

EURANDOM

Annual Report 2007

EURANDOM is a European research institute for Statistics, Probability, Stochastic Operations Research and their Applications, founded June 30, 1997.



TU/e technische universiteit eindhoven

Mission statement

The mission of EURANDOM is to foster research in the stochastic sciences and their applications. It achieves this mission:

- by recruiting and training talented young researchers and helping them to find their way to tenured positions in academia and industry;
- by carrying out and facilitating research through postdoctoral and graduate appointments, visitor exchange and workshops;
- and by taking initiatives for collaborative research at the European level

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During the Annual Excursion 2006 EURANDOM people made a painting on canvas. Pieces of this painting can be found scattered throughout this Annual Report 2007.

1. INTRODUCTION

During much of 2007, there has been uncertainty regarding the funding of EURANDOM. Basic funding by both NWO (The Netherlands Organisation for Scientific Research) and the Board of Eindhoven University of Technology would end at the closing of 2007. A request for funding by the Ministry of OCW (Onderwijs, Cultuur en Wetenschap – the Dutch Ministry of Education, Culture and Science) had been filed in 2006, but late in 2007 no decision had yet been taken. Then, in November 2007, discussions between the Minister of OCW and a group of leading Dutch mathematicians led to the Minister's request to prepare a sector plan for Dutch mathematics, and all parties involved felt that a proposal for a stochastics cluster, centered around EURANDOM, should be part of such a sector plan. The stochastics cluster proposal had actually been written in early 2007, in a very constructive collaboration with researchers from Leiden University, the VU University, Amsterdam and CWI. It involves all the leading Dutch researchers in the areas of probability, statistics and stochastic operations research. The Minister of OCW subsequently decided that he would not separately fund EURANDOM, as the possible funding of EURANDOM should be part of a larger plan for Dutch mathematics.

In the meantime, EURANDOM had several discussions with the Board of Eindhoven University of Technology and with the Faculty Board of the Department of Mathematics and Computer Science of Eindhoven University of Technology about the future of EURANDOM. Fortunately, the Board of Eindhoven University of Technology and the Department of Mathematics and Computer Science of Eindhoven University of Technology very much treasure the strong scientific position of EURANDOM, and they have agreed to jointly support the institute - financially and in kind. For this a change in the formal organization was necessary, and on January 1, 2008 the institute has become embedded in the Department of Mathematics and Computer Science.

European Investment Bank

In 2007 EURANDOM signed a contract for the provision of a grant under the European Investment Bank University Research Sponsorship programme (EIBURS) on the topic 'Quantitative analysis and analytical methods to price securitization deals'. It involves (i) a research project on the quantitative modelling, analysis and assessment of important risks in ABSs, CLOs and other securitization deals; (ii) the organization of an annual workshop on the state-of-the-art, and on recent developments and new directions in the field of securitization; (iii) the embedding of seminars on the above topic into the running of the EURANDOM Multivariate Risk Modelling seminar series; and (iv) the organization of training sessions for EIB personnel related to Credit Risk Modelling and Securitization. The funding enables EURANDOM to set up an extensive visitor programme related to the research project (open for EIB personnel) and the employment of a postdoctoral researcher to be hosted at EURANDOM.

Scientific activities

Throughout the year, EURANDOM was bustling with scientific activities. 62 research reports were produced; we welcomed almost 50 visitors, some of them staying for several weeks or even months. We had a large number of research seminars, and also two long-running reading seminars devoted to Lévy processes and to Large Deviations, respectively. May 21, 2007 Peter van de Ven successfully defended his thesis *Equivalences in Design of Experiments* at the Eindhoven University of Technology.

EURANDOM attaches much importance to its workshop series. We consider this as an important service to the stochastics community. In 2007, we organized 13 workshops. Among them YEP IV: the fourth in a series of annual meetings organized by and for Young European Probabilists. The fact that these YEP meetings are so successful has led us to start an annual series of meetings with a similar format and scope in Queueing

Theory (YEQT) and Statistics (YES). The board of our university has agreed to support these meetings financially.

Next to the workshops, EURANDOM also organized a large conference: the 14th INFORMS Applied Probability Society conference (July 9-11, 2007), with 360 participants. It featured keynote lectures by Peter Glynn, Frank Kelly and Alain-Sol Sznitman, and tutorials by Maury Bramson, Paul Glasserman and Philippe Robert.

Scientific Council

The scientific council met on November 17, 2007. Members of the Scientific Council are appointed for three years but their appointment can be extended. This year we extended the appointment of Professors Dawson (chair), Borst, Frigessi, Green and Veraverbeke.

EURANDOM Chair

In September 2007 we welcomed Professor Roberto Fernández as EURANDOM chair. Roberto Fernández is Professor at the Laboratoire de Mathématiques Raphaël Salem CNRS, Université de Rouen. He is a leading expert in Gibbsian and non-Gibbsian states, cluster expansions and quantum lattice models. He is spending the academic year 2007-2008 in The Netherlands, working with researchers from the University of Groningen, Leiden University, Eindhoven University of Technology, Philips Research Eindhoven and EURANDOM.

Senior fellows

Remco van der Hofstad, senior fellow of RSS, has been awarded the 2007 Rollo Davidson Prize "for his work in probability and statistical mechanics". The Rollo Davidson Trust was founded in 1975 in memory of Rollo Davidson, an accomplished mathematician of remarkable potential, and Fellow-elect of Churchill College (Cambridge), who died on the Piz Bernina in 1970. The Trustees award an annual Prize for very talented young probabilists.

February 2, 2007, Michel Mandjes (QPA-senior fellow) gave his inaugural lecture at the University of Amsterdam. Title of his lecture: 'Nieuwe kansen' (New chances). May 10, 2007 Richard Boucherie (QPA-senior fellow) gave his inaugural lecture at the University of Twente. Title of his lecture: 'Het antwoord of de vraag' (The answer or the question).

Three new senior fellows joined the QPA-programme in 2007: Bas Werker of the University of Tilburg, working in the Multivariate Risk Modelling project, Nico Dellaert and Geert-Jan van Houtum. The latter two are both from the Eindhoven University of Technology, Department of Technology Management. They were appointed in the framework of an agreement between EURANDOM and the Department of Technology Management; four PhD students of that department will also spend part of their time in EURANDOM.

Frank Redig, one of the senior fellows of the RSS-programme, decided to stop his activities at EURANDOM. We gratefully acknowledge his contribution to the RSS-programme.

Alumni

At the beginning of 2007 we appointed six former EURANDOM postdocs as research fellow: Cristian Giardinà, Peter Grünwald, Bernd Heidergott, Johan van Leeuwen, Nelli Litvak and Francesca Nardi. Several alumni attended the 14th INFORMS Applied Probability Society conference, and we organized a dinner for the alumni on this occasion.

In 2008 we celebrate the 10th anniversary of the institute -- the first postdocs arrived in September, 1998. The celebrations include a conference on August 27 and 28. We hope to welcome many of our alumni, friends and colleagues on this occasion; and we hope that ongoing activities like the sector plan for mathematics and the integration in the Department of Mathematics and Computer Science of Eindhoven University of Technology will in the meantime lay the foundation for a healthy future of EURANDOM.



Prof.dr.ir. Onno Boxma
Scientific director EURANDOM
June 2008

2. THE INSTITUTE

- 2.1. Management
- 2.2. Scientific Council
- 2.3. Senior Fellows and Steering Committees
- 2.4. Scientific Staff
- 2.5. Administrative Support

2.1. Management

EURANDOM is a foundation with the mission to enhance scientific research in statistics, probability and stochastic operations research and its applications in Europe. To realise this goal the foundation has established a research institute with the same name.

The **Board** of the foundation consists of:

- Dr.ir. J.M.M. Ritzen (chair), until December 31, 2007;
- Professor dr.ir. C.J. van Duijn (member);
- Professor dr. F.A. van der Duyn Schouten (member).

Directors

- Professor dr.ir. O.J. Boxma (Eindhoven University of Technology & EURANDOM), scientific director;
- Drs. C.M.M. Cantrijn, managing director.

2.2. Scientific Council

EURANDOM has a Scientific Council, which advises the Board and the directors on the scientific programme and on strategic research issues. The following scientists serve as member of the Scientific Council:

- Professor S. Asmussen (Aarhus University, Sweden)
- Professor F. Baccelli (École Normale Supérieure, Paris, France)
- Professor J. Beirlant (KU Leuven, Belgium)
- Professor E. Bolthausen (University of Zürich, Switzerland)
- Professor S. Borst (Eindhoven University of Technology and Lucent, Murray Hill, USA)
- Professor D. Dawson - Chair (Carleton University, Ottawa & McGill University, Montreal, Canada)
- Professor F. Delbaen (Eidgenössische Technische Hochschule Zürich, Switzerland)
- Professor A. Frigessi (University of Oslo, Norway)
- Professor P. Green (University of Bristol, United Kingdom)
- Professor A. Greven (Friedrich-Alexander Universität, Erlangen-Nürnberg, Germany)
- Professor P. Hall (Australian National University, Canberra, Australia)
- Professor P. Massart (Université Paris Sud XI, Orsay, France)
- Professor V. Schmidt (Ulm University, Germany)
- Professor N. Veraverbeke (Hasselt University, Diepenbeek, Belgium)

The Scientific Council of EURANDOM met on November 17, 2007. Main item on the agenda: the state of affairs with regard to the future research structure of EURANDOM.

2.3. Senior Fellows and Steering Committees

The research of EURANDOM is structured according to three programmes. Each programme is led by senior scientists who supervise the programme and provide guidance to the research of the postdoctoral fellows (PDs) and graduate students (PhDs). The activities in each programme are overseen by an international steering committee.

Queueing and Performance Analysis (QPA)

Senior fellows

- Dr. I.J.B.F. Adan (Eindhoven University of Technology)
- Professor R.J. Boucherie (University of Twente)
- Professor O.J. Boxma (Eindhoven University of Technology)
- Dr. N.P. Dellaert (Eindhoven University of Technology) – since May 2007
- Professor G.J.A.N. van Houtum (Eindhoven University of Technology) – since May 2007
- Professor M.R.H. Mandjes (CWI & University of Amsterdam)
- Professor W. Schoutens (KU Leuven, Belgium)
- Professor J. Teugels (KU Leuven, Belgium)
- Professor B.J.M. Werker (Tilburg University) – since September 2007

Steering committee

- Professor F. Baccelli (École Normale Supérieure, Paris, France)
- Professor S.G. Foss (Heriot Watt University, Edinburgh, United Kingdom)
- Professor O. Kella (The Hebrew University of Jerusalem, Israel)
- Professor F.P. Kelly - Chair (Cambridge University, United Kingdom)
- Professor G. Koole (VU University, Amsterdam)
- Professor J. Wessels (Eindhoven University of Technology)

Random Spatial Structures (RSS)

Senior fellows

- Professor R. van der Hofstad (Eindhoven University of Technology)
- Professor W.Th.F. den Hollander (Leiden University)

Steering committee

- Professor E. Bolthausen (Universität Zürich, Switzerland)
- Professor A. Bovier (Weierstrass Institute for Applied Analysis and Stochastics, Berlin, Germany)
- Professor A.C.D. van Enter (Universiteit of Groningen)
- Professor G.R. Grimmett (University of Cambridge, United Kingdom)
- Professor C. Maes (KU Leuven, Belgium)
- Professor R.W.J. Meester (VU University, Amsterdam)
- Professor E. Olivieri (Università degli Studi di Roma 'Tor Vergata', Italy)
- Professor V. Sidoravicius (Instituto de Matemática Pura e Aplicada, Rio de Janeiro, Brasil)
- Professor J. Steif (Chalmers Tekniska Högskola, Gothenborg, Sweden)

Statistical Information and Modelling (SIM)

Senior fellows

- Dr. A. di Bucchianico (Eindhoven University of Technology)
- Professor P.L. Davies (Eindhoven University of Technology & Universität Duisburg-Essen, Germany)
- Professor R.D. Gill (Leiden University)
- Professor M.C.M. de Gunst (VU University, Amsterdam)
- Professor C.A.J. Klaassen (University of Amsterdam)
- Dr. M.N.M. van Lieshout (CWI, Amsterdam)

Steering committee

- Professor P. Donnelly (University of Oxford, United Kingdom)
- Professor U. Gather (Universität Dortmund, Germany)
- Professor P. Green (University of Bristol, United Kingdom)
- Professor M. Newby (City University, London, United Kingdom)
- Professor S. Tavaré (University of Southern California, Los Angeles, United States of America)
- Professor A. Tsybakov (Université Paris VI, France)

In addition to these programmes one project is running since the beginning of 2006:

Integrated Batteries (i-BAT)

Senior fellow

- Professor P.H.L. Notten (Philips Research Laboratories, Eindhoven, The Netherlands)

2.4. Scientific Staff

The junior scientific staff of EURANDOM consists of Postdocs (PDs) with appointments from 6 months up to 2-3 years; PhD-students (PhDs) with appointments of 3-4 years and research fellows with part-time 1-year appointments.

During the year 25 junior researchers were (co-)financed by external funds, from which:

In natura (14):

- NWO-VIDI grant Professor R. van der Hofstad: 1 PD (until September 2007) via an appointment at the Department of Mathematics and Computer Science, Eindhoven University of Technology;
- NWO-VICI grant Professor R.J.W. Meester: 1 PhD via an appointment at the VU University, Amsterdam;
- NWO-Open Competition grant Professor W.Th.F. den Hollander: 1 PD via an appointment at Leiden University;
- NWO-Open Competition grant Dr. A. di Bucchianico: 1 PhD via an appointment at the Department of Mathematics and Computer Science, Eindhoven University of Technology (until July 2007);
- FWO grant Professor W. Schoutens: 1 PD (since December 2007) via an appointment at the KU Leuven, Belgium;
- Joint employment with KU Leuven: 1 PhD (since October 2007)
- Individual FWO grant: 1 PD (October–December 2007);
- 4 PhDs of the Department of Technology Management (since May 2007);
- 2 PhDs of the Department of Mathematics and Computer Science (since resp. September and December 2007);
- Philips contract: 1 PhD.

Industry (1):

- Philips-EET contract: 1 PD.

Other (10):

- Marie Curie Intra-European Fellowship: 1 PD;
- NWO-Open Competition grant Professor W.Th.F. den Hollander: 1 PD (until November 2007);
- BRICKS grant via Department of Mathematics and Computer Science, Eindhoven University of Technology: 1 PD;

- STW grant Dr. I.J.B.F. Adan (Department of Mathematics and Computer Science, Eindhoven University of Technology) and Dr.ir. L.F.P. Etman (Department of Technology Management, Eindhoven University of Technology): 1 PhD (September - November 2007);
- Joint employment with the Department of Mathematics and Computer Science and the Department of Technology Management, Eindhoven University of Technology: 1 PhD;
- Joint employment with the Department of Mathematics and Computer Science (Net-ReFound): 1 PD (since March 2007);
- Joint employment with CWI & Department of Mathematics and Computer Science: 1 PD (since May 2007);
- Joint employment with University of Amsterdam: 1 PhD (since August 2007).

On December 31, 2007, **27** researchers (PDs and PhDs) were working at EURANDOM, and 1 PhD was closely linked to the research at the institute, via the senior fellow Professor R. van der Hofstad.

Queueing and Performance Analysis

PDs

- Denis Denisov (until April 2007)
- Henrik Jönsson
- Brian Fralix (since March 2007)
- Andreas Löpker
- Vika Masol
- Balakrishna Prabhu (since May 2007)
- Vsevolod Shneer
- Joris Walraevens (October 2007-December 2007)

PhDs

- Paul Beekhuizen
- Marko Boon (since December 2007)
- Josine Bruin
- Çağdas Büyükkaramikli (since May 2007)
- Paul Frenken; visiting position (September-November 2007)
- Florence Guillaume (since October 2007)
- Jevgenijs Ivanovs (since August 2007)
- Gergely Mincsovcics (since May 2007)
- Ingrid Reijnen-Koens (since May 2007)
- Peter van de Ven (since September 2007)
- Ingrid Vliegen (since May 2007)

Research Fellows

- Bernd Heidergott (VU University, Amsterdam)
- Johan van Leeuwen (Eindhoven University of Technology)
- Nelli Litvak (University of Twente)

Random Spatial Structures

PDs

- Sébastien Blachère
- Dimitris Cheliotis (since September 2007)

- Mark Holmes (until September 2007)
- Wouter Kager
- Tobias Müller
- Nicolas Pétrélis
- Cristian Spitoni
- Maarten van Wieren (until September 2007)

PhD

- Anne Fey-den Boer
- Markus Heydenreich

Research Fellows

- Cristian Giardinà (Eindhoven University of Technology)
- Francesca Nardi (Eindhoven University of Technology)

Statistical Information and Modelling

PDs

- Ambedkar Dukkipati (since April 2007)
- Efang Kong (since January 2007)
- Guangming Pan (since June 2007)

PhDs

- Isaac Corro Ramos (until July 2007)
- Peter van de Ven (until March 2007)

Research Fellows

- Peter Grünwald (CWI Amsterdam)

IBAT

PD

- Dmitry Danilov

For details on the work of the researchers, see Chapter 3, Section 3.4.1. For more information about their publications, see Chapter 5, Section 5.1 and 5.2.

2.5. Administrative Support

- Mrs. M.E.J.G.H. (Marlies) Brangers - management assistant (0,9 fte)
- Mrs. L. (Lucienne) Coolen-van Will - workshop officer (0,8 fte)
- Drs. J.J. (Jonelleke) Kamperman - personnel officer and policy assistance (0,8 fte) – on maternity leave after September 2007
- Mrs. P.M. (Patty) Koorn - administrative officer (0,5 fte)
- Ms. E. (Elisa) Mariani - temporary personnel officer and policy assistance (0,8 fte) since September 2007

The scientific and administrative staff is appointed by the Eindhoven University of Technology and seconded to EURANDOM.

From Eindhoven University of Technology assistance was received in the following areas:

- Legal, social and financial administration of personnel - Department of Personnel Affairs;
- Financial administration of the organisational unit and of the foundation - Department of Economics and Financial Affairs;
- Housing (including heating, building services, etc.) - Department of Housing;
- Arranging for accommodation in the University Guest House - Student Service Centre;
- Support and advice on visa matters - Back-Office Personnel Department;
- Library services, especially from the Department of Mathematics and Computer Science;
- Installation and management of the EURANDOM computing facilities - Department ICT Services;
- Assistance with the organisation of workshops and conferences and printing services - Department of Internal Affairs.

