Annual Report 2010

EURANDOM

European Institute for Statistics, Probability,
Stochastic Operations Research
and their Applications

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The core business of Eurandom is to foster research in the stochastic sciences and their applications by a visitor exchange and workshops program. Eurandom acts as an international meeting point for researchers in the various areas of stochastics and takes initiatives for collaborative research at a national as well as at a European level.

Festive dinner in the DAF museum during the ESF-EMS-ERCOM workshop "Combinatorics and Analysis in Spatial Probability"

Introduction

Eurandom was founded as an international institute on June 30, 1997 by the Netherlands Organization for Scientific Research (NWO) and Eindhoven University of Technology (TU/e), with a large grant from the Ministry of Education and Science. It has been operational since the summer of 1998. Basic funding came from NWO and TU/e, until January 1, 2008.
Since January 1, 2008 the institute is organizationally embedded in the Department of Mathematics & Computer Science. Over the years this will be more materialized. In 2010 it was decided to transform the institute into a workshop centre. The location, Laplace building, will not change until the Department of Mathematics & Computer Science moves into a new building. Funding from the foundation Eurandom is presently supplemented with money from grant applications. In addition, since 2008 part of the costs are covered by (in kind) contributions by the general board of TU/e and the Department of Mathematics & Computer Science, TU/e.

An important development in Dutch stochastics and in the evolution of Eurandom, was the start of the fourth mathematics cluster, STAR: Stochastics - Theoretical and Applied Research. STAR was launched on May 15, 2009.
The scientific committee of STAR consists of Frank den Hollander, Chris Klaassen, Rob van der Mei, Aad van der Vaart and Onno Boxma (chair). In December 2009 NWO decided to give STAR a 1,5 M euro grant, covering a 2 year period.

1. Mission Statement

The mission of Eurandom is gradually shifting; the institute is transforming into a workshop centre. In the new situation the institute no longer appoints junior researchers. All researchers involved will then be either appointed at the department or will be linked to Eurandom based on their appointment at another university, having ties to the research area of stochastics.

2. The role of stochastics

Stochastics, consisting of statistics, probability theory and stochastic operations research, is a mathematical discipline that plays an important role in our technological society. We are more and more faced with organizations, systems and processes so complex that description and analysis in terms of random elements is more appropriate and effective than a fully deterministic approach. Accordingly, stochastics is becoming increasingly important in other disciplines, like physics, chemistry, biology, economics and telecommunication.
Stochastics is internationally flourishing. Consequently, there is a great need to train a new generation of mathematicians with a strong knowledge of the foundations of stochastics, a good insight into the applicability of stochastics in diverse areas, and an open attitude toward newly developing theories and applications. Sharing and disseminating this knowledge of course plays an important role as well.

3. Research at Eurandom

Research areas covered by Eurandom are *stochastics and its applications*, as well as its interfaces with other disciplines. In spite of its modest size, Eurandom is engaged in many activities at a local, national and international scale, making it into an important research facility in Europe.

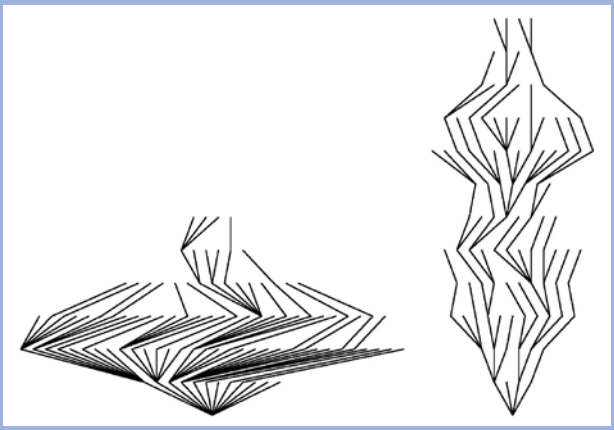
One of the key instruments of Eurandom in realizing its mission is its workshop and visitor program. This program offers young scientists a well-developed training opportunity. Workshops gather top researchers in the field to exchange the latest developments and ideas; sometimes concentrated mini-courses are given. In some cases junior researchers play a special role in a workshop. Senior and junior researchers staying at the institute frequently develop a close cooperation with the visitors.
The scientific activities of Eurandom are organized in four research programs, which are all central in the area of stochastics. Programs have two to four themes.

