2019 Conference of the Association for the Advancement of Artificial Intelligence (AAAI) -- Townhall Meeting

Developing a 20-Year AI Research Roadmap for the US

Roadmap Co-Chairs:

Yolanda Gil, University of Southern California

Bart Selman, Cornell University

Workshop Co-chairs:

Marie desJardins, Simmons University

Tom Dietterich, Oregon State U

Ken Forbus, Northwestern University

Fei-Fei Li, Stanford U

Kathy McKeown, Columbia University

Dan Weld, University of Washington

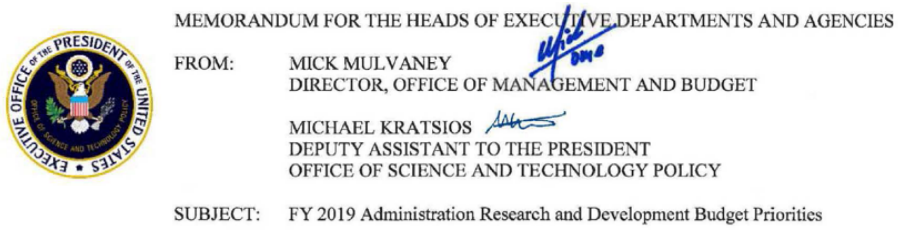
CCC
Computing Community Consortium
Catalyst

January 27, 2018

Association for the Advancement of Artificial Intelligence

Important Note

- **This presentation gives an overview of ongoing efforts to create a 20-Year AI Research Roadmap for the US. It summarizes current views, and introduces preliminary ideas for potential recommendations.**
- **The presentation captures interim ideas, and is intended to promote community input and discussion.**
- **The annual conference of the Association for the Advancement of Artificial Intelligence (AAAI) was considered an ideal opportunity for gathering community input. AAAI is widely considered to be the premier scientific society for AI, and its annual conference is a top venue for publication of AI research, applications, and education. The timing of the conference also fit well the timing of the roadmap efforts.**
- **A live recording of the session is publicly available at https://aaai.org/Conferences/AAAI-19/townhall-a-20-year-roadmap-for-ai-research/**



MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: MICK MULVANEY
DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET

MICHAEL KRATSIOS
DEPUTY ASSISTANT TO THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY

SUBJECT: FY 2019 Administration Research and Development Budget Priorities

FY 2019, 2020 R&D Budget Priorities Memo

"Continued leadership in AI, quantum information science (QIS), and strategic computing is critically important to our national security and economic competitiveness. Agencies should invest in fundamental and applied AI research, including machine learning, autonomous systems, and applications at the human-technology frontier."

A 20-Year AI Research Roadmap for the US

"…prioritize emerging technologies critical to economic growth and security, such as data science, encryption, autonomous technologies,… advanced computing technologies, and artificial intelligence. "

Interim report, AAAI Townhall, 27 January 2019

National Leadership in AI

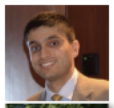
Office of Science & Technology Policy (OSTP)

Lynne Parker, NSF
Assistant Director for AI

Jim Kurose, NSF
Former Assistant Director for AI

National Science and Technology Council (NSTC)

France Cordova, NSF
AI Select Committee
Co-chair (with DARPA, OSTP)



Erwin Gianchandani, NSF
Jim Kurose, NSF
MLAI co-chairs

Henry Kautz, NSF
NITRD AI WG co-chair

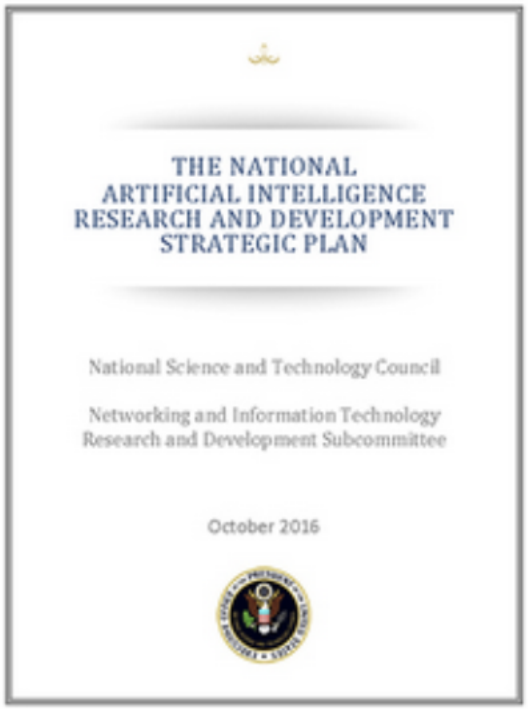
Jeff Alstott, IARPA
NITRD AI WG co-chair

A 20-Year AI Research Roadmap for the US

Interim report, AAAI Townhall, 27 January 2019

US National AI Research & Development Strategic Plan

- NITRD Working Group of 40+ Federal Funding Agencies
- Co-Chairs: Henry Kautz (NSF) and Jeff Astott (IARPA)
- April 2019: Update to 2016 Plan and Implementation Report
- Updating 2016 National AI Research and Development Strategic Plan (RFI responses were due Oct 26)


THE NATIONAL ARTIFICIAL INTELLIGENCE RESEARCH AND DEVELOPMENT STRATEGIC PLAN

National Science and Technology Council

Networking and Information Technology Research and Development Subcommittee

October 2016


FEDERAL REGISTER

The Daily Journal of the United States Government

Notice

Request for Information on Update to the 2016 National Artificial Intelligence Research and Development Strategic Plan

A 20-Year AI Research Roadmap for the US

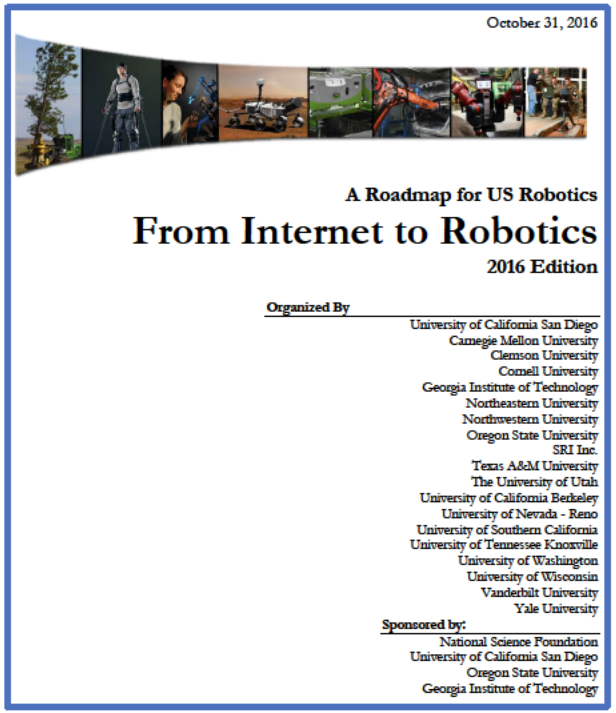
Interim report, AAAI Townhall, 27 January 2019

