

The future of work in the knowledge economy will be influenced by the constant development of Artificial Intelligence (AI). Most of routine and repeatable work will be automated and carried out by AI, with the exception of tasks that are too difficult, which will be done by Crowdsourcing (CS) services. Crowdsourcing, the remote work of large, open and distributed teams, will become the future of work. The growth of the Crowdsourcing market is currently a double-digit number (in 2011, it was about 75% globally). Amazon Mechanical Turk, the largest Crowdsourcing platform, has over 500 thousand CS workers. There exist several other, specialized CS services, such as TryMyUI, Duolingo, Tagasauris.com, CrowdTrans.com, Gengo.com, 99designs.com, as well as CS platforms enabling the employment of freelance knowledge workers, such as Odesk, Elance, RentACoder.

The rise of Crowdsourcing is therefore a durable economic trend that cannot be easily changed. However, it can be accommodated in order to realize important social goals. This requires that research on Crowdsourcing should progress in new directions. If CS systems are to offer work for young (studying) or elderly (retiring) workers, CS systems must become more robust to uncertain quality of work results. New algorithms and methods for CS platforms are needed that will allow to find high-quality solutions for jobs under uncertainty, while at the same time minimizing employer costs for quality evaluation. At the same time, CS platforms should offer workers an opportunity to improve their practical skills through real work.

The goal of the project is to design **new algorithms for ranking, aggregation, job scheduling, and a reputation algorithm for Crowdsourcing (CS) platforms that use 2nd-Order Crowdsourcing (CS2). CS2 uses new CS jobs for evaluating quality of results obtained from ordinary (1st-Order, CS1) jobs.** In order to realize this goal, a **formal model of the CS worker** must be developed, using concepts from game theory and decision support. The worker model will be validated using empirical experiments on Amazon Mechanical Turk. The focus of the project will be on algorithms for ranking and aggregating uncertain results, based on pairwise comparisons of results done by other CS workers. This problem occurs in many CS applications, which sometimes lack ground truth or are highly uncertain due to their cognitive difficulty, or human factors such as diverse skills of workers, as well as autonomous decisions of workers whether to spend effort on their jobs. The notion of **effort** (based on psychological and game-theoretic research) is a crucial one, since workers can be motivated to put in effort using appropriate mechanisms. One such mechanisms are reputation systems that will also be designed in the project.

Research on CS systems that use CS2 has only started recently in 2013. The achieved results, while promising, are not comprehensive. Research on **new designs of CS2 jobs that use comparisons of two or more CS1 job results** is especially promising (instead of using the evaluation of a single CS1 result on a Likert scale, like in previous research). Another important innovative aspect of the research proposed in this project is the design of algorithms by taking into account **robustness to intelligent adversaries who aim to minimize their effort while maximizing their reward.**

In the proposed project, research on Crowdsourcing will progress in new directions. The research proposed in this project will lead to the improvement of known algorithms and methods for Crowdsourcing platforms, taking into account the perspective of the worker, including opportunities for learning and motivation mechanisms. The diverse perspectives of the employer and platform will also be considered, allowing for an increased range of applications of Crowdsourcing for tasks under uncertainty. Taking into account the discussed economic and social trends, such research can have a high, positive social and economic impact.