3rd ANKARA-ISTANBUL WORKSHOP ON STOCHASTIC PROCESSES
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MIDDLE EAST TECHNICAL UNIVERSITY

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SPEAKERS, TITLES & ABSTRACTS

The speakers are in alphabetical order with respect to their last names.

Speaker	Serdar Altok, Department of Mathematics, Boğaziçi University, İstanbul
Title	Leaf Related Statistics on Uniform Recursive Trees
Abstract	Uniform recursive trees (URTs) are random trees that have a wide range of applications. In this talk we shall give a simple proof of the asymptotic normality of the number of leaves in a uniform recursive tree (URT) with convergence rates. This result was also obtained by Zhang without a convergence rate. We shall also discuss how to generalize this result in two different directions, first by looking at the number of "runs" of leaves in a URT and second, by changing the uniformity assumption in the URT construction. This is joint work with Ümit Işlak. [1] Zhang, Y., On the number of leaves on a random recursive tree, Brazilian Journal of Probability and Statistics, 2014 .

Speaker	Çağın Ararat, Department of Industrial Engineering, Bilkent University, Ankara
Title	Systemic Risk Measures via Convex Duality
Abstract	Measurement and allocation of systemic risk, the overall risk of an interconnected financial system, have been of increasing interest after the recent financial crisis. In this talk, we will focus on a recent multivariate approach for measuring systemic risk where the state of the financial network is modeled as a random vector of individual equities. Then, the systemic risk measure is defined as the set of all capital allocation vectors that make the "impact of the system to the society" acceptable. We present a dual representation theorem for the systemic risk measure and provide economic interpretations of the dual variables. We also show that the systemic risk measure can be seen as a multivariate shortfall risk measure under model uncertainty. As examples, we consider the classical Eisenberg & Noe network model with and without central clearing, a flow network model, and a financial system with exponential aggregation mechanism.

Speaker	Mine Çağlar, Department of Mathematics, Koç University, İstanbul
Title	Coalescing Flow Solution of an SDE with Correlated Brownian Motions
Abstract	We study stochastic flows where single particle motion follows two correlated Brownian motions on the positive and negative axes, respectively. As the corresponding stochastic differential equation can be cast into the perturbed Tanaka's equation, it follows that it has a strong solution. In the extreme case when the correlation coefficient is 1 it would be Tanaka's equation, which only has a weak solution. We prove that the flow solution is unique and it is a coalescing flow. That is, two particles meet in finite time almost surely and then continue their motion together. Reflected Brownian motion on the quadrant with correlated coordinates is characterized and used in the proof. This is joint work with Abdullah Karakuş and Hatem Hajri.

Speaker	Hans Frenk, Faculty of Engineering and Natural Sciences, Sabancı University, İstanbul
Title	The Impact of Price Policies and Arrival Rates on the Optimal Time to Exit the Market and the Optimal Replenishment Order for a Fashionable Product with a Short Life Span.
Abstract	We consider the problem of determining the time to withdraw from the market when dealing with a highly fashionable product. An example of such a product is a gadget which became suddenly popular and for which there is a high demand during a short time period. In general such a product has a short life span and because of this short life span there is only one replenishment opportunity. Customers buying this product arrive according to a non-homogeneous Poisson process and depending on the considered price policy and the forecast of the demand over time the supplier faces the problem of when to withdraw from the market and how much to order at time zero. In its most general form this can be seen as a challenging optimal stopping problem but in this talk we focus on its static version where the time to exit the market needs to be determined at time 0 together with the order size. We first give under a general cost and revenue structure (price of the product is a decreasing function over time) a short derivation of the profit using some well known results from martingale theory. We also propose an algorithm to select the optimal static policy making use of the concavity of the function in the order quantity given the exit time. As such this work is an extension of a recently published paper by Ayşegül Toptal (Bilkent University) and Sıla Çetinkaya (Texas A&M) and is a joint work with Semih Onur Sezer and Canan Pehlivan from Sabancı University.

