

Reactive Versus Anticipative Decision Making in a Novel Gift-Giving Game

Elias Fernández Domingos¹²³, Juan Carlos Burguillo³, and Tom Lenaerts¹²

¹ AI lab, Computer Science Department, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium,

² MLG, Département d’Informatique, Université Libre de Bruxelles, Boulevard du Triomphe CP212, 1050 Brussels, Belgium

³ Department of Telematic Engineering. University of Vigo. 36310-Vigo, Spain
`eliferna@vub.be`, `tlenaert@ulb.ac.be`,

Gift-giving games are often used to model situations related to the presence of trust and fairness in human behavior. The Dictator and Ultimatum games [1] are well known examples that have been thoroughly studied, both analytically and through behavioral experiments, where results contrast with the traditional assumptions of rationality in Game Theory [3]. In a recent paper published in the proceedings of the AAAI-17 conference [2] we highlight the importance of anticipatory reasoning over human decision-making in the context of gift-giving games. Particularly, we study how agents embedded with anticipatory capabilities perform on a variant of the Dictator Game, known as the Anticipation Game (AG), and show how they are able to reproduce the capacity of humans to adapt to context observed in behavioral experiments [5].

The Anticipation Game (AG) takes place between pairs of individuals, i.e., dictators and receivers. The latter must decide whether to accept or reject the interaction with the dictator, based on some information about her actions on past games, which conforms her reputation. If she accepts, the game proceeds as a Dictator Game (DG), where the dictator receives an endowment and is requested to give an amount between zero and the entire endowment to the receiver. However, if she rejects, both players receive a payoff of zero. Therefore, the dictator must anticipate the effects that her actions will have over her reputation. Yet, Game Theory predicts, under assumptions of selfish and rational behavior, that dictators’ share should be minimal and, receivers should always accept.

Nonetheless, the experiment performed in [5] has shown that participants deviate from this rational behavior. Concretely, the experiment was divided in three treatments that evaluate how dictators and receivers behave when receivers were given full information about the dictator’s past three actions; when this information was only available 50% of the time; and when it was never available. The results show that receivers tend to accept more when they have no information available and dictators reduce considerably their donations – which is the sub-game perfect Nash equilibrium, while in the full information case, the donations get close to half of the endowment and receivers punish unfair dictators with rejection – deviating from rational behavior. The case with partial information stands in the middle of the previous cases. This indicates not only

that humans are neither hyper-rational nor fully selfish, but also that we are able to identify changes in context and alter their strategy based on that. Thus, it reveals the need for an analytical model that loosens this constraint and provides insights into the cognitive mechanisms required to produce the choices observed in experiments.

With this in mind, we investigate how anticipatory reasoning affects human decision-making in the Anticipation Game and whether it's a vector strong enough to drive the emergence of generosity. Hence, we embed an adaptive agent, that should play as dictator, with anticipatory capabilities by taking the definition provided in [4]: *An anticipating system will be defined here as a system containing a predictive model of itself and/or its environment, which allows it to change state at an instant in accord with the models predictions pertaining to a later instant.* In our setup, the predictive model is implemented with a Recurrent Neural Network (RNN) and its predictions are used to evaluate the effects of the available actions into the future and update the strategy of the agent. Afterwards, to determine if anticipation was a relevant cognitive ability in our scenario, we compared this anticipative (forward-looking) model with a reactive (backwards-looking) one. During the simulations, dictator agents that implemented those models, played against a receiver with a fixed strategy for each different context – emulating the treatments of the experiments. Our results demonstrate that only dictators using the anticipative model, were able to account for changes in the context of games and play optimally in each of them [2], which indicates that models that take into account anticipation are more suited to represent human behavior in this sort of scenarios.

References

1. Cooper, D., Kagel, J.H.: Other regarding preferences: a selective survey of experimental results. In: Cooper, D., Kagel, J.H. (eds.) *Handbook of experimental economics*, vol. 2. Princeton: Princeton University Press (2012)
2. Domingos, E.F., Burguillo, J., Lenaerts, T.: Reactive versus anticipative decision making in a novel gift-giving game. In: *Proceedings of the AAAI Conference on Artificial Intelligence*. vol. 5, pp. 4399–4405. San Francisco, USA (2017)
3. Engel, C.: Dictator games: A meta study. *Experimental Economics* 14(4), 583–610 (2011)
4. Rosen, R.: *Anticipatory systems : philosophical, mathematical, and methodological foundations*, vol. 1. Pergamon Press, Oxford (1985)
5. Zisis, I., Di Guida, S., Han, T., Kirchsteiger, G., Lenaerts, T.: Generosity motivated by acceptance-evolutionary analysis of an anticipation game. *Scientific Reports* 5, 18076 (2015)