Wolfgang Stadje, forty years of research in probability and OR

Osnabrück, Germany

October 20-21, 2016

Scientific Program

Thursday, October 20

09.30:	Welcome	
09.40:	S.K. Bar-Lev (Haifa):	Group Testing Procedures with Incomplete Identification and their Applications in Medical and Industrial Problems
10.25:	I. Kleiner (Haifa):	Recycled Incomplete Identification Procedures for Blood Screening
10.50:	Coffee Break	
11.15:	E. v. Doorn (Twente)	Asymptotic Aperiodicity and the Strong Ratio Limit Property of Markov Chains
11.40:	P. Moyal (Compiègne)	Stability of the General Stochastic Matching Model
12.05:	O. Kella (Jerusalem)	Wolfgang and I, the Small Collaboration Part of Over Two Decades of Our Personal Friendship
12.30:	Lunch break	
13.45:	R. Ravid (Braude)	A New Look on the Shortest Queue with Jockeying
14.10:	A. Löpker (Dresden)	Time Reversal and Perfect Simulation for the INAR(1) Autoregressive Process
14.35:	A. Gnedin (London)	Cycle Counts in Random Permutations and the Infinite-Server Queues
15.00:	Coffee Break	
15.30	M. Haviv (Jerusalem)	Self-Regulation in Three Queueing Scenarios
15.55:	E. Schulte-Geers (BSI)	Probability in a Calculus Problem

Visit at the museum (16.45-18.00) followed by workshop dinner

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Friday, October 21

09:30:	I. Adan (Eindhoven)	A Rate Balance Principle
09.55:	K. Avrachenkov (INRIA)	Hitting Times in Markov Chains with Restart and their Applications to Ranking
10.20:	Y. Baryshnikov (Illinois)	Search on the Brink of Chaos
10.50:	Coffee Break	
11.15:	J.A.C Resing (Eindhoven)	Some Two-Dimensional Queues and Risk Models
11.40:	S. Kapodistria (Eindhoven)	A Matrix Geometric Approach for Random Walks
12.05:	U. Yechiali (Tel Aviv)	Exact Analysis for Multi-server Queueing Systems with Cross Selling
12.30:	Lunch break	
13.45:	M. Stadje (Ulm)	Time-Consistent and Market-Consistent Evaluations
14.10:	M. N. Katehakis (Rutgers)	Simple Data Driven Policies for MDPs
14.35:	D. Perry (Haifa)	On My Joint Work with Wolfgang
15.00:	Coffee break	
15.30:	S. Zacks (Binghamton)	Telegraph Process with Random Velocities
16.00:	Closing session	

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Ivo Adan
A rate Balance Principle

We introduce a rate balance principle for general (not necessarily Markovian) stochastic processes, with special attention to birth-death like processes. This principle appears to be useful in deriving well-known, as well as new, results for various queueing systems.

Kostia Avrachenkov
Hitting Times in Markov Chains with Restart and their Applications to Ranking

Motivated by applications in telecommunications, computer science and physics, we consider a discrete-time Markov process with restart in the locally compact Borel state space. At each step the process either with a positive probability restarts from a given distribution, or with the complementary probability continues according to a Markov transition kernel. The main focus of the present work is the expectation of
the hitting time (to a given target set) of the process with restart. Observing that the process with restart is uniformly ergodic, we obtain the expression of its unique invariant probability, as well as the expression of the expected hitting time of the restarted process to a target set. These formulae allow us to refine some known
stability results about the underlying process in terms of hitting times. Then we show that the problem of optimization of the expected hitting time with respect to the restart probability is well denned and possesses desirable properties. We illustrate our results with examples in uncountable and countable state spaces as well as with application to network node ranking.

