Abstracts 240322

Arvid Asplund - Optimal time-to-calibration of intraday volatility surfaces - Nasdaq Technology AB

The financial market is a complex and dynamic environment where market participants strive to reach their economic goals while minimizing the exposed risk. One tool used when evaluating risk is the volatility surface. The volatility surfaces are currently calibrated on a static one-minute basis to reflect the market in close to real-time. This ensures accurate risk calculations, but it comes at a cost. Calibrating the volatility surfaces for every available option chain is computationally expensive. We investigate if there are alternative, more effective, calibration methods that can be used without sacrificing precision. The alternative methods are implemented and the result is compared to a benchmark, the volatility surface calibrated every minute. The results suggest there are alternative methods that can be used to optimize the time efficiency.However, the best precision is always achieved by calibrating the volatility surface as frequently as possible. And if this trade-off is worth it is ultimately up to the end-user. These results are achieved by evaluating one volatility surface over one day, this leaves room for further research, evaluating how well these alternative methods work across different option chains and over an extended period of time.

Axel Eriksson - Balancing Accuracy and Complexity: Predictive Models for Proactive Scaling of Financial Workloads in Cloud Environments - Nasdaq

Predicting the future is an essential element in many fields, as it can lead to significant cost savings due to efficient resource allocation. Modern Cloud systems are composed of large numbers of processing and storage resources, giving the potential to dynamically scale the resources provided to workloads throughout the day. If the amount of resources required is known in advance, proactive scaling can be implemented, and only the necessary amount of resources are allocated, resulting in optimal performance and cost efficiency. This study aims to accurately and efficiently forecast the workload of a financial system, characterized by high frequency, noise, and unpredictability.
Based on the dataset a model within each category, statistical, machine learning, and artificial neural network was implemented. The models within each category with the most promising qualities for such data were, SARIMA, XGBoost, and LSTM. These 3 models were compared on different scenarios with a focus on the trade-off between accuracy and complexity. An optimal model has a low complexity which means efficient but still has a high accuracy. The result of this study showed that the workload within this specific system can be predicted using the 3 models. The optimal model varies depending on scaling requirements, for short-term high-accuracy predictions LSTM is the best with an R2 score of 0.92, but also the most complex. XGBoost is less complex than LSTM and has an overall better accuracy on different scenarios. SARIMA, though simpler, exhibits the best accuracy for long-term predictions with an R2 score of 0.75. This study concludes that it is possible to predict certain financial workloads in advance, paving the way for further research into proactive scaling in such scenarios.

Andreas Nilsson - Accelerating Radiowave Propagation Simulations: A GPU-based Approach to Parabolic Equation Modeling - FOI

This study explores the application of GPU-based algorithms in radiowave propagation modeling, specifically through the scope of solving parabolic wave equations. Radiowave propagation models are crucial in the field of wireless communications, where they help predict how radio waves travel through different environments, which is vital for planning and optimization. The research specifically examines the implementation of two numerical methods: the Split Step Method and the Finite Difference Method. Both methods are adapted to utilize the parallel processing capabilities of modern GPUs, harnessing a parallel computing framework known as CUDA to achieve considerable speed enhancements compared to traditional CPU-based methods.
Our findings reveal that the Split Step method generally achieves higher speedup factors, especially in scenarios involving large system sizes and high-frequency simulations, making it particularly effective for expansive and complex models. In contrast, the Finite Difference Method shows more consistent speedup across various domain sizes and frequencies, suggesting its robustness across a diverse range of simulation conditions. Both methods maintained high accuracy levels, with differences in computed norms remaining low when comparing GPU implementations against their CPU counterparts.

