**Title:** Work in the Age of Intelligent Machines

**Authors of the Report:** Jeffrey V. Nickerson and Matthew Lease

**Author contact emails:** jnickerson@stevens.edu, ml@utexas.edu

**Abstract:** The Workshop on *Work in the Age of Intelligent Machines* was held at the 6th AAAI Conference on Human Computation and Crowdsourcing (HCOMP) on July 5, 2018 in Zurich, Switzerland. The workshop explored ways in which human work and occupations will be changed as artificial intelligence becomes more increasingly prevalent in the workplace. The workshop was a part of a series of workshops funded by a National Science Foundation (NSF) convergence grant on the future of work. A range of academic, industry, and government participants engaged in collective identification of key research questions which merit further study.

**Body of the Report:**

Artificial intelligence and machine learning are becoming increasingly prevalent in the workplace. While much media and academic attention has focused on forecasts of the displacement of workers, less attention has focused on ways AI might change the workplace, and in particular ways AI might generate new jobs or mitigate the displacement of workers. By doing so, AI may help address a large scale societal problem, a shift in skills needed in the workplace. This workshop, part of a series of workshops supported by the National Science Foundation, brought together researchers from academia, government and industry to address the future of work.

The workshop's goal was the generation of key research questions on the topic which merit further study. Research questions were generated in discussions around two topics: *AI-Human Team Dynamics*, facilitated by Kurt Luther (Virginia Tech), and *New Jobs/Education & Training/Unemployment*, facilitated by Matthew Lease (UT Austin).

The *AI-human Team Dynamics* group posed the following questions:

- "How can human and AI agents participate in competitive interactions in order to obtain better outcomes?" This question inverts the commonly held view that humans and machines should complement each other. Instead, organizing friendly competition between humans and machines may help us better understand human and machine capabilities. This competition can be the precursor to negotiation, in that once comparative advantages between humans and machines are understood, it becomes easier to figure out how to trade or align cognitive effort in the service of a shared goal.
- How can AI and human agents effectively interact through negotiation? How can humans represented by AI agents (with potentially different value systems) effectively interact with each other through negotiation? How can we combine them? Answering these questions may help to produce new techniques for product design, which may open up new products and human jobs around the communication and support of those products. Manufacturing, transportation, autonomous vehicles, and entertainment industries.

The *New Jobs/Education & Training/Unemployment* group addressed complementary issues. While AI may displace workers, it may also help retrain people to work in jobs that require skills in short supply. That is, AI may substitute for some tasks, but can also help build human capabilities complementary to machine intelligence.

- How can we use AI to reduce skill barriers to jobs, thereby growing job opportunities and the scalability of labor?
- How can we combat a potential skill-technology gap and thereby reduce labor market frictions?
- How can AI be used to simplify highly-skilled jobs to make them accessible to a larger part potential workforce?

This led to a series questions related to the labor force:

- What new jobs and/or transformation of existing jobs will come from the advent of intelligent technologies?
- What job descriptions are emerging on job boards related to AI?
- Do some industries hire more people as automation increases?

For example, the group discussed the potential impacts of autonomous vehicles on restaurants: less expensive and more ubiquitous transportation might encourage more nights out.

This led to questions about how AI might enhance jobs:

- How can we integrate AI alongside human workers in such a way as to enhance (in some balanced way) productivity, satisfaction, and career growth?

The group addressed what is known about intelligent tutoring, about predicting student failure in advance and providing interventions, and about peer assessment and feedback, especially research informed by MOOCs and crowd-based approaches to skill building and work. A meta question was also posed: In order to work in the age of intelligent machines, what do typical people *need* to know about AI, what would be *helpful*, and what don't they need to know?

Overall, the workshop on *Work in the Age of Intelligent Machines* raised a variety of important questions that necessitate further research, so that we may be proactive in addressing human work and occupational changes as AI becomes increasingly ubiquitous in the workplace. As part of a series of NSF workshops on the future of work, the community can expect these ideas to be further discussed and explored in both these workshops and other community events. The workshop was organized by Jeffrey V. Nickerson, Kevin Crowston, Ingrid Erickson, and Matthew Lease; Professors Nickerson and Lease ran the workshop in Zurich. This workshop was supported by the National Science Foundation under grant IIS-17454643.

**Authors' titles and affiliations:** Jeffrey V. Nickerson is a professor in the School of Business at Stevens Institute of Technology. Matthew Lease is an associate professor in the School of Information at the University of Texas at Austin.