Zoom 210607

SIMULATION FRAMEWORK OF EMBEDDED SYSTEMS IN ARMORED VEHICLE DESIGN – **Christoffer Bergström** - https://umu.zoom.us/j/69610485328

Embedded systems are a mixture of electric and mechanical hardware along with the software that is controlling them. BAE Systems Hägglunds, which designs and builds armored vehicles, is interested in knowing how to simulate these systems for logic validation and testing different design variations. The goal of this thesis was to create a framework for carrying out these simulations. This was done by analyzing hardware and software design at BAE and Identifying the necessary conditions for creating a model which can be simulated. Matlab Simulink is suggested as the tool for these simulations. The framework suggests dividing the model into smaller modules which reflects design principles at BAE. These modules will be made up of sub-modules containing hardware and software in layers. The hardware foundation will be made up of pre-designed components created in Simulinks physical simulation library. The software will be imported into specialized sub-modules and integrated into the hardware using proposed bridge functions which converts information between the two systems. The framework is designed to provide a comprehensive solution instead of a deep one that can be adapted to changing circumstances. This framework still needs to be tested on a large-scale system, which was not possible during this thesis. In conclusion, this is a stable foundation that needs to be built upon.

Simulation challenges in robotic grasping – **Sabina Andersson -** https://umu.zoom.us/j/63220586418

Grasping and dexterous manipulation is a huge area in the current robotic research field. Traditionally in industrial environments, robots are customized for a certain task and work well with repetitive movements where the entire process are predetermined and the same every time. For a robot to be able to adapt to its surroundings and manipulate objects with unknown properties, new models and methods are needed. This thesis focuses on making development of dexterous robot hands easier by exploring the possibilities to use simulation in Algoryxs physics engine AGX Dynamics for experimentation and evaluation of design, motion planning, contact models, geometry etc. The aim is to be able to simulate complex grasping situations in AGX Dynamics and build knowledge about contact mechanics to fully capture the dynamics of grasping in simulation. It is done by validating the simulation library with regards to fundamental physics characteristics involved in grasping by a series of benchmark tests. The work has exposed friction as one of the biggest challenges in simulation. Two new friction models that better represents reality have been implemented and tested and shows promising results for further development.

On the Interaction Between Electromagnetic, Gravitational, and Plasma Related Perturbations on LRS Class II Spacetimes – **Philip Semrén**

- https://umu.zoom.us/j/64616026461?pwd=L2VCMUNqNExZRExmRzc4YmQ1Z0xNUT09

In this thesis, we investigate the interaction between electromagnetic, gravitational, and plasma related perturbations on homogeneous and hypersurface orthogonal Locally Rotationally Symmetric (LRS) class II spacetimes. By using these spacetimes, which allow for the inclusion of a non-zero magnetic field, as backgrounds in a perturbative approach, we are able to see interactions between the electromagnetic and gravitational variables already to first order in the perturbations. This is in contrast to earlier works using isotropic Friedmann-Lemaître-Robertson-Walker (FLRW) backgrounds, where one is usually faced with going to second order in the perturbations. To get the equations governing our perturbations, we use a 1+1+2 covariant approach and gather relations from the Ricci and Bianchi identities, Maxwells equations, particle conservation, and energy-momentum conservation for the individual plasma components. After linearising these equations around a LRS background, performing a harmonic decomposition, and using the Magnetohydrodynamic (MHD) approximation for a cold plasma, we then arrive at a closed system for the first order perturbations. This system, consisting of ordinary differential equations in time and a set of constraints, is then reduced to two separate subsectors, containing seven and nine variables respectively. These variables include quantities related to the Weyl tensor, the vorticity, and the electromagnetic fields, as well as perturbations in the plasma velocity and energy density. Through numerical calculations, we use the equations for these variables to show that perturbations in the magnetic field can be sourced by perturbations in both the plasma velocity and the gravitational variables. We also observe beat-like interference patterns for large values of the Alfvén velocity. These results can be of interest when considering the large scale cosmic magnetic fields, as their origin still seems to elude us. However, since we neglect thermal pressures and dissipative fluxes, it should be noted that our results are mainly applicable in the limit of low temperature and in cases where the thermal pressure is smaller than the pressure due to the electromagnetic fields.