Anneli Nilsson - Evaluation of ultra-hypofractionated radiotherapy with focal boost for prostate cancer by histological grades - Institutionen för diagnostik och intervention

Prostate cancer (PCa) is the second most common cancer diagnosis for men and the fifth leading cause of death worldwide. A common treatment strategy for PCa is external beam radiation therapy (EBRT), where high doses of radiation are used to kill cancer cells. Recent developments in RT include maintaining acceptable side effects during intensified treatment over fewer treatment occasions (hypofractionation) and boosting the level of radiation to tumors visible on multiparametric magnetic resonance imaging (mpMRI) and positron emission tomography (PET). Despite the evidence supporting the efficacy of focal boosts, there are still uncertainties surrounding the association between what is delineated as tumor (GTV) and the true underlying disease. Without a histopathological (HP) reference, the dose distribution cannot be compared to the varying grades of aggressivity within the cancer, known as ISUP grade groups (IGGs). The aim of this master thesis project was to explore the dose distribution over IGGs using a gold standard HP reference and investigate the mitigating effects of rectal spacers, following a hypofractionated RT schedule with focal boosts. The dataset consists of 15 patients, planned for radical prostatectomy. These patients harbored high-risk disease (IGG ≥ 4) in the GTV. HP evaluations following surgery resulted in physical slices of the prostate, showing the location and IGG of lesions. EBRT treatment plans were made based on the upcoming RT-PC-HYPO-Boost trial protocol where ultra-hypofractionation strategy is combined with boosting the GTV. The dose distributions were evaluated by dose volume histograms (DVHs) over the target volumes, organs at risks (OARs) and the lesions. Robust evaluations of targets and OARs were performed by recalculating doses following translations of the patient by 2 mm in all directions. Similarly, lesions were shifted by 2 mm in all directions with respect to the nominal dose plan to estimate the sensitivity to motion. The effects of the translations were assessed by examining the impact on the DVHs and percentage of passed clinical goals. Two viable dose plans for each patient were produced, one for a 10 mm spacer and one for 8 mm. Both plans fulfill all rectum goals. For the 10 mm plan, the average median dose (D50) was greater than the prescribed prostate dose (42.7 Gy) for all IGGs by at least 1.1 Gy. The D50 of the higher grades (IGG 3, 4 and 5) were 47.5, 46.4 and 48.7 Gy, meaning that they were closer to the desired GTV dose 49.0 Gy than the prescribed prostate dose. This thesis project showed that it is possible to reach high GTV doses while sparing the OARs and that the higher IGGs received a higher dose than the lower grades. Examining rectal dose depending on different spacer thicknesses allowed us to recommend a spacer thickness that is safe to use, which can provide increased patient comfort while saving time and resources.

Erik Sjöberg - Adaptive search patterns for utility mapping with GPR - Guideline Geo

Ground Penetrating radar is often used for finding utilities like pipes and cables in the subsurface. In many GPR surveys a full grid patterns is performed even if the goal of the survey is to just locate a few utilities. The aim of this project was to develop an adaptive serchpattern for utility mapping that uses as short path as possible and that could be applied to an autonomous single channel GPR system in the future. The searchpattern was developed and simulated with Python. Animation and static plots were generated for demonstration and evaluation of its performance. A few configurations of pipes were created for testing and performance evaluation. The result of the project is a searchpattern that can traverse and map a network of utilities. It is able to find and map most pipes in test configurations but there are corner cases that need more attention. It can be used as a guide for a human operator, which mean that a computer tells the operator how to move the system. The efficiency of the searchpattern was evaluated. On a fairly sparse network of pipes, it can reduce the time consumption by at least 50% compared to the corresponding grid search.

Fatima Khaled - Development of Optically Selective Plasmonic Coatings - Institutionen för fysik

In the fields of solar technology development, there are many advanced solar energy systems engineered to generate renewable energy for diverse use. Comprising essential components such as reflectors and a solar receiver tube, these solar energy systems are equipped to efficiently capture and convert solar irradiation into usable thermal energy. As an integral facet of an ongoing research, this project contributes to optimize the reflection and absorption capacity in receiver tubes of Absolicon’s solar collectors. The aim is to investigate optically selective plasmonic coatings intended as an undercoating in the solar selective surfaces. The main coating material that was used and analysed is gold due to its plasmonic properties and inert nature as well as its low toxicity. The gold was coated on stainless steel using physical vapor deposition (PVD) and then annealed at mid-to-high temperatures to produce a plasmonic surface. The effect of Au thicknesses, annealing times/temperature and was investigated to optimize the coating with regards to optical properties based on a systematic method called Design of Experiments (DoE). The goal for the gold coating was to increase the reflectance in the infrared region while generating a plasmonic absorption peak in the visible region, making it a more beneficial surface to coat a solar selective surface than the original stainless steel (SS). The results show that either thinner Au-undercoatings with short annealing time exhibit high absorption peak in the solar spectrum and, achieving the surface features required for plasmonic effects.

