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**Local polynomial approximation of drivers and branching process based resolution of BSDE**

We propose to investigate a new type of numerical schemes for (reflected) Backward Stochastic Differential Equations based on branching processes, that has been first proposed by [2]. It is based on the Feynman-Kac representation of the KPP equation of Skorokhod [11], Watanabe [13] and McKean [9], recently further explored by Rasulov, Raimov and Mascagni [10] and [6, 7, 8], which provides a pure forward representation of BSDEs with polynomial drivers in terms of a family of branching processes. The main idea of [2] is to make these polynomials local, so as to be able to approximate any Lipschitz driver. This is obtained by using a Picard type iteration, but which has the main advantage of not requiring a precise initial prior.

The first aim of this project will be prove the convergence of the method in the case where the driver depends on the $Z$ component of the BSDE and the ghost approach is used to avoid explosion of the variance, see [12]. Secondly, the group will study how this method can be adapted to approximate reflected BSDEs. Numerical experiments will be done on examples coming from the industry. Various variance reduction techniques will also be considered.

# References

[1] K. B. Athreya and P. E. Ney, *Branching processes*, Springer-Verlag, New York, 1972. Die Grundlehren der mathematischen Wissenschaften, Band 196.

[2] B. Bouchard, X. Tan and Y. Zou.*Numerical approximation of BSDEs using local polynomial drivers and branching processes*. arXiv preprint arXiv:1612.06790.

[3] B. Bouchard, X. Warin, *Monte-Carlo valuation of American options: facts and new algorithms to improve existing methods*. In Numerical methods in finance (pp. 215-255). Springer Berlin Heidelberg, 2012.

[4] N. El Karoui, S. Peng, M.C. Quenez, *Backward stochastic differential equations in finance*, Mathematical finance 7(1), 1-71, 1997.

[5] E. Gobet, J.P. Lemor, X. Warin, *A regression-based Monte Carlo method to solve backward stochastic differential equations*. The Annals of Applied Probability, 15(3):2172-202, 2005.

[6] P. Henry-Labordère, *Cutting CVA's Complexity*, Risk magazine (Jul 2012).

[7] P. Henry-Labordere, N. Oudjane, X. Tan, N. Touzi, X. Warin, *Branching diffusion representation of semilinear PDEs and Monte Carlo approximation*. arXiv preprint, 2016.

[8] P. Henry-Labordere, X. Tan, N. Touzi *A numerical algorithm for a class of BSDEs via the branching process*. Stochastic Processes and their Applications. 28;124(2):1112-1140, 2014.

[9] H. P. McKean, *Application of Brownian motion to the equation of Kolmogorov-Petrovskii-Piskunov*, Comm. Pure Appl. Math., Vol 28, 323-331, 1975.

[10] A. Rasulov, G. Raimova, M. Mascagni, *Monte Carlo solution of Cauchy problem for a nonlinear parabolic equation*, Mathematics and Computers in Simulation, 80(6), 1118-1123, 2010.

[11] A.V. Skorokhod *Branching diffusion processes*, Theory of Probability & Its Applications, 9(3):445-449, 1964.

[12] X. Warin. *Variations on branching methods for non linear PDEs*. arXiv preprint arXiv:1701.07660.

[13] S. Watanabe, *On the branching process for Brownian particles with an absorbing boundary*, J. Math. Kyoto Univ. 4(2), 385-398, 1964.