

Presentation Abstraction for the Workshop on Games for Design Research and Education at 7th International Conference on Design Computing and Cognition

Title: Game Theory and Behavioral Experimentation in Engineering Design

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Abstract: The objective of this presentation is to demonstrate how the analytical game-theoretic models and behavioral experimentation can be synergistically used to gain a better understanding of design situation, thereby facilitating the engineering design. Engineering design is often carried out under competition from other designers or firms, where each competitor invests effort with the hope of winning a contract, winning customers, or a prize. A special scenario of design under competition is crowdsourcing where designers compete for monetary prize. Motivated by this observation, this presentation is particularly focused on the decision-making in crowdsourced design. I will present an economic decision game which well captures main characteristics of design activities in crowdsourcing. In such a game, players compete in groups of two with the goal of finding the minimum of a randomly generated convex function $F(x)$, which can be a mathematical abstraction of a real design problem, such as the optimization of a cantilever beam. The information of the function is never revealed. Players are provided with an initial funding, and start to sample x values for gaining information of the unknown function so that they can be guided to pick the next point which leads to a lower value. However, for each sampling, there will be a cost associated with it. The player who has a lower value after both players stop sampling wins. During the game, players' strategies, such as whether to stop sampling or not and where to sample the next point, directly affect the design quality (the closeness to the real minimum), which, in turn, affects the winning probability. Therefore, during each round of play, players need to adjust strategies and make a trade-off between winning and earning. With this well designed game, I will show how non-cooperative game-theoretic models can be used to model participants' decision-making behaviors under design competition. The theoretical results describe what players with assumed behaviors and cognitive capabilities would do under specified conditions. For example, as the design cost increases, participants tend to sample less and consequently are less likely to win the game. To validate the results from the theoretical study, I did a human-subject experiment. In this presentation, I will also show the details of the design of experiment, and how data collected from such experiment can be used to statistically test hypothesized causal relationships, quantitatively evaluate impacts of game design options, estimate model parameters, refine models, and inform further development of the theory. Finally, I conclude my presentation with new insights on using crowdsourcing contests for design as well as some of my ongoing research with this game.