Tuesday, August 30, 14:00, Room H1012

Analysing $GI|E_r|1$ Queues

Ivo Adan, Eindhoven University of Technology

In this talk we study the $GI|E_r|1$ queue.

In the first part of the talk we show that the arrival distribution of the number of service stages in the system can be expressed as a linear combination of powers. This characterization directly leads to an explicit expression for the waiting time distribution under the first-come first-served discipline in the form of a mixture of exponential distributions.

In the second part of the talk it is investigated whether the explicit expressions are numerically useful. It is shown for some classes of interarrival time distributions that the results lead to an efficient and stable numerical procedure, which still works well for high traffic intensities and high values of the parameter r of the Erlang distribution.

Tuesday, August 30, 14:30, Room H1012

An $M|Ph|1$ Queueing System Subject to Breakdowns with Non-Homogeneous Interarrival, Service, Life and Repair Times

Michel van Eenige, Eindhoven University of Technology
Jan van der Wal, Eindhoven University of Technology

We consider a single server queue with server breakdowns. At this server, jobs arrive according to a non-homogeneous Poisson process with a non-homogeneous service time distribution which is of phase type. The life times of the server are non-homogeneously exponentially distributed. When a server breakdown occurs, the server will be repaired and in the mean time, all jobs wait. The repair times of the server have a non-homogeneous phase type distribution. The non-homogeneity of these distributions will be due to the dependence of their parameters on the number of jobs at the server and to the interdependence of these parameters. More precisely, the arrival rate depends on the number of jobs at the server, on the phase of the service time and on the phase of the repair time. The service rates depend on the number of jobs in the system. Finally, both the failure rates and the repair rates of the server depend on the number of jobs at the server and on the phase of the service time.

For example, one may think of the production to order of a product which requires a number of different operations such as sawing, boring, milling and polishing. Due to wear and breakage, every now and then a tool has to be repaired or replaced. Furthermore, it may be possible to speed up the production process, e.g., by using more expensive tools or hiring additional capacity.

For this queueing system, we give an explicit recursive matrix representation for the stationary queue length distribution.

Tuesday, August 30, 15:00, Room H1012

Perturbation Analysis of the Mean Waiting Time in the $M^x|G|l$ Queue

Rein Nobel, Vrije Universiteit Amsterdam

Recent years have shown a lot of interest in the study of stochastic gradients to estimate the gradient of a performance measure with respect to some vector of parameters ϑ. The performance measure is usually an expectation of some almost surely differentiable random variable $L(\vartheta)$. In complicated stochastic systems we have to resort to simulation to find an estimate for $\mathrm{E}[L(\vartheta)]$, so *a fortiori* we will need simulation to get an estimate for the gradient $\nabla_\vartheta \mathrm{E}[L(\vartheta)]$. The idea of *infinitesimal perturbation analysis* is to estimate this gradient by 'observing' realizations of the stochastic gradient $\nabla_\vartheta L(\vartheta)$ from a single simulation experiment for a fixed value of ϑ. One of the main problems is the unbiasedness of this estimate, i.e. $\mathrm{E}[\nabla_\vartheta L(\vartheta)] = \nabla_\vartheta \mathrm{E}[L(\vartheta)]$. For steady state performance measures strong consistency is the key question, i.e. does $\nabla_\vartheta L_n(\vartheta) \to \nabla_\vartheta \mathrm{E}[L(\vartheta)]$ a.s. as $n \to \infty$, if $L_n(\vartheta) \to \mathrm{E}[L(\vartheta)]$ a.s. as $n \to \infty$?

We briefly review the conditions which guarantee these properties and will apply the results to study the sensitivities of the mean waiting time of the $M^X/G/1$ queue with respect to service rate, arrival rate and batch size, by a single simulation. Also we will compare our results numerically with the analytical formulae to get a better insight into the practical value of perturbation analysis for sensitivity studies by stochastic simulation.