During 2007 a total of 21,7 fte was employed by Eindhoven University of Technology - EURANDOM, including the scientific director, the managing director and the support staff.

In addition 17 senior scientists were associated with EURANDOM as senior fellow and 6 junior scientists were associated as research fellow.

In 2007 16 researchers started to work at EURANDOM, 7 researchers left EURANDOM.

3. RESEARCH PROGRAMMES

3.1. Queueing and Performance Analysis (QPA)

- 3.1.1. Summary of the research by members of the QPA group
- 3.1.2. Research activities
- 3.1.3. External contacts / cooperation

3.2. Random Spatial Structures (RSS)

- 3.2.1. Summary of the research by members of the RSS group
- 3.2.2. Research activities
- 3.2.3. External contacts / cooperation

3.3. Statistical Information and Modelling (SIM)

- 3.3.1. Summary of the research by members of the SIM group
- 3.3.2. Research activities
- 3.3.3. External contacts / cooperation

3.4. Integrated Batteries (λ -BAT)

- 3.4.1. Summary of the research by members of the λ -BAT group
- 3.4.2. External contacts / cooperation

The research description below is listed under the name of the principal investigator, but collaboration is the normal way of work at EURANDOM.

For details concerning the scientific results obtained, we refer to the publications of the researchers and to the EURANDOM report series. *See Chapter 5, Section 5.1. and 5.2.*

3.1. Queueing and Performance Analysis (QPA)

Senior fellows for this programme are Ivo Adan (Eindhoven University of Technology), Richard Boucherie (University of Twente), Onno Boxma (Eindhoven University of Technology), Nico Dellaert (Eindhoven University of Technology), Geert-Jan van Houtum (Eindhoven University of Technology), Michel Mandjes (CWI & University of Amsterdam), Wim Schoutens (KU Leuven), Jef Teugels (KU Leuven) and Bas Werker (Tilburg University).

The goal of this programme is to give a strong impetus to the analysis of queueing systems and their applicability to the performance analysis of computer, communication and production networks, and to the analysis of multivariate risk models. The programme consists of four themes:

- Queueing Theory
- Performance Analysis of Production Systems
- Performance Analysis of Communication Systems
- Multivariate Risk Modelling

Queueing phenomena occur in several real-life situations when resources (machines at a factory, elevators, telephone lines, traffic lights) cannot immediately render the amount or the kind of service required by their users. Similar congestion phenomena also arise at the byte level, in modern data-handling technologies (communication systems, computer networks); they are typically less visible but their effects at user level are usually not less serious. Such congestion phenomena are often very effectively studied by mathematical methods from queueing theory. Adopting the abstract terminology from queueing theory, the object of study is formulated as a network of service units with customers requir-

ing services at those units. The nature of the arrival and service processes is usually such that they have to be represented by stochastic processes. Accordingly, queueing theory is an area of applied probability theory and of stochastic operations research.

Queueing theory is an extremely active area of research. One of the key reasons for its strong viability is that, time and again, interesting new questions from, mainly, computer-communications and manufacturing give rise to new and challenging queueing problems. Much research is being triggered by the need to understand and control the behaviour of modern computer, communication and manufacturing systems, and thus to improve their design and performance.

Information and communication technology is a vital sector in today's world economy. The future development of this field strongly depends on contributions from mathematics. In the early stages of this development in the design of computer-communication systems, the emphasis was on functionality. In recent years quality of service has become the most important criterion, which is expressed in terms of performance and reliability of the systems in relation to telematics applications. Queueing networks also provide the models for the description of manufacturing systems and for the analysis of their performance and reliability aspects. These economically vital applications of queueing networks make this project of prime interest.

Multivariate Risk Modelling (MVR)

This new project lies at the interface of economics, finance and insurance. In the framework of a dynamic financial analysis, there is a strong need to investigate financial and economic issues that are relevant with respect to risk modelling.

The MVR-project will develop multivariate Lévy models that will be applied to different kinds of financial derivatives written on a portfolio of assets. These financial derivatives can be viewed as insurance / financial contracts, where the holder of the derivative receives protection against, from the holder's viewpoint, unfavourable events (e.g., default), in return for a premium (the price of the derivative).

The proposed project aims to exploit the close mathematical similarities between models and methods used in queueing theory and in insurance / risk analysis. It is part of the QPA programme that houses a vast expertise in queueing theory and in mathematical tools like Markov processes and Lévy processes. The project is being run in collaboration with the group of professors Wim Schoutens and Jef Teugels from the KU Leuven (Belgium).

The QPA programme keeps close ties with the Stochastic Operations Research group (SOR) at the Eindhoven University of Technology, Department of Mathematics and Computer Science and with the Operations, Planning, Accounting and Control group (OPAC) at the Eindhoven University of Technology, Department of Technology Management. Several members of these groups are involved in the activities of the project. There are also several interactions with researchers from the groups at the KU Leuven, CWI, Universities of Amsterdam and Twente, and the VU University, Amsterdam.

Former postdocs Bernd Heidergott, Johan van Leeuwen and Nelli Litvak are associated to the QPA programme as research fellows.

3.1.1. Summary of the research by members of the QPA group

Ivo Adan

Together with E. Tzenova, M. Mandjes (University of Amsterdam) and W. Scheinhardt (University of Twente) I. Adan continued to work on the asymptotics for networks of two fluid queues. Together with J. Vissers (Erasmus MC, Prisma) and N. Dellaert (Eindhoven University of Technology) he studied admission planning in hospitals taking into account stochastic length of stay at the IC and MC departments. Further, with V. Kulkarni (UNC) he worked on fluid risk models and with M. Haviv (University of Jerusalem) he continued to study the problem of conditional ages and residuals in an $M/G/1$ queue. Together with A. Economou and S. Kapodistria (University of Athens) he studied synchronized renegeing in queueing systems with vacations. Further, he worked on the problem of inventory rationing for a system with heterogeneous customer classes together with P. Enders, A. Scheller-Wolf (Carnegie-Mellon University) and G.J. van Houtum (Eindhoven University of Technology).

Paul Beekhuizen

P. Beekhuizen has been studying networks where multiple communication flows share a single resource. This study is motivated by networks on chips where multiple processors share a single memory. Such networks can be mathematically modelled as discrete-time networks consisting of multiple polling nodes employing the 1-limited service discipline. By utilising the structure induced by the discrete-time nature of such networks, it is possible to reduce them to single nodes, which allows one to apply existing approximations for mean performance measures.

Marko Boon

On December 1st, 2007, M. Boon started his PhD in the QPA group under the supervision of O. Boxma and I. Adan. His first topic of interest was a polling model with different priority levels within each queue. In particular, waiting time distributions of each customer class were studied.

Onno Boxma

- Various studies with EURANDOM researchers J. Bruin, B. Fralix, H. Jönsson, V. Shneer; please see their text;
- With visitor H. Albrecher: a study in which the relation between queueing and risk models is being exploited;
- With visitor S. Bar-Lev: queueing models for blood banks are being developed and analyzed;
- With visitor O. Kella, with R. Bekker (VU University Amsterdam) and/or senior fellow M. Mandjes: several studies on Lévy processes and queues, focusing on workloads in models with dependence between active periods and vacations;
- With visitor D. Perry: various exploratory studies on queueing models, with an emphasis on workload maxima and on models with restricted accessibility (regarding the latter topic, a paper with D. Perry, W. Stadje and S. Zacks was completed);
- With visitor U. Yechiali and with J. van der Wal, a polling model with batch gated service has been analyzed;
- With visiting PhD student A. Wierman and E. Winands: scheduling in polling systems.

Richard Boucherie

Research of R.J. Boucherie concentrated on mathematical models for health care systems, and wireless communications systems. For health care systems, hospital departments such as intensive care units, daycare and outpatient clinics have been studied to minimize the patient's waiting times. Research on wireless networks has focused on mathematical

models and algorithms for multi-hop ad-hoc networks such as typically occurring in emergency situations. Typical methods and techniques include a combination of networks of queues, and discrete mathematics.

Josine Bruin

Together with G.J. van Houtum and T. Tan, J. Bruin studied the fixed cycle strategy on multi-item production systems with switch-over times. Together with J. van der Wal, she obtained some results on a system with backlogged customers using a generating function approach. For lost sales, we used successive approximation to analyse this fixed cycle strategy and are now able to analyse the performance of the one step improvement approach with a simulation programme.

Çağdas Büyükkaramikli

Ç. Büyükkaramikli investigates the cost benefits of periodic capacity adjustment policies in a jobshop under a lead-time performance constraint. In the previous studies, under lead-time constraints, either the capacity is assumed constant, or the capacity adjustments can be done on a continuous basis. The performance characteristics (distribution of the sojourn time, of the number of jobs in the beginning of a period, etc.) of a single production unit under a periodic capacity adjustment policy are derived, and it is shown that capacity adjustment policies can lead to substantial cost savings due to the capacity usage.

Nico Dellaert

N. Dellaert worked on several health care topics, together with I. Adan, G. Mincsovcis, J. Vissers (EUR) and J. Jeunet (Paris Dauphine). Topics included the development of a platform for comparison of hospital admission systems, patient mix optimisation and stochastic dynamic nursing service budgeting. He also worked on several topics in the area of (human) capacity planning, such as integral capacity and inventory decision making (with S.D. Flapper and T. Tan), workload-dependent capacity control (with G. Mincsovcis) and on optimizing fixed and flexible labour force under a budget constraint (with G. Mincsovcis and J. Jeunet). Furthermore, he worked on several solution methods (like scatter search and particle swarm methods) for multi level lotsizing problems, together with Y. Han (NEU Shenyang).

Denis Denisov

Together with A. Dieker and V. Shneer, D. Denisov has finished a paper on large deviations probabilities for random walks. In this paper for a given one-dimensional random walk with a subexponential step-size distribution, they present a unifying theory to study the probabilities that the random walk exceeds a large value. They also investigate the stronger 'local' analogue, of these results. When specialized to the most important subclasses of subexponential distributions that have been studied in the literature, they reproduce known results. Importantly, they supplement these well-known theorems with new results.

Furthermore, together with V. Shneer he has finished their work on local asymptotics for the busy period of the M/G/1 queue. In this work they give a short derivation of these local asymptotics using an explicit formula for the distribution of the busy period.

Brian Fralix

Since arriving at EURANDOM, B. Fralix has been interested in various aspects of polling systems. Currently, he is interested in studying various properties of the sojourn time distribution of an arbitrary customer that arrives to a polling system, under different types of policies. He is also interested in finding probabilistic arguments that generate equations which can be used to estimate mean waiting times of customers in these systems as well.

He has also been interested in stochastic models that describe the movement of particles (be it particles on a circle, or customers in a queue), when this movement is further influenced by an outside environment process (typically a semi-Markov process).

Paul Frenken

For two months P. Frenken has been working at Eurandom. In this period he worked on an article about "Decomposition Algorithms with EPT based input: A Case Study in the Automobile Industry" which was also the subject of his Master thesis which was completed shortly before his presence at EURANDOM. Summarizing the content of the article: they proposed an algorithm that efficiently and accurately estimates the throughput and delay of a single-server tandem queue. A case study was performed to test the performance of the algorithm for an assembly line in the automobile industry. The performance of the algorithm is good. Currently the article is still in preparation. The other authors of the article are I. Adan, M. van Vuuren, S. Resing and F. Nijssse.

Florence Guillaume

F. Guillaume has worked on an extension of the Gaussian factor copula model to the class of Lévy factor copula models for the pricing of CDO-squared tranches. She has considered both a full Monte method and a Monte Carlo approximation which rests either on the multivariate normal approximation of the joint inner CDO loss distribution or on the multivariate Poisson approximation of the joint number of defaults affecting the inner CDOs. More particularly, she has implemented and compared the three approaches under the Gaussian factor copula and the shifted Gamma factor copula models for three particular dates characterised by a low, medium and high level of the quoted iTraxx and CDX index spreads. Currently, she is working on the Delta-hedging of CDO-squared tranches.

Geert-Jan van Houtum

G.J. van Houtum worked on the following research lines:

- Maintenance and availability management of capital goods, and in particular the control of spare parts and service tools, and the optimization of the use of lateral transshipments in spare parts networks (with I. Vliegen, I. Reijnen, A. van Wijk, P. Enders, A. Scheller-Wolf, I. Adan, T. Tan, and R. Boucherie);
- The effect of design decisions on life cycle costs of capital good, and in particular measurement of total life cycle costs and a study on the effect of component reliability on design and service costs (with K. Öner and G. Kiesmüller);
- The stochastic economic lot scheduling problem (with E. Winands and I. Adan);
- Multi-echelon production-inventory systems (with R. Güllü, M. Dogru, and A. de Kok).

Jevgenijs Ivanovs

J. Ivanovs started his PhD under supervision of O. Boxma and M. Mandjes in August 2007. The first research question concerned stationary distribution of a Markov modulated Lévy queue. This led to the analysis of a matrix cumulant generating function of a spectrally positive Markov additive process. Some progress has been made on the problem of the number of zeros of this function in the right-half complex plane.

Henrik Jönsson

Together with W. Schoutens, H. Jönsson has been working on two papers on pricing of single name credit derivatives using single sided jump models. The first paper is on exotic options on single name credit default swaps, the second on pricing of constant maturity credit default swaps. Both papers have been published as EURANDOM reports and are submitted to leading journals in the field.

H. Jönsson has also collaborated with O. Boxma and J. Resing (Department of Mathematics and Computer Science, Eindhoven University of Technology), and V. Shneer. In this project an alternating risk model with a constant barrier is studied.

Andreas Löpker

Investigation of different applied models in connection with Piecewise Deterministic Markov Processes. Together with J. van Leeuwen (Eindhoven University of Technology): Study of the window size process for the TCP Internet protocol, in particular analyzing the transient behavior and the asymptotics of hitting times. With D. Perry (University of Haifa, Israel): Study of the finite G/M/1 queue, focusing on new ways to find formulas for the distribution of the idle period. With W. Stadje (Osnabrück, Germany): Investigation of the asymptotic behavior of hitting times for growth collapse models. With B. Fralix and M. Holmes (EURANDOM): Study of a traffic model, where randomly arriving cars interact on a street with fixed length. During a visit of S. Thonhauser (Linz, Austria): Discussion of a risk process with dividend payments, where the dividend strategy depends on the time since the last claim occurred.

Michel Mandjes

Research of M. Mandjes concentrated on several topics in applied probability and queueing theory. There was a specific focus on Lévy-driven queues; their correlation structure was intensively analyzed, and generic Lévy-based queueing models were constructed and solved. Furthermore, attention was paid to a fluid-analysis of a bottleneck node in an ad-hoc network, both in the exponential and heavy-tailed case. A third branch of research concerns Gaussian queues, with emphasis on inversion formulas and characterization of the correlation structure.

Vika Masol

Together with W. Schoutens, V. Masol has been investigating Lévy base correlation (LBC) models for pricing and hedging synthetic CDOs tranches. The Lévy base correlation concept has been introduced and worked out for pricing models based on Gamma, IG and CMY distributions. Pricing and delta-hedging performance of a number of LBC models has been analysed and compared to the standard Gaussian model.

Gergely Mincsovics

G. Mincsovics is about to complete his PhD. The summary of his thesis gives a good overview of his past four years of work: A rising number of agencies provide companies the opportunity for supplementing their permanent capacities temporarily with contingent capacities to meet their uncertain, fluctuating demand. However, it has been still unclear, how the companies should manage contingent capacities, how the permanent capacity level should be set, and what value contingent capacities may bring to different situations. The thesis comprises of separate studies on the permanent-contingent capacity management encompassing different company situations in accordance with three types of systems distinguished in the operations management: production-to-stock, production-to-order, and services. The studies give an overview of the results obtained in all three fields, and address the questions above by means of mathematical modelling, analysis and computational experiments. Results are obtained concerning the optimal policies for the permanent and contingent capacity arguments as well as on the value of employing contingent capacities.

Balakrishna Prabhu

Together with R. Núñez Queija (CWI, Amsterdam), B. Prabhu has been investigating scaling laws for broadcast times in large-scale networks. They have shown that, depending on the level of cooperation between nodes, broadcast times scale either linearly or logarithmically with the number of nodes. Furthermore, together with O. Boxma, O. Kella

(Hebrew University of Jerusalem, Israel), and D. Perry (University of Haifa, Israel), he investigated the performance of queues with customer impatience and an adaptive arrival process. They have obtained the Laplace-Stieltjes transform of the joint stationary workload and arrival rate process. This work was initiated during the visit of O. Kella and D. Perry at EURANDOM in July 2007.

Ingrid Reijnen-Koens

I. Reijnen is studying the spare parts provisioning of a high-tech manufacturer in one geographical area. Installed machines are spread over the whole area and demands for spare parts are generated by machine failures. Each machine is assigned to a local warehouse, but spare parts may be provided from multiple local warehouses via lateral transshipments. However, the machine has to be reached within a specified service time window; otherwise an emergency shipment from a central warehouse is applied. For the resulting form of partial pooling, she develops an evaluation algorithm for the performance under given stock levels. This evaluation algorithm is used in a heuristic aimed at the minimization of total costs consisting of inventory holding, lateral transshipment, and emergency shipment costs.

Seva Shneer

Together with D. Denisov (Heriot-Watt University, Edinburgh) and T. Dieker (IBM T.J. Watson Research Center), V. Shneer has been investigating the big-jump domain of the large deviations for random walks in the case when the increments have an arbitrary subexponential distribution. He was also working with O. Boxma, H. Jönsson and J. Resing (Eindhoven University of Technology) on ruin probabilities in two types of alternating risk processes. The main research interests of V. Shneer are in stability and large deviations in different spatial stochastic systems. He is working on a variety of problems in this area, together with S. Borst (Eindhoven University of Technology), S. Foss (Heriot-Watt University, Edinburgh), M. Jonckheere (Eindhoven University of Technology) and P. van de Ven.

Jef Teugels and Wim Schoutens

The risks present in the credit risk market are huge. Typically it involves events (default) that occur with very low probability but that involve huge amounts of money (Enron's default involved more than 100 billion USD losses). Moreover, the products traded nowadays are of an unprecedented complexity. Nominally they are insurance against defaults, but they encourage greater gambles and credit expansion, which are moral hazards.