Evaluation of tomographic methods for limestone characterization – **Albert Askengren**

- https://umu.zoom.us/j/62050444407

In this project X-ray tomography was used to examine limestone samples. The aim was to determine if X-ray tomography, including synchrotron-based XRT, is a reliable method to determine porosity, pore structure and internal distributions of pores and pyrite (FeS2) grains in limestone. The aim also included to determine if XRT could be used to resolve material variations, fine-grained and larger crystals in limestone. There were ten limestone samples in total and samples were scanned by Advanced Light Source in Berkeley, California and by Luleå University of Technology. A brief comparison between Berkeley and Luleå was also done by inspecting samples that have been through XRT at both facilities. The main software used for analysis was Avizo v.9.2.0. The results showed that X-ray tomography is a suitable method for determining porosity and pore distribution. Interactive thresholding was used as in Avizo for measuring porosity. The porosity was determined as a single value and as a narrow range, where a narrow range was less ambiguous. X-ray tomography was also found to be a suitable method for visually determining a variety of textures within the samples. Areas with different materials (such as dolomite) and/or newly-formed crystals were visually distinguishable but individual newly-formed crystals were not as clear when compared to scanning electron microscopy. Individual older fine-grained and larger crystals were hard to resolve.
Internal distributions in 3D of both pores and pyrite grains were possible to obtain with X-ray tomography. The equivalent diameter of pores and pyrite grains was also measured and plotted in histograms. The X-ray tomography performed in Berkeley had higher resolution than the X-ray tomography performed in Luleå (0.65 vs 2 µm). Lower resolution over-estimated the average equivalent diameter of pores and boundaries of pores and cavities were harder to see. Therefore, the higher resolution from Berkeley was preferable.
These results contribute to understanding limestone characteristics. Limestone is a raw material in the cement and quicklime industry and knowledge about limestone characteristics can help improve and optimize production processes. In the end this can lead to a reduction in CO2 emissions from the industry.

Combinatorial analysis of multispectral and radar satellite data – **Andreas Holmberg**
- https://umu.zoom.us/j/61538564479

Remote sensing technologies, such as satellite imagery, have proven to be a powerful tool for landcover classification when combined with machine learning algorithms. Depending on which type of sensor is used for the imagery, different properties of land cover classes may be distinguished. Because of this, a data set containing a combination of data from different sensors could potentially further improve the classification accuracy. To determine if adding data from a radar sensor to data from a multispectral sensor could improve the accuracy of land cover classification, a tool for combining radar data from the satellite constellation Sentinel-1 with multispectral data from the satellite constellation Sentinel-2 was developed. The classification accuracy using the combined data was then compared to using non-combined Sentinel-2 data with a neural network and a random forest classifier. We found that the random forest classifier produced a higher accuracy than the neural network for both the combined data and non-combined data. The combined data increased the accuracy further compared to the non-combined data. However, the increase produced by the combined data was small and most likely not worth the extra computational power required to implement Sentinel-1 data to Sentinel-2 data.

Estimation of satellite orbits using ground based radar concept – **Jonas Gabrielsson**
- https://umu.zoom.us/j/61407930418

Today there is an abundance of objects in earth captured orbit and monitoring these objects has become a national security interest. One way to map any object in orbit is with their Keplerian elements. Here a method for estimating the Keplerian elements of a satellite orbit using a ground based radar station has been studied. A frequency modulated continuous wave radar (FMCW) with a central transmitter antenna and a grid of receivers was simulated in MATLAB. The maximum likelihood estimator (MLE) was obtained to estimate the parameters from the received signal. The method takes advantage of the relations between the Cartesian position and velocity and the Keplerian elements to confine the search space. For a signal to noise ratio (SNR) of 10dB, the satellite was followed during a time period where the positions were found within average error of: range 1.4m, azimuth 2.0 10^-6 rad and elevation 8.4 10^-7 rad. Using a linear approximation of the velocity the Keplerian elements were found within average error of i: 0.0051 rad, LAN (Omega): 0.0050 rad, AoP (w): 0.0054 rad, a: 2.60 10^5m, e: 0.0021 and TA (nu): 0.0054 rad. A method to obtain more accurate estimates is proposed

A comparison of different machine learning algorithms applied to hyperspectral data analysis – **Axel Vikström**
- https://umu.zoom.us/j/61730232110

Data analysis is a rapidly growing field of research and being one of the strongest trends within it, machine learning attracts the attention of scientists and industry alike. One such industry is the hyperspectral industry, which works with image data where each pixel contain hundreds of wavelengths acquired from spectral measurements. Common methods for quantifying and classifying hyperspectral data are the chemometric methods PLS, PLS-DA and SIMCA, which have been around for a couple of decades. They provide rapid computations along with intuitive modelling and diagnostic tools. However, they lack the ability to efficiently model more complex data such as non-linear data sets. Here, I have examined methods that could act as possible complements to the chemometric methods, to be used when handling more problematic data. Using the chemometric methods and methods taken from Microsofts ML.NET library, I solved six classification problems as well as two quantification problems in order to compare the performance of the methods. The results show that the ML.NET methods are well suited as complements to the chemometric methods. In particular, the decision tree methods provided highly accurate classification and quantification while the maximum entropy methods had the best balance between accuracy and computational time. These methods proved to be the best to handle similar objects in the images, larger amounts of classes and non-linear settings. The remaining ML.NET methods performed as well and often better than the chemometric methods, but requires additional testing with other data sets in order to find where their strengths lie.

