Poisson intensity estimation with reproducing kernels*

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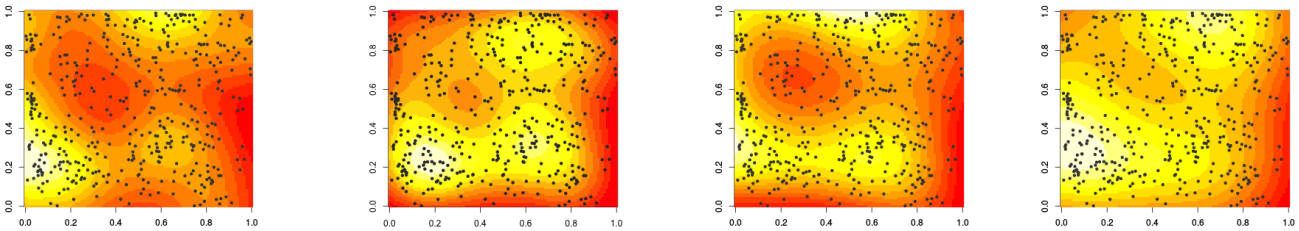
Despite the fundamental nature of the inhomogeneous Poisson process in the theory and application of stochastic processes, and its attractive generalizations (e.g. Cox process), few tractable nonparametric modeling approaches of intensity functions exist, especially in high dimensional settings. We develop a new, computationally tractable Reproducing Kernel Hilbert Space (RKHS) formulation for the inhomogeneous Poisson process. We model the square root of the intensity as an RKHS function. The modeling challenge is that the usual representer theorem arguments no longer apply due to the form of the inhomogeneous Poisson process likelihood. However, we prove that the representer theorem does hold in an appropriately transformed RKHS, guaranteeing that the optimization of the penalized likelihood can be cast as a tractable finite-dimensional problem. The resulting approach is simple to implement, and readily scales to high dimensions and large-scale datasets. We observe strong performance of the proposed method on a variety of synthetic, environmental, crime and bioinformatics data.



(a) KIE with edge correction (b) KIE without edge correction (c) Our RKHS method with $\tilde{k}$ (d) Naïve RKHS method

Figure 1: Location of white oak trees in Lansing, Michigan, smoothed with various approaches. Squared exponential kernels are used throughout. Edge correction makes a noticeable difference for classical kernel intensity estimation (KIE). Comparing (a) and (c) it is clear that our method is automatically performing edge correction.

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