



Transregio
391

tu technische universität
dortmund

Workshop on Robust Statistics and Experimental Design for Spatio-temporal Data and Farewell Celebration

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1 Location

Room 1.001 of Building SRG1
Nordcampus of TU Dortmund
Friedrich-Wöhler-Weg 6
44227 Dortmund

The walking distance from the S1-Station Universität is approximately 20 Minutes.

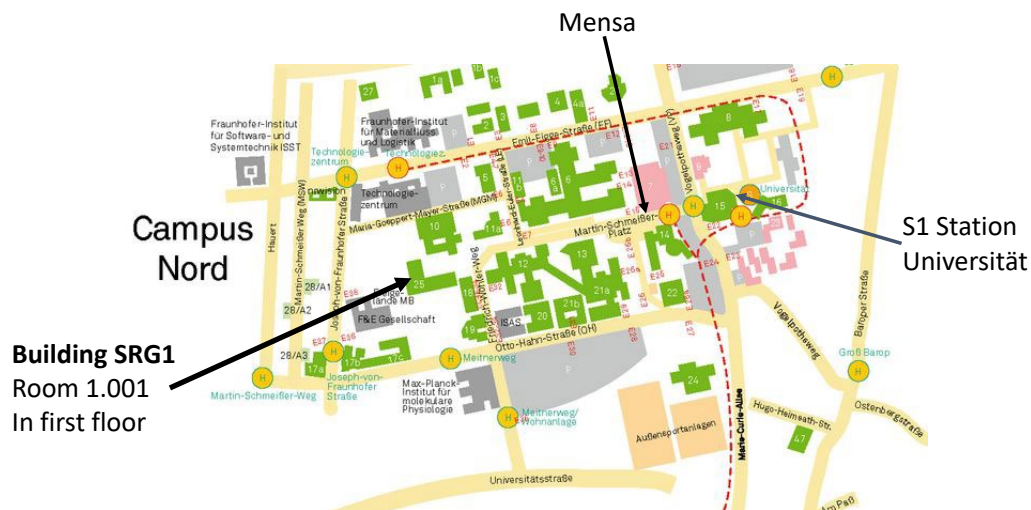
The S1 needs approximately 5 minutes from the railway station Dortmund Hbf and runs every 15 minutes on weekdays and every 30 minutes at the weekend.

With the car:

- via Ruhrschnellweg (A 40 / B1), leave at "Dortmund-Dorstfeld",
- via Sauerlandlinie (A 45), leave at "Dortmund-Eichlinghofen".

Furster information can be found under

<https://www.tu-dortmund.de/campus/kontakt-und-anreise/>



2 Program

Friday	September 26, 2025
10:00 - 11:00	Chair: Christine Müller
10:00 - 11:00	Welcome and Presentations of Problems in the TRR 391
10:00 - 10:20	Optimal design for functional data <i>Robin Solinus</i>
10:20 - 10:40	Optimal designs for nonlinear regression with dependent errors using matrix norms <i>Pauline Baur</i>
10:40 - 11:00	The use of experimental designs in the metamodeling of simulations of logistical systems <i>Sonja Kuhnt</i>
11:00 - 11:30	Coffee and Tea
11:30 - 13:00	Chair: Sonja Kuhnt
11:30 - 12:15	The virtual noise method and its use in the design of spatial experiments <i>Werner Müller</i>
12:15 - 13:00	Optimal discrimination between mixed models through nature-inspired algorithms <i>Jesús López-Fidalgo</i>
13:00 - 14:00	Lunch
14:00 - 15:30	Chair: Kirsten Schorning
14:00 - 14:45	A transport map approach to sequential design for high-dimensional inverse problems <i>Karina Koval</i>
14:45 - 15:30	Design of agricultural field experiments accounting for both complex blocking structures and network effects <i>Steven Gilmour</i>
15:30 - 16:00	Coffee and Tea
16:00 - 17:30	Chair: Mirko Jakubzik
16:00 - 16:45	Multivariate singular spectrum analysis by robust diagonalwise low-rank approximation <i>Mia Hubert</i>
16:45 - 17:30	New perspectives on simplicial depth <i>Stanislav Nagy</i>
from 18:00	Dinner at La Gazetta <i>An der Palmweide 56, 44227 Dortmund</i>