Multivariate Risk Modelling (MRM)
This topic lies at the interface of economics, finance and insurance.
The research of the MRM group focuses on subjects closely related to the credit crisis that developed during 2008. The research is directed towards both fundamental and applied research. The aim is to relate new models, techniques and settings to real world data, cases and situations. To realize this, the MRM group has a close cooperation with the financial industry.

Currently, the MRM Group is active in three themes:
- New Rating Models for Asset Backed Securities (ABSs)
- Alternative Volatility models
- Credit derivatives and their risk management

The shape of optimal paths in a random network
by dr. Jesse Goodman

First passage percolation is a model for optimal routing in a network with *random* connection costs. For every link between two nodes in a network - for instance, every road between two cities or every link between two computers - assign a positive random number representing the cost of crossing that link. The cost of traversing a path is the total of the link costs along the path. Given a starting node, we can produce a "map" of optimal paths: for each possible destination node, take the path with the *smallest* total cost. The nature of the optimal paths reflects an interplay between the geometric features of the underlying network (such as the spatial arrangement of the nodes in road and rail networks or the prevalence of highly connected nodes in social networks) and characteristics of the random link costs (particularly the prevalence of extremely low-cost links). We study first passage percolation in the extremely symmetric setting of the complete graph, where each of the n nodes has a link to each other node.
Adding randomness changes the complete graph dramatically. No longer highly connected and symmetric, the map of optimal paths becomes inhomogeneous and locally tree-like. A long path of especially inexpensive links may cost less than a shorter path, so an optimal path may be surprisingly long. Moreover, the size of this effect depends on the underlying distribution of the random link costs.



The "map" of optimal paths in the complete graph with 100 nodes. The vertical direction shows the number of links traversed. When low-cost links are more frequent (as in the right illustration) optimal paths can traverse more links.

In joint work with Maren Eckhoff, Remco van der Hofstad and Francesca Nardi (Eurandom and TU/e), we use coupling and branching process techniques to quantify the dependence between the link costs and the lengths and total costs of optimal paths. In particular, we find a smooth transition between possible path length scaling regimes, from tightness to log n to $n^{1/3}$, in terms of parameters of the link cost distribution.

Queueing and Performance Analysis (QPA)
The goal of QPA 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.

The program consists of three themes:
- Queueing Theory
- Performance Analysis of Production Systems
- Performance Analysis of Communication Systems

Random Spatial Structures (RSS)
The RSS-program 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.

The themes in wich the RSS group is active are:
- Critical phenomena
- Disordered media
- Combinatorial probability
- Applications in biology

Statistical Information and Modelling (SIM)
The SIM-program conducts research on a variety of topics in mathematical and applied statistics. The research currently mainly focuses on semi- or nonparametric problems. Such problems naturally arise in many different contexts, when complex statistical models are used that involve a very large number of unknown parameters, possibly infinitely many. These so-called high-dimensional statistical models are often encountered in areas like image analysis, mathematical biology, finance or climate science.
Particular fields of interest in mathematical statistics include inverse problems, nonparametric Bayesian inference and semi- or nonparametric inference for stochastic processes. On the applied side the group is among others involved in projects in image analysis and climate predictions.

