Western Norway University of Applied Sciences

Master Project Proposals 2019

Engineering Computing

Transfer learning in medical imaging

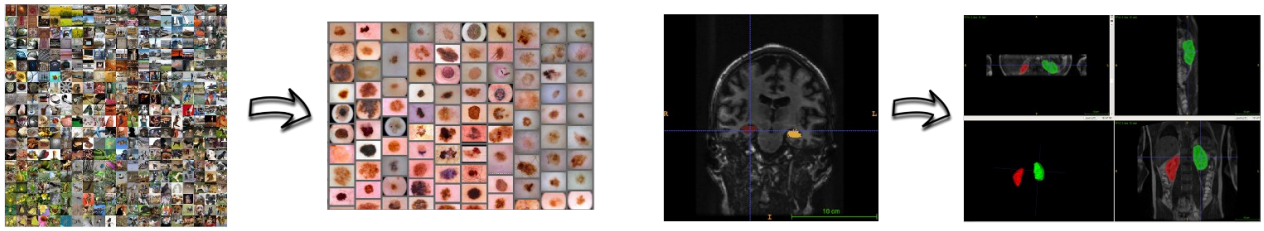
Deep learning – a subfield of machine learning – is behind an ongoing revolution in several areas associated to “artificial intelligence”. From being poor at recognizing objects in images and videos computers have now reached the human level. From computers being almost incapable at text and speech recognition to widespread use of powerful personal assistants like Siri, Cortana and Google Assistant. From playing at an amateur level in games like Jeopardy, Poker, Dota, and Go, computers are now beating world champions. Until recently, cars could only provide very limited driving assistance. Now, completely autonomous vehicles are being developed by a large number of companies worldwide.

The reason for these developments are breakthroughs in deep learning, a set of techniques particularly well-suited for extracting complicated patterns and connections in big, heterogeneous data sets. The potential impact on the analysis of medical data is huge, and already being intensely explored.

One common stumbling block for supervised learning methods based on deep neural networks is the large number of labeled examples required for training. This is particularly troublesome when trying to use deep learning methods for segmentation (partitioning) of structures in 2D and 3D medical image data. Creating labeled data for a segmentation model typically involves producing manual delineations, a time-consuming, difficult and often unreliable process.

When using convolutional neural networks (CNN) to train a image recognition or image segmentation system the layers in the CNN typically gives a hierarchical representation of the images. The first layers correspond to basic features in the images, like edges and other primitive shapes, while the later layers build upon these. By transferring the weights of the first layers from a network that has been trained to perform one task to a new network designed for another, similar task, one can reduce the number of parameters to be learned and therefore the number of labeled examples needed to train the new network.

This project will investigate the value of transferring knowledge from tasks that have an ample supply of annotated training data to other tasks with few training examples, and construct techniques and software facilitating such transfers. The goal is to enable application-specific 3D segmentation in medical data with relatively modest need for manual input.



The tools used in this project are well-established state-of-the-art frameworks and software packages from deep learning and general data anlysis. Knowledge of these tools will be extremely valuable for any project involving deep learning, and also machine learning and advanced data analysis in general.

If you want more information about the project, feel free to contact me at alexander.selvikvag.lundervold@hvl.no.

PS: I will also offer other projects related to machine learning. These will be presented on Oct. 4th.

Some references:

- Nature, 2015: https://goo.gl/t5NXAM
- https://www.newyorker.com/magazine/2017/04/03/ai-versus-md
- http://cs231n.github.io/transfer-learning
- Helse Medisin Teknologi, 2017: https://goo.gl/mB7Amx
- https://goo.gl/3v5bgf

Deep reinforcement learning

Reinforcement learning is an exciting field within machine learning tasked with creating intelligent agents interacting with their environment. Recently, reinforcement learning has been combined with deep learning, creating the field of **deep reinforcement learning**. This development that has put reinforcement learning at the forefront of research in artificial intelligence. The most stunning use-case is perhaps AlphaGo's superhuman performance at the board game Go. Other recent examples include DeepMind's Atari playing systems, data center energy optimization, reinforcement learning for self-driving cars, and the OpenAI's Dota 2 bot beating several top professional players .

