KUNGL TEKNISKA HÖGSKOLAN

Activity Report

July 1, 1997 – June 30, 1998

Mathematical Statistics

Department of Mathematics
Royal Institute of Technology
S-100 44 Stockholm, Sweden

1. Personnel

Professor:	**Lars Holst,** FD. Main research areas: Combinatorial probability theory, limit theorems and approximations in probability, stochastic modelling.
Associate professor: (Biträdande professor)	**Jan Grandell,** FD. Main research areas: Point processes and risk theory.
Associate professors: (Universitetslektorer, docenter)	**Boualem Djehiche,** FD. Main research areas: Stochastic analysis, mathematical epidemiology, risk theory. **Timo Koski,** FD. Main research areas: Statistical learning theory, classification, cyclostationary random processes and signals.
Senior lecturers: (Universitetslektorer)	**Josefin Bodell,** TeknD. **Jan Enger,** FD. **Gunnar Englund,** TeknD. **Mikael Raab,** TeknD.
Researcher:	**Torkel Erhardsson,** TeknD.
Senior tutors: (Universitetsadjunkter)	**Gunnar Karlsson,** civiling. **Göran Rundqvist,** FK.
Graduate students:	**Anna Carlsund,** FM. **Andreas Lindell,** civiling.

2. Research

(See the home page of the Division of Mathematical Statistics:
http://www.math.kth.se/matstat/matstat.html.)

2.1. Large deviations for measure-valued processes

Research leader
Boualem Djehiche.

Scientists
Ingemar Kaj (Uppsala University) and Alexander Schied (Humboldt-Universität, Berlin).

Keywords
Hierarchical ensembles, large deviations, McKean-Vlasov limit, measure-valued processes, superprocesses, weak interaction.

Project description
Establish a large deviations principle for classes of superprocesses and multilevel measure-valued jump processes, for which the interaction of the underlying particle system is of long-range and hierarchical type. Next, apply these results to catch the long-term behaviour and metastability of the underlying particle systems.

2.2. Mathematical epidemiology

Research leader
Boualem Djehiche.

Scientist
Håkan Andersson (Stockholm University).

Keywords
Branching approximation, epidemic processes, Kendall equation.

Project description
Extension of the stochastic analysis of SIR-models to spatial models taking into account the age-structure, the hierarchy, and the geography of the population. SIR-models on random graphs.

2.3. Risk theory and point processes

Research leader
Jan Grandell.

Keywords
Cox process, Lundberg inequality, martingale methods, ruin probability.

Project description
Generalization of the classical risk models to cases where the occurrence of the claims may be described by more general point processes than the Poisson process.

2.4. Compound Poisson approximations for Markov chains, with applications

Research leader
Lars Holst.

Scientist
Torkel Erhardsson.

Keywords
Compound Poisson approximation, coupling, extreme-value theory, Johnson-Mehl model, Markov chain, point processes, Stein's method.

Project description
Compound Poisson approximations for the number of visits of a stationary Harris ergodic Markov chain to a rare subset of the state space are studied. In particular, a new method for obtaining total variation distance bounds for such approximations based on the theory of Stein equations has been developed. Also, applications of the method to particular Markov chains are considered, e.g. in connection with the Johnson-Mehl model for the formation and growth of crystals.

2.5. Extremes in stochastic processes related to the Gaussian

Research leader
Lars Holst.

Scientist
Mikael Raab.

Keywords
Chi-square processes, coupling, extreme-value theory, moving average processes, Poisson approximation, Stein-Chen method.

Project description
Studies of accuracy of Poisson and compound Poisson approximations for extremes in sequences related to Gaussian. Applications connected with analysis of noisy data.

2.6. Probabilistic analysis of self-organizing structures

Research leader
Lars Holst.

Scientist
Josefin Bodell.

Keywords
Binary search trees, move-to-front, move-to-root, Poisson processes, self-organizing search.

Project description
Investigations by probabilistic models and methods of search times for heuristics used for data structures like lists and trees.

2.7. Stable distributions

Research leader
Lars Holst.