Semi-Supervised Learning for Cell Death Assays – **Nelly Westman -** https://umu.zoom.us/j/67893804785

Cell death assays are a vital tool for evaluating anti-cancer drug efficiency. Today, most cell death assays are using fluorescent dyes, which upon illumination can cause phototoxicity. To overcome the problem with phototoxicity, Sartorius Stedim Data Analytics is examining new approaches that are not relying on fluorometric detection. Given the morphological changes that dying cells undergo, it seems possible to classify cell death directly from phase contrast images using deep learning. The disadvantage of using supervised learning for cell death classification is that the labels still have to be accessed from fluorescent images. This thesis thus aims at examining how semi-supervised learning performs compared to supervised learning when using it for cell death assays. We further investigate if model generalization depends on the cell type: A549, AU565, and HeLa. Using the framework SimCLR for self-supervised pre-training, we examine if a model can distinguish between dead and live cells (binary problem), and further if it can tell whether the cells died from apoptosis or from other cause (3-class problem). Using supervised learning, our model achieves 76.1% and 53.6% accuracy on the binary and 3-class problem respectively. We demonstrate that the accuracy can be increased to 84.3% and 65.6% on respective problem using semi-supervised learning. The models generalize least to AU565 and most to HeLa. Nevertheless, we show that semi-supervised learning can improve model generalization. For future research, we suggest further adjustments of SimCLR settings on cell data. We also encourage including more cell death types in the classification problem, instead of just apoptosis. Lastly, we suggest using random extraction of images used for self-supervised pre-training.

Machine Learning Model for predicting the Repayment Rate of loan takers – **Emma Oskarsson -**

Machine Learning (ML) uses statistics to find patterns in high dimensional data. The Swedish Board of Student Finance (CSN) wants to improve the way they classify new loan takers. Using Machine Learning (ML) on data of previous loan takers can help to find patterns to use on new loan takers. The aim of this study is to investigate if CSN can improve the way they classify loan takers by their ability to pay back their loan. In this study, different ML methods are applied to a data set from CSN, their performance are compared and investigated by the most related factors affecting individuals repayment rate. A data set of a total of 2032095 individuals were analysed and used in the different methods. Using Random Forest (RF) for binary classification produced the best result with a sensitivity of 0.9695 and a specificity of 0.8058.

On the topic of Unconstrained Black-Box Optimization with Application to Pre-Hospital Care in Sweden – **Tim Anthony -** https://umu.zoom.us/j/4982816528

In this thesis, the theory and application of black-box optimization methods are explored. More specifically, we looked at two families of algorithms, descent methods and response surface methods (closely related to trust region methods). We also look at possibilities in using a dimension reduction technique called active subspace which utilizes sampled gradients, to make the descent methods more suitable to high-dimensional problems, which turned out to be most effective when the data have a ridge-like structure. Finally, the optimization methods were used on a real-world problem which in the context of pre-hospital care where the objective is to minimize the ambulance response times in the municipal of Umeå by changing the positions of the ambulances. Before applying the methods on the real-world ambulance problem, a simulation study was also performed on synthetic data. This to find the strength and weaknesses of the different models when applied different test functions, at different levels of noise. The results showed that we could improve the ambulance response times across several different performance metrics compared to the current response times. This indicates that there exits adjustments that can benefit the pre-hospital care in the municipal of Umeå. However, since the models in this report find local and not global optimums, there might still exist even better ambulance positions that can improve the response time further.

Food Industry Sales Prediction A Big Data Analysis Sales Forecast of Bake-off Products – **Maja Lindström**
- https://umu.zoom.us/j/66722910155

In this thesis, the sales of bread and coffee bread at Coop Värmland AB have been studied. The aim was to find what factors that are important for the sales and then make predictions of how the sales will look like in the future to reduce waste and increase profits. Big data analysis and data exploration was used to get to know the data and find the factors that affect the sales the most. Time series forecasting and supervised machine learning models were used to predict future sales. The main focus was five different models that were compared and analysed, they were; Decision trees regression, Random forest regression, Artificial neural networks, Recurrent neural networks and a time series model called Prophet. Comparing the observed values to the predictions made by the models indicated that using a model based on the time series is to be preferred, that is, Prophet and Recurrent neural network. These two models gave the lowest errors and by that, the most accurate results. Prophet yielded mean absolute percentage errors of 8.295% for bread and 9.156% for coffee bread. The Recurrent neural network gave mean absolute percentage errors of 7.938% for bread and 13.12% for coffee bread. That is about twice as good as the models they are using today at Coop which are based on the mean value of the previous sales.