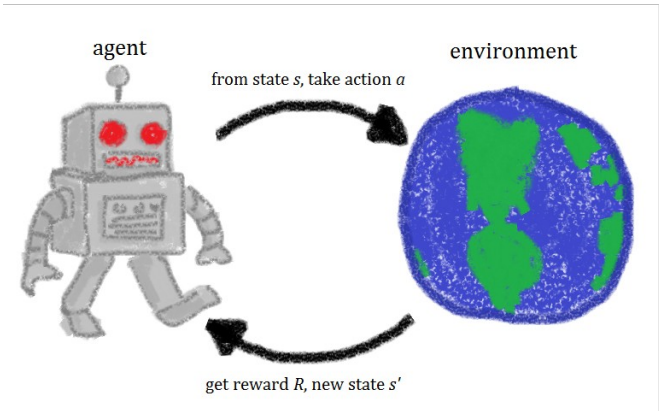
The techniques used in these systems are widely applicable: robotics, automation, self-driving cars, mobile healthcare, smart devices, image processing, and much more.

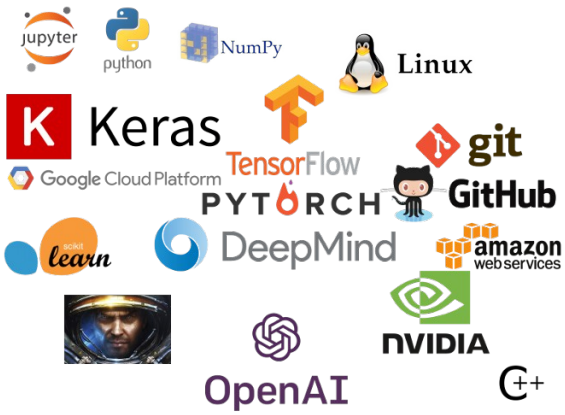
DeepMind has partnered with Blizzard to release an AI research environment based on the computer game StarCraft II. This is a very difficult real-time strategy game requiring both careful execution of commands ("micro") and long-term planning ("macro"), making it a very interesting – and extremely challenging – research environment for reinforcement learning.

Also quite recently, OpenAI and others have released several reinforcement learning agents able to solve a variety of tasks.

The MSc project aims to contribute to the field of deep reinforcement learning by creating AI agents aimed at playing custom *mini-games* of SC2 – designed as part of the project – based on algorithms created by OpenAI and others.

By completing this project the student will become familiarized with a number of different state-of-the-art technologies and methods from machine learning and data science. These are highly sought-after competencies, and will make the candidate ideally suited for a career or further research in these fields.





If you want more information about the project, feel free to contact me at alexander.selvikvag.lundervold@hvl.no.

PS: Other projects related to reinforcement learning will be presented on Oct. 4th.

Some references:

- MIT Technology Review, 10 breakthrough technologies 2017: Reinforcement Learning: https://www.technologyreview.com/s/603501/10-breakthrough-technologies-2017-reinforcement-learning
- DeepMind: Deep Reinforcement Learning: https://deepmind.com/blog/deep-reinforcement-learning
- NVIDIA, Deep Learning in a Nutshell: Reinforcement Learning: https://devblogs.nvidia.com/parallelforall/deep-learning-nutshell-reinforcement-learning
- DeepMind and Blizzard. https://deepmind.com/blog/deepmind-and-blizzard-open-starcraft-ii-ai-research-environment
- OpenAI, Dota 2: https://blog.openai.com/dota-2, https://blog.openai.com/more-on-dota-2

Parameter estimation in multimodal medical images

The purpose of medical imaging is to diagnose abnormal conditions, identify and understand the underlying mechanism that control these conditions, guide therapeutic interventions and follow up treatment. Qualitative image assessment dominates the clinical practice worldwide. Yet, it has become clear that for most advanced applications it is too complicated for the human eye to extract information across hundreds and even thousands of medical images. Instead, tissue properties must be modelled and parameters can be quantified across such large image data sets. This type of tissue parameter estimation (also known as feature extraction) involves many scientific disciplines.

Magnetic Resonance Imaging (MRI) is one imaging modality which can be used to extract different properties of the same tissue or disease condition. MRI works because we can observe the way protons in the human body respond to external magnetic fields. Because most disease processes lead to changes in the fluid content of the tissue, MRI is sensitive to a wide range of disease processes.

The purpose of the proposed master project is to extract tissue properties based on MRI data in time, i.e. four dimensional image data. The student will learn about MRI, apply simple mathematical models to MRI data and attempt to extract the features in actual MRI patient data. What is required from the student is an interest in the field of medical imaging, good programming skills and an ability to communicate with colleagues having different scientific training.

--
For 2015 projects: MRI is ideal for imaging in children because no ionizing radiation is involved. In the current project, there is a focus on children with arthritis affecting various joints in the body. The question is if advanced MRI acquired in time can be used to identify pathological changes early in these children so that appropriate treatment can be applied.

