SPMS 2023

Report of Contributions

https://indico.fjfi.cvut.cz/e/SPMS2023

Contribution ID: **1** Type: **not specified**

Beta- Version of Application for Preference Tailoring

Thursday, 29 June 2023 09:15 (20 minutes)

This presentation focuses on the specification of user's preferences in decision-making, particularly in cases where users have limited knowledge of decision-making (DM) theory and express their preferences incompletely.
The decision-making task is solved by a fully probabilistic design (FPD), which models a closed loop between the user and the system. The FPD introduces an ideal probability density, which has high probability values of preferred behavior and low probability values of inappropriate behavior. By minimizing the Kullback-Leibler divergence of the real pd and the ideal pd an optimal decision policy is found.
We also work with contradictory preferences between states and actions. This brings even more burden on the specification of preferences, since it is impossible even for the user who understands the theory of DM to quantify the relation of these two preferences before knowing the dynamic of the system. To overcome the limitation of incompletely specified preferences, another closed-loop was added. The user observes the sequences of states and actions and then they rate how they like it using marks as at school. Based on the feedback the parameters of the main closed-loop are tuned.
We want to make a survey of how different users rate similar observation and also find out if they are satisfied with our results.
We decided to create an application to collect data so that we can draw conclusions about whether our theory would be helpful. We will introduce the first version of our application, which was developed in Python. This presentation serves to explain how the application works, what the users should rate and how. In the end of the presentation we send the app to the audience and we will ask them to participate in our survey.

Primary author: SIVÁKOVÁ, Tereza

Presenter: SIVÁKOVÁ, Tereza

Session Classification: Dynamic Decision Making

Contribution ID: **2** Type: **not specified**

Modeling the excess return of ČEZ a.s. stock

Thursday, 29 June 2023 14:20 (20 minutes)

We propose a multifactor asset pricing model for evaluation of excess return of ČEZ a.s. stock which is derived from the Asset pricing theory. Besides the market risk, factors, that can affect the performance of ČEZ a.s. stock, are also added. They are the price of electricity, the price of natural gas, the price of CO2 emission permits and index of industrial production. Taking into account a possible persistence of the excess return and external shocks, the autoregressive and moving average terms are also included into the model. It is therefore an ARMAX model from econometric perspective. We verify the validity of the model on monthly and quarterly data from 9-2007 to 4-2023. The results of our analysis show that the model we propose can exceedingly well explain the variability of excess return of ČEZ a.s. stock in both monthly and quarterly time frequencies. The results obtained show that the proposed model has extremely high explanatory power.

Primary author: TRAN, Quang Van (KSI, FNSPE, CTU in Prague)

Presenter: TRAN, Quang Van (KSI, FNSPE, CTU in Prague)

Session Classification: Stochastic monitoring control

Contribution ID: **3** Type: **not specified**

Application of machine learning methods for the identification of proton decay in liquid argon detector

Tuesday, 27 June 2023 11:20 (20 minutes)

The Deep Underground Neutrino Experiment (DUNE) is a long baseline neutrino oscillation experiment hosted by the Fermi National Accelerator Laboratory (Fermilab). Beyond its primary focus on advancing neutrino physics, DUNE also aspires to explore the possibility of proton decay, which holds the potential to provide evidence for grand unified theories.
The DUNE far detector comprising four 10 kiloton liquid argon time projection chambers (LArTPCs), which utilize ionization charge collection as a detector technology, will enable the search.
Currently, data simulations are being conducted to generate both signal samples (proton decay via $p \to K + \nu$) and background samples (atmospheric neutrino interactions on argon). Distinguishing between these types of events poses a considerable challenge due to the intricate nature and vast volume of the data.
To address this challenge, we explore the potential of deep neural networks for proton decay detection at DUNE. By leveraging the capabilities of neural networks, we aim to enable and improve detector event classification. It is important to note that our work is still ongoing. Currently, we are working with pretrained models, employing transfer learning and fine-tuning techniques to adapt them to our case. In the future, we aspire to develop a model specifically designed to address the task of proton decay detection.

Primary author: GUĽA GARTMAN, Anna

Presenter: GUĽA GARTMAN, Anna

Session Classification: Data processing

Contribution ID: **4** Type: **not specified**

Understanding Deep Image Prior

Tuesday, 27 June 2023 09:50 (20 minutes)

Inverse problems in imaging, like denoising, inpainting or superresolution usually require a suitable regularization of prior to achieve good reconstruction results. It was shown that untrained neural networks can replace traditional handcrafted priors and achieve superior performance. This contribution will focus on Deep Image Prior, the pioneering work utilizing untrained neural priors, its applications for image reconstruction problems, and possible explanations of its success.

