ParisTech

École des Ponts
ParisTech

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Mathematics and their applications

Subfield: Probability theory

Title: Central limit theorem for nonlinear functionals of the empririal mean of non i.i.d . samples

ParisTech School: Ecole des Ponts ParisTech

Advisor(s) Name: Benjamin JOURDAIN
Advisor(s) Email: benjamin.jourdain@enpc.fr
Research group/Lab: ENPC/CERMICS
Lab location: Champs-sur-Marne
(Lab/Advisor website): http://cermics.enpc.fr/~jourdain/home.html

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
The central limit theorem is with the strong law of large numbers one of the two fundamental limit theorems in probability theory. The confidence intervals that it permits to derive have major applications in Monte-Carlo methods as well as in statistics. In reference 1. below, B. Jourdain and his postdoctoral student A. Tse have extended to nonlinear functionals of the empirical measure of independent and identically distributed random vectors the central limit theorem which is well known for linear functionals given by the integral of a function against the measure. The main tool permitting this extension is the linear functional derivative, one of the notions of derivation on the Wasserstein space of probability measures that have recently been developed and are subject of an intensive research. Central Limit Theorems for linear functionals of non independent and identically distributed random variables such as the successive values of an ergodic Markov chain are long known. The PhD student will investigate extensions to nonlinear functionals in these settings.

Required background of the student: (What should be the main field of study of the applicant before applying?) Probability theory and/or mathematical statistics

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. B. Jourdain, A. Tse, *Central limit theorem over non-linear functionals of empirical measures with applications to the mean-field fluctuation of interacting particle systems*, Preprint arXiv:2002.01458
2. A. Alfonsi, J. Corbetta, B. Jourdain, *Sampling of probability measures in the convex order by Wasserstein projection*, Annales de l'Institut Henri Poincaré B, Probabilités et Statistiques, 56(3):1706-1729, 2020
3. A. Alfonsi, B. Jourdain, *Lifted and geometric differentiability of the squared quadratic Wasserstein distance* , accepted in ESAIM: Probability and Statistics, arXiv:1811.07787
4. G. Fort, B. Jourdain, T. Lelièvre, G. Stoltz, Co*nvergence and efficiency of adaptive importance sampling techniques with partial biasing*, Journal of Statistical Physics, 171(2):220-268, 2018
5. G. Fort, B. Jourdain, T. Lelièvre, G. Stoltz, *Self-Healing Umbrella Sampling: Convergence and efficiency*, Statistics and Computing 27(1):147-168, 2017