Tuesday, August 30, 15:30, Room H1012

On the Sojourn Time Problem in Discrete-Time Tandem Networks

Hans Daduna, Universität Hamburg

We consider tandem systems of Bernoulli-servers under First-Come-First-Served Schedule in discrete time. In equilibrium we derive the distribution of a customer's sojourn time in the system.

A first step in the derivation is to prove an "Arrival theorem" for the distribution of the other customers in the system seen by an arriving customer.

Semi-Plenary Lecture
Tuesday, August 30, 16:30, Room H1012

Explicit Solutions for Queueing Problems: An Overview of Methods and Results

Jaap Wessels, Technical University Eindhoven, The Netherlands

Most attempts to finding explicit solutions for queueing problems are based on the analysis of a Markov chain, which represents important features of the queueing process. These Markov chains can be high-dimensional. A time-dependent analysis appears to be feasible only in rare cases and even then the solutions are quite complicated. Therefore, attention is focussed on the equilibrium distribution. For an extensive class of models, the equilibrium distribution appears to be a product of powers. This is particularly the case for a class of queueing networks. For other models, there seem to be two main approaches which work for substantial classes. The oldest alternative is Neuts' matrix-geometric approach, which works in cases where the matrix of transition rates has a convenient block structure. The other, newer, approach may be viewed as a generalisation of the product-form-approach. It aims at identifying Markov chains which have an equilibrium distribution that can be written as a linear combination of product forms. In some cases, e.g. Ek/Er/c, the linear combina- tion appears to be finite. In other cases, e.g. the shortest queue model, the linear combinations appear to be countably infinite. In such cases particular techniques are required to generate the terms. It appears that these solutions for the equilibrium distributions also produce explicit and tractable solutions for the main performance characteristics, including higher moments.

Wednesday, August 31, 10:00, Room H1012

Uncertain Employment in Competitive Best Choice Problems

Krzysztof Szajowski, Wrocław Technical University, Poland

Mathematical models of competitive selection problems are considered. Two decision makers observe sequentially goods or applicants for a post. These objects are characterized by some numbers. The aim of the players is to accept the most profitable object. The following are rules of acceptance. The object can be accepted only at the moment of its appearance. At each moment n one object is presented only. When both players want to accept the same object then some rules of assignment are applied. The object accepted by the decision maker is available with some probability only. This is extension of the best choice problem with both uncertain employment solved by Smith (M. Smith, *A secretary problem with uncertain employment*, J. Appl. Probab., 12 (1975), pp. 620–624) and the competitive version of the problem with the priority and the random priority (K. Szajowski, *Markov stopping games with random priority*, ZOR, 39 (1994), pp. 69–84). The restricted and unrestricted number of tries are investigated. Several nested Bellman equations are investigated. The solution of examples justifying the model are given.

Wednesday, August 31, 10:30, Room H1012

A Stochastic Model for Layered Defence System

D. K. Al-Mutairi, Kuwait University
T. M. Al-Khamis, Kuwait University

A stochastic model is presented for analyzing layered defense system. This approach incorporates the dependence of attrition probability on the size of attackers going into any layer by using available information. Relevant information on the strength of layers is used to motivate the joint prior distribution for the attrition probabilities at all layers. Results at any particular layer is used to revise the attrition probabilities and also to determine the probability distribution of each surviving attacker at current layer, as well as at subsequent layers. A general formula is developed for computation of the predictive distribution as well as the posterior distribution under three cases separately: (i) independent identical distribution, (ii) independent, but not identical, distribution, and (iii) a Dirichlet distribution as the prior distributions for a transformation of the attrition probabilities. The results are incorporated with illustrations.