Implied Lévy Volatility
by dr. Florence Guillaume

Despite its well known shortcomings, the Black-Scholes model remains the standard quoting tool for vanilla options. In the Black-Scholes setting, the logarithm of the stock price is assumed to follow a normal distribution with only one intrinsically unobservable parameter, namely the volatility of the stock. In particular, the Black-Scholes model assumes a constant volatility over the option strike prices and times to maturity, i.e. a flat volatility

surface. This simple model performed really well before the Black Monday, when the stock market experienced the largest one day crash in history. Since 1987, typical volatility shapes have been observed depending on the particular area of the financial market: the implied volatility is typically smirking and smiling at us under the equity and foreign exchange markets, respectively. Hence, these last two decades, many stock models have been proposed by academics, including stochastic volatility characteristics or/and jumps in order to capture the smile inherent to financial markets. Although all these models turn out to fit the implied volatility surface with the same precision, they typically produce hedge ratios which differ from the Black-Scholes ones and different prices for exotic (i.e. illiquid) options.

Figure 1: Fudging of the volatility parameter of the Black-Scholes model by traders via the concept of implied volatility

More than twenty years after the crash in the equity market, there is still no model which comes to the fore. Actually the Black-Scholes model has remained the standard tool to quote vanilla options in terms of the implied volatility; which might be explained by its relatively conceptual simplicity and by the intuition that traders have developed about its model parameter.

Given the great appeal of the implied volatility concept and the empirical evidence of skewed and fatter tailed stock price processes inferred from both stock time series and vanilla option price surfaces, we extend this widespread concept to the class of Lévy processes. In particular, we propose two classes of models, namely the Lévy space implied volatility and the Lévy time implied volatility models which give rise to the concepts of implied Lévy space and time volatility, respectively, and which are derived in a similar way as the Black-Scholes implied volatility. By considering such more suited Lévy distributions, we introduce additional degrees of freedom into the model, which can be set in order to minimize the volatility skew. Numerical examples emphasize the fact that any smiling or smirking volatility skew adjustment under the Black-Scholes model corresponds to a flat Lévy volatility curve under some particular symmetric and asymmetric Lévy volatility model, respectively.
The flat volatility curve in the Lévy models benefits practitioners faced with the pricing of exotic options with a payoff depending on more than one strike and deals with the recurrent problem of numerical errors in the volatility skew originating from interpolation or extrapolation procedures.
This project has been carried out during my Ph.D. program at both the Catholic University of Leuven, Belgium and the Eindhoven University of Technology, within the group Multivariate Risk Modeling of Eurandom.

5. Board, Scientific Council and Directors

Board
Prof.dr. F.A. van der Duyn Schouten (chair / treasurer),
until December 31, 2010.
Prof.dr.ir. C.J. van Duijn (member)
Prof.dr.ir. G. van Oortmerssen (member), until December 31, 2010.

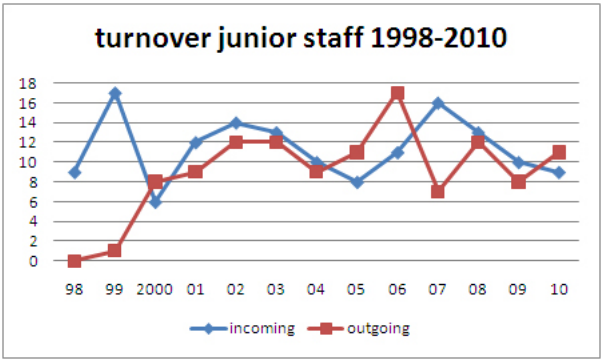
New members will be:
Prof.dr. A.M. Cohen and prof.dr.ir. J.C. Fransoo

Scientific Council
- Professor J. Beirlant (Katholieke Universiteit Leuven, Belgium)
- Professor D. Dawson - Chair (Carleton University, Ottawa & McGill University, Montreal, Canada)
- Professor Ph. Robert (Centre de Recherche INRIA Paris-Rocquencourt, France)
- Professor A. Schied (Universität Mannheim, Germany)
- Professor V. Schmidt (Universität Ulm, Germany)
- Professor D. Silvestrov (Mälardalen University, Sweden)
- Professor V. Sidoravicius (CWI, The Netherlands)
- Professor A.W. van der Vaart (Vrije Universiteit Amsterdam, The Netherlands)
- Professor T. de Wet (University of Stellenbosch, South Africa)

