SEMINARIO

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An improved central limit theorem for the empirical sliced Wasserstein distance

Abstract: Optimal transport theory has become a fundamental tool for handling diverse types of data, with growing applications across various fields. However, the Wasserstein distance presents significant computational and statistical challenges in high-dimensional settings. To address these issues, alternative distances such as the sliced Wasserstein distance, which leverages one-dimensional projections, have been introduced. In this work, we establish a novel central limit theorem for the p-sliced Wasserstein distance, for $p > 1$, using the Efron-Stein inequality—a technique that has proven effective in related problems. This approach yields a central limit theorem centered at the expected value of the empirical cost, under mild regularity conditions. Notably, unlike the general Wasserstein distance in arbitrary dimensions, we demonstrate that, under specific assumptions, the centering constants can be replaced by the population cost, which is essential for statistical inference. This generalizes and significantly refines existing results for the one-dimensional case. Consequently, we present the first asymptotically valid inference framework for the sliced Wasserstein distance between probability measures that are not necessarily compactly supported, for $p > 1$. Finally, we address key practical aspects to ensure its applicability to statistical inference, including Monte Carlo approximation of the slicing integral and consistent estimation of the asymptotic variance.

Seminario del IMUVA, edificio LUCIA
Martes 1 de Julio de 2025 (11:00)