Wednesday, August 31, 14:00, Room H1012

Approximate Mean Sojourn Times of a Multi-Queue Processor Sharing System with Permanent Customers

Andreas Brandt, Humboldt-Universität zu Berlin

We consider a single server system consisting of n queues of different types of customers (Poisson streams) and k permanent customers. The permanent customers and those at the head of the queues are served in processor sharing by a single service facility. For the model considered a pseudo work-conservation law will be derived for arbitrary service time distribution. In case of exponential service times we obtain a pseudo conservation law for the mean sojourn times. Since for $n \geq 4$ an exact analytical or/and numerical treatment of the model becomes hopelessly complex, we propose a heuristic approximation for the mean sojourn times for the different types of customers. For the symmetric system the approximation is exact. Numerical as well as simulation studies show that, over a wide range of parameters, the approximation works well.

Wednesday, August 31, 14:30, Room H1012

Mean Sojourn Times in a Processor Sharing System with Queues of Different Types

Manfred Brandt, Konrad-Zuse-Zentrum für Informationstechnik Berlin

We consider a single server system consisting of two queues with different types of jobs and of permanent jobs. For each of the two queues we make the assumption of a Poisson arrival process and exponential service times. The permanent jobs and the top jobs of each queue share the processor. The generating function of the stationary distribution satisfies a functional equation. We reduce the solution of this functional equation to a Riemann-Hilbert problem and the Riemann-Hilbert problem to a Dirichlet problem for a circle. The solution of the Dirichlet problem yields the mean length of each queue and by the Little equation the mean sojourn times as an elliptic integral.

Wednesday, August 31, 15:00, Room H1012

Optimierung von Leistungsgrößen in einem geschlossenen Warteschlangennetz mit mehreren Kundenklassen

Rainer Schmidt, TU Clausthal

Warteschlangennetze finden in vielen Bereichen ihre Anwendung, wie z. B. bei Computernetzen, der Telekommunikation oder in der Produktionsplanung. Komplexe Systeme, insbesondere Systeme, die stochastischen Einflüssen unterliegen, lassen sich oft mit Warteschlangennetzen modellieren, so daß bekannte Verfahren zur Verfügung stehen, um gewisse Leistungsgrößen zu ermitteln. Mit der Berechnung von Leistungsgrößen eines Systems stellt sich oft auch die Frage nach deren Optimierung.

Es werden geschlossene Warteschlangennetze mit mehreren Kundenklassen betrachtet. Es soll eine Funktion, die die mittleren Kundenanzahlen in den Knoten, den Durchsatz und die mittleren Verweilzeiten mit gewissen Kosten belegt, minimiert werden. Die Optimierungsparameter können die Routingwahrscheinlichkeiten, die mittleren Bedienzeiten und die Anzahl der Bedienkanäle in den Knoten beeinflussen. Mit diesem allgemeinen Ansatz lassen sich eine Reihe von praxisrelevanten Problemen modellieren, z. B.

- die Wahl eines optimalen Routings von Bauteilen in einer flexiblen Fertigungslinie, oder
- die optimale kapazitive Ausstattung von Fertigungszellen (Anzahl der Maschinen, deren Leistungsfähigkeit) in der Linie.

In dem Vortrag werden exakte und approximative Verfahren vorgestellt, die es ermöglichen, den Gradienten der Kostenfunktion zu berechnen, um so Schritt für Schritt zu einem lokalen Optimum zu gelangen. Die betrachteten Verfahren basieren auf der Mittelwertanalyse und deren approximativen Erweiterungen für geschlossene Warteschlangennetze.

Wednesday, August 31, 15:30, Room H1012

Assigning Traffic in Multi-Machine Systems

Jan van der Wal, Eindhoven University of Technology

We consider a queueing system with m nonidentical machines. Jobs are of a number of different types and arrive according to independent Poisson processes. All service times are exponential. The means are the same for any machine-type combination. Each machine can serve only a subset of the types. If the subsets are disjoint the system becomes a set of independent M—M—1 queues. If any machine can serve all the types the system becomes an M—M—m queue. What happens in the region between? How much overlap is needed in order to obtain most of the benefits of a multiserver system?