Filip Smedjegård - Fine-tuned convolutional neural networks for improved glaucoma prediction - Region Västernorrland

Glaukom, mer känt som grön starr, är en av de vanligast förekommande ögonsjukdomarna som orsakar blindhet. Det är viktigt att diagnostisera glaukom tidigt i sjukdomsförloppet för att genom behandling, sakta ner eller stoppa ytterligare synförlust. Att diagnostisera glaukom kan vara utmanande, eftersom det vanligtvis inte visar några tidiga symtom. Artificiell intelligens (AI), eller mer specifikt maskininlärning (ML), kan hjälpa läkare att ställa rätt diagnos om det används som ett beslutsstöd. Faltande neurala nätverk (convolutional neural network, CNN) kan lära sig att känna igen mönster i bilder, för att därigenom klassificera bilder till olika kategorier.

Ett sätt att diagnostisera glaukom är att studera näthinnan och synnerven i ögats bakre del, som kallas ögonbotten. I denna studie finjusterades redan tränade CNN:s för att prediktera glaukom utifrån ögonbottenbilder. Detta uppnåddes genom att träna om modellerna på publikt tillgängliga ögonbottenbilder. Målet var att jämföra nätverkens noggrannhet på en delmängd av bilderna, samt att evaluera dem på ögonbottenbilder från sjukhus i Region Västernorrland (RVN). För att uppnå detta ingick det även i metodiken att utforska begränsningarna och möjligheterna med hur patientdata får användas, samt att undersöka hur datat bör lagras och tillrättaläggas för att möjliggöra utvecklingen av prediktionsmodeller. Syftet med studien var att öka noggrannheten vid diagnostisering av glaukom.

Resultaten visade att en ensemble baserad på majoritetsröstning av alla modeller gav den bästa noggrannheten, ungefär 94%. Sensitiviteten och specificiteten var 0.90, respektive 0.97. Vidare klassificerades 90% av ögonbottenbilderna från RVN korrekt. Resultaten tyder på att maskininlärning är effektivt för att förbättra den diagnostiska noggrannheten för glaukom. Det understryker också vikten av strategisk lagring och förberedelse av medicinska data för att utveckla prediktiva maskininlärningsmodeller i framtiden.

Gustav Felländer - Drought Stress Detection using Hyperspectral Imaging - Knightec AB

This master’s thesis project investigates the utilization of a low-cost hyperspectral(HS) imaging rig to identify and classify drought stress in pine plants. Drought stress is a widespread environmental challenge affecting global forestry, requiring more resources as the industry grows and global warming rises. This provokes a need for affordable, and efficient monitoring methods. HS imaging, with its ability to capture a wide range of spectral information, offers promising methods for quick and precise measurements of plant stress. The project methodology is comprised of redesigning an existing HS imaging rig, with the camera employing push-broom technology, to yield precise and consistent HS images. This involved exploring the camera’s spectral range, designing components to ensure consistent artificial lighting using blackbody radiation sources, and calibrating the HS camera for focal depth and aberrations like smile and keystone. Two experiments were conducted to obtain the experimental data for pine plant stress detection, first for two binary categories: Control, and 100% Drought, and later introducing a third semi-drought category in the second experiment. The data analysis encompassed preprocessing the HS images to correct the lighting intensity distributions and normalization of pixel values. Accompanied by filtering, resampling spectral data, and feature extraction facilitating consistent drought identification, and data management. To identify stress patterns in pine plants and temporal decay rates, methods such as spectral reflectance analysis, various vegetation indices (VI), and statistical learning techniques like discriminant analysis and logistic regression were evaluated for distinguishing between stressed and healthy plants. The results demonstrate the accuracy of the HS imaging rig in measuring spectral reflectances from plants, capturing changes between 550 − 670 nm in the visible spectrum and 750 − 890 nm in the NIR spectrum due to increasing stress affecting chlorophyll levels. NDVI, along with empirically designed indices, NGOR and GIRI, indicate reliable early detection. Comparing multiple VIs to statistical learning

models shows similar performances in binary classification tasks. Feature selection methods using correlation matrices, and LASSO penalty for logistic regression support stress effects visible in the data, paving the way for cost-effective strategies in sustainable forestry management.