Supervisors:

- Renate Grüner (Radiologisk avdeling, HUS og IFT ved UiB)
- Jon Eivind Vatne

Naive and adapted utilization of the GPU for algorithms in image processing/simulations

The increase in computational power of Graphics Processing Units (GPUs) in recent years allows much better simulations in computer graphics, for instance for modelling fluid motion (e.g. water, smoke, fire). There are standard libraries for utilizing this power, but to fully exploit the GPU for a given task, an implementation adapted to the task will perform better.

The task is to compare running time for various implementations of the same algorithms. A naïve implementation using standard packages and libraries will be quicker to develop, but the end result of an adapted and more sophisticated implementation will be better. For what tasks will this increased effort be worthwhile?

Possible tools: MATLAB (including the Parallel Computing Toolbox), CUDA, OpenCL,...
Contacts: Supervisors:

- Jon Eivind Vatne
- Talal Rahman

View-Dependent Refinement of Terrain Meshes using the Longest-Edge Bisections

Level of detail (LOD) is an important modern topic due to the tremendous strides in graphics hardware, however the tension between fidelity and speed continues to haunt us. The complexity of our 3D models — generally measured by the number of polygons — seems to grow faster than the ability of the hardware used to render them. The fundamental concept of LOD is simple: when rendering, use a less detailed representation for small, distant, or unimportant portions of the scene.

An important concept associated to LOD is geomorphing. It means to blend smoothly between levels of detail in object space, morphing the vertices in one LOD toward those in the next LOD. For example, H. Hoppe [1] used geomorphing to smooth the visual transition resulting from a vertex split, or its inverse the edge collapse. In this work we propose to use the scheme of H. Hoppe but implementing triangle operations that are bisection refinements using the longest edges of triangles [2].

The final approach implemented will be in C++ and can be included in the open-source project Glob3 Mobile (http://www.glob3mobile.com/)

References

[1] H. Hoppe. View-Dependent Refinement of Progressive Meshes. Proceedings of SIGGRAPH 97. pp. 189–198. 1997.
[2] S. Korotov, A. Plaza, J. P. Suarez. Longest-edge n-section algorithms: Properties and open problems. Journal of Computational and Applied Mathematics (available online 5 June 2015).

Supervisors:

- Sergey Korotov

Software Engineering

Implementation of an algorithm to analyze model differences

In model driven engineering model changes may happen frequently. Given the original and a new version of a model one can calculate the difference between the models. Based on this difference there is developed an algorithm that deduces a sequences of editing steps that transform the old version of the model to a new version. The proposal is to implement this algorithm using the Eclipse Modeling Framework. Model-Driven Engineering (MDE) is a software development methodology which focuses on software models rather than on coding. In MDE models are first-class entities of the software development process. These models are used to generate (parts of) software systems by means of model-to-model and model-to-text transformations.
In MDE, model changes may happen frequently. Given the original and a new version of a model one can calculate the difference between the models. Based on this difference there is developted an algorithm that deduces a sequences of editing steps that transform the old version of the model to a new version. The proposal is to implement this algorithm using the Eclipse Modeling Framework. More details of the approach are given in the paper Integrating the Specifcation and Recognition of Changes in Models.
The proposal is given in cooperation with the software engineering group at Philips Univeritat Marburg Germany. It will be posible to have research stay at Philips Universtat during the project.

Supervisors:

- Yngve Lamo
- Gabriele Taentzer

Lars M. Kristensen: Engineering of Concurrent and Distributed Systems

The increasing use of handheld devices, embedded computers/sensors/actuators, wireless communication and cloud computing means that still more software development projects are concerned with concurrent software systems, i.e., systems consisting of software components and processes that communicate, synchronise, and share resources. This trend is expected to accelerate in the future in the context of pervasive and ubiquitous computing systems and in the visions of the Internet of Things (IoT). Since software is required to support increasingly advanced use of information technology, it becomes still more complex, and it becomes challenging to ensure correctness and reliability.

Projects are offered in the following areas:

- Advanced graphical software tools for concurrent and distributed systems [https://www.youtube.com/watch?v=ZRzHi1eW1QE]
- Model-based testing of distributed systems protocols.
- Platforms, frameworks and technologies for IoT.
- Process mining in healthcare systems.