Wednesday, August 31, 16:30, Room H1012

On a Theoretical Aspect of Dynamic Discrete Stochastic Choice Modelling

Bruno Dejon, Universität Erlangen-Nürnberg

Random utility models of discrete choice have been broadly applied, during the last 25 years, in urban and regional economics, and, more recently, also in modelling national economies. For disequilibrium situations, dynamic laws have been formulated that provide migration rates of economic agents between all pairs of discrete choice alternatives. In most applications these migration rates are dependent on the current distribution of economic agents across the set of discrete choice alternatives. In this paper it is argued that - under rather weak and natural conditions - those migration rates nevertheless are the transition rates of some Markov chain.

Wednesday, August 31, 16:30, Room H1029

Testing Whether Two Distributions are Stochastically Ordered or not

Karl Mosler, Universität der Bundeswehr Hamburg

A probability distribution function F on the reals is stochastically larger than another probability distribution function G, $F \geq_{st} G$, if $F(x) \geq G(x)$ holds for all $x \in \mathbb{R}$. In this paper we investigate significance tests for deciding between different pairs of alternatives which involve that one distribution function is stochastically larger than the other. First, we consider the null hypothesis that $F \geq_{st} G$ holds against the alternative that this is not the case. Second, the null that either $F \geq_{st} G$ or $G \geq_{st} F$ holds is tested against the alternative that this is not the case. Third, homogeneity, i.e. $F = G$, is taken as the null, and $F \geq_{st} G$ as the alternative. The tests proposed are modifications and extensions of known procedures such as the Kolmogorov-Smirnov and other nonparametric tests. Applications of the tests are numerous. They include location tests with ordinal data, specification tests for duration models, and problems in reliability and queueing.

Wednesday, August 31, 17:00, Room H1029

Validation of a Generalized Multiple Linear Regression

Ivan Kavkler, University of Maribor, Slovenia
Lilijana Arih, University of Maribor, Slovenia

To control some processes by an optimization model it is possible to construct this model directly from the sample for the random variables by which the process is representatively discribed. Because of the assumption of linearity it may first occur to us to find the interdependences among all variables using multiple linear regression (*MLR*). But *MLR* presupposes the independence of exogenous variables which rarely occurs. So, our new method to find linear interdependences among the variables by using factor analysis is presented. The factor analysis offers the possibility to find linear dependences considering dependences among exogenous variables and so the new regression coefficients are much better than those obtained by *MLR*.

Validation of the obtained results was performed by simulation experiments. We constructed the expressions of endogenous variables by exogenous variables and compared these expressions to dependences obtained by our method. The dependences arrived at enable us to compute percentual changes, called statistical elasticities, of each endogenous variable with respect to 1 % change of a chosen exogenous variable.

Wednesday, August 31, 17:00, Room H1012

Qualitative Theory of Ordinary Differential Equations and Almost Sure Convergence of Two Dimensional Stochastic ApproximationType Procedures

Yuri Kaniovski, International Indtitute for Applied Systems Analysis Laxenburg
Arkadii Kryazhimskii, International Indtitute for Applied Systems Analysis Laxenburg

We suggest a new approach to study convergence of stochastic approximation type procedures. Contrary to the standard one it does not use Liapunov functions. Instead we use characterization of the trajectories of the related system of ordinary differential equations given by the theorem of Bendixson. Then, using different criteria for cancelling cycles, we can show the convergence (for almost every elementary outcome). The particular applications for this approach known to us are in evolutionary games and generalized urn shemes.

Wednesday, August 31, 17:30, Room H1012

Some Problems on an Optimal Selection Problem

Toru Nakai, Kyushu University, Japan

We treat several optimal selection problems for a random number of observations per period. First we consider several essential properties about an optimal selection problem as in Nakai (Operations Research, vol. 34, 478-485, 1986). We treat this problem for two cases, i.e., a case witha previously known about the total number of arriving jobs, and a case not knowing about the number of jobs but only knowing the probability distribution of this number at each period. For these problems, there exists threshold values depending only on the distribution function of arriving observations. We obtain the optimal policy and the expected value obtainable under this policy by using these threshold values.