Primary author: BROŽOVÁ, Antonie

Presenter: BROŽOVÁ, Antonie

Session Classification: Stochastic monitoring control

Contribution ID: **5** Type: **not specified**

Localization of continuous acoustic emission sources using cross-correlation and time reversal signal processing

Thursday, 29 June 2023 11:55 (20 minutes)

Localization of continuous acoustic emission (generated, e.g. by leakage) is a very important problem in the field of non-destructive testing, but especially due to wave dispersion, velocity, and/or geometry changes the localization is still a challenge. An effective tool to overcome these problems is time reversal (TR) signal processing, which works very well in the case of burst acoustic emission signal localization. In the case of continuous acoustic emission TR itself does not give so satisfactory results, and the cross-correlation itself also does not give good results, but a combination of TR and cross-correlation provides very precise localization. In our experiment we used a piezoelectric transmitter to emit a leakage (recorded at a real leak), signals were recorded at different positions of the plate, time-reversed, and rebroadcast back to the structure using the reciprocal TR method. For precise localization, detailed surface scanning around the roughly estimated source position was necessary. The scanning may be realized e.g., by a scanning laser interferometer. The experimental results show the successful application of TR signal processing in continuous acoustic emission localization.

Primary authors: Mr KOBER, Jan; Mr KROFTA, Jan; Mr CHLADA, Milan; Ms HIRSEKORN, Sigrun; Mr PŘEVOROVSKÝ, Zdeněk; DVOŘÁKOVÁ, Zuzana

Presenter: DVOŘÁKOVÁ, Zuzana

Session Classification: Defectoscopy

Contribution ID: **6** Type: **not specified**

Cramér - von Mises type estimators

Tuesday, 27 June 2023 09:30 (20 minutes)

The contribution study the minimum distance density estimators based on Kolmogorov and Cramér -von Mises distance. Inequalities between Kolmogorov and Cramér -von Mises distances are proven to achieve $n^{-\gamma}$ consistency in (expected) L_1 norm of M(CM)E. Further, the generalized Cramér - von Mises distance is defined together with so called Kolmogorov - Cramér distance which includes both Kolmogorov and Cramér - von Mises distance as limiting special cases. We prove $n^{-\gamma}$ consistency in the (expected) L_1 norm of both minimum distance estimators based on newly defined distances.
Our numerical simulation illustrates the quality of consistency property covered by theoretical results. The proportionality constants of the consistency order are approximated from simulated data since they are not given by the proofs of theorems. Dependence of consistency in the L_1 norm on ε - contamination neighbourhood of the true model is studied and, further, the robustness of these newly defined estimators is investigated for contaminated Normal family. Numerical simulations are used to compare statistical properties of all studied estimators and to determine the optimal or preferable choice of parameters of newly defined estimators. Finally, we bring comparison of all studied estimators with Rényi and Power divergence estimators.

Primary author: HRABÁKOVÁ, Jitka (FIT CTU)

Co-author: KŮS, Václav (KM FJFI CVUT)

Presenter: HRABÁKOVÁ, Jitka (FIT CTU)

Session Classification: Stochastic monitoring control

Contribution ID: **7** Type: **not specified**

Notes on Mathematical Notation: Enhancing Clarity and Accessibility

Monday, 26 June 2023 17:15 (45 minutes)

This presentation delves into the essential rules and guidelines, as outlined by norm ISO 80000 and the guidelines of CTU in Prague, for writing math text, aiming to improve the clarity, accessibility, and visual appeal of mathematical content. We will explore the fundamental principles of mathematical typography, including the appropriate usage of symbols, notation, and formatting conventions. Additionally, we will discuss the dos and don'ts of mathematical typography, covering aspects such as font selection, spacing, and alignment. The presentation will emphasize the importance of adhering to these established norms and guidelines to enhance the readability and comprehension of mathematical equations and expressions. By following the prescribed norms and guidelines, mathematicians, educators, and researchers can effectively communicate mathematical ideas to diverse audiences while ensuring clarity and accessibility.

