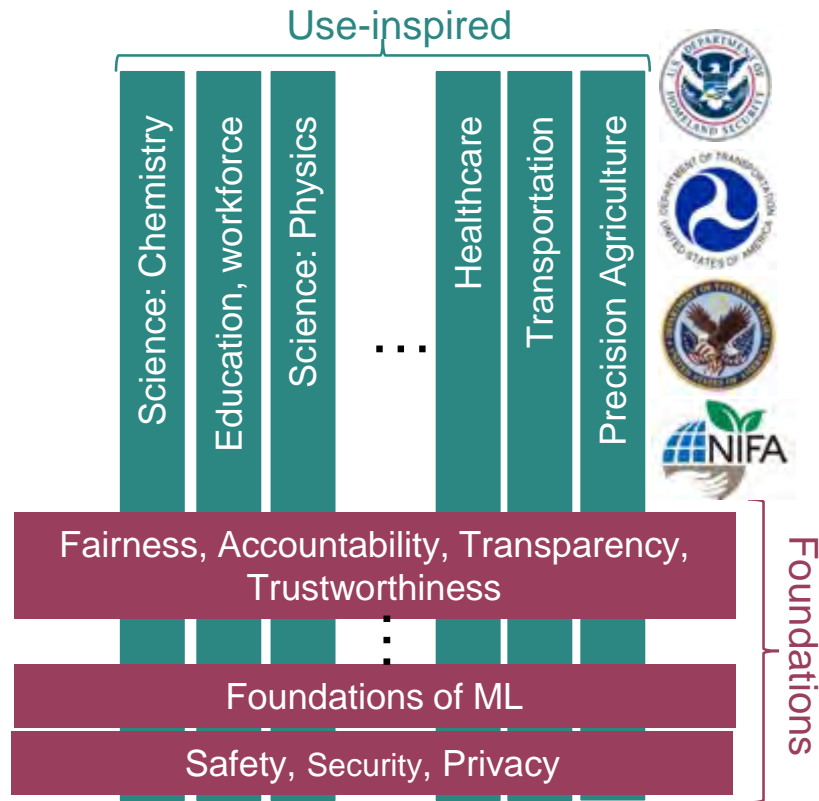- Address both "foundational" challenges and "use-inspired" opportunities

# Foundational and Use-Inspired AI Research

## Foundational AI

- Theory and methods independent of any particular domain of application.

## Use-inspired AI research

- Basic research that has use for society in mind.
- Situating in a domain of application to simultaneously inform progress in AI and solve particular use cases.
- In contrast to "applied research", the goal is to go beyond applying known techniques, and adds new knowledge and understanding in both *foundational AI* and *use-inspired domains*.



Use-inspired

Science: Chemistry | Education, workforce | Science: Physics | ... | Healthcare | Transportation | Precision Agriculture

Fairness, Accountability, Transparency, Trustworthiness

Foundations of ML

Safety, Security, Privacy

Foundations

# Platforms for Advanced Wireless Research (PAWR) Program

- Announced on July 15, 2016 by the White House and NSF
- $50M (NSF) for 4 new city-scale wireless research platforms
- 32-member Industry Consortium contributing ~$50M in cash and in-kind contributions to support platforms

# PAWR Goals

- Enable "city-scale" experimentation, larger than any single campus or company lab can typically support – in real-world conditions

- Connect industry and NSF's academic research community

- "Proving grounds" for pre-competitive wireless technology developed in industry and academia

- Accelerate technology transfer and promote US leadership

# PAWR Platforms

- Cloud Enhanced Open Software-Defined Mobile Wireless Testbed (COSMOS)
  - Location: Upper Manhattan
  - Technologies: mmWave, Optical x-haul. advanced software-defined radios

- Platform for Open Wireless Data-driven Experimental Research/ Reconfigurable Eco-system for Next-generation End-to-end Wireless (POWDER/RENEW)
  - Location: Downtown Salt Lake City
  - Technologies: massive MIMO, advanced software-defined radios

- Aerial Experimentation and Research Platform for Advanced Wireless (AERPAW)
  - Location: Research Triangle Park, North Carolina
  - Technologies: Unmanned Aerial Systems, advanced software-defined radios

FCC "Innovation Zone"

FCC "Innovation Zone"

# NSF Quantum Computing and Information Science Faculty Fellows Program

- Goal: grow US capacity in QIS to support research advances in QIS <u>over the long term</u>.

- Approach: Encourage academic departments to hire faculty in QIS-related areas.

- How: <span style="color:red">Pay salary and benefits of a new hire faculty member</span> for up to three years.
    - Only for faculty who do not currently hold a tenure-track position.

- Emphasis on cross-departmental collaboration.

# Thoughts on Trust

Reaching the targets "C-Avatar Capitalism" and "C-Avatar Life" requires that we be able to trust:

• the infrastructure on which they run

• the information we receive through the systems

Challenge: human beings' ways of deciding what is trustworthy are very much tied to our physical presence and embodiment.

# *Thank You!*

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