Scientist
Lennart Bondesson (Uppsala University).

Project description
Studies of convergence to stable distributions using Laplace transforms.

2.8. Range of random walks

Research leader
Lars Holst.

Scientists
K. S. Chong (Hong Kong University) and R. Cowan (Sydney University).

Project description
Studies of the distributions of the range for simple random walks and Brownian motions using the ruin problem and weak convergence.

2.9. Numerical taxonomy

Research leader
Timo Koski.

Scientists
Mats Gyllenberg and Tatu Lund (University of Turku).

Keywords
Clustering theory, data mining, predictive inference, stochastic complexity.

Project description
The project is initiated by problems of identification of bacteria. In numerical bacterial taxonomy a classification is not fixed but is continuously updated as new bacteria are discovered. This means that an item is either identified, that is, put into an already existing class, or, if it is sufficiently different from all established classes, it forms a new class. The statistical models for this are formulated in terms of exchangeability.

Classification can amongst other things be viewed as a means for storing and compressing information as well as for rational organization of databases. The availability of the simplest possible system of classes is thus a prerequisite for understanding of and learning about the underlying phenomena.

Classification means the task of establishing the classes themselves from a given database of 'unclassified' items, i.e. of inferring both the number of classes, the class descriptions, and the class memberships for a given data set. Thus the project is concerned with 'unsupervised learning' in an extended sense, as it is also trying to infer a structural parameter (the number of classes) from the data.

Since classification amounts to clustering of vectors, the algorithms can actually be developed without reference to any specific application. Hence the results can be used in several fields of electrical and computer engineering.

The research is supported by NFR and by Knut and Alice Wallenberg Foundation.

3. Education

3.1. Undergraduate courses

The Department of Mathematics gives undergraduate courses in mathematical statistics at all programmes of the Royal Institute of Technology (KTH), except at the School of Architecture; in all nine courses. The following courses have been given:

5B1501 Probability Theory and Statistics for the School of Industrial and Management Engineering, the School of Surveying, the School of Mechanical Engineering, the School of Vehicle Engineering, and the School of Civil Engineering.

5B1503 Statistics and Design of Experiments for the School of Materials Technology and the School of Chemical Engineering.

5B1504 Mathematical Statistics for the School of Electrical Engineering.

5B1506 Mathematical Statistics for the School of Computer Science and Technology and the School of Engineering Physics.

5B1538 Reliability Theory.

5B1540 Probability Theory.

5B1545 Time Series Analysis.

5B1550 Applied Mathematical Statistics.

5B1555 Computer Intensive Methods in Mathematical Statistics.

The first four courses are basic courses for the different programmes of KTH. The last five courses are higher undergraduate courses. About 1300 students a year study courses in mathematical statistics; more than 2000 lessons are given each year.

The course 5B1550 was given together with the Institute of Actuarial Mathematics and Mathematical Statistics at Stockholm University.

The Department of Mathematics had also some responsibility for the examination in mathematical statistics at Mälardalen University.

3.2. Doctoral thesis

Torkel Erhardsson: *Compound Poisson approximation for Markov chains.* December 1997.

3.3. Master theses (Examensarbeten)

Lina Bertling: *Driftsäkerhet vid kravverifiering, speciellt för stridsvagn 122.* October 1997.

Stefan Tordai: *Quantitative Analysis of Credit Risk.* November 1997.

Stefan Kloss: *Approximations for an Occupancy Problem.* November 1997.

Roger Olmås: *Prediktering av elspotpris medelst linjär regression.* April 1998.

Marc Bohlin: *Pricing of Options with Electricity Futures as Underlying Assets.* April 1998.

Petra Nitell: *Tillgänglighetsanalys för Stockholms elnät.* April 1998.

Claes-Erik Rydberg: *Prissättning av caplets: Analytisk och empirisk jämförelse av olika modeller av räntan.* May 1998.

Yann Ollivier, Cédric Schwartzler: *Nettointäkter av automatspel — påverkan av spelarbeteendet och den teoretiska utdelningen.* June 1998.

