

Abstracts of selected publications

Piotr Morawiecki

Thesis

P. Morawiecki, “Simulation of wood pyrolysis in chosen experimental reactors”, Master Thesis, Warsaw, 2018

Abstract: Biomass heated to the high temperatures in absence of oxygen undergoes a series of chemical reactions, making up the pyrolysis process. During these reactions complex organic molecules (like cellulose, hemicellulose and lignin) are transformed to simpler molecules, forming charcoal and flammable gases among others. The purpose of this work is to numerically simulate the processes occurring inside the experimental reactors and compare the results of the simulations with the experiments. The numerical results accurately reconstructed all phases of the process, the direction of reaction front and the flow of the gas inside and around the wood particle. Moreover, a significant relationship was found between the gas flow in the reactor and the dynamics of chemical reactions occurring inside the particle. The developed simulations can be considered as the first step toward the optimization of industrial processes for obtaining charcoal and wood gas.

P. Morawiecki, “Inverse problem to river networks evolution”, Bachelor Thesis, Warsaw, 2016

Abstract: Headward erosion is a phenomenon responsible for extending the river valley into the hillside and hence creating a ramified drainage networks. Interestingly, this process can be modelled in terms of the geodesic growth of thin lines in a field described by the Poisson’s equation. Here, I analyse numerically the river network evolution for different growth laws and different bifurcation rules, which determine the moments when the stream bifurcates into two daughter branches. Finally, I formulate and analyse the inverse problem: can the growth law of a river be inferred from the analysis of the geometrical structure of its network? The growth law was successfully estimated in a series of numerical tests on synthetic data.

Technical reports from Study Groups

K. Kiradjiev, P. Morawiecki, R. Pisarczyk, “Finding a Fair Heat Settlement Model”, Warsaw, 2019

Abstract: The project was delivered by Fortum, a multinational energy company that, among other things, delivers heat to individual blocks of flats in cities. Such buildings are heated using heat substations that are connected to a district heating network. Fortum charges the whole building based on the total heat delivered to the heat substation. The cost is then split between the apartments using an appropriate heat settlement models. The goal of the project was to proposed a heat settlement model based on the heat distribution in the building.

J. Hook, K. Kamil, P. Morawiecki, E. Wilson, “Understanding the screening process of new molecules”, 138. ESGI, Bath 2018

Abstract: The project proposed by Syngenta, agricultural company which each year develop around one thousand new compounds that could be used as herbicides. In order to attempt to select only the best performing compounds in a cost effective way, Syngenta use a screening cascade composed of several testing stages. After each of them only part of compounds passes to the next stage. The problem is to develop methodology to optimize the screening cascade in a principled way, drawing on areas of Mathematics such as Statistics and Optimization. During the study group three highly simplified models of the screening process were developed, which can be extended to be more realistic in a number of ways.

A. Champneys, G. Benham et al., “Optimisation of fluid mixing in a Hydrosac growing module”, 138. ESGI, Bath 2018

Abstract: Project was delivered by Phytoponics, an 'AgTech' start-up, which has invented a new type of low cost and versatile growing system that could deliver a huge impact globally. Hydroponics involves growing plants in a water-based nutrient solution to induce higher growth rates. The challenge is to optimise the design of the fluid mixing within the Hydrosac growing modules, such that oxygenation is maximised in the pool of water, and that nutrients are well mixed without any dead zones or unintended concentration gradients.

M. Croci, P. Morawiecki et al. “Classification of Two-Dimensional Gas Chromatography Data”, 130. ESGI, Warwick 2017

Abstract: The aim of the project proposed by DSTL was to use data from two-dimensional gas chromatography (GCxGC) to attribute samples to a particular region or cultivar. Several difficulties must be overcome before being able to do this: noise from sample, peak misalignment, and low quantity of samples. As a research team, we investigate several methods to overcome such difficulties, and then classify the data. We are very successful in telling apart blanks from seeds, but obtain limited success when trying to classify between seeds. The most promising results were achieved with k-Nearest Neighbours classification by Wasserstein distance. Some recommendations were proposed, which can lead to improvement of classification accuracy.

H. Braviner, O. Hryniv, et al. „The Computer as a Solution Space”, 107. ESGI, Manchester 2015

Abstract: Zenotech, company providing cloud-based high performance computing (HPC) services to customers wanting to run large parallelised simulations, challenged the study group to find a mathematical characterisation of a HPC system that would allow for a more effective mapping of algorithm topology onto HPC network topology and a better understanding of scalability and robustness in the system. We investigated how to best optimise partition size and time of data transfer on a square lattice and the effect of using old boundary data for continued calculation when new data does not arrive on time. We also produced a toy network model to test the effect of different partition choices and communication strategies.

Technical reports from projects completed at the Centre for Industrial Applications of Mathematics and Systems Engineering (most of them in Polish):

„Regression Methods for Large Binary Matrices”, report from industrial project facilitated by Microsoft, Warsaw, 2017. Joint work: P. Morawiecki, P. Sakrajda, K. Kulesza, et al.

Abstract: The report was the summary of the project titled "Powerful Rapid Inversion of Super Matrices" (PRISM). It was conducted in collaboration with a global corporation in the technology sector interested in the area of on-line advertisement among others. One of the problems in this area is estimating click-through rate (CTR) of online advertisement based on information about the user search history and keywords defined by an advertiser. As the databases are large and regularly updated this task may be treated as Big Data problem and requires nonstandard tools for data analysis. As part of the work, theoretical and numerical issues in the area of linear algebra were considered, including the problem of inverting large matrices.