Detecting anomalies in data streams driven by a jump-diffusion process – **Carl Paulin**
- https://umu.zoom.us/j/6994607804

Jump-diffusion processes often model financial time series as they can simulate the random jumps that they often exhibit. These jumps can be seen as anomalies and are essential for financial analysis and model building, making them vital to detect. The realized variation, realized bipower variation, and realized semi-variation were tested to see if one could use them to detect jumps in a jump-diffusion process and if anomaly detection algorithms can use them as features to improve their accuracy jumps. The algorithms tested were Isolation Forest, Robust Random Cut Forest, and Isolation Forest Algorithm for Streaming Data, where the latter two use streaming data. This was done by generating a Merton jump-diffusion process with a varying jump-rate and tested using each algorithm with each of the features. The performance of each algorithm was measured using the F1-score to compare the difference between features and algorithms. It was found that the algorithms found improvement from using the features; Isolation Forest saw improvement from using one, or more, of the named features. For the streaming algorithms, Robust Random Cut Forest performed the best for every jump-rate except the lowest. Using a combination of the features gave the highest F1-score for both streaming algorithms. These results show one can use these features to extract jumps, as anomaly scores, and improve the accuracy of the tested algorithms, both in a batch and stream setting.

Simulation of rain on a windshield: Creating a real-time effect using GPGPU computing – **Katerina Koblik**
- https://umu.zoom.us/j/8177965965

Modelling and rendering natural phenomena, such as rain, is an important aspect of creating a realistic driving simulator. Rain is a crucial issue when driving in the real world as it for instance obstructs the drivers vision. The difficulty is to implement it in a visually appealing way while simultaneously making it look realistic and keeping the computational cost low. In this report, a GPGPU based approach is presented where the final product is a rain simulation rendered onto a 2D texture, which can then be applied to a surface. The simulated raindrops interact with gravity, wind, a windshield wiper as well as with each other, and are then used to distort the background behind them in a convincing manner. The simulation takes into account multiple physical properties of raindrops and is shown to be suitable to run in real-time. The result is presented in form of a visual demonstration. In conclusion, even though the final simulation is still in its first iteration, it clearly highlights what can be accomplished by utilizing the GPU and the benefits of using a texture-based approach. The appropriate simulation approach will however always depend on the characteristics of the problem and the limitations of the hardware.

Regularization parameter selection methods for an inverse dispersion problem – **Anna Palmberger -** https://umu.zoom.us/j/7072059132

There are many regularization parameter selection methods that can be used when solving inverse problems, but it is not clear which one is best suited for the inverse dispersion problem. The suitability of three different methods for solving the inverse dispersion problem are evaluated here in order to pick a suitable method for these kinds of problems in the future. The regularization parameter selection methods are used to solve the separable non-linear inverse dispersion problem which is adjusted and solved as a linear inverse problem. It is solved with Tikhonov regularization and the model is a time integrated Gaussian puff model. The dispersion problem is used with different settings and is solved with the three methods. The three methods are generalized cross-validation, L-curve method and quasi-optimality criterion. They produce rather different solutions and the results show that generalized cross-validation is the best choice. The other methods are less stable and the errors are sometimes orders of magnitude larger than the errors from generalized cross-validation.

Algorithms for Order Matching in Securities Lending – **Thobias Ivarsson -**

Order matching is an important part of the securities lending businesses. Which lender should you take a loan from and to who you should lend out securities to maximize the banks profits is not always as clear as it seems. It it a very simple problem until you introduce that some lenders and borrowers have a minimum quantity of the stock they need or want to lend out. In this paper I have created two main algorithms that solves this problem and one combined algorithm that uses the strength of both main algorithms. The result is that it is possible to automate the order matching with these algorithms. In real world data from Nordea there is not a problem to use a brute force approach to solve the problem optimally in almost all cases. In the few cases where the brute force approach is too slow, and to future proof the software we can use a greedy approach to solve the problem very quickly, even if we have a lot of orders with a minimum quantity. The trade-off is that we introduce an average error of 0.02% from the optimal solution. However, this is small enough that for most real world applications it is better to have a good solution fast than an optimal solution slow.

Comparing pre-trained CNN models applications on agricultural vehicles – **Douglas Söderström -**

Deep learning networks such as convolutional neural networks have become the go to image classification tool. Researchers have over the years proposed numerous architectures in order to push the accuracy on the ImageNet1K dataset. These pre-trained models have 3 applications, prediction, feature vector extraction and transfer learning. In this thesis the author has looked at the models VGG16, InceptionV3, ResNet50V2 and MobileNetV2, to compare the different architectures in their ability of their application performances with the focus on images of agricultural vehicles. All of the pre-trained models performed well in predicting agricultural vehicles. But the ResNet50V2 model achieved the highest overall probability score. Visualising the pre-trained models feature vectors all of the models failed in distinguishing the agricultural vehicles in separate clusters. Constructing support vector machines on the feature vectors, all the models achieved an accuracy of over 0.95, with ResNet50V2 achieving the highest accuracy of 0.983. Transfer learning i.e retraining the model to solve your own image classification problem proved that the VGG16 model had the best overall validation accuracy. The author could not find a clear connection between the pre-trained models accuracy on the ImageNet1K dataset and their performance presented in the thesis.

