Bayesian Persuasion under Ex Ante and Ex Post Constraints

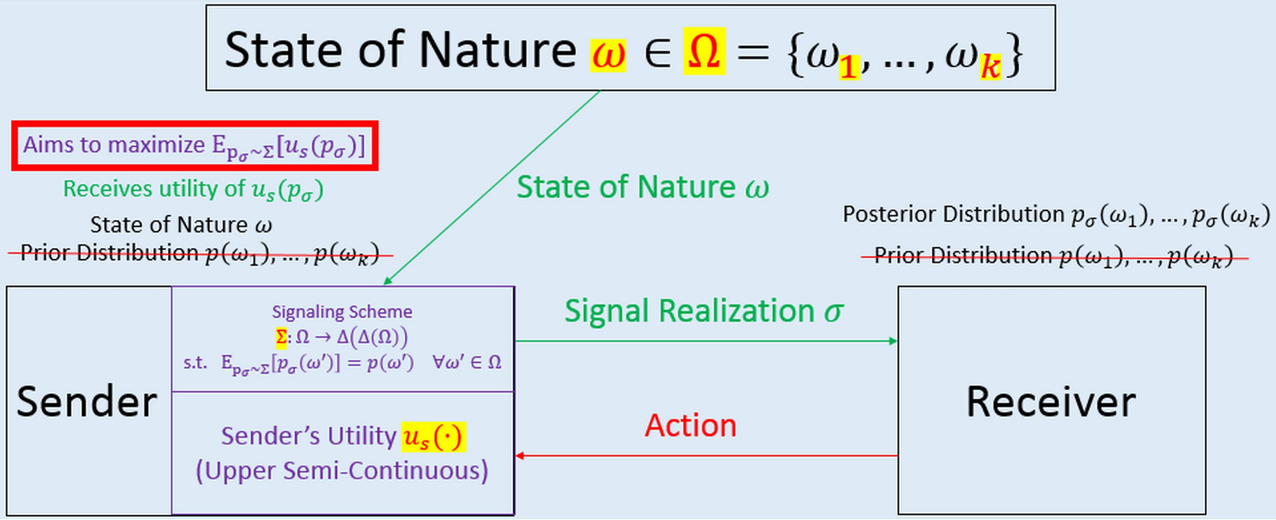
Yakov Babichenko, Inbal Talgam-Cohen and Konstantin Zabarnyi (Technion – Israel Institute of Technology)

What is Bayesian Persuasion [KG2011]?

- Sender-Receiver information transmission
- Sender commits on a signaling scheme
- Goal: to design a signaling scheme that maximizes Sender's expected utility
- Sender's utility can be, e.g., the welfare or the revenue in an auction
- Applications: online ad auctions, information management in organizations, persuasion of voters,…

Practical Concerns

- Individual Privacy
  - Online ad auctions: an advertising platform reveals information about a user to potential advertisers
- Discrimination
  - Online ad auctions: gender, religion or race might be revealed
- Receiver's Limited Attention
  - Information management in organizations: the executive is busy



Existence

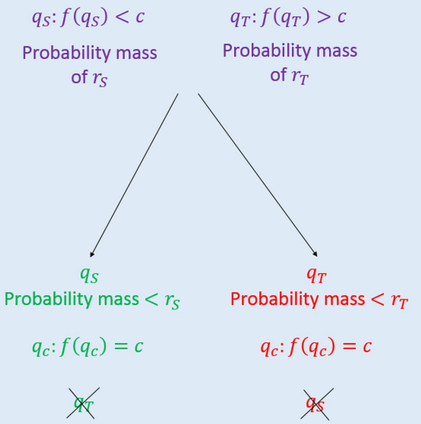
- We show that at most *k* signals are required under ex post constraints (same tight bound as in the basic setting)
- By previous (independent) work [DS18], at most *k+m* signals are required under *m* ex ante constraints (the bound is tight)

Computational Results

- An additive bi-criteria PTAS/FPTAS for a constant *k*
- An additive single-criteria PTAS/FPTAS for a constant *k* under a Slater-like regularity condition
- No analogous result or a constant-factor multiplicative approximation for a general *k* even in the unconstrained setting (unless P=NP) [DX17]

Ex Post vs Ex Ante Results

- An optimal scheme for a constant number of convex ex ante constraints outperforms the one for the *corresponding* ex post constraints by at most a constant multiplicative factor for a natural utility function class
- It yields approximation algorithms for ex ante-constrained auctions (including single-item second-price and sponsored search auctions) with exponentially many states for some constraint families



Our Solution

- A simple and general mathematical model of constrained persuasion, with two constraint families:
  - ex post – every Sender-Receiver communication instance is restricted: $f(p_\sigma) \le c \quad \forall p_\sigma \in \mathrm{supp}(\Sigma)$
  - ex ante – a more general family that can also restrict in expectation: $\mathrm{E}_{p_\sigma \sim \Sigma}[f(p_\sigma)] \le c$
- $f: \Delta(\Omega) \to \mathbb{R}$ continuous, $c \in \mathbb{R}$

References

- [DS18] Laura Doval and Vasiliki Skreta. "Constrained information design: Toolkit." arXiv preprint arXiv:1811.03588 (2018)
- [DX17] Shaddin Dughmi and Haifeng Xu. "Algorithmic persuasion with no externalities." Proceedings of the 2017 ACM Conference on Economics and Computation. 2017
- [KG2011] Emir Kamenica and Matthew Gentzkow. "Bayesian persuasion." American Economic Review 101.6 (2011): 2590-2615