Directors
Prof.dr.ir. O.J. Boxma, scientific director
From April 1, 2011 prof.dr. R.W. van der Hofstad has taken over the scientific directorship
Drs. C.M.M. Cantrijn, managing director

6. Scientific Staff

Until 2011, at any time about 25 junior researchers are working at Eurandom, from which 8-10 were (partly) employed by the institute (through TU/e) in 2010. Each program hosts postdocs and graduate students, supervised by senior fellows. Since its start, around 135 PD's and PhD's have been working at the institute.
Most of the researchers (about two thirds) have found tenured positions in academia or industry after leaving the institute; approximately 10 have been appointed full professor at different universities. Approximately one third of the former employees found a position at a Dutch university or in a research program of a Dutch company.



Senior fellows

There were no changes among the senior and research fellows.

Awards & Grants

Frank den Hollander (UL and Eurandom), former Eurandom scientific director received an **ERC Advanced Researcher Grant.**

Markus Heydenreich, former Eurandom PhD student started as **STAR assistant professor** in Leiden and CWI. Markus was granted a Veni by NWO, on the use of mathematical models to explain abrupt changes in physical systems.

Dr. **Maria Vlasiou** (TU/e and Eurandom)
former PhD student was rewarded an **NWO grant** for her proposal: Error Bounds for Structured Markov Chains .

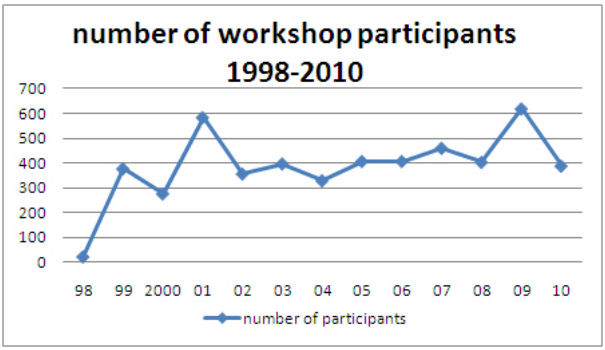
The European Research Council (ERC) has granted dr. **Johan van Leeuwaarden** former PhD student a **Starting Grant** for his project Critical Queues and Reflected Stochastic Processes (CritiQueue).

Prof.dr. **Harry van Zanten** (TU/e and Eurandom), senior fellow and Prof. dr. **Peter Grünwald** (CWI and UL and former postdoc at Eurandom), received the Van Dantzig Prize 2010.

Prof.dr. **Peter Grünwald** (CWI and UL) also received a VICI-grant for his project called "Safe Statistics"

7. Facts and Figures

Workshops and Conferences
Workshop topics are chosen by the senior fellows and other people linked to the research programs. Ideas for topics also come from postdocs and visitors, and through the various European networks and programs in which Eurandom participates. An overview of all workshops is available on: http://www.eurandom.tue.nl/events/workshops/all_workshops.htm



The YEP, YES and YEQT workshops are organised by and for young researchers. They attract a lot of participants, who sometimes present their work for the first time to an audience outside of their institute. This is a highly successful format.

Number of workshops in 2010: 8 from which 7 at Eurandom
Total number of participants in 2010: 389

March 8-13, 2010 (RSS)
YEP-VII workshop "Probability and Algorithms"

April 13-16, 2010 (hosted)
Workshop "Nonlinear Dynamics of Natural Systems+"

June 24 & 25, 2010 (LOIS / QPA)
Workshop "Stochastic Models for Manufacturing Systems"

September 29 - October 1 (QPA)
Second Dutch-Israel workshop

October 22, 2010, KU Leuven (MRM)
EIBURS Workshop "Asset backed securities: The march forward"

REPORT of a workshop
by dr. Ismael Castillo

"This workshop was organized as the fourth in the series Young European Statisticians (YES), within the framework of Eurandom's Statistical Information and Modelling (SIM) program. The workshop was sponsored by Eurandom, NWO (Netherlands Organisation for Scientific Research) and STAR.

