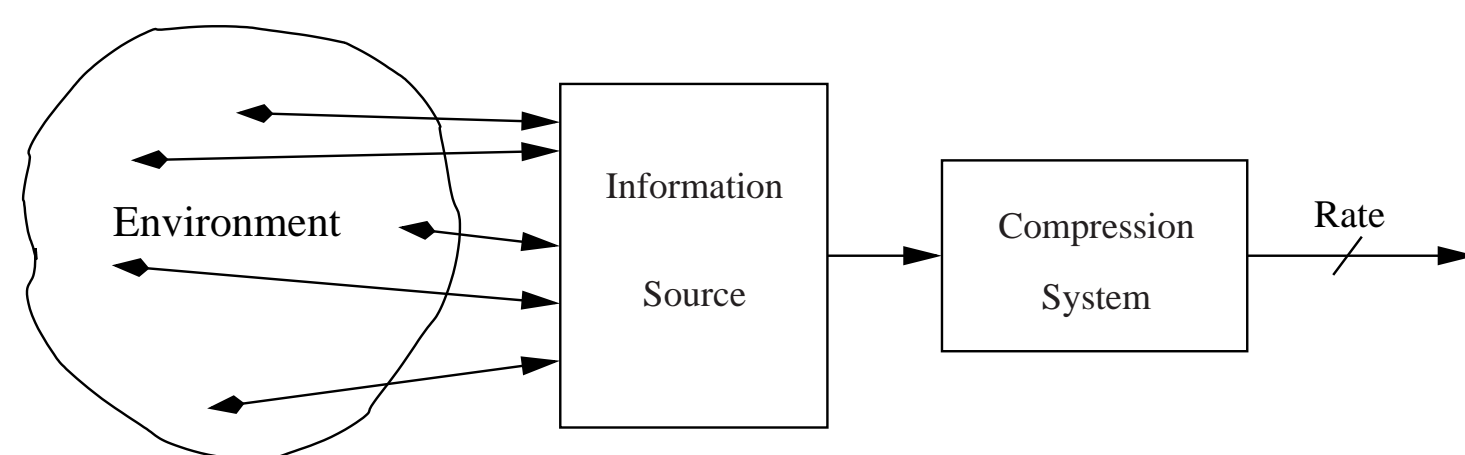


Hari Palaiyanur and Anant Sahai

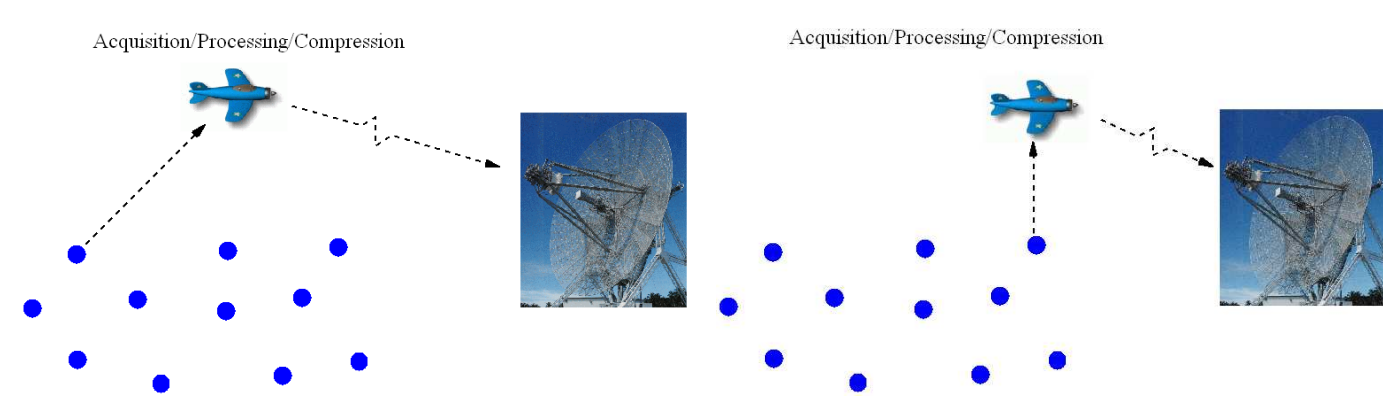
Department of Electrical Engineering and Computer Sciences, University of California, Berkeley

