Workshop: Work in the Age of Intelligent Machines

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ABSTRACT

This all-day workshop aims to promote convergence among its participants on research related to working with intelligent machines. We define intelligent machines as both material (e.g., robots) and immaterial (e.g., algorithms) computing technologies that can be characterized by autonomy, the ability to learn, and the ability to interact with other systems and with humans. The workshop has three goals: identifying specific research problems around work and intelligent machines, developing a common language base that can facilitate interdisciplinary collaboration among researchers, and identifying information and cyber-infrastructure needs to support convergent research. Workshop activities will facilitate interdisciplinary dialogue and strive to generate high-impact research ideas to advance each of these goals.

Author Keywords

work; intelligent machines; research convergence; workshop

ACM Classification Keywords

K.4.2 Social Issues: General; K.4.3 Organizational Impacts: Automation; K.4.1 Public Policy Issues: General

DESCRIPTION OF WORKSHOP THEME

This all-day workshop aims to promote disciplinary convergence among participants on research related to working with intelligent machines. The workshop is sponsored by the newly NSF-funded Research Coordination Network on Work in the Age of Intelligent Machines (NSF 17-45463, https://waim.network/).

This workshop has two foci–one topical and one methodological. The first centers on how the coming age of intelligent machines will impact work, especially how we design interactions and collaborations between humans and machines. The second focus aims to encourage participants from diverse research disciplines and/or perspectives to apprehend, challenge, critique, and, hopefully, converge on a set of common research-related outcomes.

We use the phrase "intelligent machines" to describe both material (e.g., robots) and immaterial (e.g., algorithms) computing technologies that can be characterized by autonomy, the ability to learn, and the ability to interact with other systems and with humans. Intelligent machines, though incapable of the generalized intelligence of humans, nevertheless are increasingly capable of and increasingly utilized to perform tasks that traditionally have been the sole purview of humans.

Given these capabilities, the design and development of these systems is attracting enormous attention from industry, and their deployment in multiple contexts is rapidly unfolding. For example, machines are now being used to recognize images or speech with an ability that in particular domains is more accurate than humans, with greater speed and at less cost. By contrast, the human side of this relationship—the people, organizations, legal frameworks, social values, etc., affected by this influx of intelligent machines—is evolving more slowly. The result is an impedance mismatch between intelligent technologies and the organizational and individual contexts of their design and use. This mismatch risks unexpected or undesired consequences (e.g., deskilling, overly fragile systems, or automation surprises). This situation is leading to growing public concern and calls for researchers to attend to both sides of this divide.

Much of the current rhetoric around work and intelligent machines focuses on people being put out of work by automation. But this view is too simplistic. Taking a macro-level view, it is clear that the tasks that can be automated do not stand in isolation [2]; all are defined by important issues of context, e.g., when work is done in a group [5]. Take an automated system to diagnose skin cancer [3], for example. To be practicable, such a system needs to fit with the complex work of a medical practice. Someone must order the imaging, image the correct area of the body using the right lighting, explain the diagnosis to the patient, family members, or other doctors (in varied and appropriate ways), bill insurance companies, monitor ongoing performance, defend malpractice suits, and so on. All this sur-

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rounding work needs to adapt to an automated dermatologist (and vice versa). Discussion is only now beginning to turn to the question of the appropriate nature of the relationship between humans and intelligent machines.

Taking a micro-level view, it is clear that most people spend the majority of their time working, an act that provides them not only with material rewards, but, for many, personal identity, social status and psychological well-being. Designing work in the age of intelligent machines thus implicates a worker on variety of levels, including attitudinal outcomes such as satisfaction or motivation, behavioral outcomes such as performance or turnover, cognitive outcomes such as learning, or identify and well-being outcomes, such as anxiety, stress or burnout—much more than the black and white of employment or unemployment. But at present, we lack much understanding of possible futures for work, much less critical principles for designing organizational structures or individual jobs to accommodate potentially juxtaposed needs.

The challenge of understanding and designing work in the age of the intelligent machine requires renewed focus on work as a *socio-technological* problem, requiring the joint design of social and technological systems and attention to the implications of their interdependencies. To achieve this focus when facing a protean technology that can interact with workers and work at multiple levels, researchers will have to collaborate across traditional disciplinary boundaries. This workshop will begin to advance this agenda.

AIM AND GOALS

Our aim in this workshop is to bring together researchers from diverse disciplines with a shared interest in work and intelligent machines. More ambitiously, we intend for the workshop to provide an impetus and venue for disciplinary convergence: "the deep integration of knowledge, techniques, and expertise from multiple fields to form new and expanded frameworks" [4]. To address the challenges of work and intelligent machines requires integrating perspectives and knowledge related to labor, incentives, motivation, cognition, machine learning, human learning and systems design, among others, in coherent ways. Convergent research can build the deep and systematic knowledge required to engage the complex questions that need to be addressed when considering a future in tandem with intelligent machines; even more pressing, convergent ideas are **required** to design work that both leverages expanding technological capabilities and technologies and also serves workers at the same time.