Fundamental mathematical models that realistically capture the necessary stylized features are for the moment still under development, but the market is already taking huge positions.

Recent figures of the International Swap and Derivatives Association indicate that the notional outstanding in this market has grown to over 26 trillion USD, with the last years a yearly growth of more than 100 percent. In comparison, the traditional equity (stock and indices) market "only" represents around 6.4 trillion USD. Warren Buffett has called credit derivatives "financial weapons of mass destruction". It is of utmost importance for financial institutions, regulators and the society that the essential and important risks in dealing with credit risk instruments and derivatives are thoroughly investigated.

There are essentially two well-accepted approaches for the modelling of credit risk. The first approach is a structural one, linking the occurrences of default directly with the firm's value behaviour. Default happens if the firm's value falls below a certain low threshold. The approach uses techniques and stochastic processes that are also used in equity modelling. The other approach is an intensity based approach where default happens exogenously. One models in a sense the stress on a company and defaults happens

at the jump time of a counting process driven by this (stochastic) stress or intensity process. The processes employed and techniques used in these settings are very related to interest rate and volatility modelling (positive mean-reverting processes).

Stylized features of financial data in a credit risk setting are non-normal (Gaussian) returns, heavy tailedness and very importantly jump dynamics. Defaults and credit risk are driven by shocks in the economy or individual firm. Modelling default risk without jump dynamics is not realistic and clearly severely underestimates the risks present. Therefore, standard models built out of Normal distributions, Brownian Motions and Gaussian copulas are not able of making a correct assessment of the risks involved.

In order to have a better and more realistic modelling in the credit and default products markets, more advanced modelling using jump processes is needed. These jump models (Lévy models) have been very successful in other fields in finance, like equity, interest rate and volatility modelling.

In order to be of practical use a model must allow for a fast pricing of standard liquid credit risk products (CDS, CDO, Index spreads). This is crucial for the calibration of the model on market data. Calibration algorithms return the best estimate of the model's parameters (representing the current market view of default probabilities and correlation). Numerical aspects and optimisation of computer code is of great importance. Once fast pricing and calibration algorithms are in place, one can price exotic credit risk products and portfolios by Monte-Carlo methods or other advanced numerical techniques. As such one obtains a series of tools for realistic assessment of the risk of credit derivatives.

The research carried out at EURANDOM involves:

- fast pricing and calibration on CDS data under firm's value or intensity models driven by jumps;
- the pricing of options on single name CDSs under jump models;
- modelling correlated spread dynamics of credit indices under tractable multivariate jump models;
- pricing and management of exotic credit index derivatives;
- assessing the gap risks in CPPI and CPDOs under jump dynamics;
- model and assess the important risks for the pricing, hedging and risk management of Collateralized Loan Obligations (CLOs) and a portfolio of Asset Backed Securities (ABSs).

Peter van de Ven

Together with S. Borst (Eindhoven University of Technology) and V. Shneer, P. van de Ven has been working on maxweight scheduling algorithms. They are particularly interested in the stability of such algorithms, and in the impact of various weights. The results can be applied to study wireless networks with fading.

Ingrid Vliegen

I. Vliegen studies algorithms to determine near-optimal stock levels for service tools. Together with G.J. van Houtum she developed an approximate evaluation algorithm that is accurate, and efficient for small problems. With A. Scheller-Wolf (CMU, Pittsburgh) and A. Busic (INRIA Grenoble-Rhone Alpes), she worked on bounds for the service level in the original model, and a new method for this was developed. Together with G.J. van Houtum, A. Scheller-Wolf and A. Busic, she started working on an optimization algorithm to determine near-optimal stock levels. With A. Kleingeld she started an empirical study to find the advantages and disadvantages of the use of tool kits in the field.

Joris Walraevens

J. Walraevens has mainly worked on the performance analysis of a GPS-type (Generalized Processor Sharing) queueing system (in cooperation with J. van Leeuwen and O. Boxma). This type of queues gives, in general, rise to a random walk on the two-dimensional lattice in the quarter plane. The stationary distribution can be found using the theory of (Rieman or Rieman-Hilbert) boundary value problems, but this solution requires considerable numerical efforts, including the numerical determination of a conformal mapping. Therefore we have followed an alternative, novel approach and have constructed a Power Series Approximation of the multivariate probability generating function of the buffer occupancies in a parameter of the system. This leads to approximations for, for example, the mean buffer occupancies, which are accurate and explicit in terms of the parameters of the system.

Bas Werker

B. Werker's research focuses on Mathematical Statistics and Empirical Finance. In the former field, Bas studies semiparametric methods, rank-based estimation, and copula models. With respect to the latter, emphasis is on long-term investing and market micro-structure modelling.

3.1.2. Research activities

Workshops and conferences

In 2007 QPA organized 6 workshops:

- April 16-17-18, 2007
Workshop Mathematical Methodologies for Operational Risk
- July 9-10-11, 2007
Applied Probability INFORMS Conference
- July 12, 2007
3^d Korea-Netherlands workshop on Queueing theory and its applications to telecommunications systems
- October 17-19, 2007
Workshop Queueing theory without limits: transient and asymptotic analysis
- November 15 & 16, 2007
Workshop E-Quality
- December 10 & 11, 2007
Workshop Multivariate Risk Management

See Chapter 6, Section 6.1 for more detailed information.

Lectures and Seminars

In 2007 QPA organized 33 lectures and seminars (QPA-MVR regular seminar, QPA Reading Seminar and QPA Max Plus seminar).

See Chapter 6, Section 6.2 for more detailed information.

EURANDOM visitors

In 2007 QPA hosted 16 visitors; altogether for 21 weeks.

See Chapter 6, Section 6.3 for more detailed information.

General remarks

Seva Shneer started working in March 2007 for the IST (Information Society Technologies) NetReFound (Network Research Foundations) project of the 6th EC Framework Programme. In March 2007 Brian Fralix started working at EURANDOM on polling systems. In May 2007 Balakrishna Prabhu joined EURANDOM in a joint project with CWI and Eindhoven University of Technology and four PhD-students of the Department of Technology Management of the Eindhoven University of Technology joined EURANDOM also in May 2007. In August 2007 Jevgenijs Ivanovs started to work at EURANDOM in a joint project with the University of Amsterdam. In September 2007 Florence Guillaume started her PhD research for the Multivariate Risk project in a joint appointment with the KU Leuven and Peter van de Ven started his PhD research for the NetReFound project. Paul Frenken worked two months for the STW project Effective Process Time (EPT). In the framework of an FWO grant Joris Walraevens worked three months at EURANDOM. In December 2007 Marko Boon started working as PhD at EURANDOM.

Denis Denisov is currently working at the School of Mathematical and Computer Sciences (Department Actuarial Mathematics and Statistics) of the Heriot-Watt University, Edinburgh, Scotland. He left EURANDOM in April 2007.

3.1.3. External contacts / cooperation

Internationally, the QPA programme maintains strong ties with the KU Leuven, in the MVR project.

It is also involved in an EC Network of Excellence (Euro-FGI), which gave rise to several visits to and from EURANDOM researchers, and some small funded projects, and participates in the EC research project IST (Information Society Technologies) NetReFound (Network Research Foundations). The objective of the NetReFound is to develop the theory, methods and algorithms suitable for the modelling, analysis and design of future telecommunication networks. The long-term goal is the theoretical understanding of the collective interaction of a multiplicity of communicating nodes beyond the boundaries posed by specific telecommunication standards. This will lead to a quantitative characterization of the fundamental performance limits of these systems and eventually to algorithms for achieving them. Envisioned paradigms can change the way we manage, operate and understand networks and foretell a deep impact in areas such as reliable information delivery, network resource sharing, efficient flow control, network monitoring and security. In order to understand and fully exploit the immense networking possibilities, novel research is needed that will lay foundations well beyond the currently existing communication network theory. The strategic objective of this project is to provide guidelines and visions for developing a Network Science that will result in a better understanding of how future complex networks will function. More importantly, it would provide clear and precise guidelines on how to better design and control networks. It will also build and optimize the components that will become the cornerstones of wireless networking technology in the next decades to come by developing the theoretical foundations of networking and designing the ways to achieve them. The ultimate objective of this proposal is to provide the necessary axioms, underlying theory and practical tools to achieve several orders of magnitude increase in network capacity.

Via J. Teugels, QPA is also involved in MATHFSS. The MATHFSS (Mathematics for Science and Society) project is a Support Action of the New and Emerging Science and Technology (NEST) programme of the European Commission (6th EC Framework Programme). The NEST programme aims at integrating and strengthening the European Research Area. The MATHFSS-project started in December 2005 and lasted for 2 years. It aimed to stimulate interaction between advanced research workers and to explore ways of training doctoral-level researchers in key areas where mathematics will have a newly prominent role in science and society. The MATHFSS project is a collaborative action of the Centre de Recerca Matemàtica (CRM) in Spain, the Emmy Noether Research Institute for Mathematics (ENI) in Israel, the European Institute for Statistics, Probability and Stochastic Operations Research (EURANDOM) in The Netherlands, and the Institut des Hautes Études Scientifiques (IHÉS) in France, promoted by the European Research Centres on Mathematics (ERCOM) committee of the European Mathematical Society.

Nationally, there are close ties with Philips, who funded a PhD position. Participation in BRICKS (Basic Research in Informatics for Creating the Knowledge Society) involved close cooperation with CWI and the University of Twente, and the funding of a postdoctoral fellowship.

Locally, there are many interactions with the Eindhoven University of Technology Department of Mathematics and Computer Science, the Department of Technology Management (with a jointly funded PhD student) and there are growing interactions with the Department of Mechanical Engineering. We also organized a reading seminar on Lévy processes, studying the book *Introductory Lectures on Fluctuations of Lévy processes with Applications* of A.E. Kyprianou and we started a problem session to informally discuss open problems and to stimulate interaction and cooperation between researchers.

See Chapter 3, Section 3.1.1, for more detailed information about the researchers and Chapter 5, Section 5.1 and 5.2 for more information about their publications.

3.2. Random Spatial Structures (RSS)

Senior fellows for this programme are Remco van der Hofstad (Eindhoven University of Technology) and Frank den Hollander (Leiden University).

The RSS-programme moves at the interface between probability theory and statistical physics. It focusses on the study of systems consisting of a large number of interacting random components. These components interact with each other and with their environment. Even when the interaction is local, such systems typically exhibit a complex global behaviour, with a long-range dependence resulting in anomalous fluctuations and phase transitions.

To mathematically understand these systems requires the use of powerful probabilistic ideas and techniques. The challenge is to introduce simple models, which serve as paradigms, and to unravel the complex "random spatial structures" arising in these models. Statistical physics provides the conceptual ideas, while probability theory provides the mathematical language and framework. The important challenge is to give a precise mathematical treatment of the physics that arises from the underlying complexity.

Mathematical statistical physics is currently going through a phase of rapid and exciting development. Some of the key items associated with interacting random systems are finally being understood at the mathematical level, such as critical exponents, surface fluctuations, non-Gibbsianess, and spin glass behaviour. Interacting random systems are recognised world-wide as being of primary scientific importance. Mathematical statistical

mechanics is widely known to foster interdisciplinary approaches and to provide expertise and training in analysing and modelling complex random processes.

The RSS-programme focuses on three themes:

- Critical phenomena
- Disordered media
- Combinatorial probability

In addition, the programme aims to extend towards applications in biology. Interacting random systems occur in a multitude of theoretical and applied settings. Examples are:

- Ising spins: magnetism
- Lattice gas dynamics: metastability
- Percolation: porous media
- Interacting diffusions: population dynamics
- Random graphs: communication networks
- Self-avoiding walk: polymers
- Sandpiles: self-organized criticality

Key techniques are:

- Gibbs theory, renormalization, conformal invariance, entropy production, hydrodynamic scaling
- Multi-scale analysis, large deviations, spectral theory
- Combinatorial inequalities, lace expansion, random graph theory.

There is a close interaction and collaboration with the probability and statistics group at the Eindhoven University of Technology Department of Mathematics and Computer Science. Most of the group members are active at EURANDOM. In addition, there is close contact with the group in stochastic operations research at EURANDOM and the department.

3.2.1. Summary of the research by members of the RSS-group

Sébastien Blachère

With F. den Hollander and J. Steif: "A crossover in bad configurations for Random Walk in Random Scenery" (study of the occurrence of configurations where the law of the color at the origin can be influenced by changing colors even after a large time). With P. Haïssinsky and P. Mathieu: "Asymptotic entropy and Green speed for random walks on countable groups" and "Harmonic measures versus quasiconformal measures for hyperbolic groups". Study of the Green metric on groups and its use for asymptotic properties of random walks.

Dmitris Cheliotis

D. Cheliotis has been working on three problems. The first is to prove a result in semiconductor physics, called Mott's law, in a way that will give more insight into the nature of the phenomenon. The plan is to do this by proving several conjectures that have been formulated by M. Michels and W. Pasveer from the Applied Physics Department of Eindhoven University of Technology. D. Cheliotis is consulting with Professor Michels.

The second has to do with the study of metastable behavior in Markov chains run on random polymer configurations. He is looking at this together with F. den Hollander.

The third is proving a large deviations result for the counting measure of a stationary process on the line that has a special structure. This process comes up in the study of diffusion in Brownian environment.

Anne Fey-den Boer

Together with R. Meester (VU University Amsterdam), and F. Redig (Leiden University), A. Fey-den Boer has completed a paper on stabilizability and percolation in the infinite volume sandpile model. The goal of this research is to explain self-organized criticality in the abelian sandpile model, in terms of a stabilizability phase transition. Furthermore, together with M. Dekking, A. Fey-den Boer has studied random boolean cellular automata in one dimension.

Remco van der Hofstad

R. van der Hofstad has worked on random graph theory, both for scale-free network models as well as for percolation type models on high-dimensional finite tori. On scale-free random graphs, his work focuses on distances in such graph, which quantify the 'small-world phenomenon', and on the degrees of such graphs.

An overview of this work is currently being prepared in the form of substantial lecture notes. For percolation models, his work focuses on the behavior of connected components close to criticality for high-dimensional models where mean-field behavior is to be expected.

Further problems are the investigation of the asymptotic behavior for several random walk problems, such as excited random walk and reinforced random walks. R. van der Hofstad also has several collaborations with electrical engineers, for example on the probabilistic aspects of digital-to-analog conversion.

Frank den Hollander

In 2007, F. den Hollander has been working on the following research topics:

- Intermittency in catalytic random media, with J. Gärtner (Berlin) and G. Maillard (EPFL, Switzerland)
- Copolymers in emulsions with N. Pétrelis
- Renormalization of hierarchically interacting two-type populations with D. Dawson (Ottawa), A. Greven (Erlangen), R. Sun and J. Swart (Prague)
- Random walk in random scenery with S. Blachère and J. Steif (Gothenburg)
- Quenched large deviation principle for words cut out randomly from a random sequence of letters with M. Birkner (Berlin) and A. Greven (Erlangen)
- Metastability for Kawasaki dynamics in large volumes at low density and low temperature with A. Bovier (Berlin), A. Gaudillière (Rome), F. Nardi (Eindhoven University of Technology), E. Olivieri (Rome), E. Scoppola (Rome) and C. Spitoni

Mark Holmes

M. Holmes studied the scaling limit of a particularly simple self-interacting random walk called the senile reinforced random walk. Together with R. van der Hofstad, he continued to study other self-interacting random walks and made some progress on monotonicity results, using the expansion technique that they developed in 2006. He also completed a paper based on work in his thesis, and with R. van der Hofstad and G. Slade he completed a short note, also based on work in his thesis.

Wouter Kager

Together with R. van der Hofstad and T. Müller, W. Kager has derived a local limit theorem for the critical random graph. He has also been investigating the roughness and symmetry of the front in gradient percolation, and is discussing these issues with P. Nolin.

Tobias Müller

In 2007 T. Müller was involved in (ongoing) joint work with W. Kager and R. van der Hofstad on the critical Erdos-Renyi random graph. He also worked on graph colouring (joint work with R. Kang and L. Addario-Berry) and the boundary of graphs (joint with A. Por and J.S. Sereni), and he obtained some results on random k-nearest neighbour percolation (a joint paper with R. Kang and L. Addario-Berry is in preparation).

Nicolas Pétrélis

Together with F. den Hollander, N. Pétrélis has completed their work on the supercritical regime of a copolymer in an emulsion. N. Pétrélis is currently working on the subcritical regime, which turns out to display very relevant physical phenomenon. Together with F. Caravenna he has submitted a paper concerning a polymer in a multi-interface medium. They started this work in April 2007 when N. Pétrélis visited the University of Padova and they finished it when F. Caravenna visited EURANDOM in October 2007.

Cristian Spitoni

In collaboration with A. Bovier (WIAS, Berlin) and F. den Hollander (Leiden University), C. Spitoni has been working on metastability in large volumes at low temperatures for both Ising spins subject to Glauber Dynamics, and lattice gas particles systems subject to Kawasaki dynamics.

With E.M. Cirillo (La Sapienza, Roma) and F. Nardi (Eindhoven University of Technology) he studied the problem of metastability for a stochastic dynamics with a parallel updating rule. Furthermore with A. Bovier (WIAS, Berlin) and F. Nardi (Eindhoven University of Technology) he is working on the sharp asymptotics for two models of probabilistic cellular automata.

Maarten van Wieren

Artificial life

The main goal of this research was to investigate the possibility and potential pitfalls of creating an artificial cell. Such a cell would constitute a spheroid membrane (lipid bilayer) with a set of self-replicating chemicals trapped inside. Providing such a cell from the outside with (high potential) building blocks that are small enough to pass through the membrane, the self-replicating set should generate membrane particles as a by-product while growing in volume. What happens as the cell grows depends solely on the properties of the membrane (given the environment). If the curvature is positive (with the tendency to bend inward) then the membrane will eventually form a neck between two or more compartments and split in two, resembling something like a primordial cell division.

A couple of strategies have been followed to investigate this construct. First of all a discrete model of a growing membrane was developed and this was simulated. For time- and energy-scales that would be typical of such a construct, stochastics are expected to form an important influence. Since it is hard to do analytical calculations in a stochastic setup, it was decided to do simulations. Results for a two dimensional version of the model were satisfying expectations, yielding insight in favorable temperatures and sizes. The next issue is to do such simulations in three dimensions, so that the more complex properties of the associated phase-diagram of shapes may be inspected in a stochastic and dynamic environment.