Speaker	Tahir Khaniyev, Endüstri Mühendisligi Bölümü, TOBB Ekonomi ve Teknoloji Üniversitesi, Ankara
Title	Yansıtan Bariyerli Stokastik Süreçler için Asimtotik Analiz
Abstract	Bu çalışmada stokastik süreçlerin iki önemli alt sınıfı ele alınmıştır. Bunlardan birincisi "Genelleştirilmiş Yansıtan Bariyerli Ödüllü Yenileme Süreci", digeri ise "Genelleştirilmiş Yansıtan Bariyerli Rasgele Yürüyüş Süreci" dir. Bu iki alt sınıfın her ikisi de uygulamada sık sık kullanılan stokastik süreçlerdir. Özellikle bu süreçler, fizikte yüksek enerjili partiküllerin hareketinin ifade edilmesinde, kuyruk sistemlerinde ve stok kontrol teorisinde kullanılmaktadırlar. Literatürde bu süreçlerin sayısal ve olasılık karakteristikleri için elde edilen kesin ifadeler oldukça karmaşık matematiksel ifadelerdir. Dolayısıyla, uygulama alanlarında uygulanması zor ifadelerdir. Bu nedenle, bu çalışmada asimtotik sonuçlar elde edilmiştir. Öncelikle, her iki süreç de matematiksel olarak inşa edilmiştir. Daha sonra, bazı zayıf şartlar altında süreçlerin ergodikliği ispatlanmıs ve ergodik dağılımın kesin ifadesi elde edilmiştir. Ardından, bu süreçler için zayıf yakınsama teoremi ispatlanmış ve ergodik dağılımların yakınsadığı limit dağılımlarının aşikar şekli bulunmuştur. Ayrıca, süreçlerin ergodik momentleri için iki terimli asimtotik açılımlar elde edilmiştir. Tahir KHANIYEV, Başak GEVER, Zülfiye HANALIOĞLU [1] Afanasyeva L.G. and Bulinskaya E. V., 1984, Some asymptotic results for random walks in a strip, Theory of Probability and Its Applications, 29(4), 654-668. [2] Aras G. and Woodroofe M., 1993, Asymptotic expansions for the moments of a randomly stopped average, Annals of Statistics, 29(4), 503-519. [3] Borovkov A.A., 1984, Asymptotic Methods in Queuing Theory, John Wiley, N.Y. [4] Feller W., 1971, An Introduction to Probability Theory and Its Applications II, John Wiley, New York. [5] Gihman I. I. and Skorohod A.V., 1975, Theory of Stochastic Processes II, Springer-Verlag, Berlin. [6] Khaniev T. A., Özdemir H. and Maden S., 1998, Calculating the probability characteristics of a boundary functional of a semi-continuous random process with reflecting and delaying screens, Applied Stochastic Models and Data Analysis, 14, 117-123. [7] Khaniev T. A., Unver I. and Maden S., 2001, On the semi-Markovian random walk with two reflecting barriers, Stochastic Analysis and Applications, 19(5), 799-819.

Speaker	Mehmet Öz, Department of Natural and Mathematical Sciences for Engineering, Özyeğin University, İstanbul
Title	On the Optimal Survival Strategy of Branching Brownian Motion in a Random Trap Field
Abstract	We study a branching Brownian motion Z evolving in R^d, where a uniform field of Poissonian traps are present. Each trap is a ball with constant radius. We discuss the survival problem of Z, namely, the asymptotics of the annealed probability that none of the particles of Z hits a trap. Then, we focus on a convergence result on the speed of branching Branching motion, which is intimately related to the celebrated Fisher KPP(Kolmogorov-Petrovskiy-Piskunov) equation. Finally, we apply this convergence result to the survival problem, and prove an upper bound on the number of particles that the system produces given that it avoids the trap field up to time t. This bound is an example of an "optimal survival strategy".

