



KUNGL
TEKNISKA
HÖGSKOLAN

Activity Report
July 1, 2000 – June 30, 2001
Mathematical Statistics

Department of Mathematics
Royal Institute of Technology
SE-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:** **Jan Grandell**, FD. Main research areas: Point processes (Biträdande professor) and risk theory.
- Associate professor:** **Boualem Djehiche**, FD. Main research areas: Stochastic analysis, mathematical epidemiology, risk theory. (Universitetslektor, docent)
- Senior lecturers:** **Jan Enger**, FD. (Universitetslektorer) **Gunnar Englund**, TeknD. **Johan Irbäck**, FL.
- Researcher:** **Torkel Erhardsson**, TeknD. Main research areas: Rare events in stochastic processes, probability approximations with error bounds. (Forskarassistent)
- Senior tutors:** **Gunnar Karlsson**, civiling. (Universitetsadjunkter) **Göran Rundqvist**, FK.
- Senior tutor:** **Björn-Olof Skytt**, civiling. (Forskningsingenjör)
- Graduate students:** **Fredrik Armerin**, civiling. **Anna Carlsund**, FL. **Per Hallberg**, civiling. **Henrik Hult**, TeknL.

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.

Scientist

Henrik Hult.

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. Dependence in multivariate dynamic stochastic models

Research leader

Boualem Djehiche.

Scientist

Henrik Hult.

Keywords

Multivariate time series, copulas, dependence concepts, elliptical distributions.

Project description

Investigation of dependence structures and dependence concepts for multivariate dynamic stochastic models including multivariate financial time series.

2.3. Rare events in stochastic processes and distributional approximations

Research leader

Torkel Erhardsson.

Keywords

Rare events, approximation, error bound, Stein's method, coupling.

Project description

We study random quantities related to rare events in stochastic processes (first occurrence times of rare events, the total number of rare events, etc.), and look for distributional approximations with explicit error bounds for such quantities. We also develop mathematical tools for constructing distributional approximations with error bounds, using techniques like Stein's method and couplings.

2.4. 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.

2.5. Random walks, Brownian motions, and extreme-values

Research leader

Lars Holst.

Scientist

Anna Carlsund.

Keywords

Random walk, Brownian motion, birth-and-death processes, extreme-values.

Project description

Calculations of probability distributions connected with simple random walks and birth-and-death processes and comparison with approximations based on diffusion processes related to Brownian motion. Investigation of extreme-value distributions for certain problems in combinatorial and geometric probability.

2.6. Percolation

Research leaders

Lars Holst, Olle Häggström (CTH).

Scientist

Per Hallberg.

Keywords

Ising (Pott's) model, particle systems, phase transition, percolation.

Project description

Investigation of phase transitions and percolation in the Ising (Pott's) model for infinite particle systems and their connection with existence and uniqueness of limiting probability measures for such systems.

3. Education

3.1. Undergraduate courses

The Department of Mathematics gives undergraduate courses in mathematical statistics at most programs of the Royal Institute of Technology (KTH); in all ten courses. The following courses have been given:

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

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

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.

5B1570 Martingales and Stochastic Integrals.

5B1862 Stochastic Calculus and the Theory of Capital Markets.

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. Licentiate theses

Anna Carlsund: *Cover times and hitting times for certain random walks and birth-and-death processes.* September 2000.

Henrik Hult: *Approximating some Volterra type Stochastic Integrals with Applications to Parameter Estimation.* May 2001.

3.3. Master theses (Examensarbeten)

Andreas Mattsson: *Pricing Bermudan Swaptions Using Monte Carlo Simulation Approach.* September 2000.

Johan Tegin: *Statistical analysis of tunable semiconductor laser reliability data.* September 2000.

Torbjörn Uddevik: *Trading Rules for Dynamic Liability Management.* October 2000.

Otto Francke: *The Impact of Default Risk when Pricing American Bond Options Using the Jarrow-Turnbull Approach.* November 2000.

Per Wirsén: *The Impact of Default Risk when Pricing Bermudan Bond Options Using the Jarrow-Turnbull Approach.* November 2000.