Primary author: GAŠPAR, František (FJFI)

Presenter: GAŠPAR, František (FJFI)

Session Classification: Special session

Contribution ID: **8** Type: **not specified**

Numeric Inverse Laplace Transform for Likelihood Evaluation

Thursday, 29 June 2023 14:00 (20 minutes)

The PDF of a positive continuous random variable X can be too complex for direct evaluation e.g. when X is a sum of the positive continuous random variables. But when the characteristic function $\psi(t)$ of X is known, we can employ $N = 2^k$ point FFT to obtain a table of PDF with equidistant spacing for the interpolation of $\mathrm{f}(x_k)$ and for $k = 1, \ldots, m$. Adequate time complexity of single likelihood evaluation is $\mathrm{T}(N) = N \log_2 N$ for $N > 10^7$.
Fortunately, we can evaluate $\mathrm{F}(s) = \psi(\mathrm{j}s)$ and then apply the inverse Laplace transform.
There are many various approaches to the numeric inversion. They begin with Bromwich integral formula and various finite sampling over integration contour. The time complexity of m point likelihood evaluation is only $\mathrm{T}(m, M) = m\,M$ with $M < 25$.

Primary author: KUKAL, Jaromír (FNSPE CTU in Prague)

Presenter: KUKAL, Jaromír (FNSPE CTU in Prague)

Session Classification: Stochastic monitoring control

Contribution ID: **9** Type: **not specified**

Power Spectral Features of Musculoskeletal Disorders and Their Classification

Thursday, 29 June 2023 10:15 (20 minutes)

The analysis of biomedical data on musculoskeletal disorders using data provided by motion sensors. The patient's features are extracted from the signal represented as power in dB. The feature dimensionality is then reduced using Data Whitening and classified into two classes: healthy and diseased. Two different methods are used for classification: SVM and MLP.

Primary author: VATAMANIUC, Nichita

Co-author: KUKAL, Jaromír (FNSPE CTU in Prague)

Presenter: VATAMANIUC, Nichita

Session Classification: Dynamic Decision Making

Contribution ID: **10** Type: **not specified**

Optimal control systems for rolling stock

Thursday, 29 June 2023 09:55 (20 minutes)

In this presentation, we will focus on mathematic approaches to optimal control systems for rolling stock. We will discuss several formulations of optimal control problems for trains and trams. We will then look into optimising the energy consumption under various constraining conditions, including the available power and force, time schedule, and speed limits. We will present the tram optimal energy control using reinforcement learning and the advantages of this machine learning approach for vehicle optimization in stochastic environments, e.g. in the city. Simulation results will be presented.

Primary author: NÁBĚLEK, Jiří

Presenter: NÁBĚLEK, Jiří

Session Classification: Dynamic Decision Making

Contribution ID: **11** Type: **not specified**

Estimating the parameters of the critical clearances distribution

Thursday, 29 June 2023 14:40 (20 minutes)

We study statistical modelling of clearances and critical clearances, which are the main subjects of the Gap Acceptance Theory. First, we define a mathematical model of an unsignalized T-intersection, and then we specify the problem of the partial distribution of clearances of order $k \in \mathrm{N}_0$. Assuming Generalized Inverse Gaussian (GIG) distribution of clearances and critical clearances, we derive a solution to this problem first analytically and then using Monte Carlo simulations; afterwards, we verify the correctness of both solutions. Subsequently, we present a concept for estimating the parameters of the critical clearances distribution assuming a known shape of the distribution. Finally, using up-to-date empirical datasets from three intersections in Germany, we investigate the distribution of clearances and critical clearances.

Primary author: PEČENKOVÁ, Eliška

Presenter: PEČENKOVÁ, Eliška

Session Classification: Traffic and pedestrian

Contribution ID: **12** Type: **not specified**

Transformer-based models for detector simulation

Tuesday, 27 June 2023 11:00 (20 minutes)

Detector simulations are an important component of the research in High Energy Physics. However, the current Mote Carlo-based simulation tools are computationally intensive and finding a faster alternative is necessary. This talk focuses on the current development in the domain of using deep learning models for calorimeter simulations, namely the experimentation with transformer neural networks.

