Effect of noise dependence in stochastic dynamic programming

Scientific training period proposal

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1 Organism, supervision and material conditions

Organism

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Number of students: 1

Material conditions: a financial gratification is offered

Dates: to be discussed

2 Proposal

Research domain

Mathematics, stochastic optimization.

Subject

In discrete time stochastic control, decisions (controls) are made sequentially at stages $0, \ldots, T$. At every stage, control and noise — a sequence of random variables $\boldsymbol{W}_0, \ldots, \boldsymbol{W}_T$ — affect a dynamical system and produce a state. When state, control and noise enter a criterion, one can formulate a stochastic optimal control (SOC) problem.

Stochastic dynamic programming (SDP) [1, 2] is a method to solve SOC problems under the crucial assumption that the noise is white, that is, when $\boldsymbol{W}_0, \ldots, \boldsymbol{W}_T$ are stagewise independent. When not, and in case noises follow known dynamics driven by (other) white noise, the original state can be extended and SDP can be applied. However, a larger state may render the approach practically useless, because of the curse of dimensionality.

Often, in practice, such independence assumption does not hold, but the method is applied "as if". In this proposal, we wonder whether one can obtain bounds on the error committed by neglecting stagewise dependence.

Expected work

The student will start by examining a simple problem — that is, the linear-quadratic-Gaussian case with three stages — with dependence. He/she will study the error committed by neglecting dependence. He will try to extend bounds on error to more general cases, for instance when noises follow an Autoregressive-moving-average model (ARMA) process.

References

[1] R. E. Bellman. Dynamic Programming. *Princeton University Press, Princeton, N.J., 1957.*

[2] D. Bertsekas. Dynamic Programming and Optimal Control. *Athena Scientific, Belmont, Massachusets, second edition, 2000.*