AI Presence and Overall Trends in the US

- AI has gone from an academic research area to permeating our lives
  - Significant impact on society
  - Untapped potential
- Significant influence of AI in innovation and stimulating the economy
  - White house meeting in May 2018
- Concern about safety and transparency of this technology leads to questions for AI research community about how to establish policy
- Concerted initiatives in government and in academia
  - Joint AI Center
- Increases in federal funding investments (DARPA $2B, NSF, etc)

A 20 Year AI Research Roadmap for the US

- Objectives
  - 10 - 20 year research roadmap
  - Guidance for funding agencies and Congress
  - Relate to:
    - AI research in industry
    - International AI initiatives
- Computing Community Consortium with support from US National Science Foundation
  - CCC has developed prior research roadmaps, such as the Robotics Roadmap that led to the US National Robotics Initiative


October 31, 2016

A Roadmap for US Robotics

From Internet to Robotics

2016 Edition

Organized By

University of California San Diego
Carnegie Mellon University
Clemson University
Cornell University
Georgia Institute of Technology
Northeastern University
Northwestern University
Oregon State University
SRI Inc.
Texas A&M University
The University of Utah
University of California Berkeley
University of Nevada - Reno
University of Southern California
University of Tennessee Knoxville
University of Washington
University of Wisconsin
Vanderbilt University
Yale University

Sponsored by:

National Science Foundation
University of California San Diego
Oregon State University
Georgia Institute of Technology

CCC Computing Community Consortium Catalyst

CRA Computing Research Association

Reference Documents

- US National AI R&D Strategic Plan, 2016 (currently being updated)
  - https://www.nitrd.gov/news/national_ai_rd_strategic_plan.aspx
- US National Robotics Roadmap, 2009, revised 2016:
  - https://cra.org/ccc/wp-content/uploads/sites/2/2016/11/roadmap3-final-rs-1.pdf
- 100 year study of AI, 2016 report:
  - https://ai100.stanford.edu/sites/default/files/ai100report10032016fnl_singles.pdf
- AI strategies/investments abroad:
  - https://medium.com/politics-ai/an-overview-of-national-ai-strategies-2a70ec6edfd

Timeline for AI Roadmap

- 3 small by-invitation workshops (Nov-Jan)
  - WS1: Integrated intelligence
  - WS2: Meaningful interaction
  - WS3: Learning and robotics
- Townhall at AAAI (Jan 28, 7:30pm)
- Draft report (Feb)
- Feedback period (Feb-March)
- Final report (April)

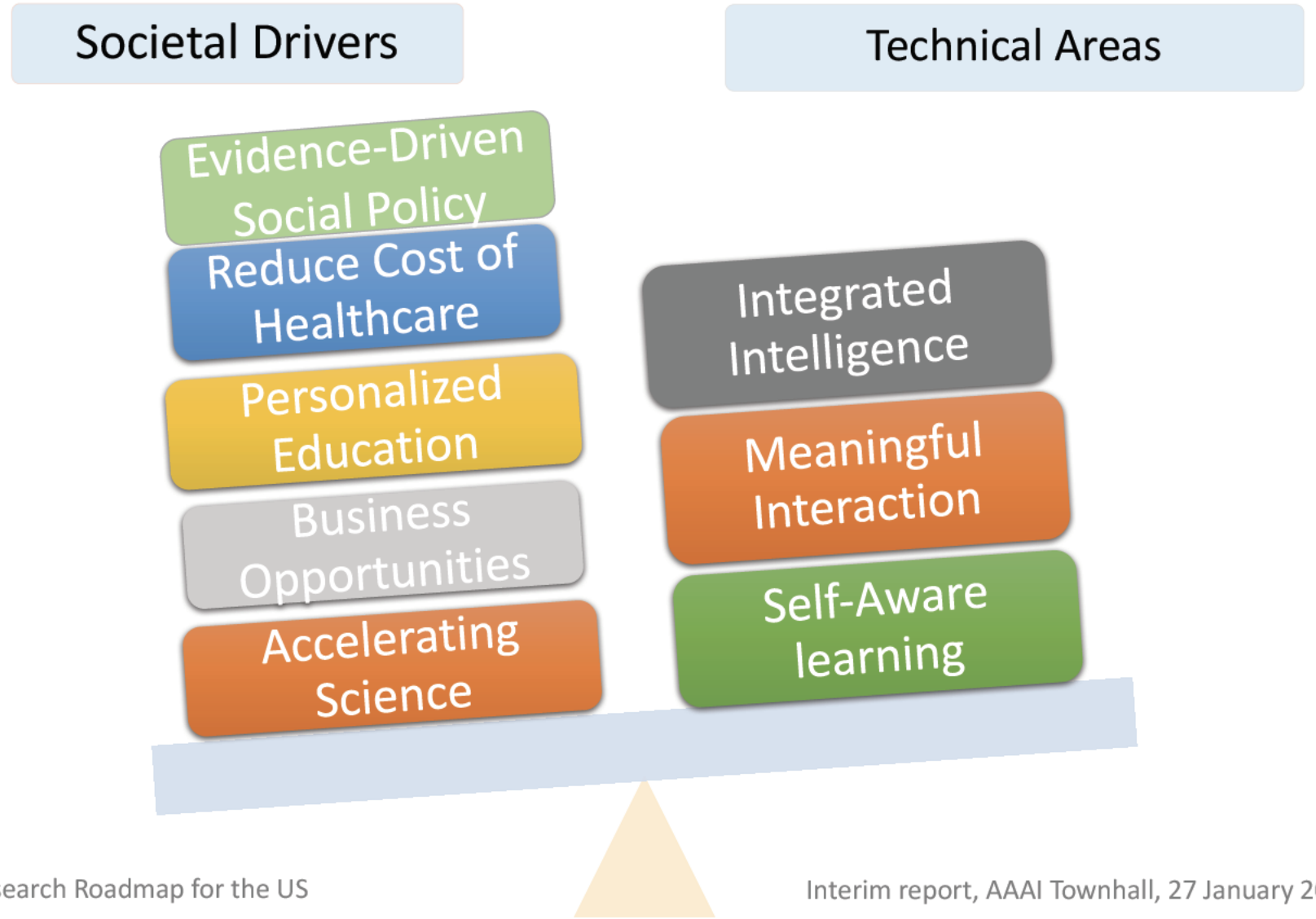
Generating a Technical Roadmap through Community Workshops