4. Publications

4.1. Published papers

Boualem Djehiche, Alexander Schied: Large deviations for hierarchical systems of interacting jump processes. *Journal of Theoretical Probability,* Vol. 11 (1998), 1–24.

Boualem Djehiche, Håkan Andersson: Limit theorems for the total size of a spatial epidemic. *Journal of Applied Probability,* Vol. 34 (1997), 698–710.

Boualem Djehiche, Håkan Andersson: A threshold limit theorem for the stochastic logistic epidemic. *Journal of Applied Probability,* Vol. 35 (1998), 662–670.

H. G. Gyllenberg, M. Gyllenberg, T. Koski, T. Lund: Stochastic complexity as a taxonomic tool. *Computer Methods and Programs in Biomedicine,* Vol. 56 (1998), 11–22.

4.2. Technical reports and preprints

Boualem Djehiche, M'Hamed Eddahbi: *Large Deviations for Nonlinear Hyperbolic SPDE's in the Besov-Orlicz Norm.* TRITA-MAT-1997-MS-06, November 1997.

Torkel Erhardsson: *Compound Poisson approximation for Markov chains.* TRITA-MAT-1997-MS-05, December 1997 (doctoral thesis).

Jan Grandell: *Simple approximations of ruin probabilities.* TRITA-MAT-1998-MS-01, June 1998.

Lennart Bondesson, Lars Holst: *Convergence to Stable Distributions Using Laplace Transforms.* TRITA-MAT-1997-MS-04, October 1997.

M. Gyllenberg, T. Koski, T. Lund, H. G. Gyllenberg: *Bayesian Predictive Identification and Cumulative Classification.* TRITA-MAT-1997-MS-03, October 1 997.

H. G. Gyllenberg, M. Gyllenberg, T. Koski, T. Lund, J. Schindler: *An Assessment of Cumulative Classification.* University of Turku, Institute for Applied Mathematics, Research Report A18, December 1997.

M. Gyllenberg, T. Koski: *Posterior Predictive Distributions for Classification of Multivariate Binary Data.* University of Turku, Institute for Applied Mathematics, Research Report A21, March 1998.

5. Seminars

1997

Sept. 8. **Lars Holst:** *Stabila fördelningar och Laplacetransformer.*

Sept. 15. **Mats Rudemo,** Göteborg: *Punktprocesser med brus.*

Sept. 22. **Lars Holst:** *Stabila fördelningar och Laplacetransformer (fortsättning).*

Sept. 29. **Jürg Hüsler,** Bern: *Extremes of Gaussian processes.*

Oct. 6. **Lars Holst:** *Stabila fördelningar och Laplacetransformer (fortsättning).*

Oct. 20. **Jan Grandell:** *Vägda Poissonprocesser och ruinsannolikheter.*

Oct. 27. **Lina Bertling:** Presentation of Master thesis: *Driftsäkerhetsanalys vid kravverifiering, speciellt för stridsvagn 122.*

Nov. 3. **Stefan Tordai:** Presentation of Master thesis: *Quantitative Analysis of Credit Risk.*

Nov. 10. **Stefan Kloss:** Presentation of Master thesis: *Approximations for an Occupancy Problem.*

Nov. 10. **Lars Holst:** *Ruinproblemet och variationsområde för Brownsk rörelse.*

Nov. 24. **Daniel Thorburn,** Stockholms universitet: *Bayesiansk statistik — en introduktion.*

Dec. 1. **Lars Holst:** *Ruinproblemet och variationsområde för Brownsk rörelse (fortsättning).*

Dec. 4. **Minisymposium in Mathematical Statistics:**
Andrew Barbour, Zürich: *Poisson-Dirichlet limits for logarithmic combinatorial structures.*
Søren Asmussen, Lund: *Martingales for Markov-modulated models.*
Holger Rootzén, Göteborg: *Rates of convergence for extremes.*

Dec. 15. **Bengt Rosén,** Statistiska centralbyrån: *Order sampling with inclusion probabilities proportional to size.*

1998

Jan. 19. **Lars Holst:** *Ruinproblemet och variationsområde för Brownsk rörelse (fortsättning).*