The talk is based on a joint work with A. Piunovskiy and Y. Zhang

Shaul K. Bar-Lev
Group Testing Procedures with Incomplete Identification and Their Applications in Medical and Industrial Problems

In this talk we review an ongoing research project on group testing procedures jointly with Wolfgang Stadje (Osnabrück, Germany), Frank van der Duyn Schouten (Tilburg, VU, The Netherlands) and Onno Boxma (Eindhoven, The Netherlands) and David Perry (Haifa, Israel). This project has already yielded several research papers.
More specifically we review various types of group testing models. The objective is to choose an optimal group size for pooled screening of a contaminated population so as to collect a prespecified number of good items from it with minimum testing expenditures. The tested groups that are found contaminated are either discarded or are used as new sampling population in later stages of the testing procedure. Since testing may be time consuming, we also consider deadlines to be met for the testing process.
We derive algorithms and obtain exact results for the underlying distributions of the associated stopping times, enabling us to find optimal procedures. We shall briefly review various aspects of group testing procedures such as multinomial group testing; unreliable results (false-positive and false-negative), window periods and expiration dates.
Some applications will be given, the most of which are concerned with blood screening for detecting viruses and some relevant industrial problems.
The talk will not be of any mathematical nature but rather a review and brief "state of art" on the subject.

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Yuliy Baryshnikov
Search on the Brink of Chaos

The classical linear search problem is studied from the view point of Hamiltonian dynamics. For the specific, yet representative case of exponentially distributed position of the hidden object, we show that the optimal plan follows an unstable separatrix which is present in the associated Hamiltonian system.

Erik A. van Doorn
Asymptotic aperiodicity and the Strong Ratio Limit Property of Markov Chains

A discrete-time Markov chain on the nonnegative integers (assumed to be homogeneous, irreducible and aperiodic) with matrix $P^{(n)}$ of n-step transition probabilities is said to have the *strong ratio limit property* (SRLP) if there exist positive constants $R, \mu(i)$ and $f(i)$ such that

$$\lim_{n\to\infty} \frac{P^{(n+m)}(i,j)}{P^{(n)}(k,l)} = R^{-m}\,\frac{f(i)\mu(j)}{f(k)\mu(l)}, \quad i,j,k,l \in \mathbb{N}_0, m \in \mathbb{Z}.$$

The SRLP was enunciated in the setting of recurrent Markov chains by Orey (1961) and introduced in the more general setting at hand by Pruitt (1965). Since then the problems of finding necessary and/or sufficient conditions on $P = P^{(1)}$ for the corresponding Markov chain to possess the SRLP, and of identifying the constants, has received quite some attention in the literature, albeit in the literature of the past millennium. The most general results to date have been obtained by Kesten (1995) and Handelman (1999).
In the talk I will give some information on the history of these problems, and discuss their solutions in the setting of birth-death processes. I will then show that by suitably interpreting the necessary and sufficient condition for the SRLP in the birth-death setting, a condition emerges which is meaningful in the wider setting at hand, and may be viewed as a conjectured sufficient condition for the SRLP to prevail. The conjecture involves the concept of asymptotic period of a Markov chain, which coincides with the period of the chain if it is recurrent, but may be larger than the period if the chain is transient.

Alexander Gnedin
Cycle Counts in Random Permutations and the Infinite-Server Queues

The probability that a random permutation has no fixed points is about 1/e. This classic fact can be viewed in the context of a natural permutation-growth process known as the Chinese Restaurant, which, however, slows down. With an exponential time-change one can achieve stationarity, so that that the cycle-counts in permutation behave like an infinite tandem of the infinite-server queues. Known results on the cycle structure of uniform and, more generally, Ewens' permutations can be revised using this analogy, and new derived from the results on busy periods and the big-intensity limits.

Based on a work in progress with Dudley Stark.

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Moshe Haviv
Self-Regulation in Three Queueing Scenarios

It is well-known that when the queue regime is first-come first-served, decisions, made by self-interested customers, are not socially optimal. Sometimes changing the queue regime incentivizes customers to behave in a socially optimal way. The talk will describe three such cases:
(1) last-come first-served in the observable M/M/1 case (Hassin '85),
(2) random priorities in the unobservable M/M/1 case (Haviv and Oz '16), and
(3) ?/M/1 bounded time queues with two customers (Haviv and Oz '17).

