VETENSKAP OCH KONST

KUNGL TEKNISKA HÖGSKOLAN

Activity Report

July 1, 1996 – June 30, 1997

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.
Senior tutors: (Universitetsadjunkter)	**Gunnar Karlsson,** civiling. **Göran Rundqvist,** FK.
Graduate student:	**Torkel Erhardsson,** TeknL.

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.

Scientist
Ingemar Kaj (Uppsala University).

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, epidemical 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 connexion 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, compound Poisson approximation, 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.

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. Numerical taxonomy

Research leader
Timo Koski.

Scientists
Mats Gyllenberg, 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.

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 eight 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 Computer Science and Technology, the School of Electrical Engineering, and the School of Engineering Physics.

5B1532 Stationary Stochastic Processes.

5B1538 Reliability Theory.

5B1540 Probability Theory.

5B1550 Applied Mathematical Statistics.

5B1555 Computer Intensive Methods in Mathematical Statistics.

The three first courses are basic courses for the different programmes of KTH. The five last 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 gave together with the Department of Geodesy and Photogrammetry the course 1E1120 Statistical Models and Error Theory for the School of Surveying.

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

3.2. Doctoral theses

Mikael Raab: *On the Number of Exceedances in Gaussian and Related Sequences.* January 1997.

Josefin Bodell: *Cost of Searching — Probabilistic Analysis of the Self-Organizing Move-to-Front and Move-to-Root Sorting Rules.* May 1997.

3.3. Master theses (Examensarbeten)

Tomas Lund: *Beslutsmodell för försäkringsreservdelar.* October 1996.

Erik Wangler: *Riskanalys på detaljer utsatta för lågcykelutmattning.* October 1996.

Göran Sporre: *Service Rates of Teletraffic with Intensity Variations.* October 1996.

Anna Linde: *A Type II Counter Model of Neurotransmitter Release.* November 1996.

Lina Johansson: *Tillgänglighetsanalyser med felträdsteknik.* December 1996.

Dan Mattsson: *Thinning a Poisson Process by Timer Mechanisms and its Impact on Queueing Systems.* January 1997.

Martin Lindquist: *Non-homogeneous Type II Counter Models for Neurotransmitter Releases.* January 1997.

Fredrik von Post: *Nätverk — Hur tillförlitliga är de? En tillförlitlighetsanalys av ett operativt nätverk.* March 1997.

Philip Ekman: *Statistical Predictor Identification using Cyclostationary Signal Representations.* May 1997.

Nils Hast, Robert Thorén: *Multipel regression som verktyg för prediktion av svenska räntan i realtid — modellbygge och analys av finansiella faktorer på historiska data.* May 1997.

4. Publications

4.1. Book

Jan Grandell: *Mixed Poisson Processes.* Chapman and Hall, London. xi + 268 pp. (1997).

4.2. Published papers

Josefin Bodell: Populärt om populariteter. *Nämnaren,* No. 3, 1996, 34 – 38.

Josefin Bodell: Cost of self-organizing search. *Selected Topics in Mathematics, Proceedings of the First Nordic Summer School for Female PhD Students of Mathematics,* pp. 5 – 8, Luleå University of Technology, 1997.

Torkel Erhardsson: On the number of high excursions of linear growth processes. *Stochastic Processes and their Applications,* Vol. 65 (1996), 31 – 53.

L. Holst, M. Quine, J. Robinson: A general stochastic model for nucleation and linear growth. *Annals of Applied Probability,* Vol. 6 (1996), 903 – 921.

T. Koski, H. G. Gyllenberg, M. G. Gyllenberg, T. Lund, J. Schindler, M. Verlaan: Classification of Enterobacteriaceae by minimization of stochastic complexity. *Microbiology,* Vol. 143 (1997), 721 – 732.

T. Koski, M. G. Gyllenberg: Numerical taxonomy and the Principle of Maximum Entropy. *Journal of Classification,* Vol. 13 (1996), 213 – 229.

T. Koski, H. G. Gyllenberg, M. Verlaan: Classification of binary vectors by minimization of stochastic complexity. Accepted for publication in *Journal of Multivariate Analysis* (1997).

Mikael Raab: Poisson appoximation of the number of exceedances of a discrete-time χ^2-process. *Stochastic Processes and their Applications,* Vol. 66 (1997), 41 – 54.