## Motivation

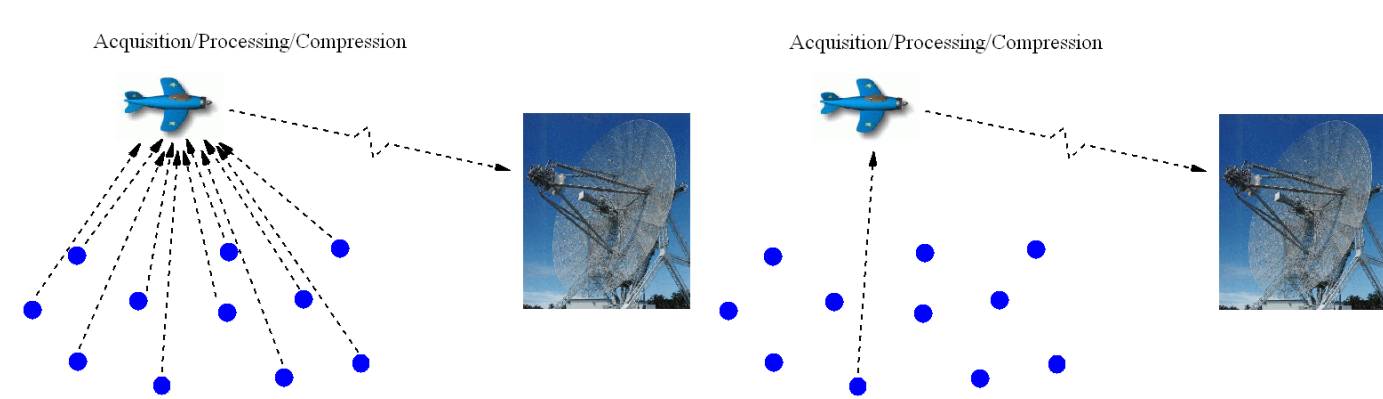
Some data sources sample their environs in a **dynamic** manner, possibly through a complicated algorithm. Even with simple probability models for the underlying world, how does one model the resulting data source simply?



For example, consider a mobile agent collecting measurements from a sensor field. The agent decides its path through the field based on the previously collected measurements.



Alternatively, mobile agent collects all samples and picks/compresses just one at a time.

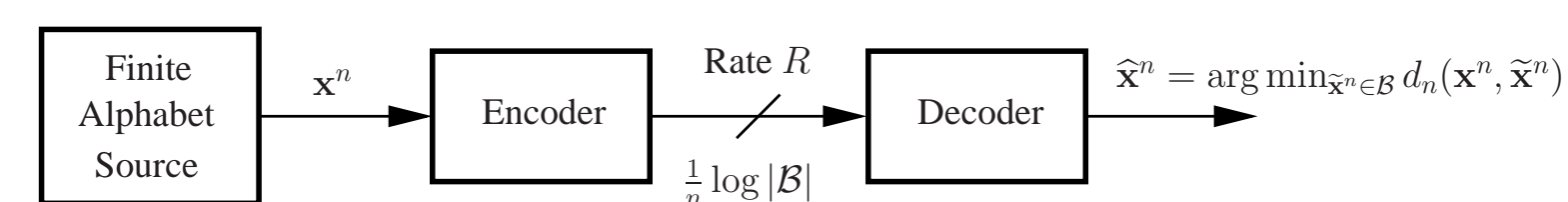


**Goal:** Obtain compression rates for generic models of such complex sources given simple model for data the overall source is ‘subsampling’

## Problem Setup

A source outputs letters from a finite alphabet  $\mathcal{X}$  once per second. The objective is to compress and reconstruct the source to within a fidelity criterion. We have a way of measuring fidelity with a distortion function  $d$ , e.g.  $d(x, \hat{x}) = |x - \hat{x}|^2$ .

