Persuading Risk-Conscious Agents: A Geometric Approach

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Abstract. Motivated by practical concerns in applying information design to markets and service systems, we consider a persuasion problem between a sender and a receiver where the receiver may not be an expected utility maximizer. In particular, the receiver's utility may be non-linear in her belief; we deem such receivers as *risk-conscious*. Such utility models arise, for example, when the receiver exhibits sensitivity to the variability and the risk in the payoff on choosing an action (e.g., waiting time for a service). In the presence of such non-linearity, the standard approach of using revelation-principle style arguments fails to characterize the set of signals needed in the optimal signaling scheme. Our main contribution is to provide a theoretical framework, using results from convex analysis, to overcome this technical challenge. In particular, in general persuasion settings with risk-conscious agents, we prove that the sender's problem can be reduced to a convex optimization program. Furthermore, using this characterization, we obtain a bound on the number of signals needed in the optimal signaling scheme.

We apply our methods to study a specific setting, namely *binary persuasion*, where the receiver has two possible actions (0 and 1), and the sender always prefers the receiver taking action 1. Under a mild convexity assumption on the receiver's utility and using a geometric approach, we show that the convex program can be further reduced to a linear program. Furthermore, this linear program yields a canonical construction of the set of signals needed in an optimal signaling mechanism. In particular, this canonical set of signals only involves signals that fully reveal the state and signals that induce uncertainty between two states. We illustrate our results in the setting of signaling wait time information in an unobservable queue with customers whose utilities depend on the variance of their waiting times.

Keywords: Bayesian persuasion · Non-expected-utility-maximizers · Revelation principle

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