Resource-Constrained Social Networks under Prospect Theory

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Consider n agents that interact with each other in a social network. Each agent i has a specific set of other agents that they interact with, which is called the *neighborhood* of i and is denoted by $\mathcal{N}_i$. In this network, each agent has a set of strategies available to them. Specifically, agent i proposes an *interaction frequency* $f_{ij} \in \mathbb{R}$ to every agent $j \in \mathcal{N}_i$. Similarly, each agent j proposes an interaction frequency f_{ji} to i. The frequency that they end up interacting at is simply the minimum of the two proposals. However, in real social networks, the agents have different preferences for who to interact with. To capture this in our model, we assign w_{ij} to be the *weight* i places on j, or similarly how much i values the interaction with j. Further motivated by real social networks, we assign all agents a uniform "budget" of interaction frequency β that they cannot exceed.

In our model we deviate from standard practices in algorithmic game theory and instead of considering that agents act in accordance with the predictions of the expected utility theory, we consider the case where the behavior of the network's agents is better captured by *prospect theory*. Prospect theory, introduced by Kahneman and Tversky [1], states that people make decisions based on the potential value of losses and gains rather than the final outcome, and that people evaluate these losses and gains using certain heuristics. This model attempts to depict real-life scenarios, where the agents sometimes act irrationally rather than making the optimal decisions for them. Therefore, we consider utility functions that capture the observation of prospect theory that in real-life situations people are *loss-averse*; in mathematical terms, if $u_i(x)$ is the utility of player i with x being the strategy profile, then $-u_i(-x) > u(x)$. In other words, utility functions studied by prospect theory are similar to the one in Figure 1, with the curve for losses being "steeper" than the curve for gains.

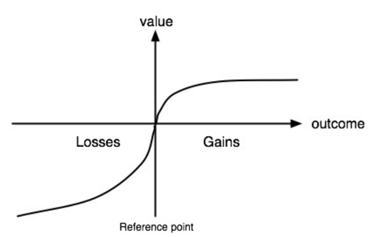

Figure 1: An agent's utility function as described by prospect theory

It is clear that our approach is motivated by real-life social networks therefore an analysis would not be complete if it remained in a theoretical level. To this end, we gather data from real online social networks such as Stack Overflow. We will collect and evaluate how an agent's post frequency changes in this type of network in relation to the "up-votes" the agent receives. We evaluate this behavior over the entire network and compare the expected convergence over all users. This will be evaluated by modeling the network with respect to expected utility theory and then comparing the convergence properties when modeled with prospect theory preferences. This real world model will help us understand whether the observations from real social networks are similar to the predictions of our model.

References

[1] D. Kahneman and A. Tversky. Prospect theory: An analysis of decision under risk. *Econometrica*, 47(2):263–291, 1979.