Gustav Marklund Brinell - Graph Neural Network Forecasting in Electric Power Systems - Svenska Kraftnät

This thesis explores the application of Graph Neural Networks (GNNs) for forecasting net-positions in the Nordic electricity market. Two GNN architectures, Gated Recurrent Unit Graph Convolutional Network (GRU-GCN) and Fourier Graph Neural Network (FGNN), were evaluated and compared to the existing forecasting model employed in the power grid. Results demonstrate that both GNN models achieve competitive performance, highlighting their potential for leveraging the graph structure inherent in power grids. However, regional variations in forecast uncertainty and the impact of data quality and disruptions necessitate further research. This thesis contributes to the understanding of GNNs in power grid forecasting and identifies future research directions, such as developing interpretable GNN models and incorporating additional data sources, to enhance the accuracy and reliability of power grid operations.

Herman Lundback - Photon-counting CT as a way to reduce the uncertainty in tissue characterisation for proton therapy dose calculation - Akademiska Sjukhuset

Radiotherapy is a cornerstone modality in treating many types of cancers.
Extensive research conducted globally over many years has led to improvements in the effectiveness and especially in the precision of these treatments, minimizing the dose to surrounding healthy tissue and reducing long-term negative effects. A significant advancement in radiotherapy has been the development of proton therapy, which is being used to treat an increasing number of patients each year. Protons have a unique dose distribution pattern, losing most of its energy in a distal peak known as the Bragg Peak and no dose beyond the peak. This allows for a precise delivery of the dose to a tumor while sparing surrounding tissues. However, the position of the Bragg Peak is highly sensitive to the patient's exact anatomy and its chemical composition. This makes accurate imaging for estimation of the tissue composition, needed for correct interaction physics cross sections in the dose calculation, important for reducing the uncertainties in proton therapy planning. Recent advancements in Computational Tomography (CT) imaging, particularly the introduction of Photon- Counting CT (PCCT), have the potential to further decrease these uncertainties by utilizing the additional information available that comes from the energy spectral information. The main objective of this project was to develop a method utilizing the spectral information to improve the estimation of the tissue composition. The impact of the improved tissue composition characterisation was evaluated by investigating the accuracy of the estimation of the Stopping Power Ratio (SPR), the most important interaction cross section for determining the location of the Bragg Peak and to compare it to previously published results. This was achieved by calibrating the PCCT with a phantom with various tissue-equivalent materials and then applying a multi-energy stoichiometric method to describe each material as a linear combination of a number of base materials. For reference, measurements were also performed using a standard Single Energy CT (SECT), and these SPRs were calculated with the Hounsfield Unit (HU) to SPR tables currently used clinically at the Skandion clinic for proton therapy planning. The results shows that the uncertainty in the SPR calculations can be reduced compared to SECT using the PCCT method developed here. The highest error in the SPR for lung-equivalent tissues was 19.0 % for SECT and 12.5 % for PCCT. For water-like tissues, the highest errors were 2.1 % for SECT and 1.4 % for PCCT and in bone-equivalent tissues, 5.6 % for SECT and 3.6 % for PCCT.

Jacob Lindström - Enhancing fan engagement through data: the relationship between sports data and fan engagement - Sportswik

During sporting events, vast amounts of data are generated. This data is utilized for multiple reasons, one of which is to improve fan engagement. Fans are a cornerstone in modern-day sports, and keeping fans satisfied and increasing fan engagement are crucial within the sporting industry today. Although the research on fan engagement is extensive, the potential to use sports data and rankings to enhance fan engagement remains unexplored. This study investigates how sports data can be used to improve fan engagement, both within floorball and sports in general. By categorizing fans by their interest in data rather than the conventional fan metrics, like revenue generated or loyalty, we can provide more tailored data to visualize what the fans want and enhance fan engagement. To attract and retain fans by focusing on their interests to improve the fan experience of all categories of fans. The study also highlights the importance of incorporating fan feedback and improving data collection methods to improve fan engagement. The key findings emphasize the novel approach to categorizing fans, the impact of tailored data visualizations, and the importance of fan feedback and data collection improvements.

