Classification of mixtures of Strauss and Poisson point processes

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We investigate mixtures of point processes which are superpositions of a regular point process, a Strauss process in our case, and some Poisson noise, and the aim is to decide which of the two processes each point belongs to. The motivation comes from glaciology, where the analysis of deep polar ice cores has become an important tool for deriving climate information from the past. Interpretation of ice core records requires an accurate dating of the ice. However, dating techniques are not satisfyingly developed until now. Redenbach et al. (2009) showed that information on the motion history of an ice shield can be estimated from the point pattern of bubble centers extracted from tomographic images of ice core samples. As the bubble centers form a regular point process, motion parameters can be determined by detecting anisotropies in the neighbourhood structure of the points. Some new data revealed that additionally, the analysis of the ice samples is hampered by the existence of noise bubbles which form due to relaxation of the ice after the core is taken out of the drilling hole, see Weikusat et al. (2012). These bubbles do not carry any information on the motion history of the ice shield, and should preferably be removed prior to the motion analysis.

Our assumption is that the centers of the noise bubbles are a realization of a stationary Poisson process and the real bubble centers a realization of a Strauss process. The aim is to classify the points according to which of the two processes each point belongs to. Walsh and Raftery (2002) studied a similar question, where the aim was to detect locations of mines, which were assumed to lie in parallel lines mixed with Poisson noise. Using some of the ideas presented in Walsh and Raftery (2002), we construct an MCMC algorithm which estimates the parameters of the mixture model and obtains a posterior probability for each point to be a Strauss point. The algorithm is evaluated in a simulation study.

Keywords: Classification, Complete spatial randomness, Polar ice, Regularity, Spatial point process, Superposition.

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