The workshop is designed to advance three specific goals that create the conditions for convergence research. First, a key distinguishing feature of convergence research is that it is centered around a challenging real-world problem. Therefore, an initial goal of the workshop is to discuss and come to some consensus about specific important and challenging transdisciplinary research problems. For example, in past technological revolutions, people were able to acquire new skills that were in demand. In contrast, horses replaced by cars did not find new jobs [1]. What kinds of skills will be in demand in an age of increased automation? Taking a design perspective: What kinds of jobs can we create around those skills? How can we structure relationships across the evolving human-technology frontier that benefits all parties?

Second, we want to start to create a common, integrated language among interdisciplinary researchers about the problems, phenomena, and issues surrounding work with intelligent machines. This language base can act as a boundary object to connect researchers and research done in disparate disciplines. NSF notes that "as disciplines interact, the knowledge, theories, methods, data, research communities and languages are increasingly intermingled or integrated" [4]. Roco et al. [6] (early proponents of convergence) advocate for the development of "higher-level convergence languages based on new concepts, relationships, and methods" [6, §4.1.2], stating that "by convergence language we mean the common concepts, network relationships, methods, and nomenclature used in a multi-domain of science, technology, and society" [6, §4.3.2].

Third, we want to define resource and technology needs to facilitate convergence research within the GROUP community and beyond. Roco et al. [6] note that "emerging technologies have developed both independently and jointly to a level that now more readily enables structured convergence" [6, §4.2]. For example, they call out the increased use of technologies to support virtual collaborations and note that "an example of a process to establish a convergent language is using shared databases" [6, §4.3.2]. They particularly mention the ways that open science can facilitate productive interactions [6, §4.3.9], as well as the benefits of citizen science. Accordingly, a final goal for the workshop will be to define needs and use cases for technology and cyber-infrastructure that support convergence research.

ACTIVITIES

The workshop activities will address the aims and goals outlined above. We take inspiration, again, from [6] who advocate problem setting—e.g., "using forecasting, early signs of change, scenario setting"—"... to establish a credible vision for what is desired in the longer term for a knowledge and technology field" [6, §4.3.8]. They also promote approaches such as "develop[ing] knowledge mapping and network visualization techniques for identifying large patterns in the knowledge, technology, and societal systems" [6, §4.3.1] in support of interdisciplinary dialogue.

The workshop will include:

1. an ice-breaker activity;
2. short presentations that will either ground participants' understanding of expert projections of the capabilities of intelligent technologies or instances of work with intelligent machines in bellwether settings, or present examples of research on these topics with an emphasis on methods; and
3. small-group activities to create deliverables for each of the three goals.

POTENTIAL OUTCOMES

The workshop's potential outcomes map to the three goals described above. In specific, we envision that the goal and vision setting involved in our day-long agenda will help us to better

describe the complex issues around AI and work as a socio-technical "grand challenge". Our discussions of terminology and language will yield a clearer understanding of the range of knowledge, theories, methods, and data in use by those in the GROUP community; these insights should also help lay the groundwork for establishing how tangential disciplinary groups might best connect with one another. We also expect that this workshop will produce actionable information about requirements for developing a collaborative infrastructure to support convergent forms of research, as well as commitments from attendees to provide shared resources. Finally, in addition to the intellectual products mentioned above, we hope that individual attendees may find new research directions and potential collaborators by identifying other disciplines that might inform their own studies.

ORGANIZERS

- Ingrid Erickson is an Assistant Professor at the School of Information Studies at Syracuse University. She received her PhD from the Center for Work, Technology, and Organization in the Department of Management Science and Engineering at Stanford University. Her research centers on the way that mobile devices and ubiquitous digital infrastructures are influencing how we work and communicate with one another, navigate and inhabit spaces, and engage in new types of sociotechnical practices.
- Lionel P. Robert Jr., is an Associate Professor at the University of Michigan School of Information. His research focuses on collaboration through and with technology. Dr. Robert research includes virtual teams, crowdwork, teamwork with robots, autonomous vehicles and the sharing economy. Dr. Robert was a BAT Doctoral Fellow and KPMG Scholar at Indiana University, where he completed his Ph.D. in Information Systems and minored in Social Informatics through the Center for Social Informatics.
- Kevin Crowston is a Distinguished Professor of Information Science and Associate Dean for Research in the Syracuse University School of Information Studies. He received his Ph.D. (1991) in Information Technologies from the Sloan School of Management, Massachusetts Institute of Technology (MIT). His research examines new ways of organizing made possible by the extensive use of information and communications technology. Specific research topics include the development practices of Free/Libre Open Source Software teams and work practices and technology support for citizen science research projects, both with NSF support.
- Jeffery V. Nickerson is Professor and Associate Dean of Research in the School of Business at Stevens Institute of Technology. His research and teaching interests include collective intelligence, crowd work, decision making, and information systems design. Prior to joining Stevens he was a partner at PricewaterhouseCoopers and advised companies on issues related to the application of emerging technologies to business. Earlier in his career he developed decision support systems and trading systems for Bear Stearns and Salomon Inc. He holds a Ph.D. in Computer Science from New York University.

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