Next, we consider an optimal selection problem for a sequence of random variables which depend on a partially observable Markov process. Since we employ the Bayes' theorem for the learning procedure, several assumptions are necessary. Under these assumptions, we obtain some essential properties and a main result for this optimal selection problem.

Finally, we will treat a sequential stochastic assignment problem for a random number of jobs (observations) per period. Similarly to an optimal selection problem, there exists threshold values depending only on the distribution function of arriving jobs. We obtain the optimal policy and the expected value obtainable under this policy by using these threshold values.

Wednesday, August 31, 17:30, Room H1029

Flexible Bound Models for Queueing Systems

Geert-Jan van Houtum, Eindhoven University of Technology
Ivo Adan, Eindhoven University of Technology
Jaap Wessels, Eindhoven University of Technology and IIASA
W.H.M. Zijm, University of Twente

We present an approach for approximating a queueing model by truncation models which lead to lower and upper bounds for the relevant performance measures. Such truncation models are called bound models, and they may be useful for models which cannot be solved efficiently by standard analytical or numerical methods.

The approach consists of two parts. First some precedence relations between states of the original model are derived; a precedence relation is denoted by a pair (m, n) and tells that the state m is more attractive than the state n, in the sense that the state m leads to lower costs (or less customers in the system) than the state n. The second part consists of defining truncated state spaces and redirecting the transitions which start at states inside the truncated state space and end at states outside of the truncated state space, to states inside the truncated state space. A lower bound model for the relevant performance measure(s) is obtained if all these transitions are redirected to more attractive states (than the states where they originally ended), and an upper bound model is obtained if all these transitions are redirected to less attractive states. After having performed the first part, one can easily derive whole series of bound models in the second part. The approach has lead to successful bound models for, among others, the multi-dimensional symmetric shortest queue system.

Wednesday, August 31, 18:00, Room H1029

Bicriterion Optimization of an $M/G/1$ Queue with a Removable Server

Eugene A. Feinberg, SUNY at Stony Brook
Dong J. Kim, SUNY at Stony Brook

We study bicriterion optimization of an $M/G/1$ queue with a server which can be switched on and off. One criterion is an average waiting time, or an average number of customers in the system, and another criterion is an average operation cost per unit time. Operating costs consist of switching and running costs. We describe the structure of Pareto optimal policies and solve problems of optimization of one of these criteria under a constraint for another one.

Wednesday, August 31, 18:00, Room H1012

A Best-Choice Problem for Bivariate Uniform Distribution

Minoru Sakaguchi, Nagoya University of CBA, Japan

A sequence of n *iid* random variables is sampled sequentially one by one from bivariate uniform distribution. The bivariate random varaibles cannot be perfectly observed, and each time a random varable is sampled the sampler is informed only whether each of component values is greater than or less than some level specified by him. The optimal strategies for maximizing the probability of selecting the "best" member of the sequence are obtained by considering two kinds of objectives and two types of strategies both with a very simple structure. In the second half of the paper a dynamic programming formulation of the problem is given, Optimality Equations are derived, and one problem of bivariate independent uniform distribution is solved. Finally it is shown that finding the opitmal strategy explicitly requires a hopelessly tedious calculations even in the simplest case.

Thursday, September 1, 09:00, Room H1012

Optimal Sequential Procedures for Stationary Gaussian Processes

Ryszard Magiera, Technical University of Wrocław

The problem of finding optimal sequential procedures for estimating a parameter of covariance function of a family of stationary Gaussian processes is considered. Using quadratic error loss, a class of admissible sequential estimators is determined for estimating the value of a parameter function. In general, the estimators are not explicitly expressed. In some special cases an explicit form of the admissible sequential estimators is derived. In particular, a family of the estimators is determined for estimating variance in some models for stationary zero mean Gaussian processes.

