The Human-Technology Frontier

Beth Mynatt, Georgia Tech
Daniel Lopresti, Lehigh University
Shwetak Patel, University of Washington
What is the Human-Technology Frontier

• 2016/17 NSF working group (CISE, ENG, EHR, SBE)

• Recognizing a major change in work and the workplace
  – Driving by advancements in AI, ML, IoT, Robotics, etc

• Although motivated by the workplace, HTF encompasis a broader socio-technical consideration
  – Health, environment, physical infrastructure
What is the Human-Technology Frontier

• Understanding and building the human-technology partnership

Manufacturing “cobot”

Immersive 3D virtual environment
What is the Human-Technology Frontier

- Augmenting Human Performance

Deep learning applied to brain tumor detection and segmentation

Smart prosthetic arm and hand with sense of touch

Soft robotic exoskeleton for strength and endurance
Areas of Exploration within the CCC

• Lifelong Learning
• Mobile/Digital Health
• Intelligent Infrastructure
• Aging / AI
• Workforce Training
• Reducing Disparities
What is the Human-Technology Frontier

• Fostering lifelong learning and learning with technology

Dashboard for teachers

Virtual reality training simulation
Mobile/Digital Health

- Mental health, stress, isolation, addiction
- Need for better interventions
  - How do make mental health support less stigmatized, more accessible, and more effective
- New funnels for getting help
  - Social networks, search, etc
- Identifying new biomarkers
  - Physical and mental health are intertwined
HUMAN TECHNOLOGY FRONTIERS: INTELLIGENT INFRASTRUCTURE

The Internet of Things (IoT) has a potential economic impact of 2.7-6.2 trillion USD until 2025

<table>
<thead>
<tr>
<th>Technology</th>
<th>Low</th>
<th>High</th>
<th>X-Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Internet</td>
<td>3.7-10.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automation of knowledge work</td>
<td>5.2-6.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet of Things</td>
<td>2.7-6.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cloud technology</td>
<td>1.7-6.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced robotics</td>
<td>1.7-4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autonomous and near-autonomous vehicles</td>
<td>0.2-1.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Next-generation genomics</td>
<td>0.7-1.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy storage</td>
<td>0.1-0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3D printing</td>
<td>0.2-0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced materials</td>
<td>0.2-0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced oil and gas exploration and recovery</td>
<td>0.1-0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renewable energy</td>
<td>0.2-0.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SOURCE: McKinsey Global Institute analysis

HUMAN TECHNOLOGY FRONTIERS: INTELLIGENT INFRASTRUCTURE


The Internet of ransomware things...

HUNGRY? PAY UP AND I’LL UNLOCK MY DOOR!

ON STRIKE UNTIL YOU SEND MONEY TO MY HACKERS.

20 BUCKS IN MY PAYPAL ACCOUNT OR I’LL ONLY BREW DECAF!

I’LL BE BURNING THE TOAST IF YOU DON’T GET ME SOME DOUGH!

THE NEXT TIME YOU LEAVE, IT’LL COST YOU 100 BUCKS TO GET BACK INTO THE HOUSE, UNLESS YOU GIVE ME $75 NOW!

WIRE MY HACKER $100 OR I’LL REVERSE MY MOTOR AND BLOW DIRT ALL OVER THIS PLACE!

YOUR DIRTY DISHES CAN WAIT, I’M BUSY MINING BITCOINS.

EXCUSE US WHILE WE PARTICIPATE IN A DDoS ATTACK.

I’LL START YOUR CAR, BUT ONLY TO TAKE YOU TO YOUR BANK TO MAKE A TRANSFER.

SEND ME $25 OR I’LL TELL EVERYONE ON YOUR SOCIAL NETWORK THAT YOU WERE STUPID ENOUGH TO BUY AN INTERNET-CONNECTED BROOM!

30 BUCKS IN BITCOIN, OR NEXT TIME I SMELL SMOKE, I MIGHT JUST LET YOU SLEEP.

MY ALARM SYSTEM IS GOING TO GO OFF RANDOMLY THROUGHOUT THE NIGHT, UNLESS YOU “DONATE”.

IF YOU DON’T SEND US CASH, YOUR REPUTATION WILL BE IN THE TRASH.
HUMAN TECHNOLOGY FRONTIERS: INTELLIGENT INFRASTRUCTURE

- Important open questions in privacy, security, safety, usability, livability, health, equity, education, and jobs.
- HTF / II has potential connections to most CS research areas.
- Many CCC resources available: whitepapers, workshops, etc. We also have an Intelligent Infrastructure Task Force.
- Whitepapers on: national research agenda, future of transportation, smart grid, disaster management and public safety, city-scale platforms, smart agriculture, safety and security, rural communities, privacy, smart wireless, IoT.
- Talks from: AAAS (Disaster Management & Public Safety) and CCC Symposium (II for Our Cities & Communities).
- Developing collaboration with NIST Global Cities Team Challenge.
HUMAN TECHNOLOGY FRONTIERS: INTELLIGENT INFRASTRUCTURE

One of NSF’s “10 Big Ideas” for future investment:

“From robots on the assembly line and in the operating room to the office that travels with you 24/7, the world of work is changing. We are at the cusp on a major transformation in work that is being driven by combinations of machine learning, artificial intelligence, the internet-of-things, and robotics.”