Jan. 26. **Lars Holst:** *Ruinproblemet och variationsområde för Brownsk rörelse (fortsättning).*

Febr. 2. **Kurt Johansson,** Mathematics, KTH: *The longest increasing subsequence in a random permutation.*

Febr. 9. **Tobias Rydén,** Lund: *Bayesian inference in hidden Markov models through jump Markov chain Monte Carlo.*

Febr. 16. **Boualem Djehiche:** *Renormalization of interacting diffusions.*

Febr. 23. **Jan Grandell:** *Enkla approximationer av ruinsannolikheter.*

March 2. **Olle Häggström,** Göteborg: *Percolation processes — static and dynamical.*

March 9. **Lars Holst:** *Ruinproblemet och variationsområde för Brownsk rörelse (fortsättning).*

March 16. **Timo Koski:** *Utbytbara processer av binära vektorer och prediktiva klassificeringskriterier.*

March 30. **Andrei Borodin,** St. Petersburg: *Versions of the Feynman-Kac formula.*

April 3. **Claudia Klüppelberg,** München: *Risk management in finance: An application of extreme value theory.*

April 15. **Roger Olmås:** Presentation of Master thesis: *Prediktering av elspotpris medelst linjär regression.*

April 20. **Elisabeth Pancheva,** Sofia: *Multivariate extremal processes.*

April 24. **Marc Bohlin:** Presentation of Master thesis: *Pricing of Options with Electricity Futures as Underlying Assets.*

April 24. **Petra Nitell:** Presentation of Master thesis: *Tillgänglighetsanalys för Stockholms elnät.*

April 27. **Timo Koski:** *Kingmans representationssats.*

May 11. **Paavo Salminen,** Turku: *On Russian options.*

May 14. **Evsei Morozov,** Petrozavodsk: *Weak regenerative queueing network processes.*

May 28. **Malcolm P. Quine,** Sydney: *Asymptotic normality of processes with a branching structure.*

May 29. **Claes-Erik Rydberg:** Presentation of Master thesis: *Prissättning av caplets: Analytisk och empirisk jämförelse av olika modeller av räntan.*

June 10. **Yann Ollivier, Cédric Schwartzler:** Presentation of Master thesis: *Nettointäkter av automatspel — påverkan av spelarbeteendet och den teoretiska utdelningen.*

6. Presentations by staff

Josefin Bodell: *Options — probability and money.* Uppsala-Stockholm Symposium on Mathematical Statistics, Uppsala, May 27, 1998.

Boualem Djehiche: *Renormalization of interacting diffusions.* Second Conference on Probability and Stochastic Processes, Cadi Ayyad University, Marrakech, April 28 – 30, 1998.

Boualem Djehiche: *Large deviations for a class of SPDE's in the Besov-Orlicz space.* Annual Meeting for the European Stochastic Analysis Network, Paris, May 22 – 28, 1998.

Jan Grandell: *Mixed Poisson processes and ruin probabilities.* Conference on "Building of Actuarial Science and Education", Moscow, October 27 – 31, 1997.

Jan Grandell: *Mixed Poisson processes and ruin probabilities.* Uppsala-Stockholm Symposium on Mathematical Statistics, Uppsala, May 27, 1998.

Mikael Raab: *Compound Poisson approximation of the number of exceedances in Gaussian processes.* Seminar at the Department of Mathematical Statistics, Chalmers University of Technology, Göteborg, May 19, 1998.

7. Conferences, guest researchers, etc.

Most of the staff participated in the Uppsala-Stockholm Symposium on Mathematical Statistics, Uppsala, May 27, 1998.

Boualem Djehiche participated in the Second Conference on Probability and Stochastic Processes, Cadi Ayyad University, Marrakech, April 28 – 30, 1998.

Boualem Djehiche participated in the Annual Meeting for the European Stochastic Analysis Network, Paris, May 22 – 28, 1998.

Jan Grandell participated in the conference on "Building of Actuarial Science and Education", Moscow, October 27 – 31, 1997.