Thursday, September 1, 09:30, Room H1012

Interval Estimation for the Mean of a Stochastic Process

Gamze Tokol Sural, Middle East Technical University, Turkey
Murat Koksalan, Middle East Technical University, Turkey
David Goldsman, Georgia Institute of Technology, GA USA

In the simulation output analysis, estimating a parameter of a stochastic process and its variance to construct a confidence is one of the major issues. Since simulation outputs are usually correlated, classical statistical analysis to construct a confidence interval for the mean is not directly applicable. We study a class of variance estimators that are used in the construction of the confidence intervals for the mean of a stationary stochastic process. The intervals are based on norms of standardized time series. We present analytical and empirical works on the performance characteristics of the new intervals. Empirical results are obtained by simulating seven stochastic processes.

Thursday, September 1, 14:00, Room H1012

Sensitive Criteria in Markov Decision Processes with a Borel State Space

Alexander Yushkevich, University of North Carolina at Charlotte

We consider Markov decision processes with a Borel state space satisfying a Doeblin-type recurrence condition. Asymptotics of the value function and the existence of sensitively and Blackwell optimal policies are studied.

Thursday, September 1, 14:30, Room H1012

Parametric Linear Programming as a Tool for the Solution of Markov Decision Problems

Lodewijk Kallenberg, University of Leiden, The Netherlands

We consider a discrete time, infinite horizon Markovian decision problem (MDP) with finite state and action spaces. A policy is a sequence of decision rules, one decision for each period. The decision maker wants to find a policy which is optimal for some criterion function.

It is well known that for the usual criterion functions, as the total discounted rewards or the limiting average reward per unit time, an optimal policy can be computed by linear programming. In this talk we show that for some other situations parametric linear programming is more suitable.

The first example is the situation where a decision maker also wants to incorporate the variance in the criterion function. In this so-called mean-variance problem the formulation gives a nonlinear programming problem. Fortunately, using the structure of this problem, this nonlinear program can be solved by parametric linear programming.

The second example considers the multi-armed bandit problem. In this model the decision maker considers the state of different MDP's, and he has to choose on which process he will continue for the next period. This problem can be modelled as one multi-dimensional MDP. By a decomposition result, due to Gittins, this problem can be solved by computing in each process for each state an index. We will show that all indices in one process can be computed by parametric linear programming.

Thursday, September 1, 15:00, Room H1012

Approximation of Average Optimal Policies in Markov Decision Processes with Unbounded Costs

Evgueni I. Gordienko, Universidad Autónoma Metropolitana, México

We consider the problem of approximation the average cost optimal policies in the general Markov decision process allowing unbounded one–stage costs. It is assumed that, the state space is Borel, the action space is compact, and the transition kernel of process has some continuity properties. We are concerned with the minimization of long–run expected cost per unit time (average) cost. The problem of approximation includes both the existence of an average optimal stationary policy and robustness of the minimal average cost under the replacement of this policy by other policies related to minimization of the total expected cost over finite time interval. To obtain desired results we focus on the conditions to ensure ergodicity with respect to the special norms, which could be refered as "weighted total variation norms". The method is illustrated by treating stochastic decision processes in queuing models with controllable service rate.

Thursday, September 1, 15:30, Room H1012

Optimal Stopping Rules in Sequential Mate Choice

Vladimir V. Mazalov, Academy of Sciences, Chita, Russia

Janetos (1970), Real (1990) assume that a female when making her decision, has the information on the probabilistic distribution of male quality and its parameters. Dombrovsky & Perrin (1993) assume, quite the contrary, that a priori a female has absolutely no information about the male quality distribution. Apparently more probable are the intermediate situations of partial information. Real (1990), Clark & Mangel (1992) suggest a scheme of learning, i.e., distribution up-dating. Following this scheme, Mazalov & Dombrovsky (1994) suggested the solution of the following problem. Assume a female knows the total number of possible encounters, n. Let $w_1, ..., w_n$ be the independent identically distributed random variables representing the qualities of possible mates. We considered the case when the variables w_i have a normal distribution $N(a, \sigma)$ with unknown average value a and standard deviation σ. The shortcoming of this statement is that the number of encounters n is known. In this work we consider the problem when the payment c for each observation is introduced (it can be, for example, the time of observation), the number of observations is not fixed and can take an arbitrary value.