- $d$  is nonnegative and finite
- Want to code over blocks of length  $n$  seconds

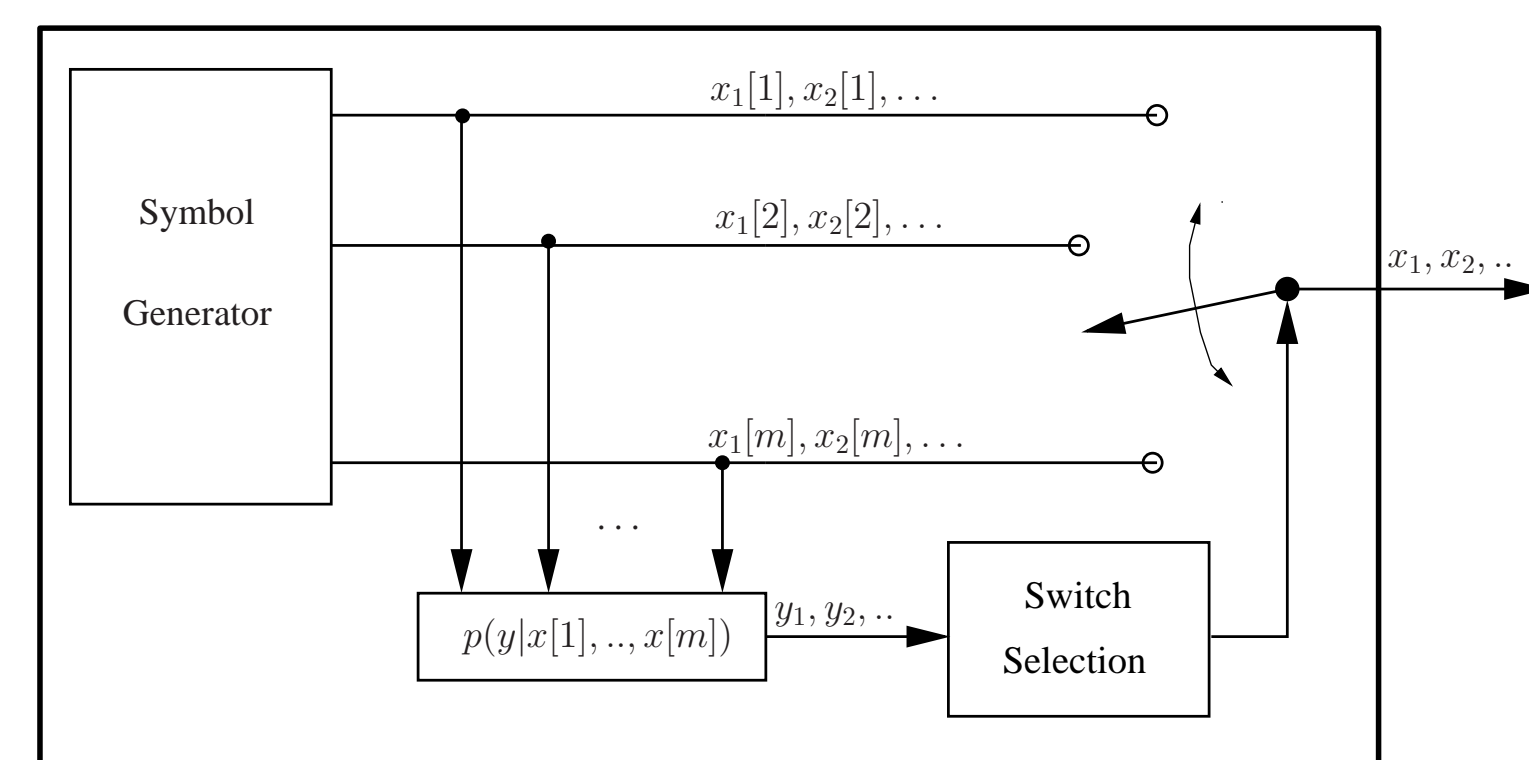


If the source is independent and identically distributed with distribution  $p$ , the rate distortion function of the source is

$$R_p(D) = \min_{X \sim p, Ed(X, \hat{X}) \leq D} I(X; \hat{X})$$

where  $I(X, \hat{X})$ . Shannon’s rate distortion theorem says that if  $R > R_p(D)$ , then the source can be compressed to rate  $R$  bits per second and to within average distortion  $D$ .