“Optimization of scheduling and job assignment for the maintenance operation”, report from industrial project facilitated by BSH Ltd (Bosch & Siemens’ maintenance company for home appliances), Warsaw, 2016. Joint work: K. Kulesza, P. Sakrajda, P. Morawiecki, et al.

Abstract: The project, done for a company from the household appliances industry, was aimed at analysing and possibly improving the service system including warranty repairs made by service technicians in the field. Work on the project involved creating a mathematical model of a service system that considers real requirements as well as logistic, organizational, economic and legal constraints. Additionally, as part of the project work, a detailed analysis of similar problems identified by other companies was prepared.

“On possible quantitative implications of new legislation proposed by the government for gambling sector in Poland”, report from industrial project facilitated by Casinos Poland (largest casinos operator in Poland), Warsaw, 2016. Joint work: K. Kulesza, P. Morawiecki et al.

Abstract: The project, ordered by Casinos Poland, concerned a quantitative analysis of proposed legislative initiatives aimed at increasing the tax imposed on the industry. Its aim was to prepare quantitative models describing in a systemic manner the consequences of implementation of the proposed changes, with taking into account both types of operators permitted by law in Poland - full scale casinos and smaller gambling places with machines only.

„Prediction model based on data from L.E.M. nano prediction market” report written as a part of a long-term project for Industrial Development Agency S.A., Warsaw, 2015. Joint work: P. Morawiecki, P. Zioło, et al.

Abstract: The aim of the project was to develop a method for the formulation of short- and long-term forecasts based on data from the L.E.M. nano prediction market (<http://lem-nano.pl/>) and other external sources. The procedure utilizes a model consisting of five modules based on predictive methods, used among others in behavioural economics and forecasting technological changes. It can be used to obtain forecasts of the breakthrough time in the development of new technologies, including the approximate time of their commercialization. It has been supplemented with a review of the forecasting methods used and the method of estimating the uncertainty of the forecasts obtained.

„Analysis of selected methods for assessing the accuracy of determining the size of wood resources in the course of the National Forest Inventory in Poland”, report from industrial project facilitated by BULIGL (state-owned company in charge for quantitative aspect for forestry in Poland), Warsaw, 2014. Joint work: P. Ziolo, P. Morawiecki, et al.

Abstract: The project, implemented at the request of a state-owned enterprise in the forest management industry, concerned selected aspects of dendrometry. The main goal of the project was the scientific analysis of statistical methods used within the framework of National Forest Inventory. Currently used procedures contain some heuristics, despite which the estimates of the thickness of the forest are characterized by high accuracy. Design work focused on the theoretical analysis of the entire procedure and the formulas used within it. Numerical simulations were also carried out to verify the stability of the model in terms of changing the parameters of the tested object and the procedure used during forest inventory.

Scientific feasibility study on scheduling of huge investments with robust effectiveness - SHIRE”, report from industrial project facilitated by DM BOŚ S.A. (leading brokerage house in Poland), Warsaw, 2014. Joint work: K. Kulesza, P. Ziolo, P. Morawiecki, et al. „

Abstract: The aim of the SHIRE project, carried out for a large brokerage house, was to develop a scientific feasibility study in the optimization of algorithmic handling of large orders carried out on the Warsaw Stock Exchange (WSE), including analysis of the relevant aspects of market microstructure created on the WSE after the implementation of the UTP (Universal Trading Platform). As part of the project, the problem was structured by identifying the ranges of typical parameters of large orders that are important for solving the problem, the main conceptual elements of the algorithm performing a single large order and the potential methods of its testing. During the work on the algorithm, several hypotheses were set up, for which it was decided to conduct statistical surveys on historical data. The result of these analyses allowed to indicate the most promising market characteristics that can be used for executing large orders.

„Modelling of the Nuclear Armageddon”, CIAMSE project during run annual summer programme Warsaw, 2013. Joint work: P. Ziolo, P. Morawiecki, et al.

Abstract: The project was aimed to describe the nuclear war model. For this purpose, a broad review of the subject literature was made, and then a mathematical model of the phenomenon occurring on a local scale during the nuclear charge explosion was constructed, depending on a number of parameters, e.g. load power, the height at which the detonation or weather conditions is made. The second important element of the model was the description of phenomena in a global scale, e.g. the impact of a nuclear war of varying scale on the economy and climate. In particular, the damage in the affected areas, human losses, problems in the functioning of medical services, as well as the lowering of the average temperature on the Earth and the resulting reduction in food production were considered. Using the described model, a scenario of an example war with the use of nuclear weapons was prepared.

Other papers

P. Morawiecki et al. "In-flight terrain mapping using Convolutions Neural Network" (final report from CanSat competition), to be published on European Space Agency website in 2019.

Abstract: The paper presents polish CanSat mini-satellite that have been launched on June 26th, 2019, during European CanSat Competition organised in Italy by the European Space Agency. The goal was to provide a cost efficient system capable of classifying different types of terrain and using them to construct simple topographic maps. These maps can be further used in order to assess the area covered by natural disasters such as floods and fires as well as prevent their spreading.