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Activity Report

July 1, 1998 – June 30, 1999

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, probabilistic bioinformatics.
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 students:	**Anna Carlsund,** FM. **Per Hallberg,** civiling. (From May 1, 1999) **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. Fractional stochastic partial differential equations

Research leader
Boualem Djehiche.

Keywords
Fractional Brownian motion, long-range dependence, stable processes.

Project description
This project addresses the problem of existence, uniqueness and regularity of solutions to stochastic partial differential equations driven by fractional white noise and fraction differential operators responsible for the spatial motion. These solutions arise as high density limits of particle systems with long-range dependence.

2.2. 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.

2.3. 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.

2.4. Stable distributions

Research leader

Lars Holst.

Scientist

Lennart Bondesson (Uppsala University and Umeå University).

Project description

Studies of convergence to stable distributions using Laplace transforms.

2.5. 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.

2.6. Random walks and Brownian motions

Research leader

Lars Holst.

Scientists

Anna Carlsund and Andreas Lindell.

Keywords

Random walk, Brownian motion, diffusion and birth-and-death processes.

Project description
Calculations of probability distributions connected with simple random walks and birth-and-death processes; comparison with approximations based on diffusion processes related to Brownian motion; finding probability distributions of functionals of certain diffusions by weak convergence of random walks.

2.7. 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 programs of the Royal Institute of Technology (KTH), except at the Program of Architecture; in all ten courses. The following courses have been given:

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

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

5B1504 Mathematical Statistics for the Program of Electrical Engineering.

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

5B1538 Reliability Theory.

5B1540 Probability Theory.

5B1545 Time Series Analysis.

5B1550 Applied Mathematical Statistics.

5B1555 Computer Intensive Methods in Mathematical Statistics.

5B1570 Martingales and Stochastic Integrals.

The first four courses are basic courses for the different programs of KTH. The last six courses are upper level 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 in cooperation 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. Graduate courses

Lars Holst gave the course 5B5502 *Convergence of Probability Measures.*

Timo Koski gave the course 5B5505 *Hidden Markov Models with Applications to Bioinformatics.*

3.3. Master theses (Examensarbeten)

Gustaf Sahlström: *Simuleringsmetoder vid driftsäkerhetsberäkningar — särskilt för armésystem.* October 1998.

Mattias Andersson: *Modelling Long-Term Capital Markets.* December 1998.

Marita Dellcrantz: *Reliability Model for Transformers.* January 1999.

Anders Larnholt: *An Alternative Approach to Estimating Default Probabilities in Credit Risks.* March 1999.

Per Edholm: *Data Envelopment Analysis of SAS Promotional Activities to Attract Tourist Travelers.* March 1999.

Peter Ekh: *Value at Risk — Beräkningar på en derivatfond.* March 1999.

Per Hallberg: *On the coverage time of a point in a one-dimensional growth process.* March 1999.

Henrik Lasu: *Kvantifiering av kreditriskpremien i räntebärande tillgångar.* April 1999.

Lennart Enström: *Multispreads.* June 1999.

Fredrik Ullvin: *How to Succeed with an Audit — A Comparison between Quality System Audit Models.* June 1999.

4. Publications

4.1. Published papers

Boualem Djehiche, M'hamed Eddahbi: Large Deviations for a Stochastic Volterra-Type Equation in the Besov-Orlicz Space. *Stoch. Proc. Appl.,* Vol. 81 (1999), 39 – 72.

Boualem Djehiche, Ingemar Kaj: A Sample Path Large Deviations Principle for L^2-Martingale-Measure Processes. *Bull. Scien. Math.,* Vol. 123 (1999), 467 – 499.

Jan Grandell: Mixed Poisson Processes (in Russian). *Obozrenie prikladnoj i promyshlennoj matematiki,* Vol. 5 (1998), 44 – 65.

Lennart Bondesson, Lars Holst: Convergence to Stable Distributions using Laplace Transform. *Math. Scientist,* Vol. 23 (1998), 95 – 107.

K. S. Chong, R. Cowan, L. Holst: The Ruin Problem and Cover Times of Asymmetric Random Walks and Brownian Motions. *Adv. Appl. Probability,* Vol. 32, No. 1 (2000), (to appear).

T. Koski, M. Gyllenberg, H. G. Gyllenberg, T. Lund: Bayesian Predictive Identification and Cumulative Classification of Bacteria. *Bulletin of Mathematical Biology,* Vol. 61 (1999), 85 – 111.

T. Koski, H. G. Gyllenberg, T. Lund, J. Schindler: An Assessment of Cumulative Classification. *Quantitative Microbiology,* Vol. 1 (1999), 7 – 20.

T. Koski, H. G. Gyllenberg, T. Lund, J. Schindler: Enterobacteriaceae Taxonomy Approached by Minimization of Stochastic Complexity. *Quantitative Microbiology* (to appear).

