Stochastic approximation based approaches for remote estimation with packet drops

Jayakumar Subramanian

Joint work with Jhelum Chakravorty and Aditya Mahajan

McGill Univeristy

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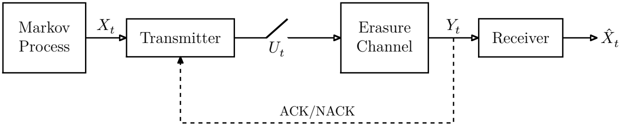
The Remote Estimation Problem



(Regenerative) Error Process

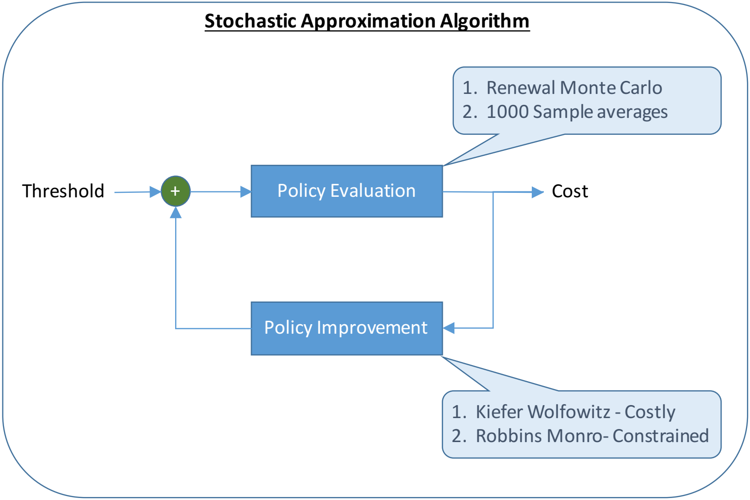
$$E_{t+1} = \begin{cases} aE_t + W_t, & \text{if } Y_t = \mathfrak{E} \\ W_t, & \text{if } Y_t \neq \mathfrak{E}. \end{cases},$$

Objective Functions

$$C^*_\beta(\lambda) := C_\beta(f^*, g^*; \lambda) = \inf_{(k)} D^{(k)}_\beta(e) + \lambda N^{(k)}_\beta(e), \quad \lambda \geq 0$$

$$D^*_\beta(\alpha) := D_\beta(f^*, g^*) = \inf_{(k):N_\beta(k) \leq \alpha} D_\beta(k),$$

Stochastic Approximation



Results

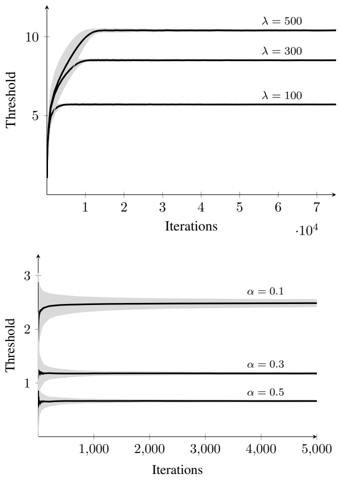


Figure : The sample paths for costly and constrained cases for $p_d = 0.3$. Bold lines represent the sample means for 100 runs and shaded regions correspond to mean $\pm$ twice standard deviation

Conclusions & Future Work

Conclusions

- We present stochastic approximation algorithms to compute optimal thresholds for remote state estimation over communication channels with packet drops.
- We verified accuracy of these methods by comparing with analytical results for no packet-drop case.
- Policy evaluation: Regenerative nature of the error process and associated renewal relations.
- Policy improvement: Structural result that threshold based strategies are optimal.

Future Work

- Extension to Gilbert-Elliott channels
- Extension to higher dimensions

Thank you.