THE UNIVERSITY OF HONG KONG

Department of Mathematics

Computational Science Seminar

A Dynamic Programming approach on a tree structure for finite horizon optimal control problems

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Abstract

The classical Dynamic Programming (DP) approach to optimal control problems is based on the characterization of the value function as the unique viscosity solution of a Hamilton-Jacobi-Bellman (HJB) equation [2]. The DP scheme for the numerical approximation of viscosity solutions of those equations is typically based on a time discretization which is projected on a fixed space triangulation of the numerical domain. The time discretization can be done by a one-step scheme for the dynamics and the projection on the grid typically uses a polynomial interpolation.

In this talk, we will discuss a new approach for finite horizon optimal control problems where we compute the value function on a tree structure built directly by the time discrete dynamics avoiding the use of a space triangulation to solve the HJB equation (see the recent work [1]). This allows to drop the cost of the space interpolation and the tree will guarantee a perfect matching with the discrete dynamics. We will also provide error estimates (see [5]) for the algorithm if the dynamics is discretized with an Euler method. Furthermore, this approach has been extended to high-order schemes and we will show some examples of second order approximation schemes. Finally, we will show the effectiveness of the method for the control of PDEs. This is a joint work with Maurizio Falcone (La Sapienza, Roma) and Luca Saluzzi (GSSI, L'Aquila).

References

[1] A. Alla, M. Falcone, L. Saluzzi, *An efficient DP algorithm on a tree-structure for finite horizon optimal control problems*, submitted, 2018, https://arxiv.org/abs/1807.11008.

[2] M. Bardi, I. Capuzzo-Dolcetta, *Optimal Control and Viscosity Solutions of Hamilton-Jacobi-Bellman Equations*, Birkhäuser, Basel, 1997.

[3] M. Falcone, R. Ferretti, *Discrete time high-order schemes for viscosity solutions of Hamilton-Jacobi-Bellman equations*, Numerische Mathematik, 67, 1994, 315-344.

[4] M. Falcone, R. Ferretti, *Semi-Lagrangian Approximation Schemes for Linear and Hamilton-Jacobi Equations*, Society for Industrial and Applied Mathematics, Philadelphia, 2013.

[5] L. Saluzzi, A. Alla, M. Falcone, *Error estimates for a tree structure algorithm solving finite horizon control problems*, submitted, 2018, https://arxiv.org/abs/1812.11194.

Date:	**January 16, 2019 (Wednesday)**
Time:	**4:00 – 5:00pm**
Venue:	**Room 210, Run Run Shaw Bldg., HKU**

All are welcome