Speaker	Semih Onur Sezer, Faculty of Engineering and Natural Sciences, Sabancı University, Istanbul
Title	Optimal Dynamic Bidding for Multiple Keywords in Search Based Advertising
Abstract	We consider an advertiser bidding for ad positions on a search engine. Keyword inquiries arrive according to a Poisson process, and at each arrival time the advertiser bids for an ad position on the result page. In this setting, the objective of the advertiser is to find a dynamic bidding policy maximizing her expected revenue over a finite horizon subject to a strict budget constraint. In this talk, we will discuss the solution of this problem, and we will illustrate some numerical examples. This is a joint work with Savaş Dayanik from Bilkent University.

Speaker	Devin Sezer, Institute of Applied Mathematics, METU, Ankara
Title	Solution of a Semilinear Parabolic PDE with Singular Boundary Values
Abstract	Define $$g(t) \doteq \frac{1}{\sqrt{T-t}}, t \in (0,T).$$ We will study the existence and regularity problems for the PDE $$\frac{1}{2}V_{xx} + V_t - \frac{1}{2}V^3 = 0,$$ over the domain $D \doteq (0,L) \times (0,T)$, with the boundary conditions $$V(0,t) = V(L,t) = g(t), t \in [0,T], \quad V(x,T) = 0, 0 < x < L.$$

Speaker	Gerhard Wilhelm Weber, Institute of Applied Mathematics, METU, Ankara
Title	Stochastic Optimal Control of Hybrid Systems under Regime Switches and Impulsiveness, in Finance, Economics and Nature
Abstract	We contribute to modern finance and OR by hybrid, e.g., mixed continuous-discrete dynamics of stochastic differential equations with jumps and to their optimal control. These hybrid systems allow for the representation of random regime switches or paradigm shifts, and are of growing importance in economics, finance, science, medicine, engineering, social sciences and fields of culture. We introduce some new approaches to this area of stochastic optimal control and present results. One is analytical and bases on the finding of optimality conditions and, in certain cases, closed-form solutions. We further discuss aspects of differences in information, given by delay or insider information. The presentation ends with a conclusion and an outlook to future studies.

Speaker	Sinan Yıldırım, Faculty of Engineering and Natural Sciences, Sabancı University, İstanbul
Title	On the Use of Penalty MCMC for Differential Privacy
Abstract	We view the penalty algorithm of Ceperley and Dewing (1999), a Markov chain Monte Carlo (MCMC) algorithm for Bayesian inference, in the context of data privacy. Specifically, we study differential privacy of the penalty algorithm and advocate its use for data privacy. We show that in the simple model of independent observations the algorithm has desirable convergence and privacy properties that scale with data size. Two special cases are also investigated and privacy preserving schemes are proposed for those cases: (i) Data are distributed among several data owners who are interested in the inference of a common parameter while preserving their data privacy. (ii) The data likelihood belongs to an exponential family.

Speaker	Atilla Yılmaz, Department of Mathematics, Koç University, Istanbul
Title	Large Deviations for Random Walk in Space-Time Random Environment: Averaged vs. Quenched
Abstract	I will present recent joint work with F. Rassoul-Agha (Utah) and T. Seppäläinen (Madison) where we consider random walk with bounded jumps on a hypercubic lattice of arbitrary dimension in a space-time random environment that is assumed to be temporally independent and spatially translation invariant. The large deviation principle (LDP) for the empirical velocity of the averaged walk (i.e., level-1) is simply Cramér's theorem. We take the point of view (POV) of the particle and establish the process-level (i.e., level-3) averaged LDP for the environment Markov chain. The rate function $I_{3,a}$ is a specific relative entropy which reproduces Cramér's rate function via the contraction principle. We identify the unique minimizer of this averaged contraction and analyze its structure. When the environment is spatially ergodic and a mild ellipticity condition holds, the level-3 quenched LDP follows from our previous work [*Comm. Pure Appl. Math.,* 66(2):202-244, 2013] which gives a variational formula for the rate function $I_{3,q}$ involving a Donsker-Varadhan-type relative entropy H_q. We provide a modified formula for $I_{3,q}$ as well as two formulas for the level-1 quenched rate function via the contraction principle. We decompose $I_{3,a}$ into the contributions of the environment (from the POV of the particle) and the walk conditioned on the former (via H_q). We use this decomposition to give three characterizations of the equality of the level-1 averaged and quenched rate functions. We also give necessary and/or sufficient conditions for the unique minimizer of the averaged contraction to be the unique minimizer of the two quenched contractions, and mention related open problems. Finally, we demonstrate our results by carrying out a complete analysis of the case of spatially periodic environments.

