Classification of Points in Superpositions of Point Processes

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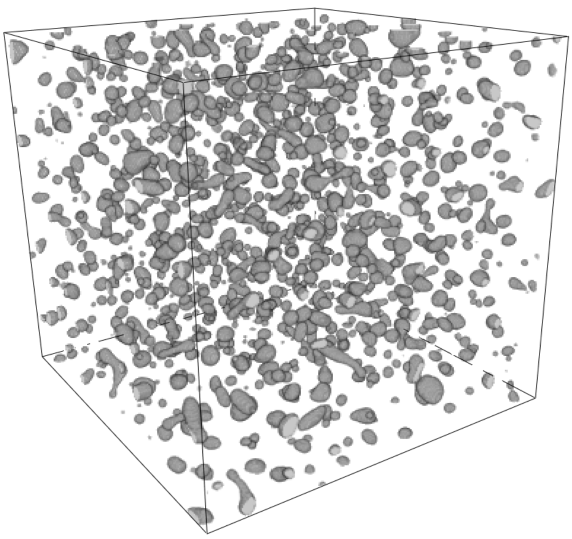
Introduction

Polar ice represents a remarkable multi-proxy archive for climate information of the past. Several proxy parameters can in fact be identified in ice, such as temperature, precipitation, dust, aerosol, sea ice extent, biological activity and atmospheric composition. Due to this reason, several deep ice cores were drilled through the Antarctic and Greenlandic ice sheets within the last decades. To give a thorough interpretation of these ice records, an accurate dating of the ice is required. For polar ice, no absolute dating tool is available. Current dating techniques rely on models whose key element is the simulation of the motion history of the ice sheet. It was recently shown (Redenbach et al. 2009), that motion model parameters can be derived from the analysis of the point process of the centres of air bubbles which are contained in ice extracted from a certain depth and can be detected from tomographic images of ice core samples. As the bubble centres form a regular point process, motion parameters can be determined by detecting anisotropies in the neighbourhood structure of the points.

Figure 1. Visualisation of the system of air pores in a sample (1.41 x 1.41 x 1.41 cm) taken at a depth of 151 m



Recently, it was discovered that ice core samples may contain noise bubbles which form due to relaxation of the ice after the core is taken out of the drilling hole. These bubbles should not be taken into consideration when performing the motion analysis, since they do not carry any information and can badly affect the quality of the results. A classification of the superposition of the newly formed and the original bubbles is therefore required.

Methods, Results and Discussion

Having the glaciological problem in mind, we introduced an MCMC approach to classify the points in superpositions of Strauss and Poisson processes using some of the ideas in Walsh and Raftery (2002). In a simulation study, the classification worked quite well in the sense that the classified Strauss processes and the original ones have similar K-functions (see Redenbach, Särkkä, Sormani, 2015). Moreover the method, as a byproduct, allows us to obtain an estimation of the parameters of the Strauss and Poisson processes, which are a priori not known. We are however interested in developing and investigating other methods, possibly with smaller computational costs, and compare them with each other. In particular we are considering an approach based on variational Bayes approximation.

Conclusion

Our aim is to investigate and compare different methods to classify superpositions of point processes, in particular superpositions of a regular process and a Poisson process. Our motivation comes from glaciology where noise air bubbles should be detected before analysing the anisotropy of the data. In this context it would also be of interest to study of the effect of Poisson noise on such an analysis.

References

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