Friday, September 2, 10:30, Room H112

Asymptotic Optimality of Buffer Overflow Estimation in Markov Modulated Fluid Models

Michel Mandjes, Free University of Amsterdam
Ad Ridder, Free University of Amsterdam

In this paper we study fluid models with finite buffers, constant capacities and input processes modulated by continuous time Markov chains. The probability of a buffer overflow is estimated by Monte Carlo simulation. Without applying some variance reduction techniques this procedure breaks down in case overflows rarely occur, i. e. with probability less than 10^{-8}. Using the concept of effective bandwidth we change the transition rates of the modulating Markov chains in such a way that peak rates get longer durations. Consequently, overflows will occur more frequently when executing the simulations. We shall show that the new Markov chains are uniquely determined in order to attain asymptotic optimality of the estimation procedure under the new measure.

Friday, September 2, 10:30, Room H1012

Compound Point Processes with Applications in Reliability and Risk Theory

Uwe Jensen, Technische Universität München

A model is investigated in which at random times governed by a point process certain amounts of money have to be paid which are described by a sequence of nonnegative random variables. There is some continuously flowing income at a deterministic rate. The risk reserve at time t, R_t, $t \in \mathbb{R}_+$ is then the difference of the total income and the total amount to be paid up to time t. An optimal stopping problem concerning the stochastic process (R_t), $t \in \mathbb{R}_+$ is considered. In addition in risk theory the first time R_t hits some lower boundary is of special interest. Some characteristics of this stopping time are investigated taking into account the available information.

Friday, September 2, 11:00, Room H1012

Reliability Systems with General Component State Spaces

Alfred Schöttl, Technische Universität München

Classical reliability systems consist of a finite set of components $i \in \mathcal{C} = \{1, \ldots, n\}$. An associated binary component state random variable X_i ($\mathbf{X} = (X_i)_{i=1,\ldots,n}$ with independent components) indicates the operation level (operating / failed) of the component i. The operation level $\Phi(\mathbf{X})$ of the entire system is determined by the system function $\Phi : \{0,1\}^n \to \{0,1\}$ mapping the component state space $\{0,1\}^n$ in $\{0,1\}$. In this lecture two major generalisations are considered. The component state and also the set of components is assumed to be uncountable. The first generalisation enables the consideration of failures of different degrees, the latter the treatment of systems (e.g. a pipeline) with an infinite number of possible positions of failures. The component state space of such systems will be defined as a space of discrete measures. The system function is then constructed using an ordering and a classification method for discrete measures. Finally the stochastic properties of systems defined this way will be investigated.

Friday, September 2, 11:00, Room H112

Optimality of Indices in Search Problems with Bayesian Approach

Thilo Liebig, Universität Ulm

We consider a Bayesian sequential decision model for search problems with an unknown number of objects and uncertainty about the distribution of the objects among the boxes.

To the classical model we add an discount factor $\beta \in (0, 1]$ and we admit uncertainty about the discover probability.

We seek to find easy optimal search strategies, i. e. strategies determined by indices. A sufficient condition for the optimality of these strategies will be shown. If these strategies are not optimal, an estimation of the deviation from the optimal strategy is given.

In the second part of the talk we use the sufficient condition to investigate in which cases these strategies are optimal and we give counter-examples for the other cases. Subsequently a sensitivity analysis for the discount factor is undertaken.