- W1: Integrated Intelligence (Nov 14-15)
  - *Chairs: Marie desJardins and Ken Forbus*
  - Understanding the mind
  - Composing intelligent capabilities
  - Open repositories of knowledge
- W2: Meaningful Interaction (Jan 8-9)
  - *Chairs: Kathy McKeown and Dan Weld*
  - Interactions that matter
  - Trust and responsibility
  - People interacting online

- W3: Self-Aware Learning (Jan 17-18)
  - *Chairs: Tom Dietterich and Fei-Fei Li*
  - Deeper learning for challenging tasks
  - Integrating continuous and symbolic representations
  - Diversified learning modalities

Identifying Societal Drivers

1. **Boost Health and Quality of Life:** Prevention of illness and elderly ailments, mental/behavioral health, reducing cost (25+% feasible) while improving care, remote patient care.
2. **Lifelong Education and Training:** Personalized, scalable education support. Improve the AI knowledge and skills of people who will lose jobs. Training next generation of AI specialists, data scientists, and software engineers
3. **Reinvent Business Innovation and Competitiveness:** Evidence-driven companies, which would increase productivity and value and open new sectors/products
4. **Accelerate Scientific Discovery and Technological Innovation:** Biomedical, environmental, new materials, personalized services, robotics, self-driving cars, etc.
5. **Social Justice and Policy:** Engaging and empowering disadvantaged communities. Improving civic and political discourse
6. **Transform Cyber Defense and Security:** AI driven systems can compensate for a relatively small cyber defense workforce, adversarial reasoning



Integrated Intelligence

Chairs:
Marie desJardins, Simmons U
Ken Forbus, Northwestern U

Technical Areas

1. Science of integrated intelligence
2. Contextualized AI
3. Open knowledge repositories
4. Understanding human intelligence

Societal Driver Vignettes

- Mental and behavioral health coach
- Accurate models of water reserves
- Speed up vaccine experiments
- Students in remote rural settings
- Retrain factory workers
- Resolve supply chain delays

Integrated Intelligence:
1) Science of Integrated AI

Components of Intelligence

Combining deliberation with perception/control

Memory types and organization

Metareasoning and reflection

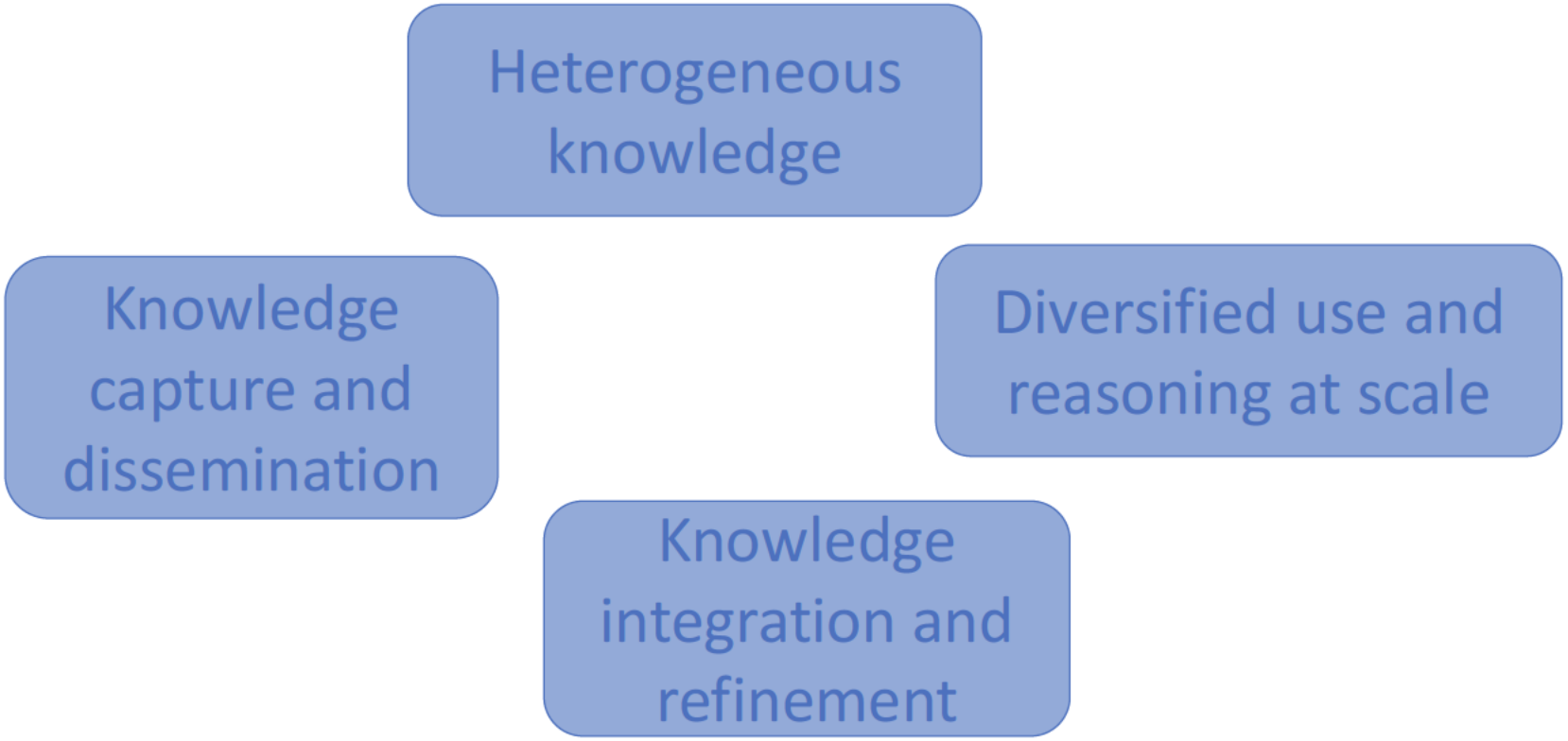
Integrated Intelligence:
2) Contextualized AI