Secondly an analysis of growth trajectories in the phase-diagram of cell-shapes was done to determine typical size distributions of a potential real-world setup. Conclusion here is that it is impossible to have cells divide in approximately the same size as typical cells in nature do, rather a set of cells of varying size will emerge where some will be so big, that they will merely shoot off cells that are so small that they will osmotically explode as

they grow. The good news is however, that in the limit of infinitely many replications, the measure of such cells will be zero (since they effectively do not replicate).

Last of all, the discrete model used in the simulations has been simplified even more in order to allow for analysis of the metastability properties that are in play for a spontaneous, growth-driven cell division as portrayed above. The complexity that remained here however was still very big. The resulting model is like a low-temperature three-dimensional three-state Ising model with conservative dynamics and range two interaction... hardly an out-of-the-toolbox problem.

3.2.2. Research activities

Workshops and conferences

In 2007 RSS organized 4 workshops:

- March 19-23, 2007
Workshop YEP-IV (Young European Probabilists) 2007 *Random Graphs and Complex Networks*
- June 18-22, 2007
Workshop *Random Polymers*
- September 10-11-12-13, 2007
Workshop *Sandpile Models and Related Fields*
- November 2 & 3, 2007
BRG Meeting

See Chapter 6, Section 6.1, for more detailed information.

Lectures and seminars

In 2007 RSS organized 38 lectures and seminars (RSS regular seminar and RSS Reading seminar).

See Chapter 6, Section 6.2 for more detailed information.

EURANDOM visitors

In 2007 RSS hosted 26 visitors; altogether for 33 weeks.

See Chapter 6, Section 6.3 for more detailed information.

General remarks

In September 2007 Dimitris Cheliotis started working at EURANDOM. Maarten van Wieren and Mark Holmes left EURANDOM in September 2007. Maarten van Wieren is now working as a developer for risk management at the insurance company AEGON. Mark Holmes returned to his home country New-Zealand to start his new job as Lecturer of Statistics (Department of Statistics) at the University of Auckland.

3.2.3. External contacts / cooperation

The RSS-group continued to have intensive contacts with scientists in Germany, amongst others in the framework of the Dutch-German Bilateral Research Group (BRG) on "Mathematics of Random Spatial Models from Physics and Biology". The activities of the

group are funded by DFG and NWO. The group meets twice a year for a two-day workshop, during which progress on joint projects is reported. One of such meetings took place at EURANDOM this year.

In 2007 again a YEP (Young European Probabilist) workshop was organized, on "Random Graphs and Complex Networks". One of the regular meetings of the Bilateral Research group took place in Eindhoven (November 2007). Moreover, two workshops on "Random Polymers" and on "Sandpile Models" were organized, which drew a large number of senior and junior researchers.

Frank den Hollander chaired the ESF Scientific Programme "Random Dynamics in Spatially Extended Systems" (RDSES), which involved 13 European countries. This programme terminated in the Summer of 2007.

Roberto Fernández (EURANDOM chair) is EURANDOM Chair September – November 2007 and is for the remaining part of the academic year a guest of the RSS programme. In the Fall of 2007 he gave a series of lectures on "Fields and Processes: common framework and relations". He is also collaborating with colleagues in Groningen and Leiden.

See Chapter 3, Section 3.2.1, for more detailed information about the researchers and Chapter 5, Section 5.1 and 5.2 for more information about their publications.

3.3. Statistical Information and Modelling (SIM)

Senior fellows for this programme are: Laurie Davies (Universität Duisburg-Essen, Germany), Alessandro Di Bucchianico (Eindhoven University of Technology), Richard Gill (Leiden University), Mathisca de Gunst (VU University, Amsterdam), Chris Klaassen (University of Amsterdam) and Marie-Colette van Lieshout (CWI, Amsterdam).

Mathematical statistics is an indispensable tool in all fields of modern science. At EURANDOM we focus on themes from four areas presently undergoing vigorous development, and supplying major challenges to statistics and data-analysis: biology, computational learning, industry and quantum information. Each area presents its own unique types of problem, but the same fundamental ideas from theoretical statistics can be applied in all, giving insight and creating underlying links. The availability of huge amounts of data, having a complex stochastic structure depending on very many unknown parameters, calls for statistical modelling and analysis techniques having a different flavour from classical methodology. Despite modern computational power, the problems require a closer than ever intertwining of algorithms and theory: scientific ambition and the size and complexity of data grow faster than our ability to mechanically process those same data. Statistical optimality and computational feasibility cannot both be achieved at the same time; compromises need to be made and the guiding principles of classical statistical theory do not necessarily lead to useful solutions. Still, we need to capitalize more than ever on what we have learnt from classical statistical theory, and in particular from asymptotic (large sample) optimality theory.

The programme used to have three themes:

- Statistical Signal and Image Analysis
- Statistics in Biology
- Statistics in Industry

Due to vacancies and a shift in the programme in 2007 mainly the first theme showed activities.

Statistical Signal and Image Analysis

This project concentrates on signal extraction for time series, and on the analysis of two- and three dimensional images. The brains of human beings are excellently equipped for pattern recognition tasks. For a computer, however, such tasks are very hard indeed, and to date no automatic procedures exist that come even close to the performance of the human visual system. In an increasingly digital world, though, there is a great need for tools in this area that are semi-automatic and limit or guide human involvement, e.g. smart camera surveillance where the system raises the alert when unusual action occurs, fingerprint or iris scan identification at airports, visual search machines for the web, or computer assisted diagnosis based on medical scans. In all these applications, the main challenge is to describe the relevant semantic content of the image mathematically and to develop efficient and robust statistical learning algorithms to carry out the task at hand. The aim of the proposed project is to do exactly this, focusing on theoretical evaluation of the performance of procedures and algorithms by subjecting them to mathematical analysis.

The SIM programme runs in close collaboration with mathematical statisticians of the stochastics groups at VU University, Amsterdam, University of Amsterdam, Leiden University, Delft University of Technology and Eindhoven University of Technology.

Former postdoc Peter Grünwald was associated to the SIM programme as research fellow.

3.3.1. Summary of the research by members of the SIM group

Isaac Corro Ramos

Together with L. Hakobyan (Eindhoven University of Technology, LaQuSo) and under the supervision of K. van Hee and A. Di Bucchianico I. Corro Ramos used state machines to model software systems and they developed efficient testing strategies and stopping rules. In the first half of 2007 they presented part of their work at the PNSE07 workshop. They continued working on the software reliability tool project for the company Refis and they presented part of their work at the VVSS (Verification and Validation of Software Systems) 07 symposium.

Laurie Davies

L. Davies' research has been in the area of robust statistics, non-parametric regression and image analysis. In the area of robust statistics work has been done on the concept of breakdown point and its relationship to invariance under a group. Research in non-parametric regression has been done on the construction of honest, non-asymptotic and universal confidence sets with applications to the construction of honest confidence bounds under shape and smoothness restrictions. Further work in this area has been concerned with the non-parametric estimation of the drift and diffusion terms of a diffusion process and with the estimation of volatility and long term trends in financial data. In the area of image analysis, work has been done on inhomogeneous diffusion smoothing with the inhomogenities being controlled by means of a multiresolution analysis of the residuals.

Alessandro Di Bucchianico

A. Di Bucchianico worked on several topics in 2007. With P. van de Ven he initiated research on applying commutative harmonic analysis on finite groups to experimental design. They finished a technical report in which they provided rigorous proofs of the equivalence of several definitions of regular fractions of factorial designs. A visit of M. Viana (University of Chicago) was very helpful to get started on applying non-commutative harmonic analysis to more sophisticated designs for micro-array experiments.

In the NWO funded STRESS project, A. Di Bucchianico worked with K. van Hee (Eindhoven University of Technology, Department of Mathematics and Computer Science) and the PhD students I. Corro Ramos (Eindhoven University of Technology) and L. Hakobyan (Eindhoven University of Technology and LaQuSo) on statistical certification procedures based on Petri net models of software. A technical report was written on connectivity properties on SMWf nets, a subclass of Petri nets.

Together with I. Corro Ramos, A. Di Bucchianico also worked on black-box models for software reliability growth models. An R package together with a Java interface is being developed in collaboration with the Refis company. Together with Mrs. Brandt and Henzen from Refis, an invited paper on two software reliability case studies has been prepared for a special issue of the journal Quality Engineering.

Ambedkar Dukkipati

A. Dukkipati explored the possibility of describing maximum and minimum entropy (ME) models in the framework of algebraic statistics. He showed that describing ME-models with a system of polynomial equations and solving them with Grobner bases method has intrinsic computational advantages: by applying elimination theorems in commutative algebra he showed that once we estimate ME-distributions with respect to all features, enumerating all the ME-distributions with respect to every subset of the feature set involves no additional computations. Further he also established some connections between Toric ideals and maximum entropy models.

Together with P. Grünwald he tried to define a concept of "joint statistical games" to extend the generalizations of entropy based on statistical games to conditional cases.

Richard Gill

R. Gills research was concentrated on forensic statistics, in particular, statistical analysis of roster data as exemplified by the case of Lucia de B.

Mathisca de Gunst

M. de Gunst worked on several projects concerning stochastic modelling and statistical analysis of biological data. With O. Shcherbakova (Department of Mathematics, VU University, Amsterdam), research was continued on several mathematical issues concerning the asymptotic behaviour of Bayesian posteriors for hidden Markov models. This research is performed in the context of the statistical analysis of ion channel kinetics. A Bernstein-von Mises theorem for hidden Markov models was proved.

Another project, with G. Geeven (Department of Mathematics, VU University, Amsterdam), G. Smit and R. van Kesteren (Molecular and Cellular Neurobiology, VU University, Amsterdam), focuses on modelling the gene network underlying neuronal outgrowth. They continued with the combined statistical analysis of gene expression microarray data and genomic search data for transcription factor binding sites (tfbs). Several methods were investigated for establishing the relationships between the presence of tfbs and the regulation of specific groups of genes.

Research with R. Jansen (Department of Mathematics, VU University, Amsterdam), A. Brussaard and A. van Ooyen (Department of Experimental Neurophysiology, VU University, Amsterdam), concerned the analysis of spatio-temporal patterns in neuronal networks. Several analysis techniques were explored for their usefulness in the joint analysis of multi-electrode data from brain slices of genetically different mouse lines in vivo.

Efang Kong

Together with O. Linton (LSE) and Y. Xia, E. Kong finished the study the Uniform Bahadur representation for generalized M-regression models. The result on uniform rate is much more useful in practice than the pointwise one. This is illustrated by an application in generalized additive model.

Closely related to this topic, she has been working with Y. Xia on single-index quantile estimation. Presumably, this would be the first attempt to combine single-index model and M-regression. Furthermore, she also worked with C. Klaassen on modelling the connectivity of neurons for replay detection.

Chris Klaassen

A research project has been started up with E. Kong, Postdoc since January 2007, on neuron networks. There is collaboration with C. Pennartz, professor of neurobiology at University of Amsterdam, who also suggested the problem of studying replay. These data consist of so-called spike trains, sequences of the time points at which neurons fire. An attempt has been made to model the spike train data in a realistic way, as opposed to the traditional way of binning up the time axis.

In October 2007 C. Klaassen visited the computational biology group of M. Samsonova at the Center of Advanced Studies of St. Petersburg Polytechnical University in the framework of the ongoing research with former postdoc N. Lalam in modelling the gene regulatory network for the segmentation phase of the embryo of the *Drosophila Melanogaster*.

Marie-Colette van Lieshout

M.C. van Lieshout's research is concerned with image analysis and spatial statistics. In collaboration with T. Schreiber (Nicolaus Copernicus University, Poland) she studied a class of Gibbs - Markov random fields that can be understood as discrete versions of coloured polygonal fields built on regular tessellations with applications to foreground-background segmentation problems. In another project the use of Markov sequential object processes was advocated for tracking a variable number of moving objects through video frames with a view towards depth calculation. The approach was evaluated on a sport sequence obtained from Philips Research.

In spatial statistics, a preliminary study into edge corrected non-parametric intensity function estimators for heterogeneous Poisson point processes was carried out. It was shown that a non-parametric mass preserving estimator for the intensity function of a Poisson point process can be defined. The new estimator's (integrated) mean squared error was compared to that of the classic Berman-Diggle estimator.

Together with L. Davies, R. Duits (Eindhoven University of Technology) and G. Jongbloed (Delft University of Technology), a workshop on 'Algorithms in complex systems' was organized (24–26 September, 2007). M.C. van Lieshout also organized a section on 'Stochastic geometry' during the INFORMS conference in Eindhoven (9–11 July, 2007).

Guangming Pan

In June 2007, G. Pan started working at EURANDOM. He has been working on large dimensional random matrices. Specially speaking, he is mainly concerned with limiting theorems for large sample mean, sample covariance matrices and Hotelling's T square statistics.

Peter van de Ven (UK)

In the first months of 2007 P. van de Ven has written up the final part of his PhD thesis "Equivalences in Design of Experiments", which he successfully defended in May 2007. His thesis covers different topics dealing with factorial designs. The main results include a

proof for the equivalence of different definitions for regularity of fractions. In his thesis he also shows the equivalence of different methods for estimating the dispersion effects from unreplicated fractional factorial designs. A third topic that is covered in his thesis is the use of split-plot designs for efficiently analyzing two-step production processes.

3.3.2. Research activities

Workshops and conferences

In 2007 SIM organized 2 workshops:

- September 24-26, 2007
Workshop Algorithms in Complex Systems
- October 8-12, 2007
Workshop Shape Restricted Inference

See Chapter 6, Section 6.1 for more detailed information.

Lectures and seminars

In 2007 SIM co-organized 26 lectures and seminars (this includes the Informal meetings of Eindhoven Statisticians).

See Chapter 6, Section 6.2 for more detailed information

EURANDOM visitors

SIM hosted 3 visitors, altogether 10 weeks.

See Chapter 6, Section 6.3 for more detailed information.

General Remarks

Three new postdocs started in 2007 to work for the SIM programme: Efang Kong (January), Ambedkar Dukkipati (April) and Guangming Pan (June). Isaac Corro Ramos continued his research at the Eindhoven University of Technology and Peter van de Ven obtained his PhD thesis in March 2007. Peter van de Ven is working as Lecturer at the University of Southampton, United Kingdom.

3.3.3. External contacts / cooperation

EURANDOM did put a lot of effort in the EU FP6. Since December 1, 2003 the SIM programme participates in the Network of Excellence called PASCAL - Pattern Analysis, Statistical Modelling and Computational Learning. The project has been terminated end of 2007.

Apart from this EU Network the SIM group, together with people from the QPA-MVR group, also participates in the MATHFSS (Mathematics for Science and Society) project. See page 27 of this report.

The members of the SIM group have contacts with industrial partners, among others via the *i*BAT project with Philips. The researchers of the SIM programme also have several contacts with groups in life science in The Netherlands.

See Chapter 3, Section 3.3.1, for more detailed information about the researchers and Chapter 5, Section 5.1 and 5.2 for more information about their publications.

3.4. Integrated Batteries (*i*-BAT)

The *i*-BAT project is a cooperation of Philips Research Laboratories, Eindhoven University of Technology (Department of Chemical Engineering and Chemistry) and EURANDOM. Projectleader is Prof.dr. Peter Notten (Eindhoven University of Technology and Philips Research Laboratories).

Small rechargeable batteries are nowadays of crucial importance for our "portable" society. Examples of portable applications are mobile phones, laptop computers, telephones, digital cameras and wireless shavers. In addition, the use of rechargeable batteries will broaden towards, on the one hand, very large applications and, on the other hand, very small applications. The present success of the so-called *hybrid cars* is evidencing such successful large-scale application. On the other outer end of the "spectrum", small-sized integrated batteries are expected to become more and more important in our daily life to "feed" the numerous wireless *Autonomous devices*, which will control our future offices and houses. This new electronic revolution is generally denoted as *Ambient Intelligence* and is considered as the next challenging development in the so-called *Knowledge age*, which we entered only a few decades ago.

Characteristic for *Autonomous devices* is that these have to operate independently. This means that the energy supply must be guaranteed wirelessly. Evidently, rechargeable batteries will play a key role in these future devices. As the energy consumption will be rather small, this opens up the possibility to integrate all-solid-state rechargeable batteries, enabling a high degree of IC integration.

The contribution of EURANDOM will be in modelling and simulation using the knowledge built up in the previous Battery Modelling and Management project (BMM).

3.4.1. Summary of the research by members of the *i*-BAT project

Dmitry Danilov

Research activity of D. Danilov is performed in close cooperation with the members of electrochemical group of P. Notten and concentrates along two main directions. First one is a simulation of All-Solid-State planar and 3D integrated Li-ion batteries. In particular, large progress had been made in modelling of solid-state-electrolytes, which constitute an important part of integrated batteries. Second direction is simulation of gas-phase and electrochemical hydrogen storage in classical and advanced hydrid-forming alloys. Recently published kinetic models combine the ability to estimate rates of basic hydrogen storage reactions with a very precise description of the pressure-composition isotherms.

See Chapter 5, Section 5.1 and 5.2 for more information about their publications.

3.4.2. External contacts / cooperation

Through the senior fellow there is a close cooperation with Philips Research Laboratories.

4. EXAMPLE OF RESEARCH: Single Sided Jump Model For Credit Default Options H. Jönsson and W. Schoutens

1. Introduction

Credit Default Swaps (CDSs) have become in the last decennium very important instruments to deal with credit risk. These financial contracts are now available in quite liquid form on thousands of underliers and are traded daily in huge volume. A market has been formed dealing with options or derivatives on these CDSs. The market is for the moment quite illiquid, but is expected to gain in volume over the next years.

Credit risk modelling is about modelling losses. These losses are typically coming unexpectedly and triggered by shocks. So any process modelling the stochastic nature of losses should reasonably include jumps. The presence of jumps is even of greater importance if one deals with derivatives on CDSs, because of the leveraging effects. Jump processes have proven already their modelling abilities in other settings like equity and fixed income (see [8]) and have recently found their way into the credit risk modelling see for example [2] where different Lévy models (both firm value and intensity) for credit derivatives pricing were explored.

In this paper we review the results on the valuation of CDSs and (exotic) options on CDSs under single sided jump models presented in [5]. More precisely, we set up a fundamental firm-value model that allows for fast pricing of the 'vanillas' of the CDS derivative markets: payer and receiver swaptions. Moreover, we describe how a CDS spread simulator can be set up under this framework and illustrate its use for the pricing of exotic derivatives on single name CDSs as underliers.