4.3. Technical reports and preprints

Håkan Andersson, Boualem Djehiche: *A Threshold Limit Theorem for the Stochastic Logistic Epidemic.* TRITA-MAT-1996-MS-05, October 1996. (To appear in Advances in Applied Probability.)

Håkan Andersson, Boualem Djehiche: *An Introduction to Martingale Theory.* Institute of Actuarial Mathematics and Mathematical Statistics, Stockholm University. April 1997.

Catharina Carlemalm, Boualem Djehiche: *On Blind Deconvolution Using a Stochastic Differential Calculus Approach.* TRITA-MAT-1996-MS-06, December 1996.

T. Koski, H. G. Gyllenberg: *Posterior Predicitive Distributions and Maximal Predictiveness for Classification of Multivariate Binary Data.* TRITA-MAT-1997-MS-01, January 1997, submitted for publication.

T. Koski, H. Hurd: *The Wold isomorphism for Cyclostationary Sequences.* Technical report, No. 484, October 1996, Center for Stochastic Processes, University of North Carolina, Chapel Hill, North Carolina. (Submitted.)

T. Koski, H. Hurd: *On the Wold isomorphism and Wold decomposition for prediction of Cyclostationary Sequences.* In Ph. Loubaton, H. Hurd: Proceedings of the Workshop on Cyclostationary Processes. Technical report, No. 485, November 1996, Center for Stochastic Processes, University of North Carolina, Chapel Hill, North Carolina.

T. Koski, H. G. Gyllenberg, M. Gyllenberg, T. Lund: *Stochastic Complexity as a Taxonomic Tool.* TRITA-MAT-1997-MS-02, June 1997, submitted for publication.

5. Seminars

1996

Sept. 9. **Lars Holst:** *Noblesseproblemet.*

Sept. 16. **Lars Holst:** *Några problem för en tillväxtmodell.*

Sept. 23. **Lennart Bondesson,** Uppsala: *Oändligt delbara sannolikhetstätheter, en översikt.*

Oct. 7. **Catharina Carlemalm,** Reglerteknik, KTH: *Modellering av kommunikationskanaler med gömda Markovkedjor och stokastisk differentialkalkyl.*

Oct. 14. **F. W. Steutel,** Eindhoven: *The number of (almost) maxima in a sample.*

Oct. 21. **Erik Wangler:** Presentation of Master thesis: *Riskanalys på detaljer utsatta för lågcykelutmattning.*

Oct. 21. **Tomas Lund:** Presentation of Master thesis: *Beslutsmodell för försäkringsreservdelar.*

Oct. 22. **Vladimir Kalashnikov,** Moscow: *Bounds of ruin probability in the presence of large claims and their comparison.*

Oct. 28. **Göran Sporre:** Presentation of Master thesis: *Service rates of teletraffic with intensity variations.*

Nov. 4. **Josefin Bodell:** *Move-to-front för två användare med tidsberoende "smak".*

Nov. 8. **Georg Lindgren,** Lund: *Om fördelningen för våglängd och vågperiod på ett stokastiskt hav.*

Nov. 11. **Anna Linde:** Presentation of Master thesis: *The release of neurotransmitter, simulated by type II counters.*

Nov. 18. **Boualem Djehiche:** *Asymptotic properties of the time to extinction of a non-linear birth-and-death process.*

Nov. 25. **Josefin Bodell:** *Move-to-front för två användare med tidsberoende "smak" (fortsättning).*

Dec. 2. **Torkel Erhardsson:** *Compound Poissonapproximation för antalet besök av en stationär Markovkedja i en sällsynt mängd.*

Dec. 16. **Lina Johansson:** Presentation of Master thesis: *Tillgänglighetsanalyser med felträdsteknik.*

1997

Jan. 13. **Sven Erick Alm,** Uppsala: *Hur uppskattar man intensiteten för händelser som (nästan) aldrig inträffat?*

Jan. 20. **Dan Mattsson:** Presentation of Master thesis: *Call gapping mechanisms for network traffic management.*

Jan. 20. **Martin Lindquist:** Presentation of Master thesis: *Non-homogeneous type II counter models for neurotransmitter releases.*