Customization of general capabilities

Social cognition

Cognizance of environment

Integrated Intelligence:
3) Open Knowledge Repositories



Integrated Intelligence:
4) Understanding Human Intelligence

AI inspired by human intelligence

AI to understand human intelligence

Unifying theories of human and artificial intelligence

Meaningful Interaction

Chairs:
Kathy McKeown, Columbia U
Dan Weld, U Washington

Technical Areas

1. Collaboration
2. Trust and responsibility
3. Diversity of interaction channels
4. Improving online interaction

Societal Driver Vignettes

- At-home robot caregiver/helper
- Collaborative materials discovery
- Training for robot repair jobs
- Custom personal devices business
- Spreading opportunities for homeless youth

Meaningful Interaction:
1) Collaboration

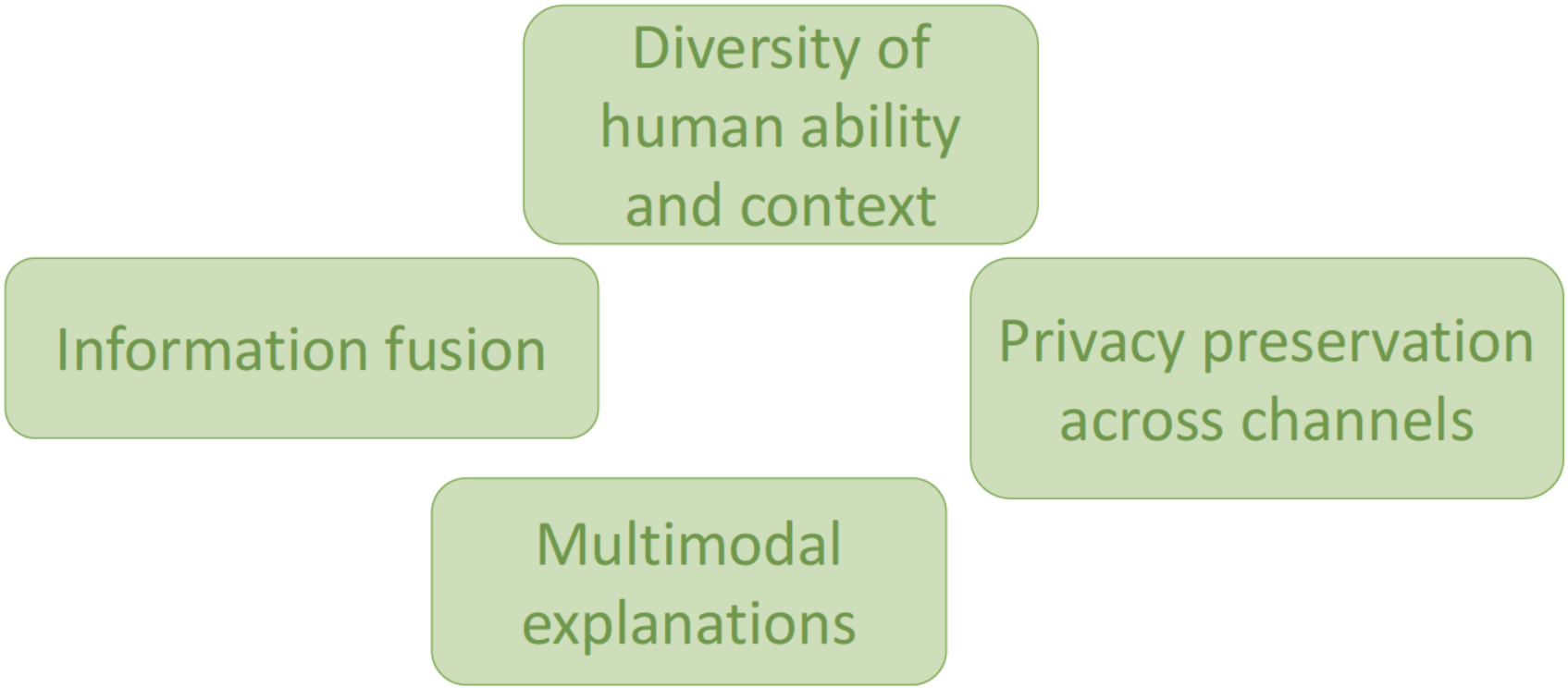
Modeling human mental states

Social norms and commonsense

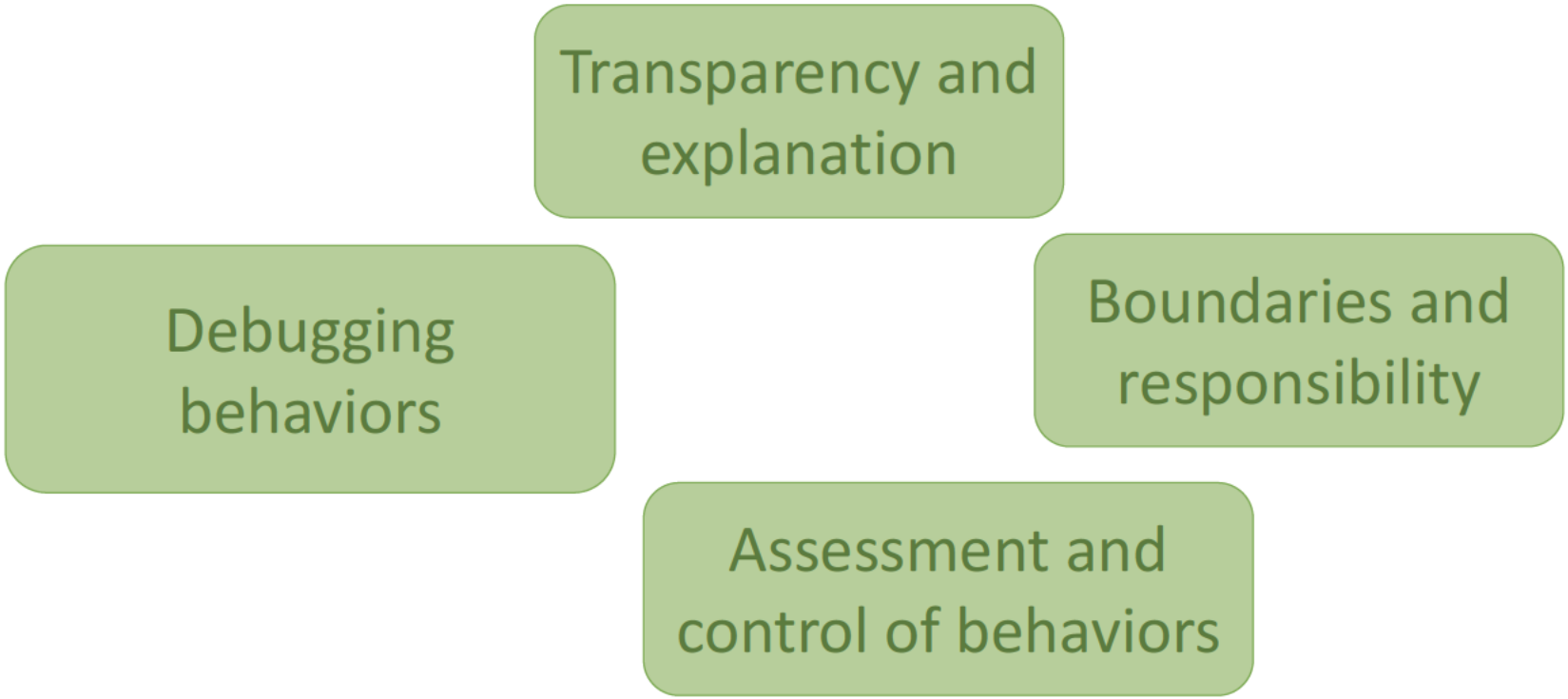
Supporting complex teamwork

Reliability and ethical behaviors

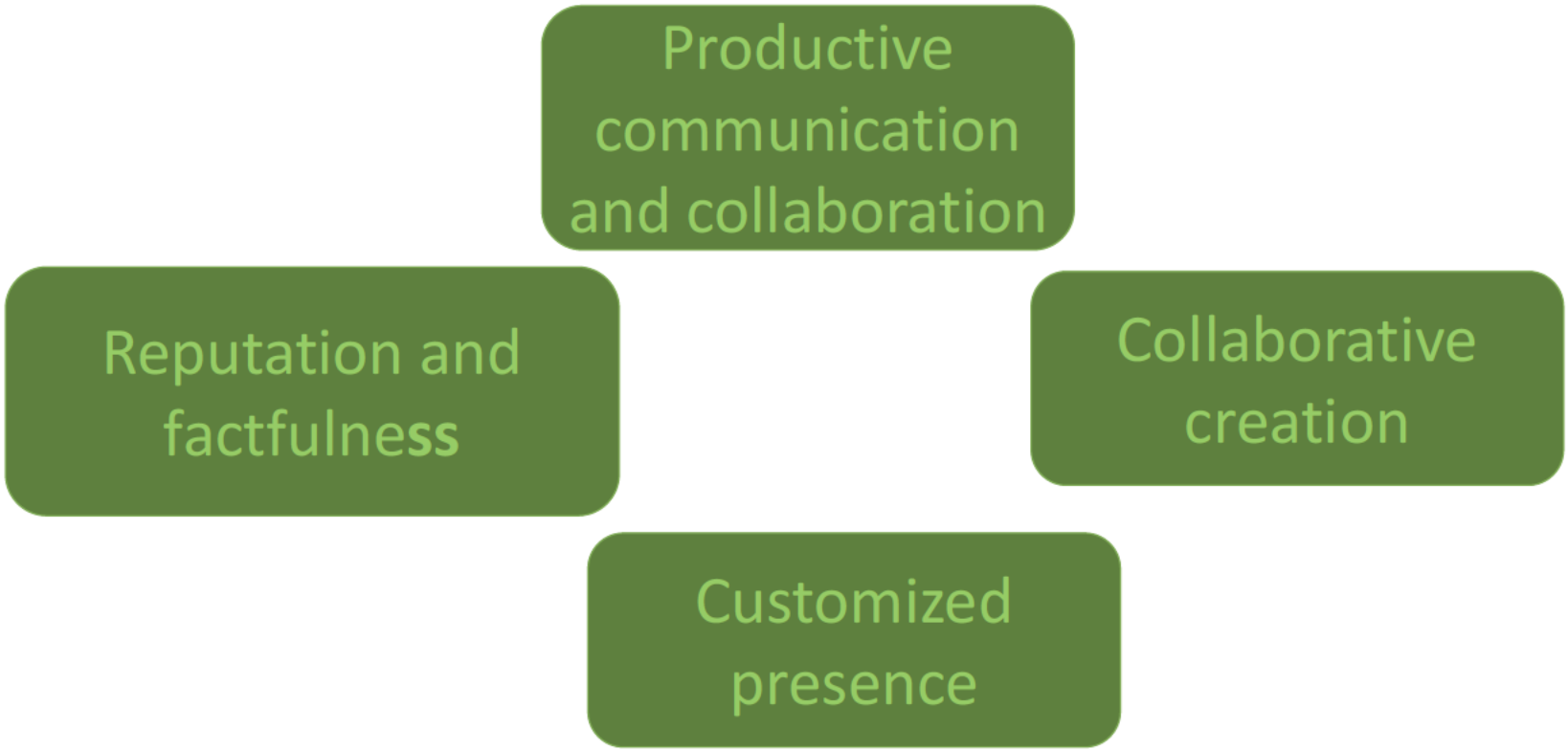
Meaningful Interaction:
2) Diversity of Interaction Channels