Simulation Model of Forestry Ground and Vegetation Damage – **Elias Hökfors**

- https://umu.zoom.us/j/68507733283

Heavy forest machines can cause damages to the ground in the form of soil compaction and creation of wheel ruts. Compaction reduces the amount of water and nutrients in the soil, and impede root growth. Furthermore, water is gathered in wheel ruts, leading to transport of organic materia and heavy metals into water courses. These damages can be avoided through planning of the harvesting activities with respect to season, weather, and the conditions on the site. The main focus point is to avoid driving on wet soil, since wetness makes it more susceptible to damage. Training simulators are used to educate forest machine operators, and it is essential to be able to train on how to avoid damages to the ground. The aim of this thesis is to investigate how this should be incorporated in a simulator. Implementations are made in Unreal Engine with AGX Dynamics for Unreal, which already has a deformable terrain called AGX Terrain. This terrain was investigated by creating two terrain materials, representing dry and wet Swedish forest soil, and driving a forwarder on them. AGX Terrain was found to be simple to use and gave fair results, the rut depths were comparable in size with empirical results. However, it was limited in the sense that shearing was not taken into account and there was no possibility of having different material properties across the terrain. A potential solution to these problems is suggested, in which a more extensive way of computing stress propagation and the resulting damages is used. Further investigations has to be made in order to find out if this approach is of good use.

Physics-Informed Neural Networks for Biopharma Applications – **Linnéa Cedergren**

- https://umu.zoom.us/j/64974925251

Physics-Informed Neural Networks (PINNs) are hybrid models that incorporate differential equations into the training of neural networks, with the aim of bringing the best of both worlds. This project used a mathematical model describing a Continuous Stirred-Tank Reactor (CSTR), to test two possible applications of PINNs. The first type of PINN was trained to predict an unknown reaction rate law, based only on the differential equation and a time series of the reactor state. The resulting model was used inside a multi-step solver to simulate the system state over time. The results showed that the PINN could accurately model the behaviour of the missing physics also for new initial conditions. However, the model suffered from extrapolation error when tested on a larger reactor, with a much lower reaction rate. Comparisons between using a numerical derivative or automatic differentiation in the loss equation, indicated that the latter had a higher robustness to noise. Thus, it is likely the best choice for real applications. A second type of PINN was trained to forecast the system state one-step-ahead based on previous states and other known model parameters. An ordinary feed-forward neural network with an equal architecture was used as baseline. The second type of PINN did not outperform the baseline network. Further studies are needed to conclude if or when physics-informed loss should be used in autoregressive applications.

Machine learning and Just-in-Time Quality Assurance : A Feature Selection Approach on Commercial – **Victor Hallberg -**

Feature selection is the process of removing redundant features. This process can boost the quality of performance and decrease the time of classification. This paper investigates feature selection methods appropriate for Just-in-Time defect prediction. There are two branches in the area feature selection, namely feature subset selection and feature ranking. We aim to find feature selection methods appropriate for Just-in-Time defect prediction and learn how executing feature selection impacts the quality of the result using classification models. The investigation also aims to find a classifier that is suitable for Just-in-Time defect prediction. We also investigated if reducing the feature space has an impact on reducing the time of classification. This thesis uses two different commercial projects with the same features but differs in the number of observations. We then processed the data in four different steps. We applied log transformation, standardising, removing zero or near-zero variance features and removing features not considered necessary. A total of eight different feature selection investigated and implemented in Python 3. After implementing the feature selection methods, we evaluated the methods using three different classifiers: random forest, K-Nearest Neighbors, and logistic regression. We then compared the full feature set how the different feature selection impacted the quality of results, especially the results of recall and precision of the two projects. % Result We found that feature selection is necessary for Just-in-Time defect prediction and that the feature selection does not harm the result. We found that time in classification was reduced compared with the full feature set. Finally, we found that feature ranking boosts the metric recall, but in precision, it is close on average compared with feature subset selection. The results show that feature selection should be applied when performing Just-in-Time defect prediction and that there is time to win in reducing feature space. We also conclude that logistic regression produces stable results on both projects examined. Feature ranking is more effective than feature subset selection.

Simulation testbed for liquid chromatography – **David Andersson -**

In this work the stlc package is proposed as a tool for simulation of liquid chromatography with implementations of several lumped kinetic models which simulate diffusive mass transport and Langmuir kinetics. Orthogonal collocation is used to discretize the spatial domain and the resulting system of ordinary differential equations is evaluated by one of several solvers made available in the package. Comparisons between numerical and analytical Laplace domain solutions for values of lumped mass transfer coefficient, k, ranging from 0 to 1000 and lumped dispersion constant values, from 10^-5 to 10^-2 are presented. Analytical results were approximated to an L^1 error in the range 10^-5 to 10^-3 with a maximum evaluation time of 0.27s for 100 grid points. The breakthrough curves of the analytical solution are accurately recreated indicating a correct implementation. Variations in accuracy can be partly attributed to oscillations induced by steep gradients in the solution. The oscillations are reduced by the addition of more points in the spatial grid. The package is implemented in Python using minimal dependencies and can produce approximations with short evaluation times. The Python programming language is dynamically typed and uses automatic memory management, properties which can improve productivity and be beneficial to research applications. The addition of this package to the extensive Python ecosystem of libraries built by the scientific community can potentially aid future developments in chromatography.