Saturday	September 27, 2025
10:00 - 11:30	Chair: Holger Dette
10:00 - 10:45	Optimal sensor location for spatiotemporal systems in the presence of correlated observations <i>Dariusz Uciński</i>
10:45 - 11:30	Meter placement in electric distribution grids: challenges, approaches and future perspectives <i>Marco Pau</i>
11:30 - 12:30	Brunch
12:30 - 13:30	Chair: Christian Rehtanz
12:30 - 13:30	Presentations of Problems in the TRR 391
12:30 - 12:50	Optimal designs for state estimation in time-dependent networks <i>Justin Lamberti</i>
12:50 - 13:10	State estimation design for efficient congestion management in distribution grids <i>Johannes Bao</i>
13:10 - 13:30	On optimal designs for the Kalman filter applied to electrical power distribution grids <i>Christine Müller</i>

13:30 - 14:15 Coffee, Tea, and Snacks

Farewell Celebration	
14:15 - 14:20	Musical opening: String Trio Op. 61 No. 1, 2nd Movement – Lebhaft bewegt, launig (Robert Fuchs)
14:20 - 14:30	Opening and welcome by the Dean Philipp Doeblner
14:30 - 15:00	Network propagation as a tool for biological plausibility analysis and data integration <i>Ralf Herwig</i>
15:00 - 15:05	Sextet for Violas, arranged for two violins, viola, and bassoon (John Hymas)
15:05 - 15:35	Liquid lifetime: a dynamic measure to forecast bond market liquidity <i>Martin Hillebrandt</i>
15:35 - 15:40	String Trio Op. 61 No. 1, 4th Movement – Lebhaft, übermüthig (Robert Fuchs)
15:40 - 16:10	Big Lin and little Lin or it is hard to predict, especially the future <i>Ivan Mizera</i>
16:10 - 16:15	Closing words
16:15 - 16:20	Musical closing: Auld Lang Syne (Trad. Scottish / arr. Aleksey Igudesman)
Musicians:	Uwe Ligges – violin, Christina Mathieu – violin, Ludger Sandig – viola, Maria Thurow – bassoon

16:20 - 17:30 Champagne Reception

3 Abstracts

The virtual noise method and its use in the design of spatial experiments

Werner Müller

Johannes Kepler University Linz, Austria

Several practically-oriented extensions and considerations for the virtual noise method in optimal design under correlation will be presented. First a slightly modified virtual noise representation will be introduced which further illuminates the parallels to the classical design approach for uncorrelated observations. Second more efficient algorithms to obtain the design measures are discussed. Incidentally, various convex relaxation methods used for sensor selection are special cases of this approach and can be solved within this framework. Finally, I provide practical guidelines on how to generally approach a spatial design problem and demonstrate how to utilize the virtual noise method in this context in a meaningful way.

Optimal discrimination between mixed models through nature-inspired algorithms

Jesús López-Fidalgo

University of Navarra, Pamplona, Spain

Co-authors: Victor Casero-Alonso, Sergio Pozuelo-Campos, Chiara Tommasi, and Weng Kee Wong

The bulk of the work in optimal designs in the literature is focused on finding model-based optimal designs for fixed effects models. Random effects models are relatively less studied even though they are increasingly used across all disciplines, particularly in the life sciences and clinical studies. They include a correlation structure of the observations. Model-based optimal designs, as the name suggests, depend on a specific model and so if the model is mis-specified, the statistical inference can be misleading or become invalid altogether. This work assumes there are several plausible random effects models and we want to use the Kullback-Leibler (KL) divergence criterion to find a design that optimally discriminates among the competing random effects models. The optimization problem is complex because the design criterion is non-differentiable and involves solving a multi-level nested optimization problem over very distinct types of domains. To this end, we develop theoretical results that simplify the computational burden and implement a nature-inspired metaheuristic algorithm to search for an optimal discrimination design. The methodology is quite general and applies to discriminating random effects models with multiple interacting factors, which may be continuous or discrete. We provide two applications; the first finds a design that optimally discriminates among fractional polynomials with a single continuous variable, and the second identifies the best design to discriminate among several multi-factor random effects models.