Mikael Raab: Compound Poisson Approximation of the Number of Exceedances in Gaussian Sequences. *Extremes,* Vol. 1 (1998), 295 – 321.

4.2. Technical reports and preprints

Mats Gyllenberg, Timo Koski: *Bayesian Predictiveness and Exchangeability in Classification.* TRITA-MAT-1998-MS-02, December 1998.

4.3. Lecture notes

Timo Koski: *Hidden Markov Models and Probabilistic Learning with Applications to Bioinformatics.* University of Turku, Institute of Applied Mathematics, Lecture Notes C10, May 1999.

5. Seminars

1998

Sept. 21. **Lars Holst:** *Om exkursionslängder hos slumpvandringar och Brownska rörelser.*

Sept. 28. **Torbjörn Thedéen,** Centre for Safety Research, KTH: *Prognoser i Sveriges Televisions valvaka.*

Oct. 5. **Gustaf Sahlström:** Presentation of Master thesis: *Simuleringsmetoder vid driftsäkerhetsberäkningar — särskilt för armésystem.*

Oct. 12. **Lars Holst:** *Om exkursionslängder hos slumpvandringar och Brownska rörelser (fortsättning).*

Oct. 26. **Lars Holst:** *Om exkursionslängder hos slumpvandringar och Brownska rörelser (fortsättning).*

Nov. 2. **Mike Keane,** Centrum voor Wiskunde en Informatica, Amsterdam: *Random coin tossing.*

Dec. 7. **Mattias Andersson:** Presentation of Master thesis: *Modelling Long-Term Capital Markets.*

1999

Jan. 15. **Marita Dellcrantz:** Presentation of Master thesis: *Reliability Model for Transformers.*

Jan. 18. **Lars Holst:** *Om exkursionslängder i en Brownsk brygga.*

Febr. 1. **Lars Holst:** *Om träd, slumpvandringar och förgreningsprocesser.*

Febr. 8. **Tommy Norberg,** Chalmers University of Technology, Göteborg: *Om restaurerandet av partiellt observerade geologiska konfigurationer.*

Febr. 15. **Marianne Månsson,** Chalmers University of Technology, Göteborg: *Approximation av antal kluster av slumpmässiga punkter.*

Febr. 22. **Cătălin Stărică,** The Wharton School, Philadelphia, and Chalmers University of Technology, Göteborg: *Change of structure in financial time series, long range dependence and the GARCH model.*

March 1. **Martin Jacobsen,** University of Copenhagen: *Discretely observed diffusions: classes of estimating functions and small* Δ*-optimality.*

March 4. **Anders Larnholt:** Presentation of Master thesis: *An Alternative Approach to Estimating Default Probabilities in Credit Risks.*

March 10. **Per Edholm:** Presentation of Master thesis: *Data Envelopment Analysis of SAS Promotional Activities to Attract Tourist Travelers.*

March 15. **Peter Ekh:** Presentation of Master thesis: *Value at Risk — Beräkningar på en derivatfond.*

March 22. **Olle Häggström,** Chalmers University of Technology, Göteborg: *Percolation and ferromagnetism on* $\mathbf{Z}^2$.

March 26. **Per Hallberg:** Presentation of Master thesis: *On the coverage time of a point in a one-dimensional growth process.*

April 12. **Timo Teräsvirta,** Stockholm School of Economics: *Modelling volatility.*

April 19. **Laurent Decreusefond,** Paris: *A functional central limit theorem for fractional Brownian motion.*

April 22. **Henrik Lasu:** Presentation of Master thesis: *Kvantifiering av kreditriskpremien i räntebärande tillgångar.*

May 3. **Timo Koski:** *Maximum-likelihood-skattningar av evolutionära träd.*

May 17. **Ola Hössjer,** Lund: *Betingad bootstrap och modellval.*

May 27. **Hermann Thorisson,** University of Iceland: *Taboo stationarity.*

May 31. **Timo Teräsvirta,** Stockholm School of Economics: *Modelling volatility (continuation).*

June 7. **Lennart Enström:** Presentation of Master thesis: *Multispreads.*

6. Presentations by staff

Boualem Djehiche: *Hedging options in market models modulated by fractional Brownian motion.* Seminar at the Centre for Analytic Finance, Aarhus, March 1999.

Boualem Djehiche: *Large deviations for a class of hyperbolic stochastic partial differential equations in Besov-Orlicz norm.* Seminar at the Department of Mathematical Statistics, University of Copenhagen, April 1999.

Jan Grandell: *Simple approximations of ruin probabilities.* Seminar at the Laboratory of Actuarial Mathematics, University of Copenhagen, October 20, 1998.

Jan Grandell: *Simple approximations of ruin probabilities.* Conference about "Rare events", Jurmala, Latvia, June 29, 1999.