Primary author: JARŮŠKOVÁ, Kristina (FNSPE CTU in Prague)

Presenter: JARŮŠKOVÁ, Kristina (FNSPE CTU in Prague)

Session Classification: Data processing

Contribution ID: **13** Type: **not specified**

Feature selection and classification of acoustic emission signals

Thursday, 29 June 2023 11:35 (20 minutes)

This contribution deals with the recognition of acoustic emission signals for use in non-destructive defectoscopy or in machining process control. Classification can either be performed by representing signals by a convenient, lower-dimensional set of attributes or more directly, by passing them in their entirety to the classification algorithm. We focused on selecting methods and tools for the automated extraction of a large number of features from signals and then performing dimensionality reduction on them. Finally, we compared the performances of various classifiers on these low-dimensional projections with the direct classification of signals using convolutional neural networks.

Primary authors: ZAVADIL, Jan; KŮS, Václav (KM FJFI CVUT)

Presenter: ZAVADIL, Jan

Session Classification: Defectoscopy

Contribution ID: **14** Type: **not specified**

Can DBSCAN Be Improved by Robust Preprocessing?

Tuesday, 27 June 2023 10:10 (20 minutes)

In this presentation, we investigate the performance enhancement of the DBSCAN algorithm through robust preprocessing techniques. We explore the impact of data whitening, geometric median, and the pursuit method for variable selection and estimation in high-dimensional models. The use of these techniques, including the estimators of scale S_n and Q_n introduced by Rousseeuw and Croux, provide robustness to outliers and promote sparsity for improved model interpretability. We present the results and comparisons on a testing dataset to showcase the effectiveness of this combined approach as a robust preprocessing step for DBSCAN.

Primary author: THIELE, Jan

Presenter: THIELE, Jan

Session Classification: Stochastic monitoring control

Contribution ID: **15** Type: **not specified**

On the origin of supercompressible states of the traffic flow

Tuesday, 27 June 2023 11:40 (20 minutes)

Studying recent empirical traffic data, we show surprising statistical anomalies in the traffic microstructure that can not be explained by current scientific approaches used in physics of traffic. We introduce the concept of Balanced Particle Systems as an effective mathematical instrument for a description of statistical properties of vehicular microstructure, quantify these anomalies mathematically and explain their cause. Concretely we deal with the specific states of traffic flow on a two-lane freeway, in which statistical fluctuations of microscopic quantities are significantly higher than in systems with absolutely random events (Poisson systems). Finally, we show that these super-random states are detected specifically in the fast lane at free-flow traffic quantities (up to 25 vehicles per kilometer).

Primary author: KRBÁLEK, Milan (Dept Math, FNSPE CTU in Prague)

Co-author: Mrs KRBÁLKOVÁ, Michaela (Faculty of Transport Engineering, University of Pardubice; Faculty of Science, University of Hradec Králové)

Presenter: Mrs KRBÁLKOVÁ, Michaela (Faculty of Transport Engineering, University of Pardubice; Faculty of Science, University of Hradec Králové)

Session Classification: Traffic and pedestrian

Contribution ID: **16** Type: **not specified**

Does quantum version of decision theory make sense?

Thursday, 29 June 2023 09:35 (20 minutes)

Contemporary decision making (DM) theory stands on classical probability. However, it has been shown that there is a variety of situations when the decision theory fails to explain some psychological and cognitive effects observed in human decision making. Other aspects not covered by the classical approach are that the results of merging information depend on the order of merging, or that the observation influences the next state. The main question posed is whether quantum probability is suitable for DM and can solve these problems.

This contribution introduces some of the potential ways how to construct quantum formulation of DM task and discusses related open questions.

Primary authors: Mr GAJ, Aleksej (Department of Mathematics, FNSPE, Czech Technical University in Prague); Dr KÁRNÝ, Miroslav (Institute of Information Theory and Automation, CAS)

Presenter: Mr GAJ, Aleksej (Department of Mathematics, FNSPE, Czech Technical University in Prague)

Session Classification: Dynamic Decision Making

Contribution ID: **17** Type: **not specified**

New observations on fatigue crack growth using acoustic emission

Thursday, 29 June 2023 11:15 (20 minutes)

With the development of hardware capabilities in the field of acoustic emission signal measurement, the directional radiation of elastic waves from a fatigue crack-type source has been observed. The configuration of the sensors on a model pipe-type body is based on a detailed numerical analysis. It allows the confirmation of the effect of random directionality of the emission source, which has been neglected in industrial standards up to now. Although this effect has been observed repeatedly on other shapes of loaded bodies, numerical models have not yet provided a satisfactory hypothesis for this phenomenon. A series of experiments on bodies of different shapes and sensor configurations are being prepared to specify the conditions for its occurrence.