Predicting failure distribution for varying load histories applied to paper materials – **Matilda Rosdahl** - https://umu.zoom.us/j/68672803454

Paper materials are renewable and recyclable and are often used for packaging applications, e.g. in corrugated fiberboard boxes. From an engineering perspective, paper materials can be used to construct packaging with low weight but with high relative strength. However, compared to other packaging materials, it can be a challenge to design paper-based packaging for distribution chains with demanding conditions. Boxes made from paper can be sensitive to exposure of moisture, duration of load, or dynamic forces. Along the distribution chain, boxes can be exposed to forces that could potentially cause failure before the boxes intended service life is fulfilled. Therefore, it is important to know how to predict the failure distribution for a specific combination of packaging and distribution chain, so that materials with the right properties can be chosen for a given purpose and the risk of failures can be minimized. In this project, we have investigated a statistical material model developed by Bernard D. Coleman. It is based on three material parameters that describe the cumulative distribution function (CDF) of a fiber-breaking behavior for an arbitrary load history. The model has been shown to work for fiber network systems subjected to constant load and constant load rate (CLR). Our purpose was to investigate if it is applicable for fiber network systems of higher structural hierarchy and for more complex load histories as well. To investigate this, we have performed compression tests with CLR on four different types of corrugated fiberboard and determined the material parameters. Afterward, we performed compression tests for a more complex load history. The complex load history was chosen to a periodic varying triangular curve. Finally, we used the material parameters from the CLR tests to determine the CDF for the periodic load cases. We compared the result with an empirical CDF. The CDFs showed to be in relatively good agreement, but there were some differences. We found that our measurements turned out to produce load history data that deviated from the intended load history. The material parameters were also shown to be less accurate than expected. Due to these deviations, we could not expect a perfect agreement between the CDFs. Therefore, we can not with certainty state that Coleman's theory is applicable for varying load histories. However, despite the difficulties to experimentally achieve the intended load history the results showed good agreement in several cases and the deviations from the theory could possibly be explained by the load history deviations. To be certain, more accurate measurements with higher accuracy need to be done.

Minimizing Liquid Waste in Peptide Synthesis: A New Application for the Rotating Bed Reactor – **Peter Nordström** - https://umu.zoom.us/j/61816234427

Peptide drugs have recently gained more interest from the scientific community. They are already used to treat a broad spectrum of diseases such as cancer and HIV and have many more promising applications. However, the most popular manufacturing method, solid-phase peptide synthesis (SPPS), is a costly and wasteful process. This project will investigate if SpinChems Rotating Bed Reactor (RBR) can make SPPS more resource-efficient. The idea is that the RBR-system can maximize the solid-phase to liquid ratio (STL), making it possible to manufacture peptides using less solvents and chemicals. The main quest of the project can be formulated into a single question: How much can we increase the STL without sacrificing the efficiency of the RBR? To answer the question, we will use Minitabs statistical software and design of experiments (DOE) to plan and perform experiments in both lab- and industrial scales. Some well-known DOE methods such as factorial experiments will be used to gain as much information as possible about the new RBR-system. The results will be analyzed and summarized to make a solid foundation for the continued work on the new RBR application. As a substitute for peptide synthesis, ionic adsorption was chosen to measure the efficiency of the RBR-system. The experiments show that the RBR does perform well for the application. In the lab-scale experiments, the decrease of ions was on average 86,5% after just 15 seconds of treatment with an average STL of 0,936. The industrial-scale experiments showed a similar result where the average decrease in ions was 92,9% after 20 seconds with an average STL of 0,947.

On-Line Metallurgical Mass Balancing and Reconciliation – **Emil Andersson**

- https://umu.zoom.us/j/6249068719

High grade metals are obtained from mined ore through mineral processing. Mineral processing is theseparation of valuable minerals from less valuable material through a series of complex processes. Onesuch process, that utilizes the surface properties of the elements in the ore, is called flotation. Flotationincludes large tanks of slurry, i.e. crushed ore mixed with water and chemicals. In the slurry, the particlesof valuable mineral has been made hydrophobic and gather on top of the slurry as foam. This foam,containing higher concentrations of valuable mineral, is recovered and processed further.The flotation circuit involves loops and buffers with long time delays. The industry is heavily de-pendent on measurements of mass flows and grades for the control and maintenance of the flotationprocess. Due to economical, practical, and technological limitations, these measurements are done atchosen number of points in the circuit and at discrete points in time.The accuracy of the acquired measurements is increased by performing mass balance and reconcilia-tion. Traditionally, mass balance uses the sum of the total mass flows and the average grades over longtimes to avoid the complicated delays that occur in the circuit. It is desirable to perform mass balancedirectly to allow for faster intervention if any failures occur in the circuit during the on-line process.This report describes an on-line dynamic approach towards mass balancing and reconciliation of themass flows and grades in a flotation circuit. The result is the formulation of a new on-line optimizationproblem. The optimization problem is implemented in MATLAB to verify the new formulation usingsynthetic data. The verification show that the new formulation does adjust the grades and mass flowssuch that the enforced constraint of mass balance is fulfilled.There are some very important aspects if this project is developed further. The unknown and cellspecific parameters of flotation ratekand recoveryRmust be found or modeled. Proposed in this report,is a possible model ofkas well as a strategy to findR. The requirements of accuracy and speed of theimplementation are also discussed. This report promotes further testing.