Johan Jonsson - Development of FROG: An imaging and analysis device for fluorescently marked contamination - FOI

Weapons of mass destruction (WMD), most commonly chemical, biological, radioactive, and, nuclear (CBRN) weapons, are one of the greatest threats from
an enemy. Since the end of the Second World War, predominantly chemical and
biological weapons have been reported usage. Chemical and biological weapons
are lethal in tiny amounts, making them fearsome and tricky to counter. Hence,
studying and developing methods with real CBR agents is very resource-intensive,
dangerous, and massively restricted, the need for alternative methods is critical.
In recent years, there has been growing interest in using fluorescence to investigate
CBRN contamination. Fluorescence is a photonic phenomenon where a molecule
emits light while absorbing light, usually ultraviolet (UV). This makes fluorescentmarked substances
visible under UV light and hence a more suitable exercise agent
for studying decontamination processes than actual CBR agents. The goal of this
thesis work is to develop a measurement module and analysis methodology, that
can detect and analyze microparticles on a surface using fluorescence and imaging. This is to study how contamination attaches to surfaces and how effective a
decontamination process is. After constructing a measurement setup with a camera, an LED, and a filter, I could use imaging to successfully detect fluorescent
microparticles on surfaces. Then by implementing software, I could via the software collect and analyze the images, giving an estimate of the number of particles
present in the image. This was done by taking the absolute value of the difference
between a nonfluorescent image and a fluorescent image, leaving only the fluorescent particles, which could then be counted. For increased portability, a small
module was constructed. Samples were then created and decontaminated with an
airflow simulating the movement of a vehicle to evaluate the developed methodology. The result was an 81.9% reduction of contamination for a clean surface while
for a greasy surface only a 17.2% reduction, indicating the importance of keeping
surfaces clean. This methodology is extremely fast compared to other methods
requiring tedious manual image manipulation or lab analysis, from hours or even
days down to seconds. This method could even distinguish single microparticles
accurately resulting in general 2 to 3 particles in standard deviation. Further testing showed that the developed methodology could distinguish two different types

of fluorescent particles on the same surface. It could even detect liquefied agents, though it failed to give quantitative data on the amount of contamination. The extremely fast measurement and analysis seemed to be an effective, and suitable method for studying decontamination processes. With further development in analyzing droplets, this could be a new way of studying CBRN contamination.

Josefin Nilsson - Benchmarking of techniques for measuring resin uptake in saturating kraft paper - Mondi Dynäs

The laminate industry is a world wide growing market with constantly new applications. Mondi Dynäs is a paper manufacturing company with an ambition of increasing their production scale of Advantage MF Boost, a stiff and porous material specially created for the composite part in laminates. Uneven resin absorption on the paper has been reported and this non-homogeneous spreading leads to quality defects on the final product. This thesis aims to improve the understanding of the resin uptake and evaluate methods to measure liquid imbibition in order to increase the quality control. Two methods currently exist within the company, one for resin penetration time and another for resin absorption. These methods are time-consuming and therefore other methods are evaluated to detect if they correlates with these two properties. The tested measurements are related to the porosity and surface characteristics, by testing a TAPPI method for liquid imbibition, surface roughness and gurley. This project has also evaluated the role of paper formation. Some visual methods were used for the evaluation, such as SEM and visual image analysis. Finally a penetration dynamic analyzer (PDA) with ultrasonic waves was tested with different liquids. Visual methods indicate that paper formation is important for the paper impregnation, it suggests that it takes longer time to penetrate larger fiber floccuations. Contradicting to this, the data could not confirm any relation between the paper formation and the resin penetration time. Instead a correlation between the paper formation and the method for the resin absorption was identified. It was concluded that poorer paper formation implicated higher resin content, this was later verified with SEM and BSE images of the resin attachment to the fibers. In theory the PDA is a promising device for this kind of measurement and the obtained measurements exhibits some trends. However, the results from the PDA provided a too large scattering in the data for a correct evaluation and is in current state not an useful tool for quality control.