2. Credit Default Swaps

The workhorse of the credit risk market is the Credit Default Swap (CDS), which admits risk transfer from one investor to another in exchange for premium payments. In more detail, an investor (B) is exposed to default risk on a reference entity. Investor B can buy protection against a default from investor S, the protection seller. This agreement is formalised in a credit default swap, where investor B agrees to periodically pay a premium to investor S (the so called *premium leg*) and investor S agrees to cover the loss given a default of the reference entity (the so called *protection leg*). The premium is paid until maturity or default, whichever occurs first. Illustration of the mechanics and cash flow of a CDS are given in Figure 1 and Figure 2.

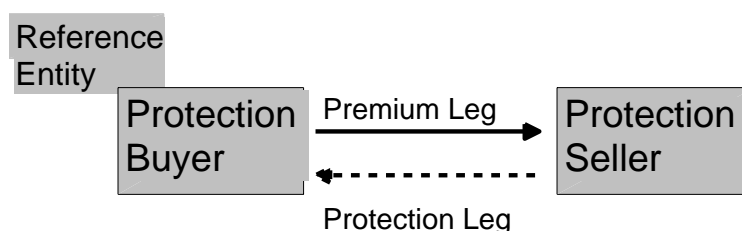


Figure 1. The mechanics of a Credit Default Swap.

The periodic premium is a fraction of the principal notional of the reference entity and is usually expressed as the spread of the CDS. We will assume through out the text that the principal notional is 1. At the time when the CDS is created the protection seller and buyer agree upon what is the fair spread to be paid. The fair spread is found using risk-neutral valuation such that the present value of the expected premium paid is equal to the present value of the expected loss given default.

If we assume that premiums are paid at moments t_1, \dots, t_M , where $t_M = T$ is the maturity of the CDS, and we also assume that default can only occur on these dates, then the present value of the premium leg at the contract date t_0 is

$$PV(\text{Premium Leg}) = S(t_0, T) \sum_{m=1}^M \Delta(t_{m-1}, t_m) d(t_0, t_m) P_{\text{surv}}(t_m),$$

where $S(t_0, T)$ is the spread in a yearly basis, $\Delta(t_{m-1}, t_m) = t_m - t_{m-1}$ is the time between two payment days (measured in years), $d(t_0, t_m)$ is the default-free discount factor and $P_{\text{surv}}(t)$ denotes the probability of survival, that is, probability of no default, until at least time t of the reference entity. Thus, each premium payment is multiplied with a discount factor to get the present value of the premium and with the probability that the payment actually takes place. The sum to the right in the above expression is usually referred to as the *risky annuity* and will be denoted by $PV01(t_0, T)$.

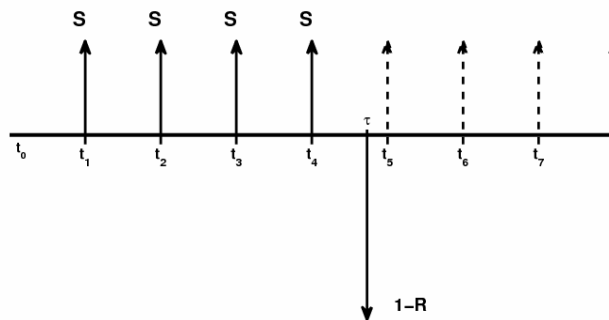


Figure 2. Cash flow of a credit default swap.

The present value of the protection leg is

$$PV(\text{Protection Leg}) = (1 - R) \sum_{m=1}^M d(t_0, t_m) P_{\text{def}}(t_m),$$

where R is the recovery rate of the entity and $P_{\text{def}}(t_m)$ is the probability of default at time t_m . The recovery rate is the value of reference entity after default expressed as a fraction of the principal value, for example, if the principal is 100 and the value after default is 40 then $R=40\%$.

Thus the fair spread at the contract date is such that

$$PV(\text{Premium Leg}) = PV(\text{Protection Leg}),$$

or, equivalently,

$$S(t_0, T) = \frac{(1 - R) \sum_{m=1}^M d(t_0, t_m) P_{\text{def}}(t_m)}{\sum_{m=1}^M \Delta(t_{m-1}, t_m) d(t_0, t_m) P_{\text{surv}}(t_m)}.$$

As we can see the pricing of a CDS depends fully on the default probability of the firm. In recent years, the calculation of these default probabilities under several Lévy driven models has been worked out. We mention especially two approaches where the calculations can be done very fast, namely the Partial Integral-Differential Equation (PIDE) approach and the double Laplace inversion approach based on the Wiener-Hopf Factorization. The first one can deal with general Lévy processes and is worked out for the very popular Variance Gamma (VG) case in for example [3], the second approach is only tractable for spectrally one-sided processes, only allowing for negative jumps and can be

found in [6] and [7]. However, one could argue that in contrast to stock price behaviour where clearly up and down jumps are present, a firm tries to follow a steady growth (up trend) but is exposed to shocks (negative jumps). It thus seems quite natural to model the underlying firm's value in a default model by a process with a positive drift and allow only for negative jumps. In contrast to the double sided situation, where the solution of the PIDE takes typically a couple of seconds on an ordinary computer, the double Laplace inversion can be performed within a fraction of a second.

3. Firm Value Models

The starting point of the model is the approach originally presented by Black and Cox in [1]. According to this approach an event of default occurs when the asset value of the firm crosses a deterministic barrier. This barrier corresponds to the recovery value of the firm's debt. Figure 3 illustrates the default and non-default events. The firm defaults if the firm's value follows the solid path and the firm survives if it follows the dashed path. The initial firm value is set to 1 and the recovery value of the firm is 60%. The firm value paths were generated using a Shifted Gamma model with parameters $a = 0.74475$ and $b = 6.59491$.

Black and Cox assumed a geometric Brownian motion for the firm's value processes. It is however well known that due to the continuous path nature of Brownian motion and the fast decaying tails of the underlying Normal distribution, the model cannot represent a realistic behavior of short term default probabilities. Indeed, the Brownian motion needs a substantial amount of time to reach a low barrier. In order to overcome these kinds of shortcomings, many extensions were already proposed. The CreditGrades™ model for example tried to lift the short time default probabilities by making the barrier stochastic [4].

Here we use the same methodology as Black and Cox but work under exponential Lévy models; Default is triggered when the firm's value is crossing a low-barrier. By doing that, due to the jump nature, not only realistic default probabilities could be produced but also the other problem of predictability of the default time is overcome.

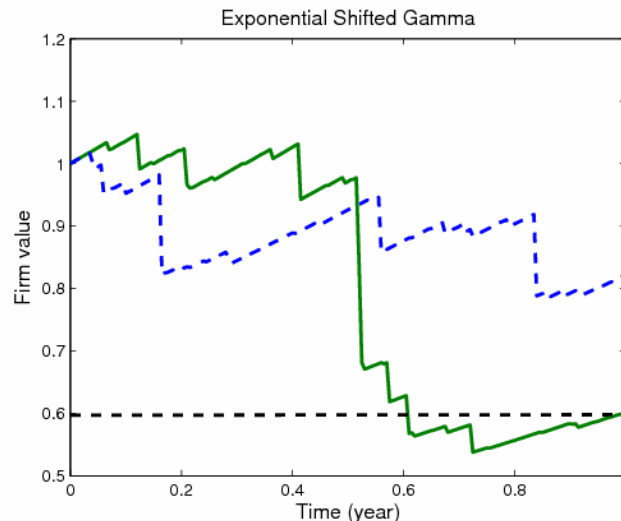


Figure 3. Example of firm value paths. The dashed line corresponds to a firm that does not default and the solid line corresponds to a default at time $t = 0.6$.

3.1 Lévy Firm Value Models

We thus work under a firm value setting, where the fundamental process that we model is the value of the reference entity of a CDS, and we opt to model the firm's value by ex-

ponential Lévy driven jump models. These Lévy models have proven their modelling abilities already in different fields, but especially in the credit modelling setting we are absolutely convinced of the necessity of jumps in the modelling of the fundamental underlying process.

So assume, $X = \{X_t, t \geq 0\}$ is a Lévy process with positive drift and negative jumps. More precisely, let

$$X_t = \mu t + Y_t,$$

where $\mu > 0$ represents a positive upward trend of the firm value and Y_t is a pure jump process with only negative jumps that represents negative news that affects the firm value. Examples of processes used for Y_t are Gamma, Inverse Gaussian and CMY processes. Figure 3 illustrates firm value paths when Y is a Gamma process.

The (risk neutral) value of the firm at time t is then modelled by

$$V_t = V_0 \exp(X_t), \quad t \geq 0,$$

and we work under an admissible pricing measure Q such that $E_Q[V_t] = V_0 \exp(rt)$, where r is the risk-free interest rate. We will refer to the process V as the firm's value process. For a given recovery rate R default occurs the first time

$$V_t = V_0 \exp(X_t) \leq R V_0$$

or, equivalently, if

$$X_t \leq \log R.$$

Let us denote by $P_{surv}(t) := P_Q(\tau > t)$ the risk-neutral *survival probability*, or in other words the probability of no-default, between 0 and t :

$$\begin{aligned} P_{surv}(t) &= P_Q(X_s > \log R, \text{ for all } 0 \leq s \leq t) \\ &= P_Q\left(\min_{0 \leq s \leq t} X_s > \log R\right) \end{aligned}$$

where the subindex Q refers to the fact that we are working in a risk-neutral setting.

4. Options on CDSs

An option contract gives the holder the right but not the obligation to buy or sell an underlying asset in the future for a fixed price called the strike price. The 'vanilla' options on the market are the European call and put options. The call option gives you the right to buy (to call) an underlying asset, the put gives you the right to sell the asset. The underlying asset can be a stock, a commodity, an exchange rate or any other tradable financial asset. A European option gives the holder the right to exercise the option only at the maturity date. There are many extensions to these vanilla options, usually referred to as exotic options. The American option, for example, gives the holder the right to exercise the option at any time up to and including the maturity. An option with a limited number of exercise dates until maturity is called a Bermudan option (referring to the physical location of Bermuda between Europe and America).

The firm value approach is ideally suitable to set up a methodology for the pricing of options on CDSs. Usually options on CDSs are referred to as credit default swaptions or just swaptions. The most common options are *payer* and *receiver* swaptions. They are the counterpart of the classical European call and put options in other markets.

A receiver option holder on a single name CDS has the right, but not the obligation, to sell protection (that is, to receive premium) at the strike spread level on expiry. Figure 4 illustrates the cash flow of a receiver option. A payer option holder on a single name CDS has the right to buy protection on the underlying CDS (that is, to pay premium) at the strike spread level on expiry. Special rules apply for the case when default happens before the option's maturity. Most common situation on the single-name payer and re-

ceiver structures is a knock-out clause, meaning that in case of early default the payoff is zero.

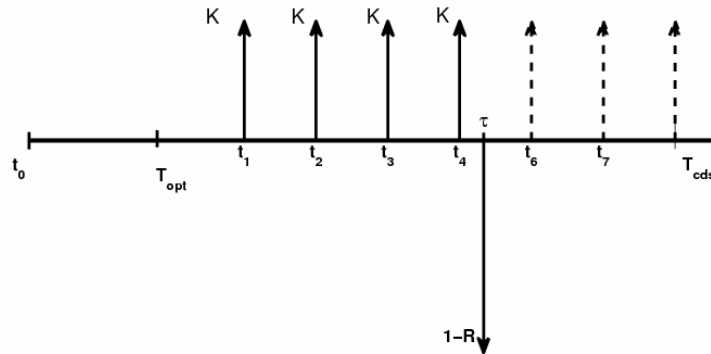


Figure 4. Cash flow of a receiver swaption. The option maturity is T_{opt} , T is the CDS maturity and K is the strike spread.

4.1 Valuation

At option maturity T_{opt} the value of the receiver and payer swaptions are given by the difference of the fair spread observed on the market and the strike spread, that is, for a receiver

$$(K - S(T_{opt}, T))^+ PV01(T_{opt}, T),$$

and for a payer

$$(S(T_{opt}, T) - K)^+ PV01(T_{opt}, T),$$

where $S(T_{opt}, T)$ is the par spread at time T_{opt} to be paid until T and $PV01(T_{opt}, T)$ is the risky annuity at time T_{opt} until T . By risk-neutral pricing the value of the options at contract date t_0 is equal to the discounted expected value of their payoffs:

Receiver:

$$\Pi_0^R(K, T_{opt}, T) = d(t_0, T_{opt}) E_Q[(K - S(T_{opt}, T))^+ PV01(T_{opt}, T) 1(\tau > T_{opt})];$$

Payer:

$$\Pi_0^P(K, T_{opt}, T) = d(t_0, T_{opt}) E_Q[(S(T_{opt}, T) - K)^+ PV01(T_{opt}, T) 1(\tau > T_{opt})],$$

where the subscript Q indicates that the expectation is with respect to the risk-neutral probability measure.

4.2 Black's Formulas and Implied Volatility

The market standard for pricing options on CDSs is the Black formulas, based on the assumption that the credit spread observed at option maturity is a log-normal random variable times the forward CDS spread observed at the valuation date.

A forward starting CDS is an agreement today to enter into a CDS contract at a time in the future. A long position in a forward starting CDS is identical to enter into a long position in a CDS with maturity T_2 and a short position in a CDS with maturity T_1 on the same reference entity, i.e., buying protection for T_2 years and selling protection for T_1 years. This will exactly replicate the premium leg and the loss leg of the forward starting CDS for the time period $(0, T_2]$. The forward spread $F_0(T_1, T_2)$ is the fair spread agreed

upon today for entering into a forward starting CDS starting at T_1 with maturity T_2 and is given by

$$F_0(T_1, T_2) = \frac{S(t_0, T_2)PV01(t_0, T_2) - S(t_0, T_1)PV01(t_0, T_1)}{PV01(t_0, T_2) - PV01(t_0, T_1)}.$$

We can now write down the Black formulas for payer and receiver swaptions respectively

$$Payer_0(T, K) = PV01_0(T_{opt}, T)(F_0(T_{opt}, T)N(d_1) - KN(d_2))$$

$$Receiver_0(T, K) = PV01_0(T_{opt}, T)(KN(-d_2) - F_0(T_{opt}, T)N(-d_1)),$$

where $N(\cdot)$ is the standard normal cumulative distribution function,

$$d_1 = \frac{\log(F_0(T_{opt}, T)/K) + \sigma^2 T_{opt}/2}{\sigma \sqrt{T_{opt}}} \text{ and } d_2 = d_1 - \sigma \sqrt{T_{opt}},$$

and $PV01_0(T_{opt}, T)$ is the t_0 -time forward risky annuity from swaption maturity T_{opt} to CDS maturity T .

Given the forward spread and risky annuities we can calculate the implied volatilities for payers and receivers with different strikes. Prices and implied volatilities for receivers written on the same underlying CDS are given in Figure 5. We have assumed a flat term structure of the interest rates of 3%. The values of the options are generated using the Shifted Gamma model ($a = 1.2028$ and $b = 5.9720$).

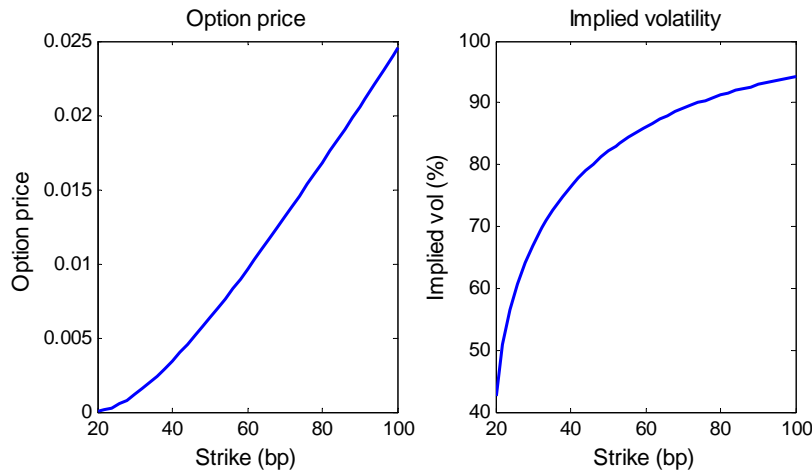


Figure 5. Prices and implied volatilities of 1y receiver option prices - Shifted Gamma model - BAE Systems CDS with 5 year maturity. Underlying model is the Shifted Gamma with $a = 1.2028$ and $b = 5.9720$. The spot (par) spread was $C_0 = 43$ basis points and forward spread of 47 bp.

4.3 Dynamic Spread Generation

The default probabilities depend on "distance to default", that is, how far away from the default barrier the firm value is. Taking this into account we can set up a simple CDS spread generator by the following algorithm:

- Calibrate on the CDS curve and obtain optimal parameters;
- Precalculate for a fine grid of distances to defaults all corresponding spread values;
- Simulate the firm value process
- Translate this in distance to default and map to corresponding spread.

We illustrate in Figure 6 the idea underlying the dynamic spread generator and also show a firm value path and the corresponding CDS spread path. Note that the spread path decreases as the firm value is increasing, that is, moving away from the default barrier implies that it is less probable that the firm defaults and the price for default protection decreases. When the firm value jumps down towards the barrier the spread has an upward jump.

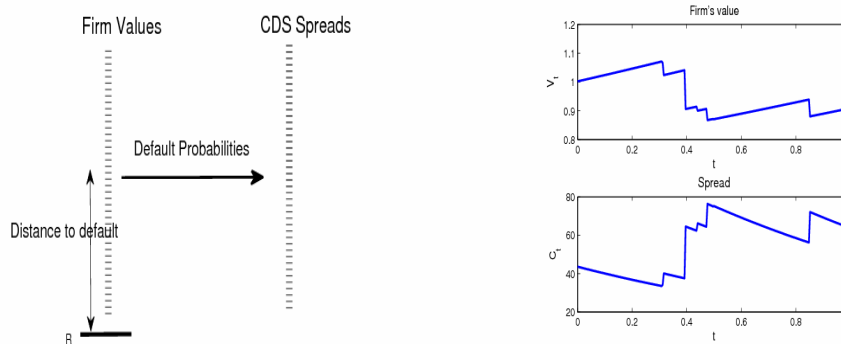


Figure 6. Mapping firm values to spread values.