## Arbitrarily Varying Source Model



## Generic Variation

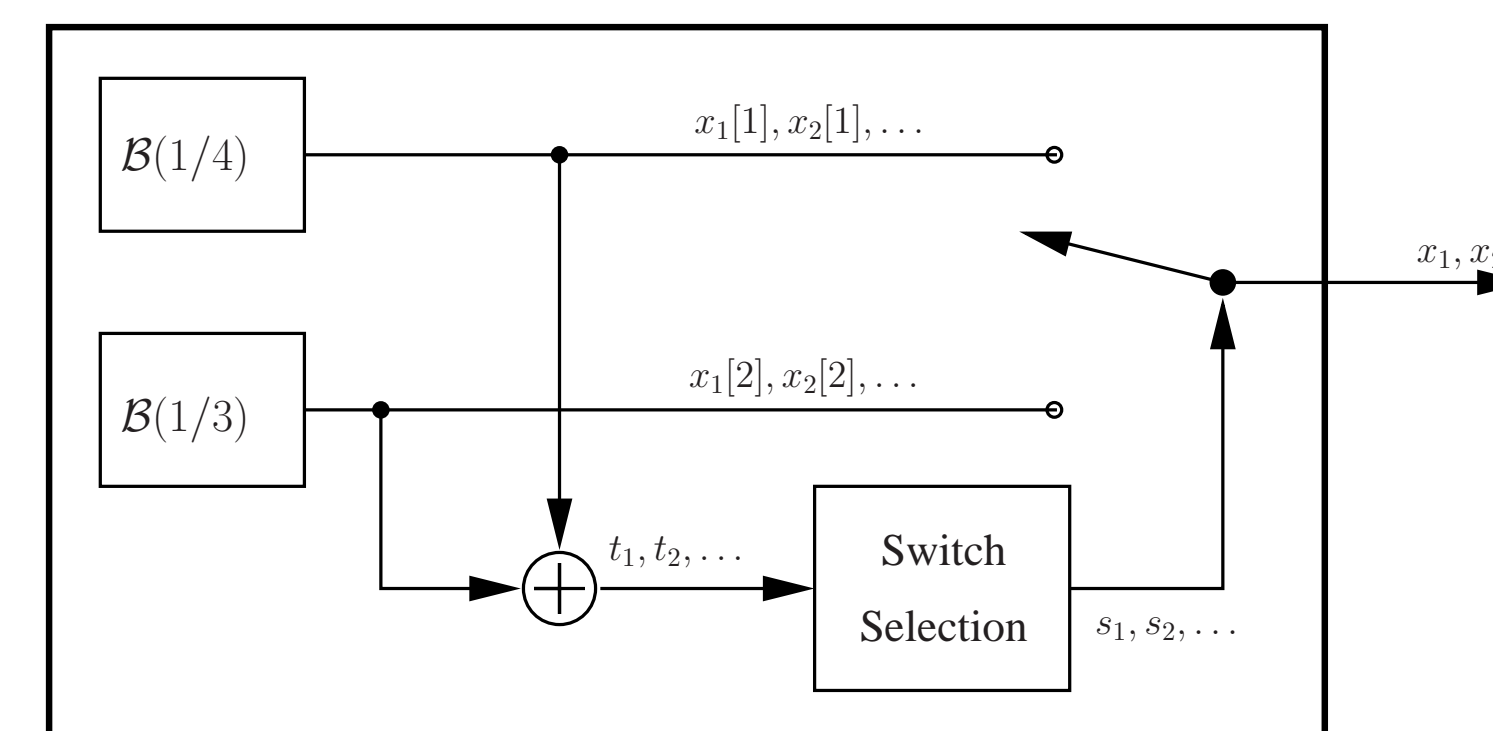