Jon Lidfeldt: *Bunden — Värdering av en implicit ränteoption.* December 2000.

David Stillberger: *On Pricing Weather Derivatives.* February 2001.

Jens Carlsson: *An Approximation Formula for an Asian Option on a Foreign Equity Basket.* February 2001.

Camilla Hiertner: *The Dupire volatility model versus the stochastic volatility model for European call options.* March 2001.

Johan Stengård: *Dynamic Investment Policies for Property and Casualty Insurance Companies.* June 2001.

4. Publications

4.1. Published papers

A. Berkaoui, B. Djehiche, Y. Ouknine: Sur les grandes déviations en théorie de filtrage non linéaire. To appear in *Studia Mathematica*.

B. Djehiche, M. Eddahbi: Hedging options in market models modulated by fractional Brownian motion. To appear in *Stochastic Analysis and Applications*, Vol. 19 (2001), No. 5.

A. Dermoune, B. Djehiche: Pressure-less gas equations with viscosity and nonlinear diffusions. *C. R. Acad. Sci. Paris*, tome 332 (2001), série 1, pp. 745–750.

J. Wiström, G. Englund, et al.: Frequency of antibiotic-associated diarrhoea in 2462 antibiotic-treated hospitalized patients: a prospective study. *Journal of Antimicrobial Chemotherapy*, Vol. 47 (2001), pp. 43–50.

Torkel Erhardsson: On the number of lost customers in stationary loss systems in the light traffic case. *Queueing Systems: Theory and Applications*, Vol. 38 (2001), pp. 25–47.

Torkel Erhardsson: Refined distributional approximations for the uncovered set in the Johnson-Mehl model. To appear in *Stochastic Processes and their Applications* (2001).

Jan Grandell: Simple approximations of ruin probabilities. *Insurance: Mathematics and Economics*, Vol. 26 (2000), pp. 157–173.

Lars Holst: Extreme value distributions for random coupon collector and birthday problems. To appear in *Extremes*.

Johan Irbäck: Asymptotic theory for a risk process with a high dividend barrier. To appear in *Scandinavian Actuarial Journal*.

4.2. Technical reports and preprints

A. Dermoune, B. Djehiche: *Global solution of the pressure-less gas equations with viscosity*. Pub. IRMA, Lille, Vol. 54, II, 2001. Submitted for publication.

P. Alaton, B. Djehiche, D. Stillberger: *On Modelling and Pricing Weather Derivatives*. 2001. Submitted for publication.

Torkel Erhardsson: *Strong memoryless times and rare events in stationary Markov renewal processes*. TRITA-MAT-2001-MS-02, April 2001.

4.3. Lecture notes

Boualem Djehiche: *Stochastic calculus. An introduction with applications*. Department of Mathematics, KTH, 2000.

Boualem Djehiche: *Extremes. An overview with applications*. 2000.

5. Seminars

2000

Sept. 4. **Andreas Mattsson:** Presentation of Master thesis: *Pricing Bermudan Swaptions Using Monte Carlo Simulation Approach*.

Sept. 4. **Fredrik Åkesson,** Carnegie Mellon University: *Arbitrage bounds for volatility swaps (joint work with Bill Morokoff and Yi Zhou)*.

Sept. 11. **Lars Holst:** *Slutgiltiga korta beviset för Stirlings formel?*

Sept. 18. **Johan Tegin:** Presentation of Master thesis: *Statistical analysis of tunable semiconductor laser reliability data*.

Sept. 19. **Maria Deijfen,** Stockholm University: *Epidemier på sociala nätverk*.