Based on this dynamic spread generator we can price any type of exotic path dependent option we like using Monte Carlo techniques. The prices for Bermudan options with maturity $T_{opt} = 1$ year with different exercise opportunities are given in Table 1.

Strike (bp)	European (€)	Semi-annually Bermudan (€)	Quarterly Bermudan (€)	Monthly Bermudan (€)
44	0.0093	0.0103	0.0120	0.0171
46	0.0090	0.0099	0.0113	0.0156
48	0.0087	0.0095	0.0107	0.0146
50	0.0085	0.0091	0.0103	0.0140
52	0.0082	0.0088	0.0098	0.0131
54	0.0080	0.0085	0.0094	0.0124
56	0.0078	0.0082	0.0090	0.0118

Table 1. The estimated values of an European payer and Bermudan payers with semiannual, quarterly and monthly exercise, respectively, all with maturity one year to enter into a single name CDS with a five year maturity. The simulation is based on 100,000 paths for the firm value process. The standard errors of the estimates all lie between $0.86 * 10^{-4}$ and $1.25 * 10^{-4}$, with the smallest standard error for the European payer and the highest for the monthly Bermudan. Underlying model is the Shifted Gamma with $a = 1.2028$ and $b = 5.9720$.

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- 5.1. Papers in journals and proceedings per programme
- 5.2. EURANDOM report series per programme

5.1. Papers in journals and proceedings per programme

The papers listed below are from postdocs and PhD's as well as from the senior fellows. Some of the senior fellows chose to mention all their publications in 2007, some of the senior fellows only mention the papers that were a result of collaboration with junior researchers at EURANDOM.

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In 2007 the EURANDOM researchers published a total of 93 articles.

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5.2. EURANDOM Report Series

The ISSN-number for the EURANDOM Report Series is: 1389-2355. Reports and abstracts can be downloaded from the EURANDOM website at: <http://www.eurandom.tue.nl>.

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A Random Multiple Access Protocol with Spatial Interactions
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A. Wierman, E. Winands and O. Boxma

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A. Löpker and J. van Leeuwaarden

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M. Holmes

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A. Fey and F. Redig

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Duality and exact correlations for a model of heat conduction

C. Giardinà, J. Kurchan and F. Redig

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Diffusion constants and martingales for senile random walks

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R. van der Hofstad and G. Hooghiemstra

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F. den Hollander and N. Pétrélis

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J. Gärtner, F. den Hollander and G. Maillard

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Convergence of lattice trees of super-Brownian motion above the critical dimension
M. Holmes

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On the localized phase of a copolymer in an emulsion supercritical percolation regime
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Stabilizability and percolation in the infinite volume sandpile model
A. Fey-den Boer, R. Meester and F. Redig

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Three lectures on metastability under stochastic dynamics
F. den Hollander

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Mean-field behavior for long- and finite range Ising model, percolation and self-avoiding walk

M. Heydenreich, R. van der Hofstad and A. Sakai

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M. van Lieshout and T. Schreiber

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Depth map calculation for a variable number of moving objects using Markov sequential object processes

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E. Kong, O. Linton and Y. Xia

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In 2007 the EURANDOM researchers published a total of **62** EURANDOM Reports.

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6. ACTIVITIES

6.1. Workshops and Conferences in 2007

6.2. Lectures and Seminars in 2007

6.3. EURANDOM visitors in 2007

6.1. Workshops and Conferences in 2007

March 19-23, 2007 - RSS

YEP IV (Young European Probabilists) 2007 Random Graphs and Complex Networks

Organizers:

Professor R. van der Hofstad (Eindhoven University of Technology) and Dr. M. Deijfen (Stockholm University, Sweden)

Participants: 49

YEP 2007 – the fourth workshop in an annual series of meeting aimed at young European probabilists - was held March 19 – 23, 2007 at EURANDOM in Eindhoven, gathering 49 participants from The Netherlands, Sweden, Norway, UK, Germany, France, Italy and Hungary. The programme contained two mini-courses, one of three hours on sexual networks, given by Fredrik Liljeros from Stockholm University, and one of six hours on preferential attachment models, given by Oliver Riordan from Cambridge. Apart from the mini-courses there were talks by invited senior researchers and contributed talks by some of the participants.

The mini-course by Liljeros was of an empirical character, focusing on properties of sexual networks. Liljeros is best known for identifying power-law degree distributions in a number of specific sexual networks (joint work with Edling, Stanley, Amaral and Åberg). In the mini-course he described this work and also pointed at some lessons to be learned from it when it comes to strategies for controlling sexually transmitted diseases.

Riordan's course was theoretical and dedicated to a rigorous mathematical treatment of so-called preferential attachment graphs, which have been proposed as models of the WWW and other complex networks. The idea is that new vertices keep arriving in the network and these new vertices are connected to already present vertices with probabilities proportional to the degrees of the older vertices. This dynamical character of the arising graphs implies that vertices with a high degree are more likely to acquire even more edges, explaining the fact that preferential attachment is often referred to as the "rich-get-richer" phenomenon. Together with Bela Bollobas, Riordan has done substantial work on this type of models, which he surveyed in a very clear and comprehensible way.

Among the senior researchers who gave talks, we mention for instance Tatyana Turova, who introduced a model that combines percolation and Erdős-Renyi graphs, giving rise to a number of interesting questions concerning the location of the threshold for appearance of a giant component and the size of such a component. Furthermore, Gerard Hooghiemstra described recent work on distances and diameters in the so-called configuration model, which is a commonly used model invented by Bollobas to generate graphs with a given degree distribution, and Tom Britton gave an introduction to epidemic models on random graphs, including an analysis of how the underlying graph can be taken into account when designing vaccination strategies. The contributed talks ranged from overview talks - such as the one by Willemien Kets on connections between game theory and random graphs - to presentations going more in depth on a specific

topic - such as the one by Markus Heydenreich on the effect of various types of boundary conditions in percolation on high-dimensional boxes and their relation to critical behaviour on the Erdős-Renyi random graph.

The workshop was throughout characterized by a relaxed and open atmosphere. The audience consisted both of applied researchers using random graphs to model complex networks, such as social networks, as well as mathematicians deriving mathematical properties of them. These differences in background, made the workshop interesting, both for the applied people learning about mathematical work, and the theoretical people, who learned about problems of interest to the applied community.

To enable discussions and interaction between the participants, the programme included long lunch breaks and it is our impression that these breaks actually served their purpose. The organized social programme consisted of a conference dinner, which was attended by most of the participants. Furthermore, the majority of the participants were accommodated at one and the same hotel in Eindhoven, which served to further facilitate communication and interaction.

March 23, 2008 - GENERAL

Stieltjes afternoon on the work of two Fields medal 2006 winners

Organizers:

Rob van den Berg (CWI and VU University Amsterdam), Remco van der Hofstad (Eindhoven University of Technology and EURANDOM) and Frank den Hollander (Leiden University and EURANDOM)

Participants: 56

A broad impression of some key aspects, ideas and consequences was given on the work of the winners of the 2006 Fields medal winners: Wendelin Werner and Andrei Okounkov. Werner received the prize "for his contributions to the development of stochastic Loewner evolution, the geometry of two-dimensional Brownian motion, and conformal field theory", and Okounkov "for his contributions bridging probability, representation theory and algebraic geometry". Speakers were Alexander Gnedin (Utrecht University) on the work of Andrei Okounkov on "Random partitions", Frederico Camia (VU University, Amsterdam) on "An introduction to Werner's work on conformally invariant systems (I)" and Vincent Beffara (UMPA - ENS Lyon) "An introduction to Werner's work on conformally invariant systems (II)".

April 16-18, 2007 - QPA-MVR

Workshop Mathematical Methodologies for Operational Risk

Organizers:

Professor T. Bedford (University of Strathclyde, Glasgow, Scotland), Dr. A. Di Bucchianico (Eindhoven University of Technology), Professor J. Teugels (KU Leuven) and Professor H. Wynn (London School of Economics, United Kingdom).

Participants: 28

Background

The original strategy in designing the two NEST-MATHFSS shops on risk was to concentrate on finance related risk in the first workshop and expand into more general areas of risk in the second, while stressing common links, particularly in the area of risk measurement. It was later decided to have one more specialist area, namely software reliability, as a way of covering a substantial non-financial area of established and growing importance. In the event the workshop divided broadly into financial, general (including reliability) and software reliability, but organized so there was a spread of subjects each day.

General risk issues and reliability

Bedford gave an overview of the study of accidents using the index of "at least N fatalities" and discussed its contribution to decision-making in risk reduction and the background meaning of uncertainty. The importance of studying variability over time was also at the centre of Newby's multivariate stochastic process approach to maintenance modelling, an area of renewed importance as the complexity of systems increases. Chiquet also used a stochastic process model based on Markov processes and in a somewhat different field: degradation of materials. Talks on the theory of reliability using novel mathematical methods included the use of non-standard probability, so-called imprecise probability by Coolen, the use of algebraic geometry methods by Wynn and extreme value method in sequential testing by Steffey. All these talks could be grouped under a heading of "reliability modelling" and showed the wide variety of methods which are available.

Financial risk

Barrieu's paper was at the heart of risk metrics, concentrating on special types of risk measures, convex and the link with economic theories which aid the study of pricing, hedging and financial instruments more generally. Some similarly innovative material was expounded by Jeanette Woerner, who covered market micro structure using fractional Brownian motion and Konstantinedes, who discussed subexponentiality.

Software reliability

This was well represented at the workshop with the introductory talk by Anderson setting the scene in discussing industrial software testing and its importance in design. The workshop was fortunate to have input from the associates of LaQuSo, the Laboratory for Quality Software at Eindhoven University of Technology. Chaudron discussed the modelling of faults in the widely used UML. The range of modelling methods was impressive. It was good to see Bayesian models being successfully used in the talk of Ruggeri, Wooff and Wiper. These seem to be effective in formulating the problem of the complex and dynamic environments of software design and testing where there has to be a good melding of data and judgement.

Conclusions: complex, dynamics and uncertain

Risk measurement and modelling has many common features across different applications and theoretical areas. In finance one hears of complex instruments and in software one has some of the most complex entities designed and built by humans. A generic word is system and hence the term: system reliability. Perhaps this should be widened to system risk, or complex system risk. One sees in all fields the subtle relationship between testing and design to make the systems robust to the environment in which they operate. But both the systems and the environment are dynamic and stochastic. In finance this is well-captured by "stochastics" but in other fields the dynamics show that indeed, the software design process itself is dynamic and both software and hardware systems can degrade dynamically as is very familiar in reliability. Uncertainty is a by-product of the intrinsic variability of the system-plus-environment but also a human attribute; na-

ture herself behaves randomly and we do not have enough data to model her accurately. This is common to all sciences but focused in risk because (i) of the large losses that can occur: risk of failure or extreme loss (ii) we may have some opportunity to design out the risk, control it or mitigate it.

June 18-22, 2007 (RSS)

Workshop Random Polymers

Organizers:

Professor F. den Hollander (Leiden University) and Professor S. Whittington (University of Toronto, Canada).

Participants: 44

Polymer models have been studied by chemists and physicists for more than fifty years, but it is only relatively recent that they have attracted serious attention from the mathematics community. They are now well-studied by probabilists and combinatorialists. The workshop was attended by people from a wide variety of different fields.

Polymer models are designed to describe the configurational and thermodynamic properties of polymer molecules in a variety of environments. Polymer molecules typically are highly flexible, so that one needs to average over their conformations, with the conformations weighed by appropriate Boltzmann factors. The monomers interact with one another and also with the environment of the polymer, such as the solvent molecules for a polymer in solution. The simplest models are random walks and directed walks. Self-avoiding walks have the advantage that they incorporate excluded-volume effects, but they are very difficult to treat. The workshop concentrated to some extent on directed walk models, although other models were discussed as well.

Polymers exhibit a variety of phase transitions, including the collapse transition where the polymer molecule collapses from a loose coil to a compact ball when the temperature is decreased, and the adsorption transition where a polymer in solution adsorbs at an impenetrable surface. These transitions pose serious challenges, which are attracting considerable attention.

Although homopolymers (where all the monomers are identical) have many aspects that are still poorly understood, the situation is even more complicated for copolymers where there are at least two types of monomers.

There are two important cases: the comonomer sequence is either periodic or random. If the two monomers are hydrophilic and lyophilic, then the polymer can localize at an interface between two immiscible solvents, oil and water. This localization transition was one of the focal topics of the workshop.

One of the aims of the workshop was to bring together people having similar interests but working in different fields, i.e., people who were interested in the same problem but who approached it with very different tools. This aim was certainly achieved. There was plenty of time for discussion, and this led to considerable interaction between people with different backgrounds. The topics discussed were those at the boundary of the subject, where progress is just beginning to be made. As such, the workshop has been successful in creating crossborder contacts.

July 9-11, 2007 - QPA
Applied Probability INFORMS Conference

Organizers:

Professor O. Boxma and Professor M. Mandjes (University of Amsterdam & CWI).

Participants: 361

The 14th INFORMS Applied Probability Conference was held on July 9 - 11, 2007, in the Auditorium of Eindhoven University of Technology, Eindhoven, The Netherlands.

The INFORMS Applied Probability Conferences are the largest conferences, worldwide, in the field of applied probability. They take place at two-year intervals, alternating between Northern America and the rest of the world. This was the first time that the conference was held in The Netherlands.

Like its predecessors, the main focus of the conference was on applications of probability theory in operations research. Emphasis was on topics like inventory theory, queueing theory, and Markov decision processes, but also substantial attention was paid to applications of probability theory outside operations research, such as interacting particle systems, communications networking, and financial engineering.

Keynote lectures were delivered by Peter Glynn (Stanford University, USA), Frank Kelly (University of Cambridge, UK), Alain-Sol Sznitman (ETH Zürich, Switzerland); tutorials were presented by Maury Bramson (University of Minnesota, USA), Paul Glasserman (Columbia University, USA) and Philippe Robert (INRIA and École Polytechnique, France). In addition, throughout the conference we had 9 parallel tracks. Each 90-minute session contained 4 talks, and there were 10 such sessions per track, resulting in 360 lectures. The topics of the parallel sessions are listed in an appendix to this report.

The number of registered participants amounted to 361; following the tradition of these conferences, almost all participants gave at least one lecture. The social programme included a banquet at the DAF museum in Eindhoven. The organizers gratefully acknowledge the generous support of the following organizations: KNAW, NWO, ASML, CQM, Philips, Stichting ABE, Municipality of Eindhoven, INFORMS, The Institute of Mathematical Statistics IMS, Eindhoven University of Technology, and EURANDOM. They were also acknowledged on the conference website, in the book containing the programme, and at the opening of the conference.

July 12, 2007 – QPA

3rd Korea-Netherlands Workshop on Queuing Theory and its Applications to Telecommunications Systems

Organizers:

Professor O.J. Boxma (Eindhoven University of Technology and EURANDOM), Dr. J.A.C. Resing (Eindhoven University of Technology) and Dr B. Kim (Korea)

Participants: 21

The 3rd Korea-Netherlands Conference on Queueing Theory and its Applications to Telecommunications Systems was held July 12, 2007 at EURANDOM. The initiative for the series of Korea-Netherlands conferences was taken by Professor Bong Dae Choi, who also organized the first edition in Seoul, June 2005. The second one took place in Amsterdam, October 2006. Exploiting the fact that a strong Korean Delegation was visiting the 14th

INFORMS Applied Probability Conference in Eindhoven, July 9 - 11, 2007, we decided to organize the 3rd conference edition right after this INFORMS conference.

The Korea-Netherlands conference series aim to bring together leading specialists in queueing theory and its applications to the performance analysis of telecommunication systems from Korea and The Netherlands, thus stimulating scientific interaction and exchange of knowledge between the two very active and prominent research communities of both countries. The talks ranged from fundamental queueing theory to relevant applications to modern telecommunication networks.

In the first talk, Choi considered IEEE 802.16e, which is designed to support high capacity, high data rate and multimedia services as an emerging broadband wireless access system. He proposed a new sleep-mode mechanism called the power saving mechanism with periodic traffic indications, and studied its performance.

Prabhu studied the broadcast time of files in a Peer-to-Peer network with a large number N of initial nodes. In a network of altruistic nodes, he showed that the mean broadcast time is $O(\log(N))$; in a network with free-riding nodes, a similar order of mean broadcast time may be achieved if nodes remain connected to the network for the duration of at least one more contact after downloading the file. Park presented an overview of wireless mesh networking technologies. He discussed promising standards for these technologies, and mentioned some challenging research issues associated with those standards. Van Ommeren studied a polling model with a so-called autonomous server. He assumed that the server spends an exponentially distributed period of time at a queue (independent of the number of customers present at each queue) before moving to the next queue. Applications of the model arise for instance in the context of wireless ad hoc networks. The next two talks were devoted to retrial queues. Kim showed that the waiting time distribution for the $M/G/1$ retrial queue is regularly varying if the service time distribution is regularly varying. Nobel considered a retrial queue with an unlimited number of servers, of which only a finite number is active. Using Markov decision theory, he tackled the problem of determining when to activate or shut down servers in order to minimize the long-run average costs per unit time. Hwang studied a cross-layer design problem for a wireless network with adaptive modulation and coding. In his cross-layer design, he considered both the physical layer and the medium access control layer. To capture the joint effect of the performance of both layers (packet transmission error rate at the PHY layer and packet overflow probability at the MAC layer) he introduced and studied the effective bandwidth function of the packet service process at the MAC. In the final talk, Borst investigated the delay-optimization problem for flows in bandwidth-sharing networks. For a class of simple linear bandwidth-sharing networks, he compared the performance of the optimal bandwidth-sharing policy with that of various alpha-fair strategies. He concluded that (optimization within) the family of alpha-fair strategies is likely to be adequate for most practical purposes.

September 10-13, 2007 - RSS

Workshop Sandpile Models and Related Fields

Organizers:

Professor R. Meester (VU University, Amsterdam) and Dr. F. Redig (Leiden University).

Participants: 37

The workshop "Sandpile models and related fields" held September 10 - 13, 2007 at EURANDOM covered various recent mathematical and physical aspects of the sandpile

model. There were contributions from algebraic combinatorics (Merino, Cori), from probability theory (Peres, Levine, Saada, Fey, Jarai), from theoretical physics (conformal field theory) (Ruelle), from experimental physics (Wijngaarden) and dynamical system theory (K. Schmidt). D. Dhar gave an overview talk of the state of the art in the field, with many inspiring examples and new open problems. R. van den Berg, A. Gillet and V. Sidoravicius gave examples of other relevant models in which self-organized criticality appears and which can be analyzed mathematically. The workshop brought together people from various areas and a real communication and exchange of ideas and new problems was attained.