Jan. 27. **Bronius Grigelionis,** Vilnius: *Mixed exponential processes and martingales.*

March 17. **Timo Koski:** *Prediktiva posteriorifördelningar och numerisk taxonomi.*

March 24. **Fredrik von Post:** Presentation of Master thesis: *Nätverk — Hur tillförlitliga är de? En tillförlitlighetsanalys av ett operativt nätverk.*

April 7. **Lars Holst:** *Slumpvandring av ordnade element.*

April 21. **Esa Nummelin,** Helsingfors: *Equilibria and large deviations for random exchange economies.*

May 5. **Mats Gyllenberg,** Åbo: *Den matematiska teorin för strukturerade populationer.*

May 12. **Harry Cohn,** Melbourne: *Global optimization by Markov chains: The simulated annealing algorithm.*

May 20. **Philip Ekman:** Presentation of Master thesis: *Statistical predictor identification using cyclostationary signal representations.*

May 20. **Nils Hast, Robert Thorén:** Presentation of Master thesis: *Multipel regression som verktyg för prediktion av svenska räntan i realtid — modellbygge och analys av finansiella faktorer på historiska data.*

May 26. **Timo Koski:** *De Finettis teorem: bevis och tillämpningar.*

6. Presentations by staff

Boualem Djehiche: *Large deviations for the Fleming-Viot process.* First Nordic-Russian Symposium on Stochastics, Helsinki, August 14 – 16, 1996.

Boualem Djehiche: *Some aspects of large deviations theory in population dynamics.* International Conference on Probability and Stochastic Processes, Marrakech, Marocco, June 25 – 28, 1997.

Boualem Djehiche: *The Cramér-Esscher transform for L^2-martingale-measures.* Department of Mathematics, Caddi Ayad University, Marrakech, Marocco, June 30, 1997.

Torkel Erhardsson: *On the number of components of the uncovered set in a linear birth-growth model.* First Nordic-Russian Symposium on Stochastics, Helsinki, August 14 – 16, 1996.

Torkel Erhardsson: *On the number of components of the uncovered set in a linear birth-growth model.* 4th World Congress of the Bernoulli Society, Vienna, August 26 – 31, 1996.

Lars Holst: *On a stochastic process modelling nucleation and growth.* First Nordic-Russian Symposium on Stochastics, Helsinki, August 14 – 16, 1996.

Lars Holst: *Noblesseproblemet.* Seminar at the Department of Statistics, Stockholm University, October 16, 1996.

Lars Holst: *Noblesseproblemet.* Seminar at the Department of Mathematical Statistics, Lund University, January 31, 1997.

Lars Holst: *En stokastisk modell för DNA-delning och kristalltillväxt.* Seminar at the Department of Mathematics, Chalmers University of Technology and Göteborg University, February 14, 1997.

Timo Koski: *On the Wold isomorphism and Wold decomposition for prediction of cyclostationary sequences.* Workshop on Cyclostationary Processes, Université Marne de la Vallée, Paris, July 1996.

Timo Koski: *Predictive identification of binary vectors.* 4th World Congress of the Bernoulli Society, Vienna, August 26 – 31, 1996.

Timo Koski: *Predictive identification of binary vectors.* First Nordic-Russian Symposium on Stochastics, Helsinki, August 14 – 16, 1996.

Timo Koski: *Wold isomorphism for cyclostationary sequences.* 50th Anniversary Conference of the Department of Statistics, University of North Carolina, October 1996.

Timo Koski: *Wold isomorphism for time series.* Seminar at the Department of Mathematics, Hampton University, Virginia, October 1996.

Timo Koski: *Predictive diagnostic taxonomies.* Seminar at the Department of Mathematics, Chalmers University of Technology and Göteborg University, November 1996.

Timo Koski: *Probabilistic methods of numerical taxonomy.* Seminar at the Department of Mathematics, University of Helsinki, December 1996.

Timo Koski: *Statistiska metoder för klassificering av multivariata binära data.* Seminar at the Department of Statistics, Stockholm University, April 1997.

Timo Koski: *Bayesian predictive self-organizing classifiers.* Seminar at the Department of Numerical Analysis and Computing Science, KTH, June 4, 1997.

Timo Koski: *Bayesian predictive identification.* Invited lecture at the 1997 Conference of the Classification Society of North America, Washington D.C., June 14, 1997.