Marcus Sundin - A field deployable method for measuring whole body radionuclide content in people - Totalförsvarets forskningsinstitut (FOI)

Since the nuclear weapons tests in the 1950s and 60s, Sweden has been monitoring radioactivity levels in different populations. After the Chernobyl disaster in 1986, which released a lot of cesium-137 (137 Cs) over Sweden, there became a need to monitor whole-body radioactivity content in the population. So far this has been done using a large container with a lead-shielded radiation detector. In this work, such a system has been combined with a simple measurement geometry and evaluated for its usability in the field.

The detector system is a mobile nitrogen-cooled HPGe spectrometer called Detective-X. This setup employs what's known as the Palmer geometry. In this method, the person being measured sits down and holds the detector in their lap with the top of the detector pressed against their abdomen while they hunch over it. We used a test population to compare the method in this work with the existing method to determine the whole body content of 137 Cs.

To calibrate our setup, we used a human-like phantom called IRINA to construct a geometry mimicking the Palmer geometry. We inserted radioactive rods into the phantom to mimic how a real human body absorbs radiation. In addition to measurements, a Monte-Carlo simulation model of both the detector

and IRINA was created. We evaluated these models in different steps until good correspondences between measurements and simulations were reached.

The results were promising. Simulated calibration factors differ by about 1% from the physical measurements. This means that the simulation model is reliable and can be used in future research. However, the Palmer setup tends to underestimate the whole body content of 137 Cs. A bigger test population and a lower background environment are needed to get more insight on the performance of the Palmer setup.

Per Sehlstedt - Implementation and Improvement of a Numerical Method for Advection-Diffusion-Reaction Equations - Sartorius Stedim Data Analytics AB

In this thesis, we mainly investigate the application of a nodal discontinuous Galerkin spectral element method (DGSEM) for simulating processes in column liquid chromatography. Additionally, we investigate the effectiveness of a total variation diminishing in the mean (TVDM) limiter in controlling spurious oscillations related to the Gibbs phenomenon. With an order-of-accuracy test, we demonstrated that our nodal DGSEM achieved and, in multiple instances, even exceeded theoretical convergence rates, especially with an increased number of elements, validating the use of high-order basis functions for achieving high-order accuracy. We also demonstrated how setup parameters could affect process outcomes, which suggests that numerical simulations can help guide the development of experimental methods since they can explore the solution space of an optimization problem much faster than experimental procedures by leveraging computational speed. Finally, we showed that the TVDM limiter successfully eliminated severe oscillations and negative concentrations near shock regions but introduced significant smearing of the shocks. These findings validate the nodal DGSEM as a highly accurate and reliable tool for detailed modeling of column liquid chromatography, which is essential for improving efficiency, yield, and product quality in biopharmaceutical manufacturing.

Petter Persson - Inverse Design of Anisotropic Nanostructures using modern Deep Learning methods – Institutionen för fysik

Nanophotonics is an interdisciplinary field in physics that combines material science and optics and has seen a revolution in recent years. Current research topics include a wide range of applications from quantum computing research to plasmonic biosensors and solar cells. With many interesting future applications that can revolutionize modern society, the demand for fast, accurate and efficient design algorithms is evident. This work therefore focuses on the research for such algorithms by also utilizing modern deep learning methods that have been successful in many other fields. This work takes a data-driven approach to optimize the design of plasmonic nanostructures by creating deep learning models to predict optical properties of a structure and do inverse design based on desired optical properties. The models used include convolutional neural networks and generative adversarial models which are state-of-the-art deep learning methods very successful in image tasks. It was found that the optical properties of nanostructures be predicted at an impressive speed with a high accuracy using a deep learning-based regression model. By also using techniques from modern generative deep learning, it was shown that nanostructures can be inversely designed, just based on desired reflection and transmission properties in the wanted design. The models presented in this work result in a large reduction in computation time compared to standard computer simulations and this is achieved at the cost of a very low error.