September 24-26, 2007 - SIM
Workshop Algorithms in Complex Systems

Organizers:

Professor P.L. Davies (Universität Duisburg-Essen and Eindhoven University of Technology), Dr. R. Duits (Eindhoven University of Technology), Professor G. Jongbloed (Delft University of Technology), and Dr. M.N.M. van Lieshout (CWI and Eindhoven University of Technology).

Participants: 29

Since March 2006, EURANDOM hosts a research theme "Statistical Signal and Image Analysis". In this broad field, and indeed in the analysis of any complex system, algorithms play an important role as the practical implementation of most procedures depends on fast, stable and accurate algorithms. The workshop included talks on algorithms in the areas of statistical analysis under (shape) constraints, Bayesian procedures, censored data analysis, biological networks, image analysis, and machine learning. The talks were videotaped and can be viewed on <http://www.videlectures.net>.

Additionally, speakers were asked for permission to publish their talks on the web, see <http://www.eurandom.tue.nl/workshops/2007/Algorithms>.

The workshop attracted about thirty participants from all over Europe and was a great success. The talks were often followed by lively discussions, continued during the breaks. Many participants stayed on to follow the public lecture by speaker and Eurandom chair Prof.dr. R. Fernández held on September 26.

October 8-12, 2007 - SIM
Young European Statisticians Workshop Shape Restricted Inference

Organizers:

Professor P.L. Davies (Universität Duisburg-Essen & Eindhoven University of Technology) and Professor G. Jongbloed (Delft University of Technology).

Participants: 37

The first Young European Statisticians workshop (YES I) was held at EURANDOM on October 8 - 10, 2007. The theme "Shape Restricted Inference" was chosen as recent research has shown that shape restrictions have certain advantages over the usual smoothness restrictions to be found in the literature. Firstly shape constraints often have an a priori justification which smoothness constraints do not have. Secondly shape restricted estimators are locally adaptive in a way that smooth estimators cannot be. Thirdly it is possible to

give honest confidence bands for shape restricted estimators which is not possible for smooth estimators without a prior bound on the smoothness. The research on this subject is relatively recent and has taken place in the last ten years.

Short seminars were given by two leading experts in the field, Prof. L. Dümbgen (Bern) and Prof. J.A. Wellner (Seattle). Dümbgen gave four talks on the algorithmic aspects of the problem with particular reference to active sets algorithms. Wellner gave three talks on asymptotics in which rates of convergence and the asymptotic distributions of suitably normalized statistics were derived using methods developed by him and co-workers. The two organizers, Prof. P.L. Davies and Prof. G. Jongbloed gave one talk each on "Minimal Shape Constraints" and "M-estimators under Shape Constraints" respectively. Further talks were given by 11 of the participants on topics arising out of their research.

October 17-19, 2007 - QPA

Young European Queueing Theorists (YEQT) on Queueing Theory without limits: transient and asymptotic analysis

Organizers:

Dr. T. Dieker (University College Cork, Ireland), Dr. J. van Leeuwen (Eindhoven University of Technology) and Dr. Z. Palmowski (University of Wroclaw, Poland).

Participants: 48

The first workshop for Young European Queueing Theorists (YEQT) has been a fruitful event. The organizers were pleased to have 48 participants, 21 of which gave a talk during the course of three days. Søren Asmussen (Aarhus University, Denmark), Sir John Kingman (former director Isaac Newton Institute, UK) and William Massey (Princeton University, USA) gave excellent keynote talks, together covering a broad range of the available methodology in queueing theory. Sir John Kingman gave a memorable talk on the rise of queueing theory as a branch of mathematics during the twentieth century. The tutorial given by Michael Drmota (Technische Universität Wien, Austria) and Genady Samorodnitsky (Cornell University, USA) covered relatively new methods and were extremely helpful for a large part of the audience.

The primary goal of the workshop was to bring together young researchers interested in the field of stochastic processes and queueing theory. The modelling of stochastic networks is a truly multi-disciplinary field and tends to attract researchers with various backgrounds. A wide variety of models was presented, and many participants were introduced to new techniques and developments.

This workshop is intended to be the first in a series named YEQT meetings, organized within the framework of EURANDOM's programme 'Queueing and Performance Analysis'. The main goal of these meetings would be to bring together young researchers in various related fields, and the scope of the meetings shall vary. After this successful pilot, there will almost certainly be a second YEQT workshop in the near future. One of key note speakers commented as follows: "I greatly enjoyed the meeting, and you and your fellow organisers should be well satisfied with its success. You got together a varied and lively group, and encouraged them to give their best."

November 2-3, 2007 - RSS
BRG-meeting

Organizer:
W.Th.F. den Hollander

Participants: 26

On November 2 - 3, 2007 the half-year meeting of the Dutch-German Bilateral Research Group "Mathematics of Random Spatial Models from Physics and Biology" took place at EURANDOM. Sponsored by DFG and NWO, this is a cluster of five research groups (Berlin, Bielefeld, Erlangen, Frankfurt and EURANDOM) working on a range of projects at the interface between probability theory, statistical physics and molecular genetics. There were 26 participants, of which 10 gave presentations about the projects. At the end of the meeting, the senior coordinators of the programme gathered to discuss the continuation of the programme, including plans for a future "international Schwerpunkt" application with DFG and NWO.

November 15-16, 2007 – QPA
Workshop E-Quality

Organizer:
Professor R. Boucherie (University of Twente)

Participants: 40

The Expertise Centre on Performance and Quality of Service in ICT ("E-Quality") is a collaborative partnership formed by the National Research Institute for Mathematics and Computer Science (CWI), Delft University of Technology, Eindhoven University of Technology, TNO-ICT and the University of Twente in response to the growing need to control and improve the quality of services and applications in the world of ICT and its increasingly complex environments. The aims of E-Quality are to conduct innovative research in the field of "QoS control" in existing and future ICT environments, to train experts, and to communicate the significance of the research field. Its ambition is to become a leading player in the international knowledge economy, and to bring its knowledge to the market through spin-offs. Specific research issues within E-Quality include:

- Network and system planning
- Resource and capacity management
- Performance evaluation and monitoring
- QoS differentiation
- Traffic and performance measurements
- Traffic modelling
- Traffic management
- SLA specification and management

E-Quality organized a two day workshop Performance Analysis of Mobile and Wireless Communications aiming at interaction among experts in academia and industry held November 15 - 16, 2007 at EURANDOM. The workshop featured 12 invited talks, 6 from academia on the first day, and 6 from industry on the second day. Speakers were Eitan Altman (INRIA, Sophia-Antipolis, France) Geert Heijenk (University of Twente) Sindo Núñez Queija (CWI), Georgios Paschos (VTT, Finland), Sem Borst (Eindhoven University of

Technology), Eric Smeitink (KPN), Wim Coenen (VOSKO Networking), Maurits de Graaf (Thales Communications), Johan Trouwborst (T-Mobile), and Jan de Jongh (TNO-ICT). Fruitful interactions between participants contributed to the success of the workshop. The meeting was supported by EURANDOM, Beta, and E-Quality.

December 10-11, 2007 - QPA-MVR

Workshop Multivariate Risk Management

Organizers:

Dr. H. Jönsson, Dr. V. Masol, Professor W. Schoutens (KU Leuven) and Professor J. Teugels (KU Leuven).

Participants: 46

The aim of the workshop was to bring together experts in multivariate risk management from different fields (finance, insurance, economics, reliability, biology, physics, etc) to find mutual interests, exchange ideas and expertise, and discuss possible common problems. The main focus of the workshop was on research methodology for multivariate risk management.

The workshop was organized in the framework of the "Multivariate Risk Modelling" project at EURANDOM. There were 14 contributed talks of 30 minutes including discussions. The speakers covered different topics of risk management in finance (credit risk, portfolio risk modelling and risk measures, and correlation), insurance (tax payments in risk theory, optimal dividends strategies, alternating pay-off policies), economics (point process models for high-frequency data, time deformation and the yield curve) and general methodology (Archimedean copulas, the comonotonicity coefficient).

The workshop gave good opportunity for the participants to get to know recent results in the field of risk management and meet researchers active in the field. The mixture of contributed talks from different topics of risk management stimulated fruitful discussions, exchange of ideas, initiation of new research collaboration.

The participants came from several European countries. We would like to point out that high percentage of the participants were PhD students and young researchers. It is also worth mentioning the large group of visitors from Ukraine who participate in the coordinating meeting of the Joint European Project IB-JEP-25054-2004 "Training Center for Actuaries and Financial Analysts" financed by the European Commission (Directorate-General for Education and Culture) held in connection with the workshop. For this group the workshop was a training opportunity offering them access to recent results in risk management in finance and insurance.

Summary of the workshops

QPA-MVR	6
RSS	4
SIM	2
General	1
Total	<u>13</u>

In total 13 workshops were (co)-organized. Total number of participants: 822. Because of the APS-INFORMS conference, which was bigger than the workshops the institute normally organizes, this number is considerably higher than the annual average of about 400. Furthermore, EURANDOM co-sponsored in 2007 the 5th European Congress of Mathematics that will take place July 14 - 18, 2008.

6.2. Lectures and Seminars

In 2007 EURANDOM organized the following seminar series:

Queueing and Performance Analysis (QPA): 33

- QPA-MVR seminar together with the Stochastic Operations Research group (SOR) of the Department of Mathematics and Computer Science, Eindhoven University of Technology: 21
- QPA Reading seminar: 8
- QPA Max Plus seminar: 4

Random Spatial Structures (RSS): 38

- RSS seminar: 31
- RSS reading seminar: 7

Statistical Information and Modelling (SIM): 26

- SIM seminar: 3
- Informal meetings Eindhoven statisticians (organized by researchers of Eindhoven University of Technology in collaboration with EURANDOM): 23

General: 17

- EURANDOM Postdoc and PhD seminar (EPPS): 6
- Philips lectures: 6
- Lectures by the EURANDOM Chair: 5.

Abstracts and presentations can be downloaded from the EURANDOM website.

Queueing and Performance Analysis seminar

Mor Harchol-Balter

Carnegie Mellon University, USA

Works-in-Progress: From Web-server farms to Limited-time-sharing systems

January 15, 2007

Budhi Arta Surya

Utrecht University

Lévy processes in finance and queuing (joint work with A. Kyprianou)

January 18, 2007

Andrew Zalesky

University of Melbourne, Australia

40 Years of Erlang's Fixed-Point Approximation

January 22, 2007

Zinoviy Landsman

University of Haifa

Portfolio optimization invariant and positive homogeneous risk measure and minimization of the quadratic functional

February 12, 2007

Michel Mandjes

University of Amsterdam

Lévy processes, reflected Lévy processes, and Markov modulation

February 15, 2007

Dmitrii Silvestrov

Mälardalen University, Sweden

Quasi-Stationary Phenomena in Nonlinearly Perturbed Stochastic Systems

February 23, 2007

Hansjörg Albrecher

Graz University of Technology

Ruin theory in the presence of dividend and tax payments

March 15, 2007

Rieske Hadianti

Institut Teknologi Bandung, Indonesia

Wiener-Hopf techniques for the analysis of the time-dependent behaviour of queues

April 10, 2007

Evsey Morozov

Institute of Applied Mathematical Research and Petrozavodsk University, Russia

Stability analysis of a multiserver system with a dependence between workload, input and service time

May 7, 2007

Bert Zwart

The H. Milton Stewart School of Industrial and Systems Engineering at the Georgia Institute of Technology, Atlanta, USA

An extension of the square root law of TCP

June 7, 2007

Ananth Krishnamurthy

Rensselaer Polytechnic Institute, Troy, New York, USA

Recent progress and Trends in Stochastic Models for Manufacturing Systems with Product Variety

June 11, 2007

Ivo Adan

Eindhoven University of Technology

Insurance Risk with Variable Number of Policies

June 14, 2007

Ad Aerts

Eindhoven University of Technology

Modelling and simulation of the CMS Tier0-input buffering process

June 18, 2007

Peter den Iseger
Cardano, The Netherlands
New algorithms for Laplace Transform Inversion
June 19, 2007

Stelios Bekiros
University of Amsterdam
Advanced Techniques in Quantitative Finance
October 8, 2007

Stefan Thonhauser
Johann Radon Institute for Computational and Applied Mathematics (RICAM), Linz, Austria
Optimal Dividend Strategies for a Risk-Process under Force of Interest
October 11, 2007

Brian Fralix
Lévy processes at first passage and insurance risk
October 15, 2007

Lasse Leskelä
Eindhoven University of Technology
On the uniqueness of fluid limits for queueing systems
November 6, 2007

Dmitriy Kim
Heriot-Watt University, Edinburgh, United Kingdom
Oscillating random processes
November 20, 2007

Artem Sapozhnikov
CWI, Amsterdam
From microscopic to macroscopic perspectives on stochastic networks
December 4, 2007

Joris Walraevens
Ghent University and EURANDOM
Introducing an approximation technique for a class of generalized processor sharing systems
December 18, 2007

Reading Seminar Series: Lévy processes in finance and queuing
A reading seminar on the book of Andreas Kyprianou "Introductory Lectures on Fluctuations of Lévy Processes with Applications".

Jacques Resing
Eindhoven University of Technology
1. Lévy Processes and Applications
January 18, 2007

Vika Masol
2. Lévy-Ito decomposition and path structure
February 15, 2007

Henrik Jönsson

3. Some distributional and path related properties of general Lévy processes

March 15, 2007

Andreas Löpker

4. General storage models and paths of bounded variation

April 24, 2007

Seva Shneer

5. Subordinators at first passage and renewal measures

May 3, 2007

Johan van Leeuwen

Eindhoven University of Technology

6. The Wiener Hopf Factorisation

June 14, 2007

Brian Fralix

7. Approximating jump processes

June 26, 2007

Dimitris Cheliotis

8. Exit problems for spectrally negative Lévy processes

November 27, 2007

Lecture series on the Max-plus algebra

Bernd Heidergott

VU University, Amsterdam

June 1, 8, 22 and 29, 2007

This series of lectures is concerned with max-plus algebra from a queueing point of view. Lecture 1 provided an introduction to max-plus algebra. The basic algebraic concepts were introduced and properties of max-plus algebra were discussed. The so called 'heap of pieces' model has been introduced and key issues in studying max-plus models were discussed.

Lecture 2 has been devoted to queueing networks. Several examples were discussed. An emphasis was on modelling of waiting times (read: vector valued Lindely recursions). In the second part of the lecture, subadditive ergodic theory for max-plus models were discussed.

Lecture 3 gave a self contained proof of the celebrated result that any open max-plus linear queueing network with traffic intensity less than one admits stationary waiting times.

Lecture 4 illustrated the link between graph theoretical concepts and ergodic theory of queueing systems. As was explained in the lecture, max-plus techniques allow to identify sub-networks and to analyze the way in which these sub-networks determine the speed of the networks.

Random Spatial Structures (RSS) seminars

Alexis Gillett

VU University Amsterdam, The Netherlands

An introduction to renormalisation and discretisation techniques for continuum percolation models

January 16, 2007

Francesco Guerra

Università Roma La Sapienza, Italy

Broken replica symmetry bounds in spin glass theory

February 5, 2007

Christof Külske

University of Groningen, The Netherlands

Time-evolved mean-field measures and catastrophe theory (joint work with Arnaud Le Ny)

February 5, 2007

Pierluigi Contucci

University of Bologna, Italy

Correlation Inequalities for Spin Glasses (joint work with Joel Lebowitz)

February 6, 2007

Sara Brofferio

Université Paris-Sud, France

Some properties of the lamplighter's walks

February 13, 2007

Wouter Kager

Patterns on percolation clusters: ratios and limit theorems

February 20, 2007

Persi Diaconis

Stanford University, USA

What do we know about the metropolis algorithm?

March 13, 2007

Thierry Bodineau

Université Paris 7, France

Current large deviations in stochastic systems

March 27, 2007

Pierre Mathieu

Université Aix-Marseille I, France

Invariance principles for random walks with random i.i.d. conductances

March 27, 2007

Yuri Yakubovich

Utrecht University, The Netherlands

Slicing Young diagrams of partitions and compositions

April 3, 2007

Ross Kang
Oxford University, United Kingdom
The t -improper chromatic number of random graphs
April 10, 2007

Dimitris Cheliotis
Bahen Center for Information Technology, Toronto, Canada
Repeating patterns for one-dimensional random walk in random environment. A law of the iterated logarithm
April 17, 2007

Marco Lenci
Stevens Institute of Technology, USA
Recurrence for quenched-random Lorentz gases and similar systems
April 17, 2007

Louigi Addario-Berry
Oxford University, United Kingdom
A General Ballot Theorem
April 18, 2007

Nicolas Pétrélis
On the localized phase of a copolymer in an emulsion: super-critical percolation regime
(joint work with F. den Hollander)
May 1, 2007

Jozef Skokan,
London School of Economics and UIUC, United Kingdom
Numbers in Ramsey Theory
May 14, 2007

Henry van den Esker
Delft University of Technology, The Netherlands
A Preferential Geometric Graph Model with Initial Attraction
May 22, 2007

Mark Holmes
Lattice trees, super-Brownian motion, the lace expansion, and integers larger than 8
June 5, 2007

Alexander Basuev
St. Petersburg Federal University of Technology and Design, Russia
Results on the semi-infinite Ising model
June 7, 2007

Emilio Cirillo
Università di Roma 'La Sapienza', Italy
Decay of correlations in disordered systems
June 12, 2007

Jesse Goodman
University of British Columbia, Canada
Invasion percolation on regular trees
June 26, 2007

Omer Angel
University of Toronto, Canada
Mixing times and Diophantine approximations
June 26, 2007

Julien Berestycki
Université Aix-Marseille I and Paris 6
The speed of coalescence (joint work with N. Berestycki and V. Limic)
August 14, 2007

Michael Steele
Wharton University of Pennsylvania, USA
Probability Inequalities Concentration via Local Changes
August 20, 2007

Matthias Birkner
WIAS, Berlin, Germany
Quenched LDP for words in a letter sequence
September 18, 2007

Andreas Greven
Universität Erlangen, Germany
On the evolution of random trees
September 18, 2007

Francesco Caravenna
Università degli Studi di Padova, Italy
The quenched critical point of a diluted disordered polymer model
October 23, 2007

Wiolette Ruszel
University of Groningen, The Netherlands
Conservation and loss of Gibbsianness of interacting spins moving on circles
November 6, 2007

Grégory Maillard
EPFL, Lausanne, Switzerland
Ergodic behaviour of signed voter model
November 22, 2007

Jürgen Gärtner
Technische Universität Berlin, Germany
On the parabolic Anderson model driven by voter dynamics
November 22, 2007

Alessandro Pellegrinotti
Università degli Studi Roma 3, Italy
Random walk in fluctuating random environment
November 27, 2007

Reading seminar "Large Deviations"

Sébastien Blachère and Francesca Nardi (Eindhoven University of Technology) started organising a reading seminar on the book "Large Deviations" of W.Th.F. den Hollander. Seven meetings took place in 2007, to be continued in 2008.