Meaningful Interaction:
3) Trust and Responsibility



Meaningful Interaction:
4) Improving Interactions Between People



Self-Aware Learning

Chairs:
Tom Dietterich, Oregon State U
Fei-Fei Li, Stanford U

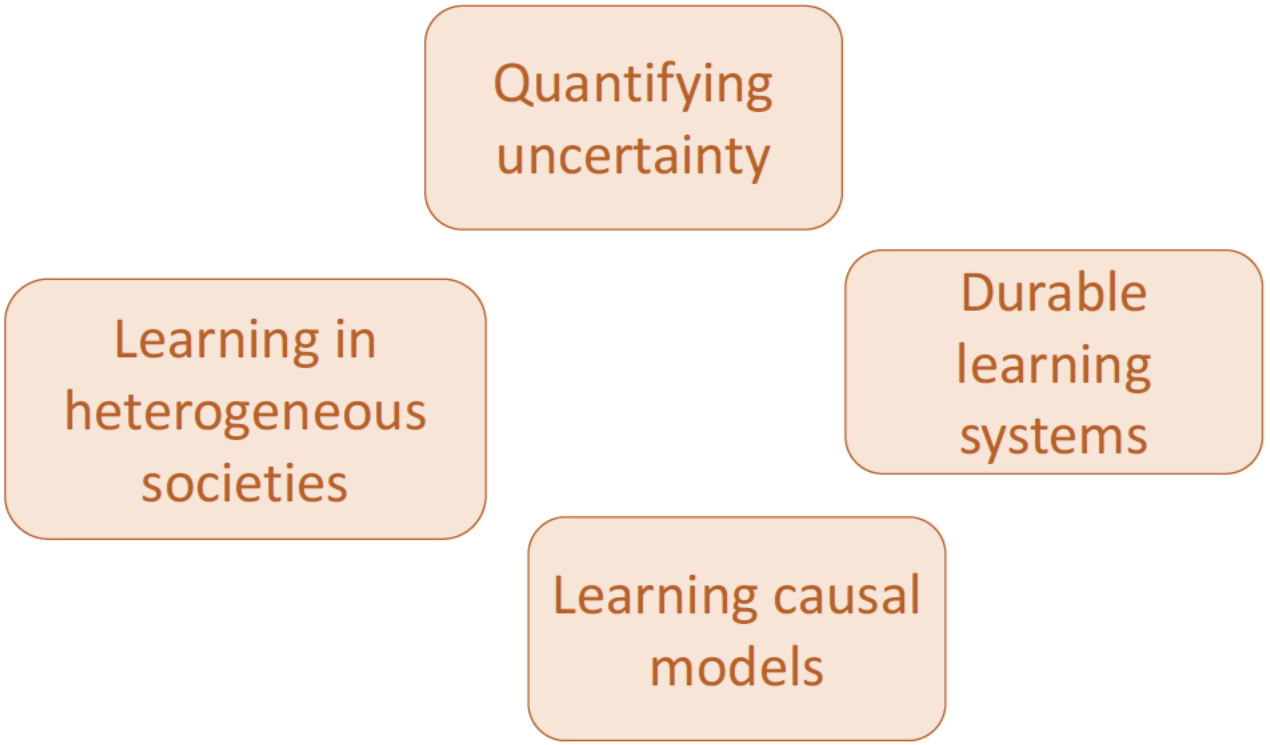
Technical Areas

1. Robust and trustworthy learning
2. Deeper learning for challenging tasks
3. Integrating symbolic and numeric representations
4. Learning in integrated AI/Robotic systems

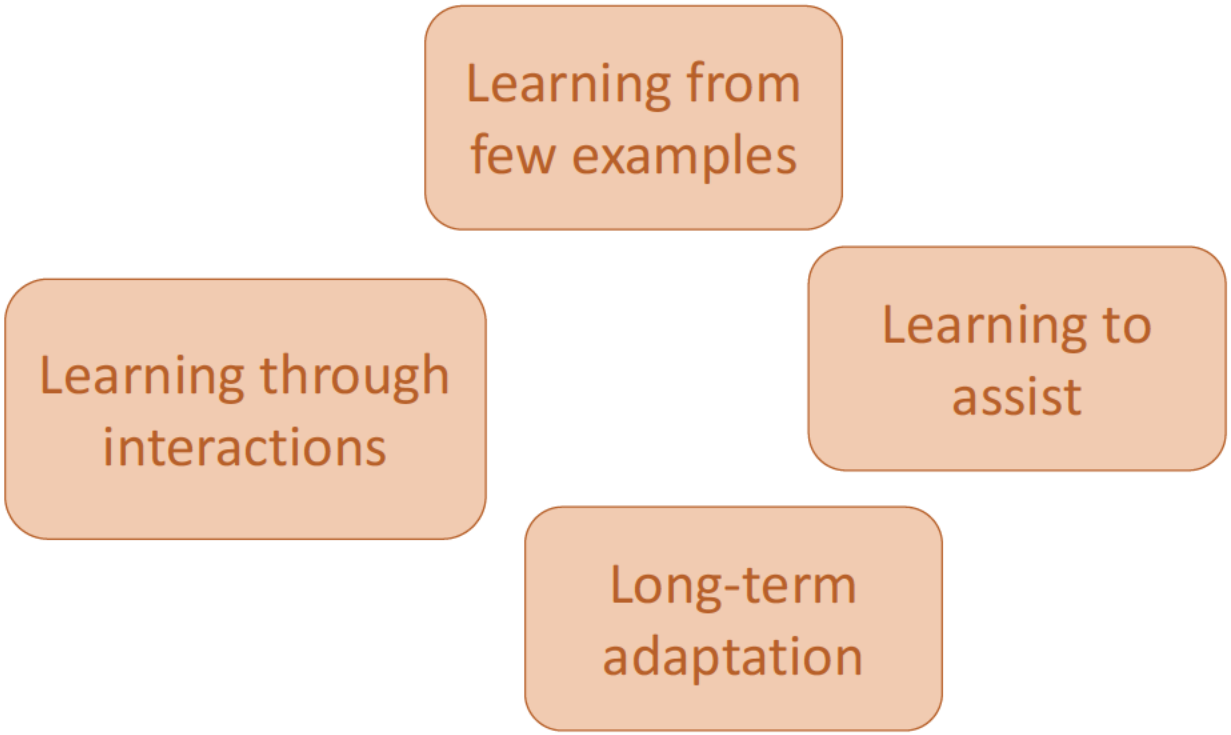
Societal Driver Vignettes

- Prevent opiate abuse
- Game design startup
- Climate models with physics and data
- Police training
- Food insecurity and distribution
- Resilient cyber-physical systems

