Ph.D. thesis summary

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The main themes of this thesis are spatial statistics and simulation algorithms. The thesis is split into five papers that may be read independently. All five papers deal with spatial models. Lund and Rudemo (1999), Lund *et al.* (1999), and Lund and Thönnes (1999b) deal with the same new model for point processes observed with noise, and Lund *et al.* (1999), Lund and Thönnes (1999b), and Lund and Thönnes (1999a) has a simulation aspect.

Lund and Rudemo (1999), Lund *et al.* (1999), and Lund and Thönnes (1999b) develop and analyse a new model for point processes observed with noise. Usually the analysis of spatial point patterns assume that the observed points (the true points) are a realization from a specific model. In contrast our approach is to assume the observed pattern generated by thinning and displacement of the true points, and allow for contamination by points not belonging to the true pattern.

Lund and Rudemo (1999) develop the model for point processes observed with noise. The likelihood function for an observation of a noise corrupted point pattern given the true positions is derived. As data for our analysis is indeed a realization of the underlying true process and its associated noise corrupted point pattern we need not consider a model for the underlying process. The parameters in the model describe how many of the true points are lost, how large the displacements are, and the number of contaminating surplus points. For estimation of the parameters in the noise model a deterministic, iterative, and approximative maximum likelihood estimation algorithm is developed. The likelihood function is a sum of an excessive large number of terms, and the algorithm works by finding large dominating terms. Alternative estimation methods are discussed.

Lund *et al.* (1999) analyse the model developed in Lund and Rudemo (1999) with respect to the now unobserved true points. We assume a noisy observation of a true point pattern and knowledge of the parameters in the model. A Bayesian point of view is now adopted and we specify a prior distribution for the underlying true process. Given the model, the prior distribution, and the noisy observation, we get the posterior distribution of the true points. This posterior distribution is investigated by samples from the distribution. These samples are obtained from a Markov chain Monte Carlo (MCMC) algorithm extending the Metropolis-Hastings sampler for point processes. A thorough discussion is provided on the choice of prior distribution and how to present the samples from the MCMC runs. The MCMC samples are used to estimate for example the K-function for the unobserved true point pattern. These estimates are clearly better than estimates based on the observed points alone.

The use of the MCMC algorithm in Lund *et al.* (1999) relies on the fact that a Markov chain run for a long time approaches its stationary distribution. Lund and Thönnes (1999b) uses a recent technique called Coupling From The Past (CFTP) to deliver a sample drawn from the exact posterior distribution of the unobserved true points described in Lund *et al.* (1999), a so-called perfect simulation. This perfect simulation algorithm is based on spatial birth-and-death processes for simulation of point processes. In order to apply CFTP in our problem the simulation is carried out on an augmented state space. The algorithm turns out to be too slow in practice and thus demonstrates possible current limits of CFTP.

Lund and Thönnes (1999a) describes a new perfect simulation algorithm for general locally stable point processes. The algorithm is based on CFTP for Metropolis-Hastings simulation of point processes and it is simpler than the previous known perfect algorithm based on Metropolis-Hastings simulation for this class of models. The present state of the algorithm is that it is far too slow to be useful in practice, and it might have some theoretical flaws. These problems are discussed in the introductory part of the thesis.

Lund (1998) develops a model for survival times of trees that take the spatial positions of the trees into account. At a finite number of timepoints it is observed whether a tree is alive or not, and thus we have interval censoring of the even aged trees. The model is a discrete time version of Cox's proportional hazards model. Positions of trees are considered as fixed, and they are used to compute competition indices that enter the model as covariates. It is shown that small trees have a higher risk of dying than large tress and the area of the experiment is inhomogeneous. In addition, Hegyi's competition index based on basal area is a significant covariate.

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References

- Lund (1998)
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