Primary author: Mr CHLADA, Milan

Co-authors: Dr KOBER, Jan (Institute of Thermomechanics of the CAS, v. v. i.); Dr ŠTEFAN, Jan (Institute of Thermomechanics of the CAS, v. v. i.)

Presenter: Mr CHLADA, Milan

Session Classification: Defectoscopy

Contribution ID: **18** Type: **not specified**

Spectral clusterin for directed graphs

Thursday, 29 June 2023 15:20 (20 minutes)

Presenter: KHOL, Daniel

Session Classification: Stochastic monitoring control

Contribution ID: **19** Type: **not specified**

Prediction of energy demand in the power system

Thursday, 29 June 2023 15:40 (20 minutes)

Presented work investigates deep learning methods, focusing on Temporal Fusion Transformer (TFT), for multi-horizon forecasting of energy demand in power systems. The TFT model's performance is benchmarked against traditional machine learning models such as XGBoost and Random Forest and evaluated over 6-hour and 24-hour ahead predictions. The TFT's capacity for handling temporal dependencies proves advantageous, enhancing the accuracy of energy demand prediction. The results illuminate the transformative potential of advanced deep learning methods in improving power system management amid growing renewable energy integration.

Presenter: PODLESNA, Yana

Session Classification: Stochastic monitoring control

Contribution ID: **20** Type: **not specified**

Spectral clustering for directed graphs

Graphs and Markov chains can be represented by matrixes. One of the most common representations is the Laplacian matrix. This presentation summarises the spectral clustering of undirected graphs. Then we consider a basic approach to spectral clustering of directed graphs by the symmetric graph. Then we show a new approach to the Laplacian matrix for directed graphs using incidence matrix M for a directed graph. We define the new Laplacian matrix for directed graphs as $1/2M * M$. We show examples of some graphs, where new spectral clustering of the Laplacian matrix for directed graphs shows better results than the traditional approach by symmetric graph. Everything concludes in the form of showing that the new Laplacian matrix for directed graphs has the same fundamental properties as a normal Laplacian matrix i. e. matrix is singular, symmetric, weakly diagonally dominant, positive semi-definite, zero is an eigenvalue and vector of ones is an eigenvector. A graph is continuous if and only if the algebraic multiplicity of 0 is one and the algebraic multiplicity of 0 is equal to a number of continuous components.

Primary author: KHOL, Daniel (Department of Mathematics, FNSPE, Czech Technical University in Prague)

Presenter: KHOL, Daniel (Department of Mathematics, FNSPE, Czech Technical University in Prague)

Session Classification: Stochastic monitoring control

Contribution ID: **21** Type: **not specified**

Surpassing the Diffraction Limit by Structured Illumination Microscopy

Structured illumination microscopy (SIM) is a powerful imaging technique that has revolutionized the field of superresolution microscopy. This talk aims to provide an overview of SIM and highlight its numerous benefits over other superresolution methods.

SIM utilizes patterned illumination to overcome the diffraction limit posed on resolution in optical microscopy, enabling the visualization of fine structures in vivo with high temporal resolution. By illuminating the specimen using a harmonic pattern, in contrast with simple uniform illumination, SIM aliases higher frequencies into the sensed image that would not be captured otherwise due to the cut-off frequency of the transfer function of the optical setup. A reconstruction of a high-resolution image is then enabled using multiple acquisitions illuminated with different parameters of the harmonic.

Compared to other superresolution techniques, SIM offers several advantages, including its compatibility with conventional fluorophores and the possibility of employing different microscopy modalities. Its simplicity and a low requirement on the number of low-resolution image acquisitions enable fast acquisition times and reduced phototoxicity also due to its photon efficiency. SIM provides an accessible alternative to superresolution techniques that, in general, require a complex optical setup and owing to this, it became very popular in recent years also considering its further benefits in the common aspects and requirements of biological sensing in modern research.

This talk will delve into the concepts that SIM uses in order to surpass the diffraction barrier and outlines the conventional reconstruction technique as well as some prospects for future improvement.

Primary author: KUNZ, Martin (Department of Mathematics, FNSPE, Czech Technical University in Prague)

Presenter: KUNZ, Martin (Department of Mathematics, FNSPE, Czech Technical University in Prague)

Session Classification: Stochastic monitoring control