- Sept. 26. **Anna Carlsund:** Presentation of Licentiate thesis: *Cover times and hitting times for certain random walks and birth-and-death processes.* Invited opponent: **Torgny Lindvall**, Chalmers University of Technology and Göteborg University.
- Oct. 2. **Fredrik Armerin:** *Credit risk.*
- Oct. 2. **Henrik Hult:** *A class of dynamic risk measures.*
- Oct. 9. **Lars Holst:** *Om tangent-, Euler- och Bernoullital.*
- Oct. 16. **Torbjörn Uddevik:** Presentation of Master thesis: *Trading Rules for Dynamic Liability Management.*
- Oct. 23. **Lars Holst:** *Bernoullital, Euler-Maclaurins summationsformel och Stirlings formel.*
- Oct. 30. **Gunnar Englund:** *Markov Chain Monte Carlo, contingency tables and Gröbner bases.*
- Nov. 6. **Torkel Erhardsson:** *Compound Poisson approximation for visits to rare sets by certain stationary Markov chains and renewal reward processes.*
- Nov. 13. **Otto Francke:** Presentation of Master thesis: *The Impact of Default Risk when Pricing American Bond Options Using the Jarrow-Turnbull Approach.*
- Nov. 13. **Per Wirsén:** Presentation of Master thesis: *The Impact of Default Risk when Pricing Bermudan Bond Options Using the Jarrow-Turnbull Approach.*
- Nov. 20. **Lars Svensson:** *On the use of Gröbner bases in mathematical statistics.*
- Nov. 24. **Ola Hammarlid**, Stockholm University: *Tillväxtoptimalt portföljval.*
- Dec. 4. **Dragi Anevski**, Lund Institute of Technology: *Skattning av ickeparametriska funktionaler, tillämpningar och asymptotik.*
- Dec. 8. **Fredrik Armerin:** *Prissättning av finansiella tillgångar.*
- Dec. 11. **Jon Lidfeldt:** Presentation of Master thesis: *Bunden — Värdering av en implicit ränteoption.*
- Dec. 18. **Timo Koski**, Linköping Institute of Technology: *EM-algoritmens egenskaper i beräkningsbiologi och i tillämpningar på modellbaserad klustring.*
- 2001**
- Jan. 15. **Lars Holst:** *Black-Merton-Scholes formel och enkel slumpvandring.*
- Febr. 26. **David Stillberger:** Presentation of Master thesis: *On Pricing Weather Derivatives.*
- Febr. 26. **Jens Carlsson:** Presentation of Master thesis: *An Approximation Formula for an Asian Option on a Foreign Equity Basket.*
- March 5. **Lars Holst:** *Om rekord och cykler i slumppermutationer.*

- March 12. **Camilla Hiertner:** Presentation of Master thesis: *The Dupire volatility model versus the stochastic volatility model for European call options.*
- March 19. **Per Hallberg:** *Perkolations i Ising- och beachmodellerna.*
- March 26. **Björn Palmgren,** Finansinspektionen: *Försäkringsderivat och andra modellfrågor i finansiell tillsyn.*
- March 30. **Anna Carlsund:** *Alarmsystem för smittsamma sjukdomar.*
- April 23. **Valentin Petrov,** St. Petersburg: *On the law of the iterated logarithm for sequences of independent random variables.*
- May 14. **Henrik Hult:** Presentation of Licentiate thesis: *Approximating some Volterra type Stochastic Integrals with Applications to Parameter Estimation.* Invited opponent: **Svante Janson,** Uppsala University.
- June 11. **Johan Stengård:** Presentation of Master thesis: *Dynamic Investment Policies for Property and Casualty Insurance Companies.*

6. Presentations by staff

Torkel Erhardsson: *Compound Poisson approximation for Markov chains using Stein's method and couplings.* Seminar at the Department of Mathematics, National University of Singapore, July 14, 2000.

Torkel Erhardsson: *Compound Poisson approximation for visits to rare sets by stationary Markov chains and renewal reward processes.* Seminar at the Department of Mathematics, Linköping University, April 4, 2001.

Torkel Erhardsson: *Compound Poisson approximation and rare events in stationary Markov and regenerative processes.* Stockholm-Uppsala Symposium on Mathematical Statistics, Uppsala University, June 6, 2001.

Jan Grandell: *Simple approximations of ruin probabilities.* Invited lecture at the International School on Mathematical and Statistical Applications in Economics, Mälardalen University, Västerås, January 15–19, 2001.