Joint work with Binyamin Oz

Stella Kapodistria
A Matrix Geometric Approach for Random Walks

The objective of this work is to demonstrate how to obtain the equilibrium distribution of the state of a two-dimensional homogeneous nearest neighbor (simple) random walk restricted on the lattice using the matrix geometric approach. This type of random walks can be modelled as a quasi-birth-death (QBD) process with the characteristic that both the levels and the phases are countably infinite. Then, based on the matrix geometric approach, if $\pi_n = (\pi_{n,0}, \pi_{n,1} \dots)$ denotes the vector of the equilibrium distribution of level n, n=0,1,… it is known that $\pi_{n+1} = \pi_n R$, $n \geq 0$. Although, this is a very well-known result, the complexity of the solution lies in the calculation of the infinite dimension matrix R. We will demonstrate a new methodological approach for the direct calculation of the eigenvalues and eigenvectors of matrix R.
This work promises 1) a wide spectrum of applicability 2) an easy theoretical framework, while also promising 3) the unification of three existing approaches for random walks (matrix geometric approach; compensation approach; boundary value problem), as well as 4) the first steps towards the probabilistic interpretation of the underlying terms involved in the solution.

Joint work with Z. Palmowski

Michael N. Katehakis
Simple Data Driven Policies for MDPs

Markov decision processes (MDPs) have a variety of applications, not just for the classical Operations Management fields but also in other directions such as computer science, engineering and biology/medical science. We first give a brief survey of the state of the art of the area of computing optimal data driven (adaptive) policies for MDPs with nknown rewards and or unknown transition probabilities. Then, we present three simple algorithms for adaptively optimizing the average reward in an unknown irreducible MDP.
The first algorithm uses estimates for the MDP and chooses actions by maximizing an inflation of the estimated right hand side of the average reward optimality equations. The

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second is based on estimating the optimal rates at which actions should be taken and the third is based on generalized Thompson sampling ideas. For the first we show that the total expected reward obtained by this algorithm up to time n is within O(ln n) of the reward of the complete information optimal policy, and in fact it achieves asymptotically minimal regret. Various computational challenges and simplifications are discussed.

Joint work with Wesley Cowan

Igor Kleiner
Recycled Incomplete Identification Procedures for Blood Screening

The operation of blood banks aims at the cost-efficient supply of uncontaminated human blood. Each unit of donated blood goes through multiple testing for the presence of various pathogens which are able to cause transfusion-transmitted diseases. The blood screening process is comprised of two phases. At the first phase, blood units are screened together in pooled groups of a certain size by the ELISA (Enzyme Linked Immuno-Sorbent Assay) test to detect various virus-specific antibodies. The second phase of the screening process is conducted by PCR (Polymerase Chain Reaction) testing of the individual blood units of the groups found clean by the initial ELISA phase. Thousands of units of donated blood arrive daily at the central blood bank for screening. Each screening scheme has associated testing costs and testing times. In addition, each blood unit arrives with an expiration date. As a result, the shorter the testing time, the longer the residual lifetime that is left for the blood unit for future use. The controller faces a natural and well-motivated operations management problem. He will attempt to shorten the testing period and reduce the testing costs without compromising too much on the reliability. To achieve these goals, we propose a new testing procedure that we term Recycled Incomplete Identification Procedure (RIIP). In RIIP, groups of pooled blood units which are found contaminated in the ELISA test are divided into smaller subgroups and again group-tested by ELISA, and so forth, until eventually the PCR test is conducted for those subgroups which are found clean. We analyze and optimize the performance of RIIP by deriving explicit formulas for the cost components of interest and maximize the profit associated with the procedure. Our numerical results suggest that it can indeed be profitable to do several cycles at ELISA.

Joint work with Shaul K. Bar-Lev, Onno Boxma, David Perry and Wolfgang Stadje

Andreas Löpker
Time Reversal and Perfect Simulation for the INAR(1) Autoregressive Process

The INAR(1) process is the integer valued counterpart of the classic AR(1) autoregressive process and is used to model count data time series. Under mild conditions the process has a unique stationary distribution and the question arises how one can sample from that distribution. We show how an exact sample can be obtained by using a method called coupling from the past, employing the time reversal of the process.