Friday, September 2, 11:30, Room H1012

Efficient Selection of Test Data from a Polyhedral Input Domain

Gabriele Danninger, University of Vienna, Austria
Walter Gutjahr, University of Vienna, Austria

We present a model for the subset $\prod_f$ of a failure-causing inputs in a polyhedral input domain $\prod \subseteq R^n$ of a numerical program. According tot he well-known principle in software testing that test data should maximize the probability of error detection, we deal with the question how to select a fixed number k of test inputs from $\prod$ such that the probability of hitting $\prod_f$ gets as high as possible. For a single input variable (case $n = 1$), this question can be answered in an analytical way: one obtains asymptotically an arcsinlaw for the optimal test distribution. For $n > 1$ input variable, simulation experiments are required. We give results of such experiments for $n = 2$ and derive a suitable heuristics for the test point selection. The behavior of this heuristics for $n > 2$ is outlined. — Besides of the mentioned application to the methodology of software testing, our model is also applicable to other, similarly structured search problems in OR.

Friday, September 2, 11:30, Room H112

Inequalities for First-Exit Probabilities and Expected First-Exit Times of a Random Walk

Wolfgang Stadje, Universität Osnabrück

For the partial sum process of i.i.d. random variables we derive new upper and lower bounds for the probability that it will exit from a given compact interval to the left and for the expected first-exit time. When these bounds are taken as initial values of a certain iterative procedure, monotone nondecreasing as well as nonincreasing sequences are generated which converge to the desired first-exit quantities at an exponential rate.

Friday, September 2, 12:00, Room H1012

A Random Number Generator for Parallel Processes

Frank Härtel, Hochschule St. Gallen

The synchronization of the input streams is important to achieve variance reduction of the output streams for the simulation of parallel processes. A reasonable heuristic for this synchronization is the use of disjoint random number streams for different classes of events and attributes (cf. e.g. Bratley et al. [1987]).

The combined random number generator which uses the addition of several multiplicative linear generators modulo one was first considered in Wichmann and Hill [1982]. It will be shown that disjoint random number streams can be achieved by changing the seeds of the individual generators in an appropriate way. This result can also be used to improve the period length and the quality of the combined random number generator.

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Friday, September 2, 15:30, Room H1012

Bayesian Nonparametric Bandit Problems

Ulrich Rieder, Universität Ulm

Sequential selections are to be made from two stochastic processes or "arms". The objective is to maximize the expected sum of the first N observations ($N < \infty$ or $N = \infty$).

Following a Bayesian approach, the processes are assumed to be Dirichlet processes. By means of a suitable stochastic dynamic program we present a new proof of the optimality of the index policy.

Then we show the monotonicity of the value functions and of the Gittins-index. We extend the stopping-property and the stay-on-a-winner-property, which are well-known for Bernoulli bandits. Our approach is based on a special partial ordering concept for measures.

Friday, September 2, 16:00, Room H1012

Optimal Allocation of Computer Time for Optimizing Simulated Systems

Georg Pflug, University of Vienna

Let $S = \{x_1, \ldots, x_m\}$ be a finite set of parametric alternatives in a Simulation Model. Running a simulation program for the time T_i with parameter x_i yields an estimate $\hat{F}(x_i)$ of the unknown expection $F(x_i)$. Assume that $\hat{F}(x_i) \sim N(F(x_i), \frac{\sigma_i^2}{T_i}$ and that an estimate $\hat{\sigma}_i$ of σ_i is available.

We discuss and answer the question, how to allocate a fixed Computer Time Budget to each of the alternatives $x_i, \ldots, x_m$ in an optimal way. The method is based on Gupta's selection rule. It can be used in a sequential manner: After the first set of simulations, a random number of $m_1 < m$ promising points are retained, the others are dropped. Then a new set of simulations is run with optimal allocated times and based on the new results, again a random number $m_2 < m_1$ of promising points are retained. The procedure is iterated until $m_k = 1$ or another stopping criterion is met.