This fourth YES-workshop allowed the participants to present their work, share ideas and interact on the subject of Bayesian Non-Parametric Statistics. Due to the variety of their applications, Bayesian methods currently play an increasingly important role within different communities, from mathematical statistics to probability, from machine learning to biostatistics and financial mathematics.

As the organizer of the workshop together with Bas Kleijn (University of Amsterdam), the first task was to agree on a list of main speakers. After four main speakers confirmed their participation, we started advertising the event in Europe. Since we work in two different countries, we organized everything by email. We could count on the help of Patty Koorn from the Eurandom staff for many practical aspects (website, hotel booking, organization social dinner, etc). About six weeks before the workshop, we made a selection of contributed talks and finished organizing the program. The final program was very dense, spanning over two and a half days, with 10 contributed speakers and more than 40 participants.

It was my first experience as organizer of a workshop. Though this required some work, it was at the same time very rewarding. As organizer, you have to know about the speakers, their talks and research areas before the workshop actually starts, so in a way, the program is customised for you. Above all, the YES-concept is a great occasion to meet young researchers from all over Europe, in a context -the Eurandom lab- and a workshop format -around 30-40 participants- which favours numerous interactions, in a quicker and less formal way than traditional larger-scale congresses."

November 8-10, 2010 (SIM)
YES-IV workshop "Bayesian Nonparametric Statistics"

November 25-27, 2010 (QPA)
YEQT IV workshop "Optimal Control in Stochastic Systems"

December 13-16, 2010 (RSS)
ESF-EMS-ERCOM workshop "Combinatorics and Analysis in Spatial Probability"

Furthermore:

- On February 1, 2010 the Eurandom Chair 2009-2011, professor Dilip Madan, gave a mini-workshop on Stochastic Processes in Financial Applications.

Professor Dilip Madan
University of Maryland, USA

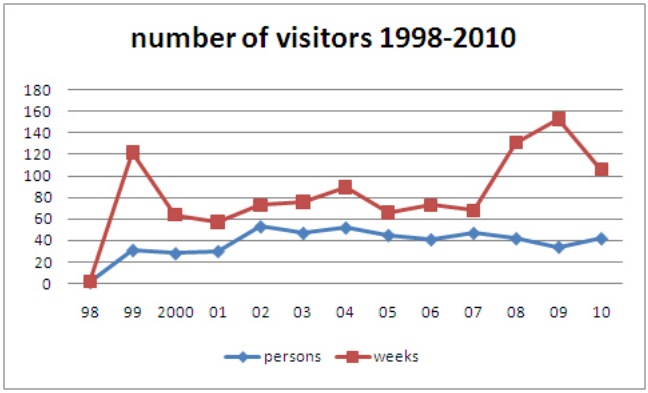
- In November 2010 Professor Sergey Foss visited the institute for the first time as Eurandom Chair 2010-2011; he gave a minicourse in 2011 "Maximal Paths in a Class of Stochastic Ordered Graphs and Related Problems".

Professor Sergey Foss,
Heriot-Watt University, Edinburgh, UK

- Eurandom organised a lecture day on the occasion of 1-year STAR cluster, on December 3, 2010.