POSTER TITLES & ABSTRACTS

The presenters are in alphabetical order with respect to their last names. Poster presentations will be added over time.

Presenter	Anıl Gülveren, Institute of Applied Mathematics, METU, Ankara
Title	Defined Contribution (DC) Pension Fund Modeling Using CPPI Strategy Under Exotic Option and Discrete Time Setting
Abstract	We consider Constant Proportion Portfolio Insurance (CPPI) strategy in a defined contribution (DC) pension plan. We examine a model that the price dynamics of a risky asset and labor income process are defined by a continuous-time stochastic process and trading is restricted to discrete time scheme. An exotic option is proposed as cushion insurance to avoid the risk that the portfolio value crashes through the floor which is denoted as gap risk in the literature. We analyze the effectiveness of derived cushion insurance on CPPI strategy in a DC pension plan by measuring its sensitivity with respect to the parameters through Monte Carlo Simulation. This is joint work with A. Sevtap Selçuk-Kestel and Z. Büşra Temoçin, Institute of Applied Mathematics, METU, Ankara.

Presenter	Etkin Hasgül, Institute of Applied Mathematics, METU, Ankara
Title	A Useful Dependence Structure for Solvency Capital Requirements using Copulas
Abstract	Solvency II directive proposes that the economic capital which is determined by using Solvency Capital Requirements (SCR) is needed to have a probability of ruin limited to 0.5% whose evaluation is based on VaR and CVaR as volatility measures Nguyen T. et al. (2011). A common SCR for a combination of different branches is calculated by not only aggregation of these branches but also considering possible dependencies. Thus, dependence between different risk factors related to corresponding branches should be known. If the association is not linear or cannot be transformed into a linear shape, using linear methods such as Pearson correlation (ρ) and Kendal's Tau (τ) will cause an incompatible calculation and a gap between the allocated reserve and the actual requisite reserve. Therefore, the dependence models which can also represent the non-linear relationships should be used in the calculation of common SCR. Consequently, more precise measurements on the risk dependencies make insurer take more secured decisions regarding the efficient allocation of the funding for (re-)insurance portfolios Zlateva and Velev (2012). The study aims to test how effective and realistic both elliptical and archimedean copulas over dependency in common SCR are and to determine dependence values in Solvency II criteria for emerging markets such as Turkey. For this purpose, non-life insurance companies in Turkey are taken into account to determine the correlation structure among the lines of business via traditional correlation coefficient measures and the copula families. A comparison on their efficiencies is done through sensitivity analyses. This is joint work with A. Sevtap Selçuk-Kestel. [1] Nguyen T. et al. Risk Aggregation by Using Copulas in Internal Models, Journal of Mathematical Finance, 2011(1), 50-57, 2011. [2] Zlateva P., Velev D. Measuring Risk Dependencies Due to Two Natural Disasters by Bivariate Copula, International Proceedings of Economics Development & Research, 2012(41), p182, 2012.

