



## Working Group on Statistical Learning Seminar

**Title:** Persistence Flamelets: Topological Invariants for Scale Spaces

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**Date:** Mon 18th November 2019 at 12:00PM

**Location:** Seminar Room SCN 1.25

**Abstract:** In recent years there has been noticeable interest in the study of the “shape of data”. Among the many ways a “shape” could be defined, topology is the most general one, as it describes an object in terms of its connectivity structure: connected components (topological features of dimension 0), cycles (features of dimension 1) and so on. There is a growing number of techniques, generally denoted as Topological Data Analysis or TDA for short, aimed at estimating topological invariants of a fixed object; when we allow this object to change with respect to a scale parameter, however, little has been done to investigate the evolution in its topology. In this work we define the Persistence Flamelet, a multiscale version of one of the most popular tool in TDA, the Persistence Landscape, which represents the topology of a scale space when taken as a whole. We characterize this new topological summary in a probabilistic framework, deriving a Law of Large Numbers and a Central Limit Theorem especially tailored for it. We also provide a bootstrap algorithm to build confidence bands on this new object and we prove its validity. This strengthens the inferential use of our proposal, as it is instrumental in assessing the significance of topological features. Finally, we show its performance as both an exploratory and inferential tool, focusing on two famous classes of statistical problem deeply affected by the presence of a scale parameter: time series analysis, where the scale parameter is time, and kernel density estimation, where the scale parameter is the bandwidth.