Lectures and Seminars
Number of seminars in 2010: 70
Lectures and seminars are organized on a regular basis within the framework of each of the research programs. Sometimes seminars are joint events, e.g. the Informal Meetings of Eindhoven Statisticians with TU/e.
An overview of all seminars is available on:
http://www.eurandom.tue.nl/events/seminars/2010.htm

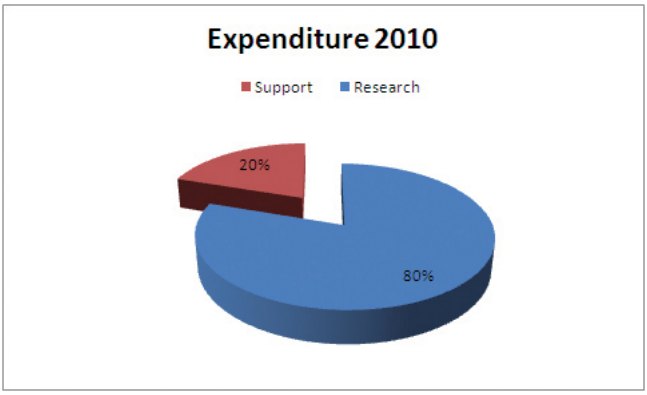
Visitors
Number of visitors (and visits) in 2009: 42
Total duration of stay in weeks: 106
One long term visitor stayed for a whole year, partly in 2010: dr. Gregory Maillard, former Eurandom postdoc, now affiliated to Université Aix-Marseille). Two others for 3 months (A. Ferreiro-Castilla (Universitat Autònoma de Barcelona) and F. Avram, Université de Pau). Most visitors come for a period of a few days up to one month.



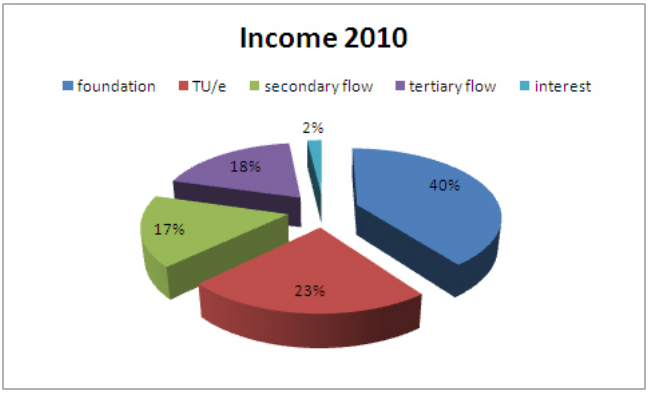
An overview of visitors is available on:
http://www.eurandom.nl/Past years/visitors_pastyears.htm

Publications
In 2010, 53 Eurandom reports were written, while the website of the Department of Mathematics and Computer Science mentions 59 external Eurandom (-linked) publications (articles in refereed journals, external reports, conference proceedings and book(chapter)s).
An overview is available on:
http://oametuep.uci.ru.nl/metue/pk_apa_n.onderzoek?p_url_id=6349

Finance
The following figures report on expenditure and income:



Research *includes costs of salary of postdocs and graduate students, scientific director, senior fellows, Eurandom chair, computing, library, workshops & visitors and travel costs.*
Support *includes salary of the administrative staff and managing director, depreciation and general costs.*



Location
Eurandom is located on the campus of Eindhoven University of Technology, The Netherlands, Laplace building. The TU/e campus is situated close to the centre and the railway station of Eindhoven.

Facilities
Eurandom provides office space and computer facilities. Lecture rooms and a modest library annex common room are also available. Full scale libraries may be found on the campus of the TU/e.
The TU/e campus offers facilities such as a sports centre, a language lab and restaurants, which are also available for Eurandom staff.

Postdocs and long-term guests can be accommodated in one of the university guest houses. All employees are allowed to join the TU/e collective health insurance and can get help with procedures concerning visa, work permit etc.

Eindhoven, July 2011

Prof.dr. Remco van der Hofstad,
scientific director

Colofon

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and for the annual report on:
http://www.eurandom.tue.nl/annual_reports/index.htm