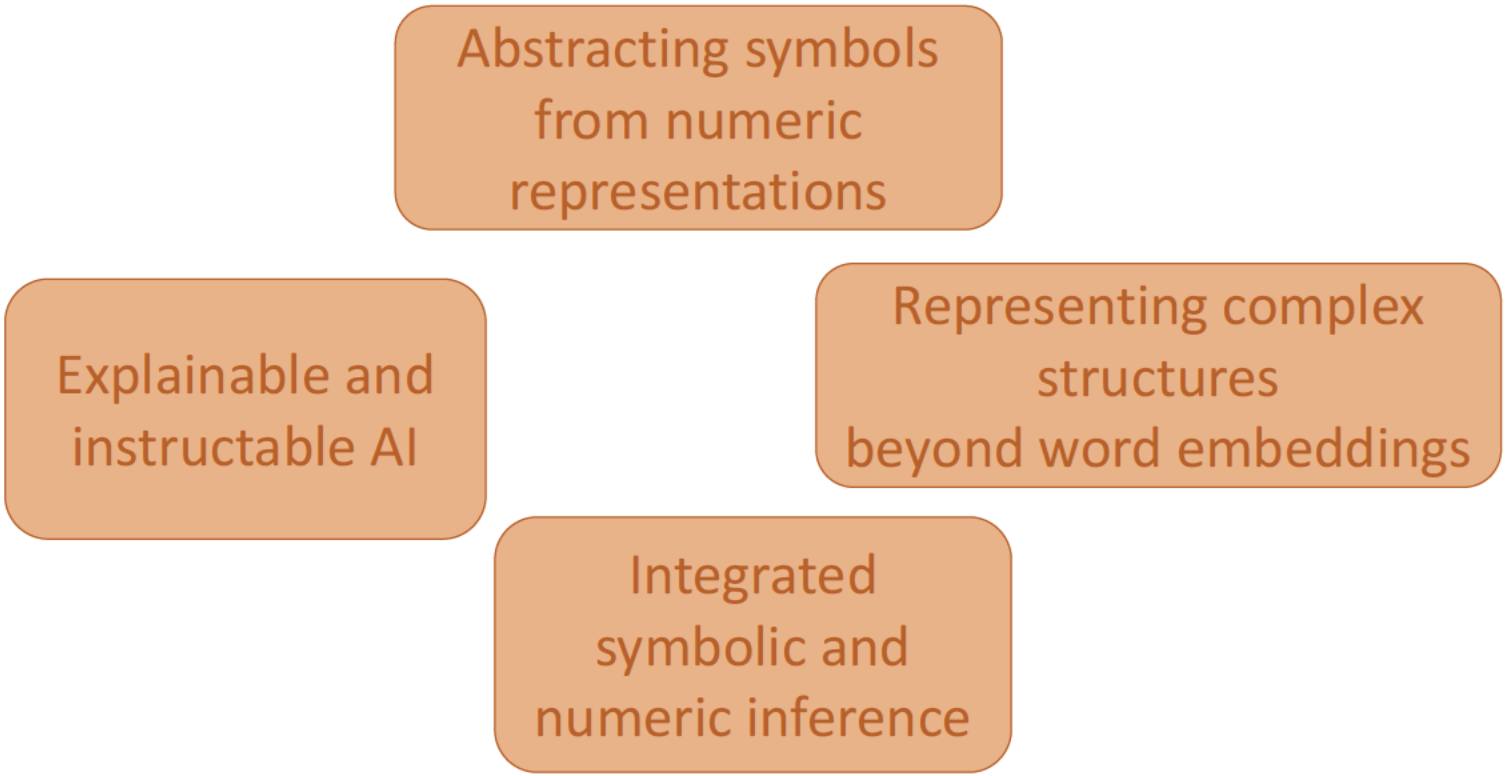
Self-Aware Learning:
1) Robust and Trustworthy Learning



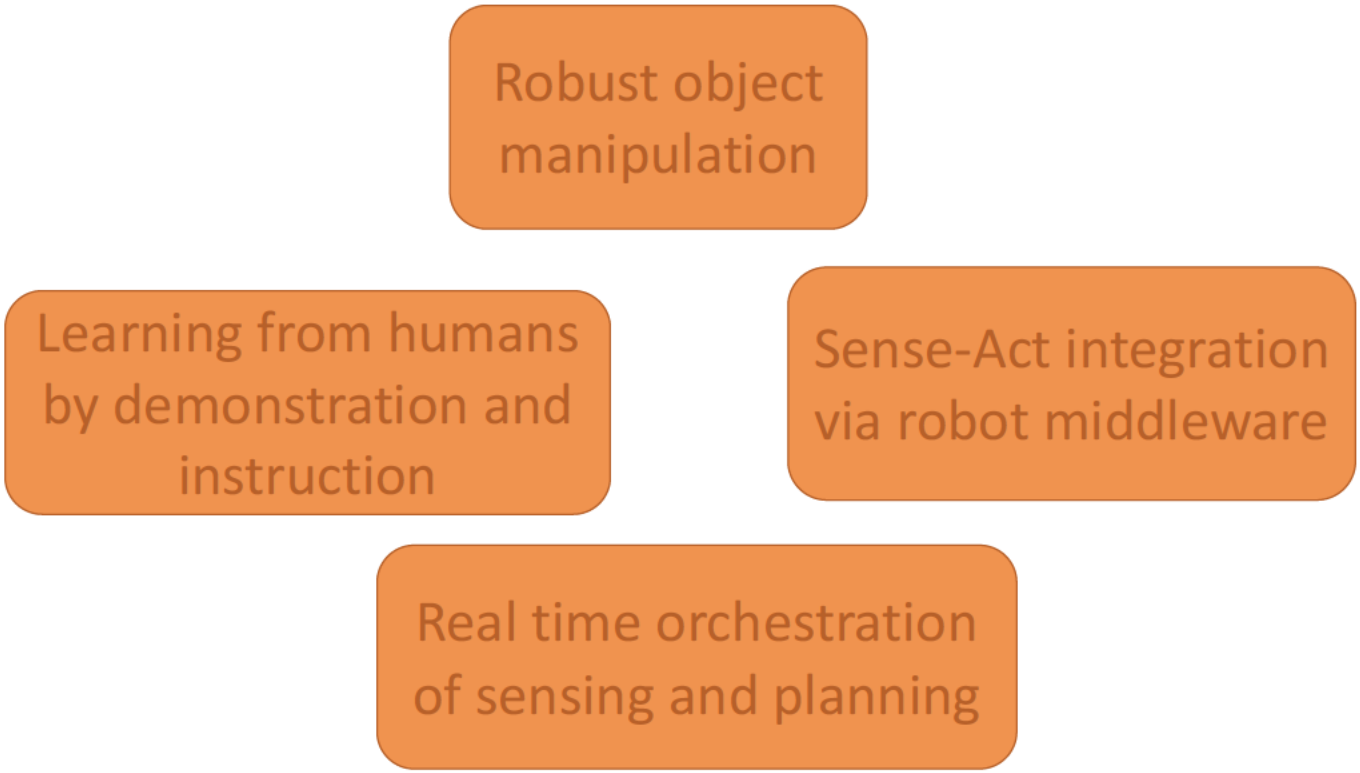
Self-Aware Learning:
2) Deeper Learning for Challenging Tasks