Philip Rosberg - Simulation of real-time Lidar sensor in non-ideal environments - Algoryx Simulation AB

Light Detection and Ranging (LiDAR) is a kind of active sensor that emits a laser pulse and primarily measures the time of flight of the returning pulse. From the measured time of flight and emission direction of the laser pulse a 3D point cloud of the scene around the LiDAR sensor can be created. This point cloud is an essential asset for the control of autonomous vehicles, and especially today, an essential basis for the training of autonomous vehicle control models. However, it remains both time-consuming and expensive to acquire the amounts of LiDAR data necessary to train the rather complex modern control models. As such, generating the point cloud through sim- ulations becomes a natural solution. Yet, many LiDAR simulations today produce perfect point clouds, corrected only by random noise, without con- sidering the physical reasons behind the imperfections visible in real LiDAR point clouds. The aim of this study was to investigate real-time simulation models for disturbances that may cause imperfections in LiDAR data. From a base investigation of LiDAR, disturbances were found, models were investigated and finally a real-time implementation of Atmospheric Effects and attenu- ation from Beam Divergence was evaluated. It was found that the imple- mented models could produce physically accurate LiDAR point placement while keeping the computational time low enough for real-time evaluation. However, to achieve correct separation of targets under Atmospheric Effects, as high as 34% of the points had to be dropped. Additionally, the intensity of the return points cloud not be properly verified. From these results it can be concluded that, with additional verification and adjustment, the presented models can achieve good results for evaluation in real-time. The results of this study thus serve as a support for future developments of realistic real- time LiDAR simulations, for use in construction and training of autonomous vehicle control models and implementation of digital twins.

Pierre Rönnqvist - Kinetic Modelling of Idealised Rotating Bed Reactor Systems - SpinChem AB

Chemical synthesis and processing are essential for the production of everyday goods as well as for regeneration and clean-up of chemical by-products or contaminants expelled into nature. For this, efficient processes are required and need to be identified. This often comes down to economic questions which make it important to optimise cost and throughput of any such processes. Moreover, the cost-efficient use of resources often aligns with environmental objectives.
To support the identification of well-suited process conditions and reactor operation modes for the implementation of SpinChem technology, this work establishes computational models in MATLAB based on idealized reactors assumptions combined with global chemical kinetics and mass balances in continuous and discontinuous systems. Hereby four different operation modes were considered: simple batch, recirculated batch, single-staged linear flow-through, and multi-staged linear cascade, all of which were also set up in the lab for model validations with the SpinChem rotating bed reactor (RBR) S2. To allow for experimental validation, a chemical reference process was selected and involved adsorbing methylene blue from an aqueous solution onto the cation-exchange resin NRW1160. Spectrophotometric analysis of experimental samples showing the progress of dye removal served as foundation for model establishment.
The final MATLAB models for all four operation modes were validated by comparison of experimental and predicted space-time yields. For discontinuous operations – batch and recirculated batch – both models performed exceedingly well and predicted process end points and space-time yields with errors < 5%, even under a range of different initial conditions (reaction volume, degree of resin consumption). Regarding continuous operations, the endpoints were predicted with an error of 10-25% compared to the experimental data. The overall predicted reaction progress resembled the experimental data in general behaviour, yet an exact match was not achieved by solely relying on global kinetics. The developed model is directly transferrable to other reaction systems, given the availability of chemical kinetics data of the sorption/reaction process of interest.

Future perspectives on improving the model could be to improve the kinetic model, apply it to a larger scale with other RBR's, incorporate temperature dependencies, change rpm or any other constant parameter.

Rebecka Johnsson - CFD analysis of the ventilation and hydrodynamics of a vertical strut - FS Dynamics