Lars Holst: *On the cover time of a random walk on a circle.* Seminar at the Department of Mathematical Statistics, Chalmers University of Technology, Göteborg, September 17, 1998.

Lars Holst: *The "Noblesse" problem.* The Lunteren Meeting, Holland, November 19, 1998.

Lars Holst: *The longest lucky period.* The Lunteren Meeting, Holland, November 20, 1998.

Lars Holst: *On the occupancy problem.* Symposium on Branching Processes in honour of Boris A. Sevastyanov, Chalmers University of Technology, Göteborg, May 6, 1999.

Timo Koski: *Exchangeability and classification of bacteria.* ComBi-seminar at Virrat, Finland, September 5, 1998.

Timo Koski: *Hidden Markov models in computational biology.* Seminar at the Rolf Nevanlinna Institute (University of Helsinki), Helsinki, December 8, 1998.

Timo Koski: *The approximate common substring problem and Bayesian learning.* Seminar at the Swedish Institute of Computer Science (SICS), Stockholm, February 24, 1999.

Timo Koski: *De Finettis sats med tillämpningar.* Seminar at the Division of Mathematical Statistics, Linköping University, May 25, 1999.

Timo Koski: *Utbytbara processer och bakterieklassificering.* Stockholm-Uppsala Symposium on Mathematical Statistics, Stockholm University, May 26, 1999.

Timo Koski: *Bayesian predictive model for bacterial taxonomy.* Invited key note address at the Nordic Region Meeting of the International Biometric Society, Copenhagen, June 11, 1999.

Mikael Raab: *Optioner i praktiken.* Stockholm-Uppsala Symposium on Mathematical Statistics, Stockholm University, May 26, 1999.

7. Conferences, guest researchers, etc.

M'hamed Eddahbi, Cadi Ayyad University, Marrakech, was guest researcher at the Department of Mathematics during the fall term 1998.

Most of the staff participated in the Stockholm-Uppsala Symposium on Mathematical Statistics, Stockholm, May 26, 1999.

Anna Carlsund, Per Hallberg, and **Andreas Lindell** participated in the Summer School on Coupling Methods at Ellös, Sweden, June 13 – 19, 1999.

Boualem Djehiche participated in the Workshop on Queueing Networks at Lund University, October 1998.

Boualem Djehiche participated in the Workshop on Mathematical Finance at Humboldt University, Berlin, December 4 – 5, 1998.

Boualem Djehiche participated in the Workshop on Turbulence and Finance at MaPhySto, Aarhus University, May 5 – 7, 1999.

Jan Grandell participated in a conference about "Rare events" at Jurmala, Latvia, June 28 – July 3, 1999.

Lars Holst participated in the Workshop on Extreme Value Theory, Chalmers University of Technology, Göteborg, August 19 – 22, 1998.

Lars Holst participated in the Workshop on Telecommunication Theory, Lund, October 1 – 3, 1998.

Lars Holst participated in the Lunteren Meeting, Holland, November 16 – 20, 1998.

Lars Holst participated in the Symposium on Branching Processes in honour of Boris A. Sevastyanov, Chalmers University of Technology, Göteborg, May 6 – 7, 1999.

Lars Holst's sabbatical semester in the fall 1998 was spent at the Stochastic Centre, Department of Mathematical Statistics, Chalmers University of Technology, Göteborg.

Timo Koski participated in the ComBi-seminar at Virrat, Finland, September 1998.

Timo Koski participated in the Nordic Region Meeting of the International Biometric Society, Copenhagen, June 1999.

Timo Koski was organizer of a session in Classification Methods in the conference "Theory and Mathematics in Biology and Medicine", June 29 – July 3, 1999, Amsterdam.

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 a member of the examination committee (betygsnämnd) at a disputation for doctoral degree at the Department of Mathematical Statistics, Lund University, November 6, 1998.

Boualem Djehiche was a member of the examination committee (betygsnämnd) at a disputation for doctoral degree at the Department of Mathematical Statistics, Göteborg University, May 6, 1999.

Boualem Djehiche was opponent for a licentiate thesis at the Department of Mathematical Statistics, Uppsala University, November 25, 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.

Jan Enger is a member of the Committee on Quality of Jernkontoret.

Jan Enger is a member of the Six Sigma Steering Group at Ericsson.

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 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 is a referee for Applied Probability, for Statistics and Probability Letters, and for Scandinavian Journal of Statistics.

Lars Holst was a member of the evaluation committee for a position as "docent/ universitetslektor" in Mathematical Modelling with Applications in the Biosciences at Chalmers University of Technology, May 1999.

Timo Koski is a referee for Scandinavian Actuarial Journal.

Timo Koski was acting professor of Applied Mathematics at University of Turku during September – December 1998.