- Social impact will be huge.
- Big repercussions, even turmoil, if we don’t get this right.
- We’re on the hook for this one.
HUMAN TECHNOLOGY FRONTIER

- Technology innovations for “aging in place”
- Future of Training
- Human-Centered AI
- Reducing Disparities
Joint NIH/CCC Meeting September 2014

Produced Workshop Report February 2015

NIH released new RFP informed by AIP Workshop October 2015

PCAST Report March 2016
Raw Sensor Data
- Motion Detectors
- Location
- Load Cells / Bed Sensors
- Contact/Door Switches
- Phone Sensors
- Computer
- Medication Tracker
- Weight Scale

Direct Assessment
- Gait Velocity
- Location Estimation
- Sleep
- Departures Arrivals
- Phone Use
- Computer Interactions
- Medication Events
- Weight

Inference
- Mobility
- Sleep Hygiene
- Socialization
- Depression
- Memory
- Attention
- Medication Adherence
- Physical Impairments

Frameworks
- Frailty
- Cognitive function
- Health management
- Activities of Daily Living
- Independence
- Quality of life
- Empowerment Engagement

Sensor Fusion
Info Fusion
Computing innovations for aging adults
Advances in Artificial Intelligence Require Progress Across all of Computer Science

February 2017

Gregory D. Hager, Randal Bryant, Eric Horvitz, Maja Mataric, and Vasant Honavar

Over the last decade, the constellation of computing technologies referred to as artificial intelligence (AI) has emerged into the public view as an important frontier of technological innovation with potential influences in many realms. Advances in many disciplines related to AI, including machine learning, robotics, computer vision, natural language processing, inference, decision-making, and planning, are contributing to new-fielded products, services, and experiences. Offerings such as navigation systems, web search, speech recognition, machine translation, face recognition, and recommender engines have become part of the daily life of millions of people. Other applications coming to the fore include semi-autonomous and autonomous ground and air vehicles, systems that harness planning and scheduling, intelligent tutoring, robotics. More broadly, cyber-physical and robotic systems, incorporating varying degrees of AI technology, are poised to be fielded in a variety of real-world settings.
70 YEARS OF INVESTMENT

AS WE MAY THINK
A TOP U.S. SCIENTIST FORESEES A POSSIBLE FUTURE WORLD IN WHICH MAN-MADE MACHINES WILL HELP US THINK

DARPA Speech Recognition Benchmark Tests

Courtesy NIST 1996 DARPA
HUB-4 Report, Pallet et al.
& new updates from DARPA
COLLABORATIVE / SYMBIOTIC / CO-EVOLVING AI

• Interweave a computer with something that is already intelligent (i.e., the human being)
  — Put cameras where eyes are
  — Put microphones where ears are
  — Put motion sensors at hands
  — If possible, look into brain for focus of attention and “intent”

• Learn how to interact with the human world by observing a human interacting with the world

• Centaur Chess…. Now bring it to the rest of the world.
Future of Training / Future of Work
Sociotechnical Interventions for Health Disparity Reduction: A Research Agenda

April 9-10, 2018
New Orleans Riverside Hilton
Hilton New Orleans Riverside, Poydras Street, New Orleans, LA, United States

Overview

The burden of negative health outcomes is, unfortunately, differential in the United States (US) and other countries, a phenomenon known as health disparities. Health disparities are differences in the incidence and prevalence of disease, as well as disease-related morbidity, mortality, and survival rates in one group when compared to the general population. Health disparities may emerge on the basis of socially stratifying factors such as socioeconomic status, race, gender, disability, sexual orientation, and place of residence. Critically, although there have been significant, coordinated governmental investments of resources to eliminate health disparities over the past 25 years in the US and elsewhere, there remain substantial and troubling inequities.

Sociotechnical interventions hold promise for reducing disparities and improving the health of marginalized populations—yet this potential is yet to be fully realized. At the same time, researchers must take care when developing any sociotechnical intervention in the health domain, since such interventions can generate unintended consequences that exacerbate disparities, as research concerning patient portal implementation shows.

In this cross-disciplinary workshop, we will bring together leading researchers in computing, health informatics, and behavioral medicine to develop an integrative research agenda regarding sociotechnical interventions to reduce health disparities and improve the health of socio-economically disadvantaged populations. As part of these discussions, approaches for guarding against unintended consequences of general interventions will also be explored. To do so, this workshop will focus on integrating insights into identifying gaps in understanding between fields, and surfacing opportunities for future interdisciplinary challenges.

The workshop will be held before the Society for Behavioral Medicine’s 39th Annual Meeting in New Orleans, Louisiana. Participants will be drawn from academia, industry, and government.
MODEL FOR INTERVENTION-GENERATED INEQUALITY PREVENTION

Veinot, T.C., Mitchell, H., Ancker, J.S. Good intentions are not enough: Taking action to ensure that informatics interventions do not worsen inequality. Journal of the American Medical Informatics Association (in press)
**“LEVELING UP” – UPSTREAM INTERVENTIONS**

<table>
<thead>
<tr>
<th>What Technology Can Do</th>
<th>Macro Level</th>
<th>Meso Level</th>
<th>Health System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support or prevent work flows and activities</td>
<td>Dynamically coordinate disaster response, with a focus on marginalized populations (e.g., in the event of a hurricane or flood)</td>
<td>Prevent high-risk activities with smart vehicles and home appliances (e.g., prevent driving above certain blood alcohol levels, prevent use of a faulty stove)</td>
<td>Develop routine workflows that reduce individual bias in healthcare providers’ care decisions</td>
</tr>
<tr>
<td>Socioeconomic and Political Context</td>
<td>Living and Working Conditions</td>
<td>Social and Community Networks</td>
<td></td>
</tr>
</tbody>
</table>

**Potential Macro- and Meso-Level Interventions in Health Informatics**

*Computing Community Consortium Catalyst*
THANKS!