M. N. M. VAN LIESHOUT

Stochastic geometry models in image analysis and spatial statistics

On April 7, 1994, M. N. M. van Lieshout received her Ph.D. from the Free University, Amsterdam, Promotor was Prof. Dr. A. J. Baddeley (University of Western Australia), co-promotor was Prof. Dr. J. Oosterhoff (Free University, Amsterdam) and the other members of the examination committee: Prof. Dr. R. D. Gill (University of Utrecht) en Prof. Dr. P. J. Green (University of Bristol).

This Ph.D. dissertation is concerned with Markov spatial processes and their applications in image analysis and spatial statistics.

After a brief introduction, chapter 2 discusses maximum likelihood approaches to object recognition, the image interpretation task of extracting an unknown number of objects of specified type from a blurred and noisy image. We show that standard computer vision techniques such as the Hough transform and mathematical morphology operators are in fact maximum likelihood methods under a simple noise model.

In chapter 3 we review Markov object processes, a class of models defined in terms of interactions between objects. The subclass used most often allows interactions between pairs of objects only. Although this class is a rich source of models exhibiting negative correlation between objects, it is believed to be less suitable for positive correlation. Relaxing the pairwise interaction assumption, we introduce a new family of Markov models that does allow for both positive and negative association, depending on the value of a scalar parameter.

Maximum likelihood recognisers tend to suffer from multiple response, detecting too many almost identical objects. To overcome this problem, in chapter 4 we propose a Bayesian approach with a Markov prior penalising scenes with many overlapping objects. We develop Markov chain Monte Carlo techniques for posterior sampling and optimisation, and discuss computational aspects.

Another area of application where Markov prior distributions are helpful is the identification of centres of clustering in a spatial pattern. In chapter 5 we adapt the techniques of the previous chapter to this problem in order to enable inference on both the location of clusters and on assigning the points in the observed pattern to one of these clusters.

Finally, in chapter 6 we prove that the standard model for clustering in stochastic geometry, the Poisson cluster process, is a (nearest-neighbour) Markov process. The Poisson assumption on the generating process can be relaxed to a Markov assumption.

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