Timo Koski: *On unsupervised learning.* Seminar at the Department of Statistics, University of North Carolina, Chapel Hill, June 18, 1997.

Mikael Raab: *Compound Poisson approximation of the number of extreme points in a stationary Gaussian sequence.* First Nordic-Russian Symposium on Stochastics, Helsinki, August 14 – 16, 1996.

Mikael Raab: *Compound Poisson approximation of the number of extreme points in a stationary Gaussian sequence.* 16th Nordic Conference on Mathematical Statistics, Lahti, August 18 – 22, 1996.

Mikael Raab: *Approximation av fördelningen för antalet extrema värden i en tidsserie.* Svenska Statistikersamfundets årsmöte, Örebro, October 16, 1996.

7. Conferences, guest researchers, etc.

Josefin Bodell, Torkel Erhardsson, Jan Grandell, Lars Holst, Timo Koski and **Mikael Raab** participated in the First Nordic-Russian Symposium on Stochastics, Helsinki, August 14 – 16, 1996.

Josefin Bodell and **Mikael Raab** participated in the 16th Nordic Conference on Mathematical Statistics, Lahti, August 18 – 22, 1996.

Boualem Djehiche was guest researcher at the Department of Mathematics, University of Nijmegen, the Netherlands, October 1996.

Boualem Djehiche and **Jan Grandell** participated in a Conference on Interplay between Financial and Insurance Mathematics, Aarhus, Denmark, February 1997.

Boualem Djehiche was invited speaker at the International Conference on Probability and Stochastic Processes, Marrakech, Marocco, June 25 – 28, 1997.

Torkel Erhardsson and **Timo Koski** participated in the 4th World Congress of the Bernoulli Society, Vienna, August 26 – 31, 1996.

Timo Koski participated in the Workshop on Cyclostationary Processes, Université Marne de la Vallée, Paris, July 1996.

Timo Koski was guest researcher at the Department of Mathematics, University of Turku, (Turun Yliopisto), September – December 1996, supported by the Academy of Finland.

Timo Koski participated in the 50th Anniversary Conference of the Department of Statistics, University of North Carolina, October 1996.

Timo Koski participated in the 1997 Conference of the Classification Society of North America, Washington D.C., June 1997.

Mikael Raab participated in Svenska Statistikersamfundets årsmöte, Örebro, October 16, 1996.

8. Other activities

Boualem Djehiche was opponent for a licentiate thesis by Staffan Wrigge at the Institute of Actuarial Mathematics and Mathematical Statistics at Stockholm University, March 11, 1997.

Boualem Djehiche was a member of the thesis committee (betygsnämnd) at the disputation for doctoral degree of Josefin Bodell, Department of Mathematics, KTH, May 30, 1997.

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 and Probability Theory and Related Fields.

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.

Lars Holst is Dean (dekanus) of the School of Engineering Physics at KTH. He is also chairman of "Fakultetsnämnden" and "Tjänsteförslagsnämnden" at the School of Engineering Physics at KTH.

Lars Holst is a member of "Ledningsgruppen" at KTH.

Lars Holst is a member of the Bernoulli Society European Regional Committee 1992 – 1996.

Lars Holst has been involved in the evaluation of research proposals to International Science Foundation, USA, and Australian Research Council.

Lars Holst is a regular reviewer for Mathematical Reviews and Zentralblatt fur Mathematik. He has been a referee for a number of papers submitted to Journal of Mathematical Analysis and Applications, Applied Probability, and Stochastic Processes and Their Applications.

Lars Holst was thesis advisor (handledare) for Mikael Raab (disputation for doctoral degree on January 24, 1997) and Josefin Bodell (disputation for doctoral degree on May 30, 1997).

Lars Holst was expert (sakkunnig) for positions as senior lecturer at Chalmers University of Technology, Linköping University, and Mälardalen University.

Timo Koski is a referee for Scandinavian Actuarial Journal.

Timo Koski was expert (sakkunnig) for a position as senior lecturer in Mathematical Statistics at Lund University.

Timo Koski was a member of the thesis committee (betygsnämnd) at the disputation for doctoral degree of Erik Agrell, Department of Information Theory, Chalmers University of Technology, April 1997.