On generating a exible class of anisotropic spatial models using Gaussian predictive processes

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Stochastic spatial models based on Gaussian processes are experiencing a surge of popularity in recent literature due to their abilities to investigate spatial variation in many physical quantities of interest in diverse application areas. A stationary Gaussian process with an isotropic covariance function is often the default choice for statistical modellers since such an assumption implies a tractable model leading to easily amenable analysis and computation. Non-stationary and anisotropic models are generally avoided because of their complexity both in formulation and in implied analysis methods. This article proposes a exible class of non-stationary and anisotropic spatial models by using recently developed Gaussian predictive processes. So far these processes are only used as approximate dimension reduction models for analysing large spatial data sets. The contribution of the current article lies in studying the nature of anisotropy implied by these predictive processes under various scenarios of selection of the knot locations where the predictive process is to be anchored even for both small and large data sets. Results obtained here show that different random and non-random choices of knot-locations lead to new flexible forms of anisotropic covariance functions not yet studied in the literature. These new models, however, unlike other competing models of anisotropy, do not complicate the fitting and analysis methods and in this article MCMC based Bayesian computation methods are used for the most complex model. The methods are illustrated using two practical data sets on modelling air pollution exposure in London and the other on modelling a well-known data set on scallop abundance in the Atlantic ocean near the city of New York.