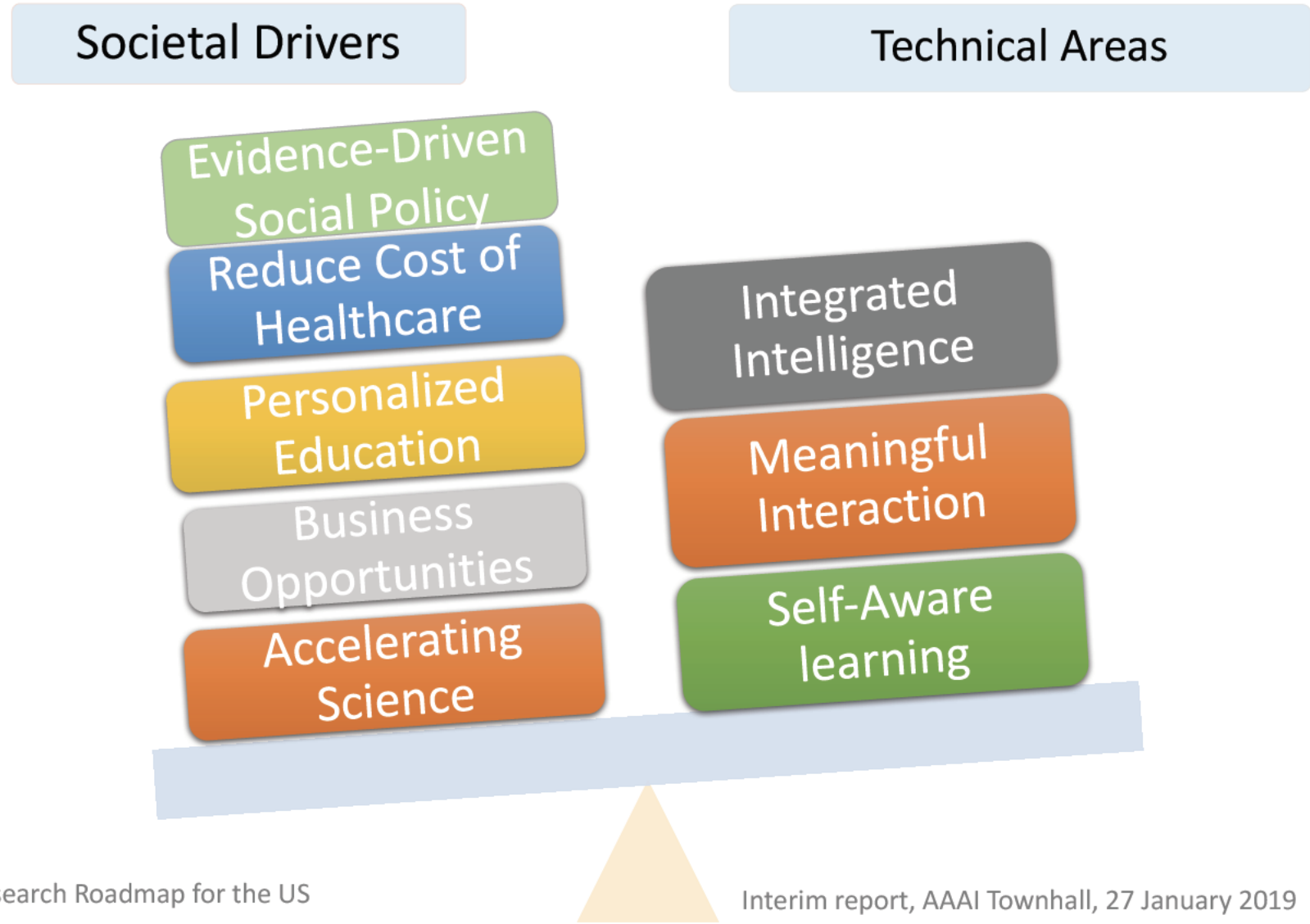


Self-Aware Learning:
3) Integrating Symbolic and Numeric Representations

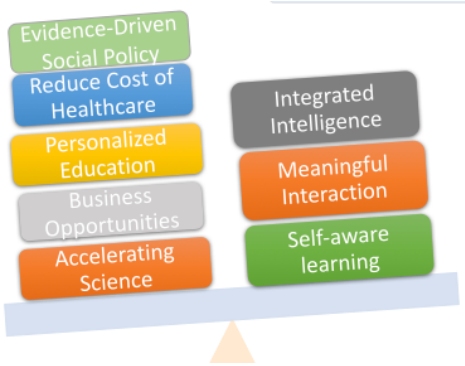


Self-Aware Learning:
4) Learning in Integrated AI/Robotic Systems





A New Era of Audacious AI Research



- Audacious AI research tackles broader AI goals
  - More integrative, requiring significant resources and diverse expertise
  - Hard for individual PIs to to stand the necessary research environments
- Arguably such environments are mostly available in industry
  - Significant driver for academics to flock to industry labs
- Requires engaging the community in shared resources and goals
  - Eg LIGO and LHC in particle physics
  - Eg Human Genome Project in medicine
  - Eg Hubble telescope in astronomy

Proposed Recommendations:
1) Open National AI Platform

- A shared ecosystem infrastructure for AI research
  - Components and services available for others to use and build on
- Example resources
  - An open knowledge network of knowledge about the world
  - Data repositories
  - Reproducible experimentation environments
  - Computational/cloud resources
- Wide range of contributors and contributions
  - Share research products
  - Experimental harness
- Infrastructure would include hardware, data, software, services, and people

Proposed Recommendations:
2) New Funding Programs and Mechanisms

- Larger scale and broader scale projects are needed to:
  - Support AI research across multiple areas
  - Support multi-disciplinary research
  - Support AI engineering, experimentation, and deployment
- Sustained funding programs
- Rewards for collaboration (rather than competition)
  - National AI Platform as a collaborative

Proposed Recommendations:
3) Broaden AI Education

- Need for development of official degrees and certifications in AI at all levels, and associate curricula – particularly for other disciplines
  - K through grey
- Need for creative incentive mechanisms to retain faculty and students in academia given the resources and salaries available in industry
  - Recommendations #1 and #2
- Fellowships for graduate students
  - Production of AI graduates should keep up with demand at the PhD level
  - Broadening of AI career paths:
    - Students tend to focus on very narrow areas of AI that are more in demand in industry, rather than the broader themes and higher interdisciplinarity of this report
    - Few students undertake new areas such as AI and policy, or AI and law

Recommendations:
4) Promote AI Policy and Ethics

- Promote AI research that focuses on characterizing and quantifying AI systems, that can inform policy and decision makers
  - Report emphasis characterization and quantification of:
    - Responsibility
    - Explainability
    - Competency
    - Robustness
- Need to promote emerging cross-cutting disciplines for AI:
  - AI and economics: impact of automation and the future of jobs
  - AI policy and law: responsibility
  - AI engineering: safety, robustness

Discussion Period

1. Clarification questions

2. Feedback and suggestions

Comments, Suggestions, Feedback?

- Email us at:

gil@isi.edu
selman@cs.cornell.edu
cccinfo@cra.org