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Pascal Moyal
Stability of the general stochastic matching model

Consider the following stochastic matching model: Items of different classes enter a system one by one according to a stochastic point process, and depart by matched pairs. A simple graph whose nodes represent the classes of items, determines the possible matchings. Upon arrival, an item is either stored in line if there is no compatible item available in the system, or leaves the system immediately together with its match, if any. A matching policy determines the choice of its match if more than one compatible items are available. This model generalizes to general graphs, the so-called Bipartite Matching model.
We investigate the influence of the matching policy on the stability region of the system. After introducing a natural necessary condition for stability (Ncond), we exhibit, first, the class of graphs for which the model can never be stable and second, the class of graphs for which Ncond is also sufficient, i.e. the model is stable whatever the matching policy. Then, for more general graphs, using fluid-(in)stability arguments we show that Ncond is never sufficient for stability.

Joint works with Jean Mairesse and Ohad Perry

Rachel Ravid
A New Look on the Shortest Queue with Jockeying

We consider a queueing system consisting of two parallel independent servers. The service times are exponential and the arrival process is Poison. An arriving customer joins the shortest line. When the difference between the lengths of the lines becomes |2|, then the last customer in the longer line, switches to be the last customer in the shorter one. The probability generating function of the number of jockeying made by a customer is derived.

Joint work with David Perry and Ivo Adan

Jacques Resing
Some Two-Dimensional Queues and Risk Models

In this talk I will discuss some of our recent work on two-dimensional queues and risk models. In particular we look at queues and risk models with simultaneous arrivals, a coupled processor model and a two-dimensional risk model with correlated net input rates.

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Ernst Schulte-Geers
Probability in a Calculus Problem

Is $x \mapsto \binom{x}{2} + \binom{x}{4} + \cdots + \binom{x}{u}$ is a convex function on $[0, \infty)$? I will show how to tackle this question with probabilistic arguments, and briefly mention a relationship to recent work of Wolfgang and me.

Mitja Stadje
Time-Consistent and Market-Consistent Evaluations

We consider the extensions of many known static risk measures into time and market-consistent directions. Specifically, we construct discrete-time risk measures constructed from properly rescaled ('tilted') one-period convex risk measures, using a d-dimensional random walk converging to a Brownian motion. Under suitable conditions (covering many standard one-period risk measures) we obtain convergence of the discrete risk measures to the solution of a BSDE, defining a convex risk measure in continuous time, whose driver can then be viewed as the continuous-time analogue of the discrete 'driver' characterizing the one-period risk. We derive the limiting drivers for the semi-deviation risk measure, Value at Risk, Average Value at Risk, and the Gini risk measure in closed form. We also propose to extend standard actuarial principles by a new market-consistent evaluation procedure which we call `two step market evaluation' and give an axiomatical characterization.

Uri Yechiali
Exact Analysis for Multi-server Queueing Systems with Cross Selling

Exact probabilistic analysis of a multi-server Markovian queueing system with threshold on cross selling is presented. Both Probability Generating Functions (PGFs) and Matrix Geometric (MG) methods are employed. The relation between the two methodologies is revealed by explicitly calculating the entries of the rate-matrix R, being the corner-stone of the MG analysis. Those entries are expressed in terms of the roots of a polynomial related to the PGFs approach.
Performance measures are calculated and extensive numerical results are presented, showing the effect of the cross selling intensity and of the threshold level on the system's performance measures.

Joint with Mor Armony, Nir Perel and Efrat Perel

Shelly Zacks
Telegraph Process with Random Velocities

We study a telegraph process X(t), describing the position of a particle moving on a line with constant speed between Poisson times, at which new velocities are chosen at random from a gives sample space. Starting with two possible velocities which are chosen with probabilities

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p and 1-p, we derive the exact distribution of X(t) at a given time t. We then formulate the distribution of X(t) when the velocity is an absolutely continuous random variable. The formulas for the first two moments of X(t) are derived too.

Joint with Wolfgang Stadje

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