Lars Holst participated in the Conference "Lunteren Meeting", Holland, November 17 – 19, 1997.

Lars Holst participated in the 17th Nordic Conference on Mathematical Statistics, Helsingør, Denmark, June 8 – 12, 1998.

Professor Andrew Barbour, Zürich University, visited the Department of Mathematics, KTH, from December 3 to December 7, 1997.

Professor Andrei Borodin, University of St. Petersburg, visited the Department of Mathematics, KTH, from March 30 to April 1, 1998.

Professor Malcolm Quine, Sydney University, visited the Department of Mathematics, KTH, from May 28 to June 9, 1998.

8. Other activities

Boualem Djehiche is a regular reviewer for Mathematical Reviews.

Boualem Djehiche is a contributing editor for Current Index to Statistics (edited by Ed Gbur) since 1992.

Boualem Djehiche is a referee for Advances in Applied Probability, for Probability Theory and Related Fields, and for Scandinavian Actuarial Journal.

Boualem Djehiche was external referee for a doctoral thesis in mathematics at Cadi Ayyad University, Marrakech, April 27, 1998.

Boualem Djehiche was a member of the examination committee (betygsnämnd) at a disputation for doctoral degree at Stockholm School of Economics, June 4, 1998.

Jan Enger is coordinator of the Swedish work in the international standardization committees ISO/TC69 Applications of Statistical Methods and ISO/TC 176 Quality Management and Quality Assurance. He is a member of the working groups on Statistical Sampling Plans belonging to ISO/TC69. He was one of the Swedish delegates at the meetings of the above-mentioned committees.

The teachers of mathematical statistics have been consulted on statistical methods several times, especially from the Institute of Wood Technology. Most of this consulted work has been carried out by **Jan Enger.**

Jan Enger is a member of the Education Committee of SFK (Swedish Organization for Quality) and of the Committee on Quality of Jernkontoret.

Gunnar Englund is senior biostatistician at Astra Arcus.

Jan Grandell is Swedish editor of Scandinavian Actuarial Journal.

Jan Grandell is a referee for Applied Probability.

Jan Grandell is censor at the Faculty of Natural Sciences at the University of Copenhagen, Denmark.

Jan Grandell is a regular reviewer for Mathematical Reviews.

Jan Grandell was a member of the examination committee (betygsnämnd) at the disputation for doctoral degree of Jorge Mari, Division of Optimization and Systems Theory, Department of Mathematics, KTH, May 26, 1998.

Lars Holst has been involved in the evaluation of research proposals to the Australian Research Council.

Lars Holst is a regular reviewer for Mathematical Reviews and Zentralblatt für Mathematik. He was a referee for Applied Probability and for Statistics and Probability Letters.

Lars Holst was thesis advisor (handledare) for Torkel Erhardsson (disputation for doctoral degree on December 5, 1997).

Lars Holst was a member of the examination committee (betygsnämnd) at a disputation for doctoral degree at Stockholm School of Economics, December 19, 1997.

Lars Holst was external examiner on the doctoral thesis of Di Warren, Sydney University, May 1998.

Lars Holst was external expert (sakkunnig) for one position as professor and one as university lecturer at Linköping University, spring 1998.

Timo Koski is a referee for Scandinavian Actuarial Journal and for Journal of the Brazilian Telecommunication Society.

Timo Koski was a member of the examination committee (betygsnämnd) at the disputation for doctoral degree of Torkel Erhardsson, Department of Mathematics, KTH, December 5, 1997.

Timo Koski was a member of the examination committee (betygsnämnd) at the disputation for doctoral degree of Ulf Hansson, Department of Data Transmission, Chalmers University of Technology, Göteborg, December 11, 1997.

Timo Koski was external expert (sakkunnig) for a position as university lecturer in mathematical statistics at Malmö Högskola.

Timo Koski was opponent for the licentiate thesis by Roland Orre at the Department of Numerical Analysis and Computing Science (NADA), KTH, June 19, 1998.

Timo Koski was external examiner at the evaluation of three Master of Science theses (progradualavhandlingar) in applied mathematics at the University of Turku.