Direct sampling of the Pulsed Eddy Current response from metals – **Sara Holmér**

- https://umu.zoom.us/j/65855716572

The non-destructive testing method Pulsed Eddy Current, or PEC, can be used to measure the thickness and resistivity of conducting and non-ferromagnetic materials. In this project I investigated if a thickness gauge at ABB, which uses PEC technology to measure the thickness of aluminium strips in rolling mills, can extract more information about the strip by sampling the data with a constant sampling frequency instead of at specific times. Using the thick-ness gauge with this new sampling method, I first compared the noise level of the integrated signal obtained by using analog and digital integration. Then I used an upper noise level limit to determine how thick the strips could be without the noise level being to high. Finally I used simulations and measurements of multi layered strips to determine if more information, such as the resistivity distribution, can be extracted from the measured data and if the sampling frequency is fast enough to detect the information. I found that the noise level can be reduced by replacing an analog integrator with a low pass filter and integrating the signal digitally. I also found that the thickness can be between 1.6 mm and 15 mm thick whereas it can be between 0.5 mm and 8 mm with the previous sampling method. Finally I found that the sampling frequency is fast enough and that it is possible to determine if a strip has clad layer or not. The results in this project suggest that it can be beneficial to change the way the data is sampled to this new method.

Correlation between PET/MRI image features and pathological subtypes for localized prostate cancer – **Jens Lindahl -** https://umu.zoom.us/j/62934168052

Prostate cancer is the most common cancer in Sweden. Patients with the condition has a good prognosis in general and most cases can be treated. Localized prostate cancer is primary treated via surgery or radiation therapy and is diagnosed with the help of different imaging modalities, such as magnetic resonance imaging, MRI, and positron emission tomography, PET. When a lesion is found the aggressiveness of the lesion can be determined by a biopsy. Samples from a small part of the prostate is extracted and is then examined. This could mean that parts with higher aggressiveness could be missed which in turn could lead to under treatment of the cancer. The aggressiveness of a lesion can be described by a Gleason Score, which is determined by an visual assessment of the shape, size and arrangement of the cells. The aim of this study was to correlate the Gleason score with in-vivo images using MRI and PET. This was done by investigating image data from PSMA PET, Acetate PET, Ktrans MRI and T2-weighted MRI from a cohort of prostate cancer patients. Regions of interest, ROI, were created and applied on all images. Statistics such as median-, and max value was extracted from each ROI. The result indicate that some of these image based measures were correlated to the Gleason Score. It also indicated that some of the modalities gives complementary information to each other, and such a combination of the modalities would better predict the Gleason Score. The implications of these findings could affect both the diagnostics and the treatment of prostate cancer.

Evaluation of margins and plan robustness for proton therapy of unilateral tonsil cancer – **Josefine Grefve -** https://umu.zoom.us/j/62934168052

During proton therapy both target volumes and healthy tissue, including organ at risks (OARs) receives radiation. Thus, radiotherapy is a trade-off between good target coverage and OARs sparing. For protons, most part of the dose is deposited right before it is stopped, termed the Bragg peak. Beyond this point no dose will be deposited, which is an advantageous feature since it enables more OAR sparing. However, this feature also makes proton therapy sensitive to uncertainties in patient position, dose calculation and geometry changes. Margins is thereby needed to ensure good target coverage. An evaluation of the margins and plan robustness for proton therapy of unilateral tonsil cancer was thereby conducted in this study to see if smarter margins could be found and supported. Verification CTs was compared with the plan CT of seven patients by using the software Elastix and MICE toolkit. Dose volume histograms (DVHs) was evaluated together with Hausdorff distances (HdD), target coverage and dose differences along the patients vertebras. Tendencies for the need of larger margins caudally from C3 was concluded from the HdD and two patients were selected to be re-planned. Four new dose plans each were created in the treatment planning system (TPS) Eclipse and the resulting plans were evaluated in MICE toolkit. Two of them with a 4/5mm margin around the whole CTV, and two with varying margins. Since Eclipse only allows the user to evaluate and optimize a plan with one margin, new structures for the CTV had to be created for the varying margins before the optimization. Caudally from C3 an added margin of 2mm and 3mm was created. Thereafter these new structures were evaluated and optimized with a 3mm margin. The limited available data suggests that the plans with varying margins shows favorable characteristics and may improve clinical outcome. The added margin of 3mm caudally from C3 seems to generate the best balance between target coverage and OAR sparing. However, more patients needs to be included in the study before certain conclusions can be made.