Today, the electrification of cars is widespread. However, the adoption of electric boats is not yet as common, partly due to the higher efficiency demands caused by the increased resistance in water. Hydrofoil technology offers a solution to this challenge. This technology uses wing-like structures, called hydrofoils, mounted below the hull. As the boat accelerates, the hydrofoils lift the hull out of the water, reducing drag and allowing for higher speeds and better efficiency. Hydrofoil technology and its associated hydrodynamics are complex. Therefore, being able to numerically model the phenomena associated with the technology is valuable for enabling improvements, fault detection, and optimization. For a hydrodynamic device operating close to the water surface, an important phenomenon is ventilation, where air is entrained into the water mainly due to pressure variations. Ventilation impacts drag and lift and can be either beneficial or unfavorable, depending on its nature and location. This thesis investigates the possibility of numerically predicting the ventilation and hydrodynamics for a vertical strut using the computational fluid dynamics software Star-CCM+ and the Volume of Fluid method. Predicting ventilation through numerical simulations is computationally demanding. Therefore, the objective was to develop a model capable of accurately predicting ventilation for a strut while keeping simulation time low. The study primarily focused on a specific strut geometry to analyze how ventilation varied with velocity. Additionally, another strut profile was included for comparison and to evaluate the model's adaptability. The numerical model successfully predicted the ventilation phenomenon within the velocity range of approximately 4-8 m/s using the Unsteady Reynolds Averaged Navier-Stokes (URANS) approach combined with the shear stress transport (SST) Menter's $k-\omega$ turbulence model for both profiles. These predictions were verified against available experimental data. However, at higher velocities, the accuracy of the predictions decreased. Consequently, it was concluded that further adjustments to the current numerical setup or investigation of alternative methods are needed, although this may compromise the goal of maintaining low simulation times.

Sam Adhami - Towards a Unified Terminology - Siemens Energy

The lack of standardized terminology within Siemens Energy's Technical Information Systems department, particularly in translating technical documents, impacts both internal operations and international collaboration. This project explores the application of machine learning to automate the standardization of terminology in Siemens Energy's technical documentation, aiming to address inconsistencies that hinder clarity and international collaboration. Specifically, it focuses on developing a Retrieval Augmented Generation (RAG) model that inputs text and outputs a text with standardized terminology, thereby simplifying translation and communication processes. Employing methods such as prompt engineering, semantic search embeddings, and generating text with a large language model (LLM), particularly OpenAI's GPT-3.5, the research involved preprocessing a non-standardized dataset, crafting effective prompts, and testing the model's performance on both a generated test dataset and real-world documents. The findings revealed a 66\% accuracy rate in the test dataset and a 60% accuracy rate in practical applications, indicating that while the model can correct terminology with moderate success, it faces limitations due to a lack of real-world examples and an optimal dataset. These results underscore the necessity for a company-wide standardized terminology database to improve communication within Siemens Energy and facilitate better for language models. The research contributes to the field of technical documentation and machine learning by demonstrating a structured approach to enhancing language model performance for terminology standardization. While time

constraints limited the exploration of various embedding models and prompts, the project highlights future work opportunities to investigate embedding techniques further and integrate a standardized terminology framework for improved model accuracy.

William Strömberg - Sustainable fabrication of light-emitting electrochemical cells - Institutionen för fysik, Umeå Universitet

Light-emitting electrochemical cells (LECs) are promising light-emitting devices with the possibility of paving the way for low cost and sustainable light-emission via solution based printing techniques. Their applications spans all the way from patient care within MedTech, to light-emitting labels aimed for brand protection, advertisement and marketing.
For such applications to be in line with a sustainable future, it is of greatest interest that LECs are manufactured in a material efficient manner.

This project investigated the reusability of the active layer in a LEC, comprised of super yellow, TMPE-OH and KCF3SO3. After recovering the used material, it was redissolved into a reformulated ink. Both the reformulated ink, and its pristine counter part was characterized with photoluminescence, infrared and ultra violet-visible spectroscopy. The results indeed showed that the photoluminescence quantum yield was well intact for the recovered super yellow. As for TMPE-OH and KCF3SO3, they were concluded to be present in the reformulated ink. After such verification, LECs was manufactured with the reformulated ink and they performed higher luminance under higher voltage than the pristine cell. Hence, this project paves the way for further development in order to reach a more sustainable material handling.

Zackarias Chronéer - Generating Artificial Portfolios - Nasdaq

In this thesis a method for generating option portfolios using machine learning, more specific WGAN-GP (Wasserstein Generative Adversarial Networks with Gradient Penalty), is presented. To reduce the complexity however, the model does not immediately generate portfolios with option series, but instead option classes, which includes the underlying asset, option type and direction of position. The generated portfolios are then transformed such that they include option series. A comparison between the real and generated portfolios was conducted, using a range of different metrics, such as number of positions, total market value and margin. Which concluded in that the model, presented in this thesis, effectively functions as a portfolio generator.