Thesis for the Degree Doctor of Philosophy of
Engineering in Mathematical Statistics

Probabilistic modeling in Sports, Finance and Weather

Jan Lennartsson

Abstract

In this thesis, we build mathematical and statistical models for a wide variety of real world applications. The mathematical models include applications in team sport tactics and optimal portfolio selection, while the statistical modeling concerns weather and specifically precipitation.

For the sport application, we define an underlying value function for evaluating team sport situations in a game theoretic set-up. A consequence of the adopted setting is that the concept of game intelligence is concretized and we are able to give optimal strategies in various decision situations. Finally, we analyze specific examples within ice hockey and team handball and show that these optimal strategies are not always applied in practice, indicating sub-optimal player behaviour even by professionals.

Regarding the application for finance, we analyze optimal portfolio selection when performance is measured in excess of an externally given benchmark. This approach to measure performance dominates in the financial industry. We assume that the assets follow the Barndorff-Nielsen and Shephard model, and are able to give the optimal value function explicitly in Feynman-Kac form, as well as the optimal portfolio weights.

For the weather application, we analyze the precipitation process over the spatial domain of Sweden. We model the precipitation process with the aim of creating a *weather generator*; a stochastic number generator of which synthesized data is similar to the observed process in a weakly sense. In Paper [C], the precipitation process is modeled as a point-wise product of a zero-one Markov process, indicating occurrence or the lack of rainfall, and a transformed Gaussian process, giving the intensities. In Paper [D], the process is modeled as a transformed censored latent Gaussian field. Both models accurately capture significant properties of the modeled quantity. In addition, the second model also possesses the substantial feature of accurately replicating the spatial dependence structure.

Keywords: Mathematical modelling; Game theory; Team sport tactics; Modern portfolio theory; Gaussian fields.

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