Stochastic decomposition applied to large-scale hydro valleys management

P. Carpentier — ENSTA ParisTech, France. Email: pierre.carpentier@ensta.fr
J.-P. Chancelier — ENPC ParisTech, France. Email: jpc@cermics.enpc.fr
V. Leclère — ENPC ParisTech, France. Email: vincent.leclere@enpc.fr
F. Pacaud — Efficacity, France. Email: f.pacaud@efficacity.com

We are interested in optimally controlling a discrete time dynamical system that can be influenced by exogenous noises. This is generally called a Stochastic Optimal Control (SOC) problem and the Dynamic Programming (DP) principle is one of the standard way of solving it [2]. Unfortunately, DP faces the so-called curse of dimensionality: the complexity of solving DP equations grows exponentially with the dimension of the variable that is sufficient to take optimal decisions (the so-called state variable).

For a large class of SOC problems, which includes important practical applications in energy management, we propose an original way of obtaining near optimal controls. The algorithm we introduce is based on Lagrangian relaxation, of which the application to decomposition is well-known in the deterministic framework. However, its application to such closed-loop problems is not straightforward and an additional statistical approximation concerning the dual process is needed. The resulting methodology is called Dual Approximate Dynamic Programming (DADP) [3, 4]. We give interpretations of DADP, and enlighten the error induced by the approximation.

The presentation is mainly devoted to applying DADP to the management of large hydro valleys. The modeling of such systems is presented, as well as the practical implementation of the methodology. Numerical results are provided on several valleys. We first study the application of such methods upon academic valleys, with a state dimension up to 12. Then we extend these results to large-scale valleys — the state dimension increasing up to 30 dams — and we conclude with the application to the management of realistic valleys. We compare our approach with the state of the art SDDP method [1].

References

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