Atmospheric Attenuation for Lidar Systems in Adverse Weather Conditions – **Johan Viklund**

- https://umu.zoom.us/j/61000668813

In this study, the weather impact on a lidar signal has been researched. A lidar system was placed with a target at approximately 90m and has together with a weather station collected data for about a year prior to this study. By using the raw ADC data from lidar unit, the full waveform can be obtained and the amplitude of the return pulse can be calculated. The return pulse correlates to the detector response of the reflected pulse. Atmospheric attenuation of lidar signals is often modeled using the lidar equation, which essentially predicts an exponential decrease in energy over the distance, under the assumptions of this study. The factor in the exponent is referred to as the extinction coefficient and it is the property studied in this thesis. By identifying models for the extinction coefficient in different weather conditions, it is possible to simulate the loss of energy. This expected attenuation can then be compared to the measured attenuation from lidar data, to draw conclusions about the accuracy of the models. The extinction coefficient was calculated using some different empirical models. Among these empirical models investigated in this thesis are Kim and Kruse models for known visibility, the Al Naboulsi model for different types of fog with known visibility, the Carbonneau model for known precipitation amount in rainy conditions, and a similar model for snowy conditions. For the case of rain, a physical model was also used, which is derived through Mie theory. This requires the calculation of extinction efficiency, which is a measure of absorption and scattering for a particular wavelength from a homogeneous sphere with known refractive index. This model also requires a particle size distribution, which is the number of particles of a certain radius per unit volume and unit change in radius, for each weather condition. This was generated using the Ulbrich raindrop size distribution, which generates a particle size distribution in rain when the precipitation amount is known. A particle size distribution for the two most common fog types was also generated. Most data was accurately predicted by the models and generally the models tend to underestimate the amplitude of the return pulse. The visibility models gave the most accurate result across most analyses, while the precipitation models performed worse. In the first couple of meters of the transmission, we expect to see some backscattered light, since the detector has a larger solid angle at lesser distances. This light will interfere with the light reflected by the detector glass and may cause the internal reflection pulse, known as zeropulse, to expand in width. By examining the zeropulse for different weather conditions, it was possible to observe a difference between the average zeropulse for some different weather conditions. This leads to the conclusion that it may be possible to extract some information about current weather conditions from the lidar data, given that some particular circumstances are met.

Development of a CFD Boundary Condition to Simulate a Perforated Surface – **Medet Kiflemariam**

- https://umu.zoom.us/j/65758574227

The adverse pressure gradients associated with Shock Wave-Boundary Layer Interaction (SWBLI) may cause boundary layer flow separation, which can result in reduced lift and higher drag in supersonic aircraft. A common way in dealing with the adverse effects of SWBLI is through removal of low-momentum flow in the boundary layer, a process referred to as bleed. In the process of bleed, the boundary layer is subjected to a pressure difference promoting flow out of the system, through a porous surface, and into a vast plenum. The porous surfaces used in the mass flow removal process contain orifices in small scales. Thus, in Computational Fluid Dynamics (CFD), creating a mesh of high quality resolving both the orifice scales and the bulk flow is a cumbersome task, and simulation-times become substantially increased. To this end, several boundary conditions which effectively model the large scale effects of bleed has been developed by researchers in the field. The aim of this study is to implement the boundary condition developed by John W. Slater into M-EDGE, the in-house compressible CFD-solver of SAAB Aeronautics. The boundary condition bases its model of bleed on empirical measurements of a dimensionless surface sonic flow coefficient, and has been shown to yield good results in correlation with wind-tunnel data. Furthermore, a simple transpiration law formulated by Reynald Bur was implemented in order to familiarize myself with the working environment. However, this model is expected to yield unsatisfactory results as reported in previous work in the field. The implemented Slater boundary condition is tested on two different two-dimensional flow channel cases with and without SWBLI. The boundary condition performance was assessed by its ability to recreate the sonic flow coefficients on which it is based. Further, the shape of downstream Pitot pressure profiles are compared with experimental data. Results from the studies indicate that the implementation manages to recreate the data for the sonic flow coefficient with small error margins. However, differences in the achieved mass flow rates are observed. For the simple channel case, the implementation consistently under-predicts the expected mass flow rate, while for the SWBLI-case, the mass flow is both under- and over-predicted at different suction pressures. The Pitot pressure profiles are shown to give satisfactory similarities in shapes with experimental data, however, due to the distinctions in mass flow rates, Pitot pressure profiles were compared at different suction pressures. The main limitation of the boundary condition is that it is case sensitive, as it relies on the wind tunnel data of the surface sonic flow coefficients, which only exists for certain bleed plate configurations and flow Mach numbers. In future work, the generality of the model could be increased by extending the data to other configurations and Mach numbers by conducting new experiments.