A transport map approach to sequential design for high-dimensional inverse problems

Karina Koval
Heidelberg University, Germany

Sequential optimal experimental design (sOED) seeks to adaptively select experimental conditions that maximize information content of incoming data. A common objective is to maximize the incremental expected information gain (iEIG) from each new observation. This is especially difficult in high-dimensional, nonlinear Bayesian inverse problems involving expensive models governed by partial differential equations (PDEs). We present a scalable sOED approach that leverages a sharp upper bound on the iEIG, computed efficiently using conditional transport maps and likelihood-informed subspaces. We demonstrate the method’s effectiveness through numerical examples, including applications with spatio-temporal data in PDE-constrained settings.

Design of agricultural field experiments accounting for both complex blocking structures and network effects

Steven Gilmour
King’s College London, United Kingdom

We propose a novel model-based approach for constructing optimal designs with complex blocking structures and network effects for application in agricultural field experiments. The potential interference among treatments applied to different plots is described via a network structure, defined via the adjacency matrix. We consider a field trial run at Rothamsted Research and provide a comparison of optimal designs under various different models, specifically new network designs and the commonly used designs in such situations. It is shown that when there is interference between treatments on neighboring plots, designs incorporating network effects to model this interference are at least as efficient as, and often more efficient than, randomized row-column designs. In general, the advantage of network designs is that we can construct the neighbor structure even for an irregular layout by means of a graph to address the particular characteristics of the experiment. As we demonstrate through the motivating example, failing to account for the network structure when designing the experiment can lead to imprecise estimates of the treatment parameters and invalid conclusions.

Multivariate singular spectrum analysis by robust diagonalwise low-rank approximation

Mia Hubert

KU Leuven, Belgium

Co-authors: Fabio Centofanti, Peter Rousseeuw

Multivariate Singular Spectrum Analysis (MSSA) is a powerful and widely used nonparametric method for multivariate time series, which allows the analysis of complex temporal data from diverse fields such as finance, healthcare, ecology, and engineering. However, MSSA lacks robustness against outliers because it relies on the singular value decomposition, which is very sensitive to the presence of anomalous values. MSSA can then give biased results and lead to erroneous conclusions. We propose a new MSSA method, named ROBust Diagonalwise Estimation of SSA (RODESSA), which is robust against the presence of cellwise and casewise outliers. In particular, the decomposition step of MSSA is replaced by a new robust low-rank approximation of the trajectory matrix that takes its special structure into account. A fast algorithm is constructed, and it is proved that each iteration step decreases the objective function. In order to visualize different types of outliers, a new graphical display is introduced, called an enhanced time series plot. An extensive Monte Carlo simulation study is performed to compare RODESSA with competing approaches in the literature. A real data example about temperature analysis in passenger railway vehicles demonstrates the practical utility of the proposed approach.

New perspectives on simplicial depth

Stanislav Nagy

Charles University in Prague, Czech Republic

The depth functions introduce elements of nonparametric statistics, such as quantiles and ranks, to data living in multivariate spaces. In this talk, we are interested in the classical simplicial depth (Liu, 1990), and its theoretical properties. Connecting the simplicial depth with advances in discrete and integral geometry, we derive several new theoretical results for this depth and the associated median: (i) the explicit simplicial depth for simple distributions in the plane, (ii) refined bounds on the breakdown point of the associated median, and (iii) a solid connection between the simplicial and the halfspace depth in the plane. Based on joint work with Erik Mendroš.

Optimal sensor location for spatiotemporal systems in the presence of correlated observations

Dariusz Uciński

University of Zielona Góra, Poland

The collection of spatiotemporal data is inevitably related to discrete spatial and temporal sampling of an inherently continuous system. This raises the question of how to locate a limited number of measurement sites so as the amount of information about the observed system be as high as possible. This is of special importance in parameter estimation of systems modelled by partial differential equations. In optimum experimental design for such systems the presence of correlations in the measurements from different sites and/or time instant must often be taken into account. As a result, the Fisher information matrix is no longer the sum of elemental information matrices stemming from single sites, which excludes use of traditional approaches. The aim of this talk is to demonstrate efficient computational procedures dealing with this challenging problem. Both modifications of the genuine exchange algorithm and various heuristics yielding convex relaxed formulations will be discussed, also when the exact correlation structure is not known exactly.