Paul Beekhuizen

Chapter I
October 11, 2007

Jevgenijs Ivanovs

Chapter II (II.1 to II.4)
October 25, 2007

Anne Fey

Chapter II (II.5 to II.7)
November 8, 2007

Sébastien Blachère

Chapter III (III.1 to III.4)
November 22, 2007

Sébastien Blachère

Chapter III (III.5 to III.8)
December 6, 2007

Francesca Nardi

Chapter IV
December 13, 2007

Dimitris Cheliotis

Chapter V
December 20, 2007

Statistical Information and Modelling (SIM) seminar

Ruilin Li

Sun Yat-Sen University, China
The application of the Markov model in health insurance actuary
January 25, 2007

Ildar Ibragimov

Russian Academy of Sciences, Steklov Institute of Mathematics
Estimation of Analytic functions
September 19, 2007

Shota Gugushvili

University of Amsterdam, The Netherlands
Decompounding under Gaussian noise
December 12, 2007

Informal meetings Eindhoven Statisticians

These meetings are organized by members of the scientific staff of Eindhoven University of Technology in cooperation with researchers of EURANDOM. Not for all meetings speakers were determined ahead; sometimes problems or subjects, suggested shortly before the meeting, were discussed. Meetings took place on:

- January 10 and 24, 2007
- February 5, 14 and 28, 2007
- March 7 and 12, 2007
- April 4 and 25, 2007
- May 16 and 23, 2007
- June 6, 13 and 20, 2007
- July 4, 2007
- September 12, 2007
- October 3, 17 and 31, 2007
- November 21 and 28, 2007
- December 5 and 12, 2007

Among the speakers were: Olaf Wittich (Eindhoven University of Technology), Remco van der Hofstad (Eindhoven University of Technology and EURANDOM), Francesca Nardi (Eindhoven University of Technology and EURANDOM), Edwin van den Heuvel (Organon), Andrey Sidorenko (Eindhoven University of Technology), Anne Krampe (University of Dortmund), Toby Doorn (NXP), Jan van Gellecum (Eindhoven University of Technology), Eefje van Dungen (Eindhoven University of Technology), Laurie Davies (Eindhoven University of Technology, Universität Duisburg-Essen and EURANDOM), Marko Boon (Eindhoven University of Technology and EURANDOM), Richard Gill (Leiden University and EURANDOM), Chris Klaassen (University of Amsterdam and EURANDOM), Jan Draisma (Eindhoven University of Technology).

General

EURANDOM Postdoc and PhD seminar (EPPS)

Andreas Löpker

Transient analysis of a Data transfer model
March 1, 2007

Josine Bruin

Cyclic Multi-item production systems
March 8, 2007

Christian Spitoni

Homogenous nucleation for Glauber dynamics
May 23, 2007

Wouter Kager and Mark Holmes

Senile walks
Episode II The scaling limit strikes back
Episode III Return of the Martingale!
June 13, 2007

Efang Kong

Uniform Bahadur Representation for Local Polynomial Estimates of M-Regression and Its Applications

October 24, 2007

Ambedkar Dukkipati

On Applications of Gröbner Bases of Elimination Ideals to Maximum Entropy models

December 12, 2007

Philips lectures

Wim Verhaegh

Data mining for Biomarker Discovery

Bart Bakker

In-Silico Models for Clinical Diagnostics

February 21, 2007

Marie-Colette van Lieshout (CWI, The Netherlands)

Image Segmentation by Polygonal Markov Fields

March 7, 2007

Martin F. McKinney

Music content analysis: extracting the style and mood from musical audio

Radu S. Jasinschi

Markers for Neurodegenerative Diseases

May 2, 2007

Vsevolod Shneer (EURANDOM)

Stability of some ALOHA-type multiple-access protocols with spatial interactions

May 30, 2007

Gerald Lucassen & Pieter de Bokx

Multivariate data analysis applied in molecular diagnostics

Ashish Pandharipande

Cognitive radio

November 7, 2007

Peter Grünwald (CWI, The Netherlands)

The catch-up phenomenon in Bayesian inference

November 28, 2007

EURANDOM Chair - Roberto Fernández

Public lecture

Random processes, partially ordered fields, Gibbs fields

September 26, 2007

Mini-series of lectures on 'Fields and Processes: common framework and relations'

Lecture I

Basic definitions, oriented specifications, examples, reconstruction from single-site kernels

October 2, 2007

Lecture II

Extremality, tail-field triviality, mixing properties, limit measures. Translation invariable ergodicity

October 16, 2007

Lecture III

Overview of uniqueness results (boundary uniformity, Dobrushin criterion, disagreement percolation) and examples of phase transitions

October 23, 2007

Lecture IV

Relation between processes and one-dimensional fields. Phase transitions in the half...

October 30, 2007

6.3. EURANDOM visitors in 2007

January 2007

14-16	M. Harchol-Balter	Carnegie Mellon University, Pittsburgh	USA	QPA
17-20	P. Glynn	Stanford University	USA	QPA

February 2007

04-07	I. Gallo	University of Bologna	Italy	RSS
12	Z. Landsman	University of Haifa	Israel	QPA
04-11	F. Guerra	Università di Roma La Sapienza	Italy	RSS
04-11	P. Contucci	University of Bologna	Italy	RSS
05-06	C. Külske	University of Groningen	The Netherlands	RSS
12-16	S. Brofferio	Université Paris-Sud	France	RSS
22-24	D. Silvestrov	Mälardalen University, Västerås	Sweden	QPA

March 2007

13	P. Diaconis	Stanford University	USA	RSS
18-27	P. Mathieu	Université de Provence, Marseille	France	RSS
26-30	T. Bodineau	Université Paris 7	France	RSS

April 2007

06-17	R. Kang	University of Oxford	United Kingdom	RSS
10	R. Hadianti	Bandung Institute of Technology	Indonesia	QPA
14-19	L. Adriano-Berry	University of Oxford	United Kingdom	RSS
16-19	M. Lenci	University of Bologna	Italy	RSS
19-20	M. Viana	University of Illinois, Chicago	USA	SIM

May 2007

06-07	E. Morozov	Russian Academy of Sciences, Karelia	Russia	QPA
11-15	J. Skokan	London School of Economics	United Kingdom	RSS
20-27	M. Viana	University of Illinois, Chicago	USA	SIM

June 2007

04-07	B. Zwart	Georgia Institute of Technology, Atlanta	USA	QPA
05-29	S. Vidal Puig	University of Valencia	Spain	SIM
06-09	A. Basuev	St. Petersburg Federal University of Technology and Design	Russia	RSS

08-14	E. Cirillo	Università La Sapienza, Roma	Italy	RSS
11	A. Krishnamurthy	Rensselaer Polytechnic Institute, Troy, New York	USA	QPA
17-27	G. Slade	University of British Columbia	Canada	RSS
17-29	J. Goodman	University of British Columbia	Canada	RSS
24-28	O. Angel	University of Toronto	Canada	RSS
July 2007				
06	B. D'Auria	Universidad Carlos III	Spain	QPA
06-August 05	O. Kella	Hebrew University of Jerusalem	Israel	QPA
07-31	D. Perry	University of Haifa	Israel	QPA
08-14	V. Kulkarni	University of North-Carolina, Chapel Hill	USA	QPA
08-18	M. Luczak	London School of Economics	United Kingdom	RSS
12-15	M. Squillante	IBM Watson Research Center, Yorktown Heights	USA	QPA
August 2007				
12-17	J. Berestycki	Université de Provence, Marseille & Université Paris VI	France	RSS
20	M. Steele	Wharton University of Pennsylvania	USA	RSS
September				
10-23	I. Ibragimov	Petersburg Department of Stek- lov Institute of Mathematics	Russia	SIM
Sept. 07-08	R. Fernández	Université de Rouen	France	Gen.
18	A. Greven	Universität Erlangen	Germany	RSS
18	M. Birkner	WIAS	Germany	RSS
October				
08-12	S. Thonhauser	Johann Radon Institute for Com- putational and Applied Mathe- matics	Austria	QPA
22-26	F. Caravenna	University of Padua	Italy	RSS
November				
10-25	J. Gärtner	Technische Universität Berlin	Germany	RSS
19-28	G. Maillard	EPFL	Switzerland	RSS
19-23	S. Foss	Heriot-Watt University	United Kingdom	QPA
19-25	D. Kim	Al-Farabi Kazakh National Uni- versity, Almaty	Kazakhstan	QPA
26- Dec. 1	A. Pelligrinotti	University Roma 3	Italy	RSS

In total **46** researchers visited EURANDOM in 2007 (from several days up to 2 months).
Total residence time: **68** weeks.

Distribution over the programmes:

Programme	Number of visits	Weeks
QPA	16	21
RSS	26	33
SIM	04	10
General	01	04
TOTAL	47	68

7. (INTER)NATIONAL COOPERATION and FUNDING

- 7.1. (Inter)national Cooperation
- 7.2. Cooperation in The Netherlands
- 7.3. Funding

7.1. (Inter)national Cooperation

As the previous sections already show, international cooperation is flourishing through, amongst others, the workshops and the visitor programme. Many international organisations are supporting the activities of EURANDOM by sending their junior and senior researchers to attend a workshop or to spend some time as a visitor. Of course the main asset for internationalisation remains the fact that most of the junior researchers come from outside The Netherlands.

Through members of the Scientific Council and members of the Steering Committees, as well as via scientists who are active at EURANDOM and postdocs who left the institute, many contact lines continue to tie EURANDOM to mathematical institutes and universities all over the world.

EURANDOM is member of ERCOM, the European Research Centres on Mathematics, a committee under EMS (the European Mathematical Society), consisting of mathematical institutes that frequently host visitors and organize workshops. Together with other ERCOM members EURANDOM participated in the NEST-programme (see below); at the moment an application is in preparation for a workshop programme within the framework of the ESF.

EURANDOM was one of the four partners in the NEST (New and Emerging Science and Technology) activity MATHFSS (Shaping New Directions in Mathematics for Science and Society, 2005-2007). This project aimed at identifying future research opportunities on the interface between mathematics and other scientific areas. The participants organized a series of workshops and round table discussions. The first workshop at EURANDOM took place in March 2006 (Risk Measures & Risk Management for High-Frequency Data, see paragraph 6.1); the second in April 2007.

Professor W.Th.F. den Hollander chaired the ESF Scientific Programme on 'Random Dynamics in Spatially Extended Systems' involving 13 European countries. This programme continued until the summer of 2007. The programme was recently evaluated very positively. Also in the proceedings of the Les Houches Summer School on "Mathematical Statistical Physics", presenting a road map on the field, among others Professor W.Th.F. den Hollander played an important role.

EURANDOM participated in the Network of Excellence PASCAL (Pattern Analysis, Statistical Modelling and Computational Learning, 2003-2007), "to build a Europe-wide Distributed Institute that will pioneer principled methods of pattern analysis, statistical modelling and computational learning as core enabling technologies for multimodal interfaces that are capable of natural and seamless interaction with and among individual human users". A proposal for a follow up was granted, but as the research plans did not fit in the core of EURANDOM's research anymore, the institute is no longer an active member. Incidental collaborations and applications are still possible.

EURANDOM also participated in the EURO-NGI project 'Design and Engineering of the Next Generation Internet', the main target of which is "to create and maintain the most prominent European centre of excellence in Next Generation Internet design and engi-

neering, leading towards a leadership in this domain". Also in EURO-FGI, the following Network of Excellence, EURANDOM is participating via the scientific director and senior fellows of the QPA programme. Both programmes will have a follow up in EURO NF (2008-2010).

There is a close cooperation with German researchers through the Dutch-German Bilateral Research Group on 'Mathematics of Random Spatial Models from Physics and Biology', which, after positive mid-term review, was granted a second period of three years. Although the German Schwerpunkt 'Interagierende stochastische Systeme hoher Komplexität' has been ended, cooperation with German scientists continues, especially in the RSS programme.

Through one of the SIM senior fellows, links with the Universität Duisburg-Essen were established. Many young researchers visited EURANDOM during the YES (Young European Statisticians) workshop and the preceding workshop Algorithms in Complex Systems.

7.2 Cooperation in The Netherlands

EURANDOM has formal agreements of cooperation with three national research schools in Mathematics in The Netherlands: MRI (Mathematical Research Institute), EIDMA (the Euler Institute for Discrete Mathematics), and the Thomas Stieltjes Institute for Mathematics.

There are intensive links with the Department of Mathematics, the Department of Technology Management and the Department of Mechanical Engineering in Eindhoven through joint appointments, joint seminars, joint visitors, researchers working together etc. Some postdocs are involved in teaching activities at the Eindhoven University of Technology.

In 2007 EURANDOM continued tightening the network with alumni. Some alumni are still linked to EURANDOM via a research fellowship. This applies especially to some former postdocs, who found tenured positions at Dutch universities.

Also the senior fellows as well as joint appointments are ways of linking the institute to the other Dutch universities, where mathematics is one of the scientific areas.

7.3. Funding

On the national level, basic financial support of EURANDOM is provided by NWO and Eindhoven University of Technology (both up to 2007) based on the 'EURANDOM Business Plan 2003-2007'. NWO will not continue financing at this moment in time. However, as already explained in the introduction, the Board of Eindhoven University of Technology and the Department of Mathematics and Computer Science of Eindhoven University of Technology have decided to jointly support the institute, financially and in kind.

Funding of the institute in the European context was not highly successful until now. However, during the last years, many grants were obtained through national research organisations such as DFG and FWO, several times young researchers received incidental, personal granting and the institute continuously received co-funding for workshops. Furthermore, EURANDOM is in the process of being recognized by CNRS (Centre National de la Recherche Scientifique, the French National Science organisation) as a "Unité Mixte Internationale (UMI)", which will result in a continuous flow of French researchers to EURANDOM.

During the year 25 junior researchers were (co-)financed by external funds. These funds came from NWO - Netherlands Organisation for Scientific Research -, including the BRICKS (Basic Research in Informatics for Creating the Knowledge Society) programme, (directly and/or via appointments at Eindhoven University of Technology or other universities), STW (Technology Foundation - the Dutch funding agency for university research), FWO (Research Foundation Flanders, Belgium), the European Commission, Philips Electronics Nederland B.V. and in joint appointments with the University of Amsterdam as well as with the Departments of Mathematics and Computer Science and of Technology Management, both at Eindhoven University of Technology. Some of the projects are continuations of earlier collaboration, such as the project on Batteries as well as the project on Cable Networks with Philips.

The European Commission Networks of Excellence PASCAL (Pattern Analysis, Statistical Modelling and Computational Learning) as well as the ESF RDESES programme (Phase Transitions and Fluctuation Phenomena for Random Dynamics in Spatially Extended Systems) both financed a workshop in 2007. The MATHFSS (Mathematics for Science and Society) project, support action of the New and Emerging Science and Technology (NEST) programme of the EC, also financed a workshop. Co-sponsoring was also received out of the TEMPUS programme (through sponsoring of participants from designated countries). Furthermore, workshops in 2007, like in the years before, were (co-)financed by the Beta Research School, KNAW (Royal Netherlands Academy of Arts and Sciences), NWO, and the Thomas Stieltjes Institute for Mathematics. Next to these organisations many others (Philips, ASML, CQM, the city council of Eindhoven, the ABE foundation and several publishers) co-sponsored the INFORMS conference in July. This was the only workshop for which conference fees were due, all other workshops were free of charge.

One long term visit was funded by an NWO-visitor grant.

8. FACILITIES

8.1. Computing

8.2. Library

8.3. Housing

8.1. Computing

EURANDOM has ample computing facilities. Desktop equipment consists of personal computers that offer access to the Windows / NT and the Unix servers. The personal computers are connected through a high-speed network to these servers and to the internet. Service on UNIX machines comes from the Department of Mathematics and Computer Science. If needed, computing time can be bought on the supercomputing facilities of NCF. The mathematical software that is available consists of Mathematica, Maple, TEX, S-plus, Matlab, R, and programming languages such as C++, C and Visual Basic. Furthermore a wifi network and a small administrative procedure, arranged by the administrative staff, enables visitors to quickly connect their own laptops to the network.

8.2. Library

A modest in-house library is available. As with computing power and software, EURANDOM follows the policy to acquire books and journals only when they are frequently needed. EURANDOM has a working library, not a complete coverage of journals in the field of stochastics. Full-scale libraries are available for EURANDOM staff at Eindhoven University of Technology, especially at the Department of Mathematics, and access is given to the Dutch academic library system. Via the library of Eindhoven University of Technology EURANDOM researchers have the possibility to access among others J-STOR. In view of the fact that almost all journals can be found and read electronically, we decided to reduce the journal part of the library in favour of a limited broadening of the book library.

8.3. Housing

EURANDOM provides well-equipped office space, meeting rooms and seminar rooms, a common room, and lunch facilities for its staff in its own building. All other facilities of Eindhoven University of Technology may be used; this includes a sports centre on campus where people can participate in various kinds of sports as well as a day-care centre.

9. EXPENDITURE

The sum of the expenditure is based on the audited financial report.

Expenditure (in K euro)

Staff	1045
Senior Fellows	170
Travel	37
Visitors	38
Housing	121
Workshops, Seminars	149
Books, Journals, Software	8
Depreciation costs	14
General costs	52
ICT Support	29
TOTAL	1663

Furthermore postdocs with a grant (303 K Euro), visitors (30 K Euro) and workshop participants (125 K Euro) with their own grants deliver an essential part of the EURANDOM activities. Based on average cost estimates this contribution "in natura" represented this year a money value of 458 K Euro.