

The Reality Game Theory Imposes (Short Summary)

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I was lucky to be exposed to game theory by Paul Spirakis, moreover to have my first PhD student, Elad Schiller staying with Paul as his PostDoc. It was a great opportunity to examine and think about the combination of philosophical and social considerations when examining the rigorous mathematical settings, results and implications of Game Theory. Implications, that should reflect our real life situations. Especially when searching for game theory tools to be used automatically by societies of (users connected to) computers that form a distributed system.

Distributed computing has changed dramatically in recent years where computing devices that participate in the distributed system are not identical anymore, and may have different hardware, software and utilities. In particular, in the scope of the Internet of things technology, heterogeneous, ad-hoc connected entities form the distributed system, implying the need for game theory techniques in managing the distributed system.

Maybe the most popular and simple example in game theory is the prisoner's dilemma. The possible actions are either to betray or be silent, and the outcome is either to be free (when one prisoner chooses to betray while the other prisoner is silent) or be in prison for two years if both betray or three years if one keeps silent while the other betrays. Such a setting is proven to imply a situation in which both betray and both stay two years in prison. Trying to formulate the game in an autonomous computer system requires the restriction of actions to be in the restricted vocabulary of either betray or keep silent, and obviously not including escape as an option. The restriction on using only rules in the game vocabulary is based on our implicit knowledge of society's authority tools and structure, where the role of the police is to prevent out of rule actions. Hence, we should implement *game authority* [2] that will enforce the vocabulary of rules in the game, and the corresponding outcome. A way to implement such an authority by (almost) identical (computer) participants, just as in society, is based on the cooperation of the majority of the individuals in monitoring and enforcing the rules of the games, possibly by using global Byzantine agreement in the distributed system. In turn, there is a need for game adoption decisions prior to the enforcement of game rules, just like the legislative service. One

Partially supported by Rita Altura Trust Chair in Computer Sciences, Lynne and William Frankel Center for Computer Sciences, Israel Science Foundation (grant number 428/11), and Israeli Internet Association.

should assume that there are moral meta-rules (say, in the style of the ten commandments) agreed upon by the vast majority of the participants. These meta-rules can then imply the majority's choice on moral (rule of) games and enforcement of the agreed upon game rules. Otherwise, when the number of Byzantine participants is more than the threshold, the society may not be able to decide on (moral) games and enforce their rules.

Once we have the game authority that enforces the rules and outcomes of the chosen games, there is still free choice for the players to act according to their (possibly unknown) utility function. Sometimes when the rules of the game are known and the utility is clear the argument and computation needed to realize the correct choice is too complicated to comprehend. The situation is even more complicated, as when some of the players deviate from their optimal choice the rest of the players may be dramatically influenced. To overcome this we suggested the *rational authority* which enforces that players choose the best action in the game according to their possible unrevealed utility [3]. The idea behind the rational authority is to provide the player with a procedure to privately compute the best choice, a procedure that also outputs a proof for the optimality of the choice, where the proof itself can be verified by many reputable proof checkers. Thus, the user can find the best action and verify the action optimality without revealing the private utility. Auditing may be used to ensure that indeed a player uses the provided procedure and verification, the user may be asked to keep signed information for future auditing.

Given the game authority and rational authority, game theory results can be applied to real life actions (or scenarios). Is this real life, or the force of democracy to administer games and impose “artificial rational” action? What action is rational, and who's to define a mathematical utility function, when the secret of creation and life is beyond our understanding? Is rationality based on selfishness ([5])? selfishness of genes ([1])? or is it uncertain ([4]) or an outcome of practical reasons ([6])?

In the end, let me reiterate, I am lucky to have the opportunity to work with Paul who introduced me to the fascinating field of Game Theory, given his deep understanding and enthusiasm for research. I wish him great success in the future.

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Scientific Papers and Essays Dedicated to Paul G.
Spirakis on the Occasion of His 60th Birthday
Zaroliagis, C.; Pantziou, G.; Kontogiannis, S. (Eds.)
2015, XVI, 409 p. 64 illus. in color., Softcover
ISBN: 978-3-319-24023-7