Information Design with Unknown Prior

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Abstract

Classical information design models (e.g., Bayesian persuasion and cheap talk) require players to have perfect knowledge of the prior distribution of the state of the world. Our paper studies repeated persuasion problems in which the information designer does not know the prior. The information designer learns to design signaling schemes from repeated interactions with the receiver. We design learning algorithms for the information designer to achieve no regret compared to using the optimal signaling scheme with known prior, under two models of the receiver's decision-making:

(1) The first model assumes that the receiver knows the prior and can perform posterior update and best respond to signals. In this model, we design a learning algorithm for the information designer to achieve $O(\log T)$ regret in the general case, and another algorithm with $\Theta(\log\log T)$ regret in the case where the receiver has only two actions. Our algorithms are based on multi-dimensional and conservative binary search techniques, which circumvent the $\Omega(\sqrt{T})$ limitation of empirical estimation in previous works.

(2) The second model assumes that the receiver does not know the prior either and employs a no-regret learning algorithm to take actions. Bayesian persuasion and cheap talk are equivalent under this no-regret learning receiver model. We show that the information designer can achieve regret $O(\sqrt{\mathrm{rReg}(T)T})$, where $\mathrm{rReg}(T) = o(T)$ is an upper bound on the receiver's learning regret. The algorithm is based on exploration + robustification. The $O(\sqrt{\mathrm{rReg}(T)T})$ regret bound is tight even when the information designer knows the prior [1].

Our work thus provides a learning foundation for the problem of information design with unknown prior.

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Category Extended Abstract

Related Version *Full Version*: `https://arxiv.org/pdf/2410.05533` [2]

References

1 Tao Lin and Yiling Chen. Generalized Principal-Agent Problem with a Learning Agent, 2024. `doi:10.48550/arXiv.2402.09721`.

2 Tao Lin and Ce Li. Information design with unknown prior, 2024. `arXiv:2410.05533`, `doi:10.48550/arXiv.2410.05533`.