Speaker	Bülent Alper İnkaya, EnerjiSA Trading Company and IAM, METU, Ankara
Title	Multi-scale Behaviour of Financial Asset Prices
Abstract	Infinitely divisible processes are the building blocks of stochastic models as Lévy processes are infinitely divisible. Infinite divisibility is closely related to the notion of self-similarity. Self-similarity property helps simplifying the modelling assumptions for finance practitioners. For example, the variance of Brownian motion linearly scales up with the time horizon it is observed. However, statistical analysis of financial asset prices (returns) points out to a more complex type of behaviour: Scale dependency of distributions. For small time scales (minutes), the return distributions are characterized by non-Gaussian features such as a large kurtosis whereas for large enough time scales (weeks, days) the distributions are quasi-Gaussian. Furthermore, absolute returns exhibit long-range correlations, which is in contradiction with the celebrated efficient market hypotheses. For modelling purposes, researchers constructed a stochastic process with all these features: multi-fractal processes. Multi-fractal processes can be constructed via a cascading generating process that is log-infinitely divisible. In this study, we will demonstrate some examples of the empirical characteristics, review the theoretical background of multi-fractal stochastic processes and suggest some new directions for multi-scale modelling. This is joint work with Yeliz Yolcu Okur, IAM, METU, Ankara.

Speaker	Deniz Kenan Kılıç, Institute of Applied Mathematics, METU, Ankara
Title	Multiresolution Analysis of S&P500 Time Series
Abstract	Time series analysis is an essential research area for almost all people who are dealing with scientific and engineering problems. Main aim is to understand the underlying characteristics of the time series by using time as well as frequency domain analyses. Then one can make a prediction for the desired system to forecast observations ahead. Time series modeling, frequency domain analysis and some descriptive statistical analysis are main subjects of this thesis. Choosing an appropriate model is the main focus of all analysis in order to make a good prediction. In this thesis financial time series are focused, particularly S&P500 daily closing prices and its return values are handled. Fourier transform and wavelet transform are creatively at the center of the frequency domain analysis. Knowing the fact that financial time series are complex data sets to sufficiently predict the future, multi resolution analysis is handled in this thesis using the wavelet transforms to figure out specialties of S&P500 data. Also, apparently, models that are appropriate for the financial time series are discussed in the application part.

Speaker	Sevim Ölmez, Department of Statistics, METU, Ankara
Title	Examination and Parameter Estimation of Single Species Population Models in presence of Randomness and Delay
Abstract	Population dynamics which is an important theme of mathematical biology, is currently an area of research that is making significant contributions to social welfare. For example, they could result in significant gains in terms of labor force, time and money while fighting some harmful organisms. Deterministic models have long been used in order to explain the population increase of single species organisms. Since real life data is dependent on numerous variables that cannot be controlled, deterministic models are frequently insufficient when used for estimation purposes, and cause errors. That is why stochastic differential equations are more appropriate for real life data. Moreover, the life story of a species can be defined by many internal and external factors that result in delay effect. Therefore, in this study, randomness and delay assumptions will be inserted to population increase models by first transforming continuous time differential equations into stochastic differential equations. This transformation will be analyzed in two different ways: by adding noise term to the net reproduction rate per individual and the rate of change in the population size. Second, the delay effect that is present in nature will be added to the drift terms of these stochastic differential equations and time-delayed stochastic differential equations will be obtained. Next,the conditional expected values and variances for each model will be calculated by using Ito calculus in order to analyze these newly proposed time-delayed stochastic differential equations. Discrete time model approaches will be developed for the models, using numerical methods. With these, the maximum likelihood method will be applied and theoretical estimating functions will be established. Data will be produced based on delay assumption, and parameter estimates will be generated, by plugging them into the estimating functions. Finally, comparisons will be made by considering the error margins of the models and, at the end of these comparisons, the model or models that make the nearly best estimates to the single species population dynamics, will be proposed. This is joint work with Ceren Vardar Acar and Yeliz Yolcu Okur, METU, Ankara.

Index