Meter placement in electric distribution grids: challenges, approaches and future perspectives

Marco Pau

*Fraunhofer Institute for Energy Economics and Energy System Technology, Kassel,
Germany*

Electric distribution grids are at the center of the ongoing energy transition. This calls for an accurate monitoring and active control of the distribution network, which must necessarily rely on measurement data collected from the instrumentation in the field. Since distribution grids are usually poorly instrumented, grid operators increasingly require ad hoc tools and solutions to determine the best strategies to deploy new measurement devices for strengthening the measurement infrastructure in their networks. This presentation aims at providing some insights on recent developments around the topic of meter placement for distribution grids. Initially, it will provide an overview of the context and of the main challenges existing for the design of optimal meter placement solutions. Then, different approaches will be presented, focusing on some recent proposals and emphasizing their strengths and possible weaknesses. Finally, still-open issues will be underlined and potential directions for further developments will be discussed.

Network propagation as a tool for biological plausibility analysis and data integration

Ralf Herwig

Max Planck Institute for Molecular Genetics, Berlin, Germany

Modern high-throughput experiments generate experimental data on a large number of genes/proteins in parallel. Additionally, deep learning prediction methods assign influence to many different features that are hard to interpret. Thus, network propagation methods aim to map these data onto biologically reasonable networks and to infer heavy-weighted sub-networks (so-called functional modules) that are related to biological functions and can explain the biological context. In the talk, we present the different components of such an approach, that we developed in the past, namely i) a large biological network of protein-protein interactions integrated from various sources [1], and ii) a network propagation method for the identification of sub-networks based on random walks with restart. We show the performance of the approach for different biomedical applications such as drug toxicity [3], and patient survival prediction using decision tree ensemble modelling [4].

References:

- [1] Herwig R, et al. Analyzing and interpreting genome data at the network level with ConsensusPathDB. *Nat Protoc* 11, 1889–1907 (2016).
- [2] Barel G, Herwig R. NetCore: a network propagation approach using node coreness. *Nucleic Acids Res* 48(17):e98 (2020).
- [3] Selevsek N, et al. Network integration and modelling of dynamic drug responses at multi-omics levels. *Commun Biol* 3, 573 (2020).
- [4] Thedinga K, Herwig R. A gradient tree boosting and network propagation derived pan-cancer survival network of the tumor microenvironment. *iScience* 25(1):103617 (2021).

Liquid lifetime: a dynamic measure to forecast bond market liquidity

Martin Hillebrand

XU Exponential University of Applied Sciences, Potsdam, Germany

We introduce the liquid lifetime as a novel, dynamic measure of bond market liquidity, grounded in a simple yet powerful exponential decay model. Our approach captures the temporal evolution of liquidity by distinguishing between buy-and-hold and buy-and-sell investor behavior, allowing for robust estimation of liquidity decline over a bond's life. Using comprehensive European secondary bond market data, we demonstrate the model's strong empirical fit and forecasting accuracy across different market regimes, including periods of quantitative easing. The analysis quantifies the impact of central bank interventions, revealing how ECB bond purchases compress the liquid lifetime by crowding out private buy-and-hold investors. We also explore how issuance strategy—such as taps versus benchmarks—affects liquidity trajectories. The insights are actionable: issuers can optimize strategies to enhance market liquidity; investors can factor liquidity decay into portfolio decisions; and policy makers gain a framework to assess the systemic effects of monetary operations on market functioning.

Big Lin and little Lin or it is hard to predict, especially the future

Ivan Mizera

University of Alberta, Edmonton, Canada, and Charles University in Prague, Czech Republic

Two papers co-authored by the two-person team consisting of Christine H. Müller and Ivan Mizera are introduced. They concern only somewhat related topics: one of them robust regression, another one data analysis via halfspace depth - but they share the important virtue that both of them can be considered significant in the publication records of both authors, both of them ranking within the first ten places in both of those. After some few details about their appreciation at the time of their creation, the talk will follow their fate up to the recent day, the fate resembling somewhat the fate of the two brothers in the classical Chinese children's book, and eventually try to make some, inevitable anecdotic, conclusions out of that.