Per Hallberg: *The Ising model and percolation.* Stockholm-Uppsala Symposium on Mathematical Statistics, Uppsala University, June 6, 2001.

Lars Holst: *Stein-Chen's metod för Poissonapproximation.* Seminar at Uppsala University, November 1, 2000.

Lars Holst: *Stein-Chen's metod för Poissonapproximation.* Seminar at Linköping University, January 24, 2001.

Lars Holst: *On some problems for simple random walks.* Seminar at ETH, Zürich, January 31, 2001.

Lars Holst: *Om rekord och cykler i slump permutationer.* Seminar at Uppsala University, March 7, 2001.

Lars Holst: *Om rekord och cykler i slump permutationer.* Seminar at Chalmers University of Technology, Göteborg, March 22, 2001.

Lars Holst: *Stein-Chen's metod för Poissonapproximation*. Seminar at Umeå University, April 4, 2001.

Henrik Hult: *Approximating some Volterra type stochastic integrals with applications to parameter estimation*. Seminar at ETH, Zürich, February 13, 2001.

Henrik Hult: *Approximating some Volterra type stochastic integrals with applications to parameter estimation*. Workshop on Fractional Brownian Motion, Barcelona, February 15, 2001.

7. Conferences, guest researchers, etc.

Most of the staff participated in the Stockholm-Uppsala Symposium on Mathematical Statistics, Uppsala University, June 6, 2001.

Fredrik Armerin, Anna Carlsund, Per Hallberg, and Johan Irbäck participated in the Summer School on Hidden Markov Chain Models, organized by the Swedish Statistical Association (Svenska Statistikersamfundet), Vålådalen, Sweden, June 10–14, 2001.

Fredrik Armerin participated in the First World Congress of the Bachelier Finance Society, Paris, June 28 – July 1, 2000.

Fredrik Armerin participated in the Nagu/Nauvo Workshop in Mathematical Modelling in Finance and Telecommunication, Nagu, Finland, August 19–22, 2000.

Torkel Erhardsson was a guest researcher at the Department of Mathematics, National University of Singapore, July 11–24, 2000.

Lars Holst visited the Department of Applied Mathematics, Universität Zürich, January 29 – February 6, 2001.

Henrik Hult was a guest researcher at Risklab, ETH, Zürich, January 29 – April 30, 2001.

Henrik Hult participated in the Workshop on Fractional Brownian Motion, Barcelona, February 2001.

8. Other activities

Boualem Djehiche is a regular reviewer for Mathematical Reviews.

Boualem Djehiche is Swedish editor of Scandinavian Actuarial Journal.

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

Boualem Djehiche has a part-time position as Actuary with emphasis on asset and liability management at Skandia Liv, from January 1, 2001.

Boualem Djehiche is a member of a committee suggested by the Swedish Insurance Federation to work out premium calculation rules for life insurance policies for people susceptible to hereditary diseases, from February 4, 2001.

Boualem Djehiche is a member of a committee suggested by the Swedish Actuarial Society to work out a master program in Actuarial Mathematics, from June 7, 2000.

Boualem Djehiche organized a forum called “Finanskontakt”, bringing together undergraduate students and representatives of major banks and financial institutions in Sweden. This took place on September 27, 2000, with 140 participants.

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 AstraZeneca.

Torkel Erhardsson is a referee for Probability Theory and Related Fields, Random Structures and Algorithms, and Stochastic Processes and their Applications.

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 a regular reviewer for Mathematical Reviews and Zentralblatt für Mathematik. He is a referee for Annals of Probability, Annals of Applied Probability, Advances of Applied Probability, Probability Theory and Related Fields, and Statistics and Probability Letters.

Lars Holst has been involved in the evaluation of a promotion to professor at the University of Athens.

Lars Holst was a member of the evaluation committee for positions as university lecturer and researcher (forskarassistent) at Linköping University.

Lars Holst was a member of the PhD examination committees for Eva Sjö, LTH, September 8, 2000, and Per Enqvist, KTH, April 6, 2001.

Lars Holst is Chairman of the Swedish Statistical Association (Svenska Statistikersamfundet).