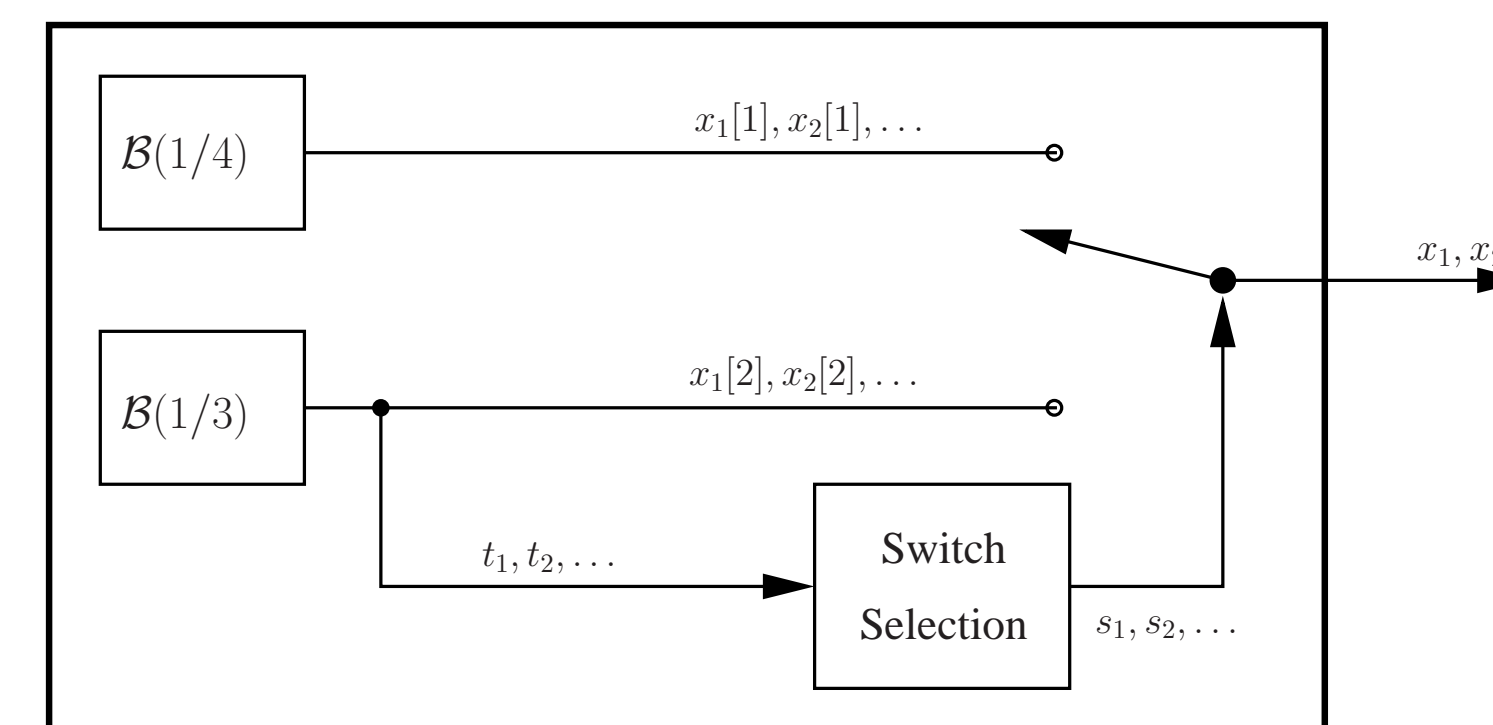
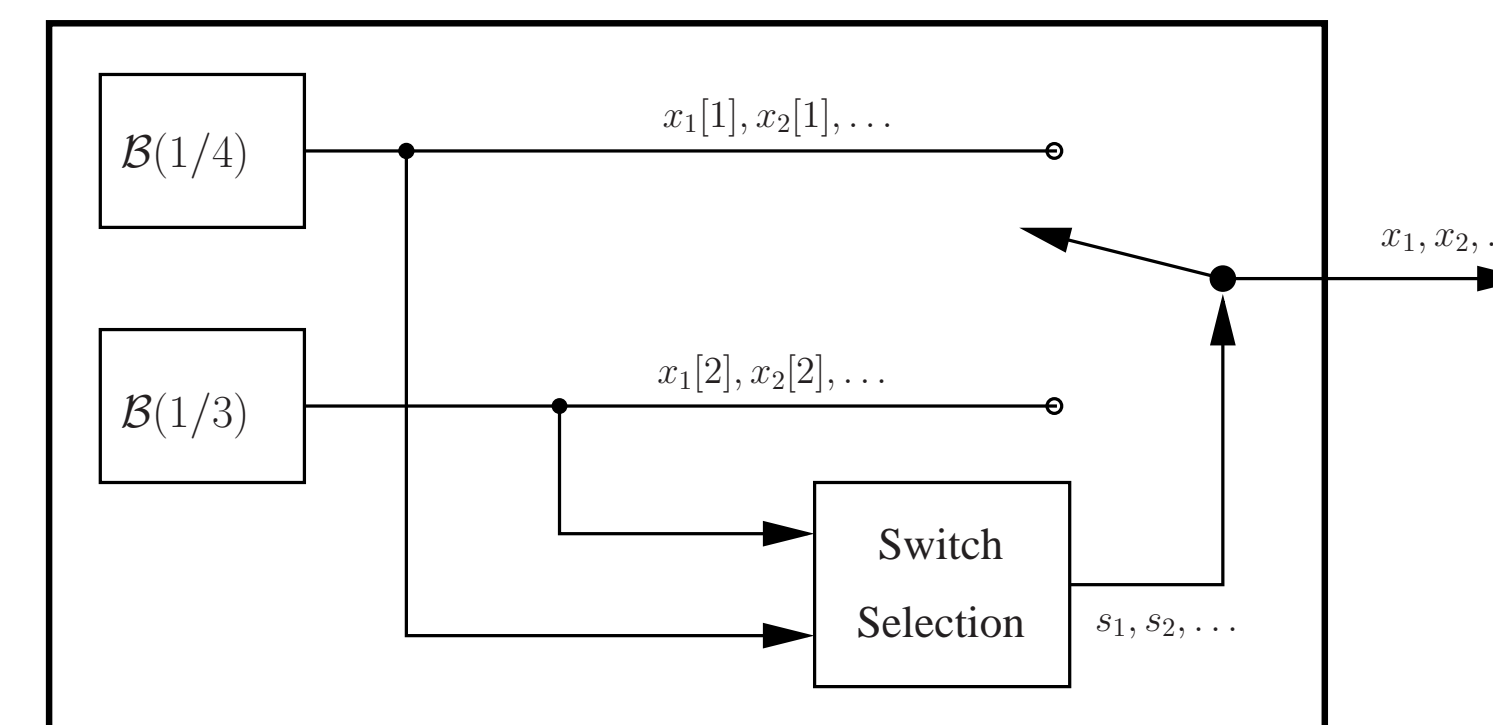
A *switcher* controls variation of switch in source. There are several generic models of switcher:

- Helpful (best case) variation vs. adversarial (worst case) variation
- Switch position can depend on past (no lookahead or strictly causal), present and past (1-step lookahead or causal), or all time (full lookahead or noncausal)

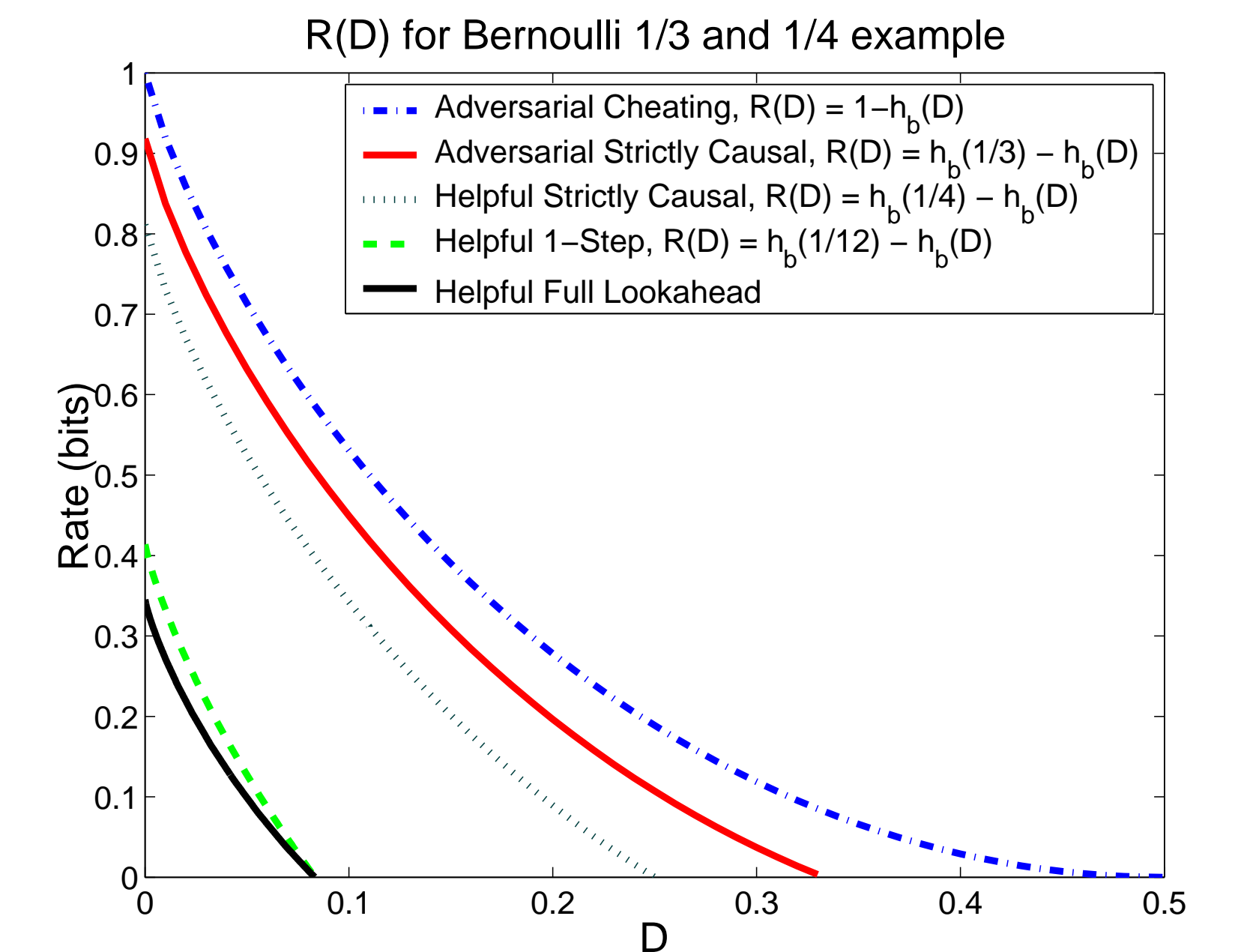
## Examples

Two binary sources, Hamming distortion

- First source produces 1 with probability 1/4
- Second source produces 1 with probability 1/3



## Comparisons



- Large range of rate-distortion functions show modelling of source is important
- Switchers with 1-step lookahead are strictly more powerful than switchers with no lookahead
- Noncausal adversary no more powerful than causal adversary, likely due to memorylessness of subsources
- Noncausal helper more powerful than causal helper
- General results can be found in paper

## Future Work

- Subsources with memory instead of IID sources
- Arbitrarily varying sources with side information

## References

- [1] Toby Berger, The source coding game, IEEE Trans. Inform. Theory, vol. 17, pp. 71 - 76, Jan. 1971.
- [2] Hari Palaiyanur and Cheng Chang and Anant Sahai, “The source coding game with a cheating switcher,” Submitted to IEEE Transactions on Information Theory. Available at <http://arxiv.org/abs/0712.2870>.