Further background information can be found via: https://github.com/lmkr/mscprojects

Supervisor: Lars M. Kristensen, E503, lmkr@hvl.no

Model-Driven Software Engineering with DPF

Model-Driven Software Engineering (MDSE) is a branch of software engineering in which the focus is changed from code to software models. In MDSE models are first-class entities of the software development process. These models are used to generate (parts of) software systems by means of model-to-model and model-to-text transformations. The Diagram Predicate Framework (DPF) is a formal framework developed at HiB/UiB as an attempt to address technologies and foundations of MDSE. The DPF project also includes tool development for MDSE. An important part of the tool support for DPF is the development of an Eclipse based MDSE workbench. Currently the DPF group consists of several master students, PhD students and (associate) professors. Further information is available from DPF web page **http://dpf.hib.no**.

There are several thesis proposals connected to the DPF, and MDSE in general. The content and tasks in the chosen project will depent on the candidate's interests and competences. Some examples of actual thesis proposals related to tool development could be:

- Develop a configurable syntax editor for the DPF workbench using Eclipse Sirius; add functionalities to develop model components, organize models into packages, create model views, zooming in and out, etc.
- Further develop the code-generation facilities of the DPF workbench using Acceleo or other technologies; apply the techniques to develop applications for web, Andriod, iOS, etc.
- Development of a versioning system for graphical models, similar to Git and SVN, but for model-centric repositories
- Linguistic extensions and functionalities for concrete/abstract syntax; apply the techniques to develop new extensions for containment, inheritance, etc.
- Implementation of model transformation tools for the DPF workbench, which enables transformation of constraints; integration of EMF Henshin or similar Graph-based transformation engines.
- Generation of DPF graphical models based on textual models; apply the techniques for the generation of DPF models from Alloy specifications
- Co-evolution of models corresponding to metamodel changes, so that broken models could be fixed and opened in the new versions of the model editor.
- Implementation of a Tableau reasoner for the DPF workbench.

The DPF group is also interested in supervising projects on the foundation and industrial applications of MDSE, e.g., code generation, model transformation, abstract/concrete syntax, model versioning, deep metamodelling, etc.

Supervisors: Adrian Rutle and Yngve Lamo

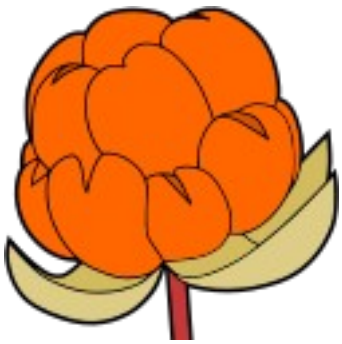
A generic framework for executable modeling

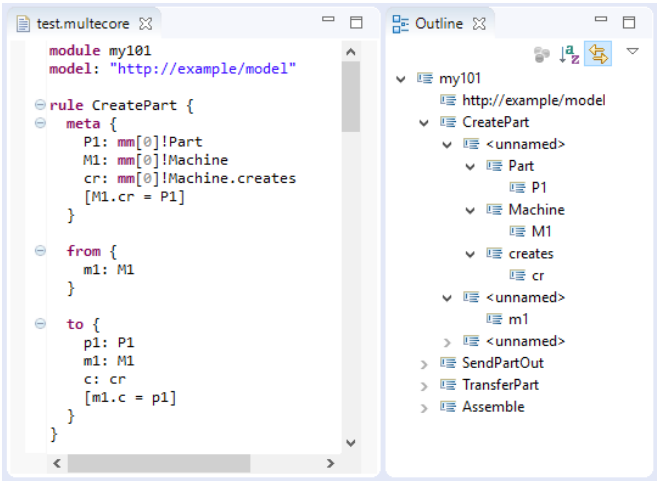
In Model-Driven Software Engineering (MDSE), the increasing complexity of software development processes is tackled through abstractions; i.e., considering abstract models as first-class entities. Using executable models one would expect to gain more from time-consuming modelling efforts, such as simulation, verification and early debugging and analysis. However, due to the lack of mature modelling tools and frameworks that facilitate both definition and execution of models, executable modelling has not gained its deserved popularity and its potentials are not yet unfold. In most cases, the definition of behavioural models for the software system to be developed is a non- trivial task, comprising complex aspects such as time constraints, resource management, failure detection and recovery, etc. Hence, automatic verification of executable models, especially using techniques from runtime verification, would be necessary for any executable modelling framework. This master project will focus on tool support for the metamodelling framework MultEcore (see http://ict.hvl.no/multecore/)

We will use model transformation rules to define the semantics of these languages.For the verification purpose, we define a modelling language for the specification of behavioural properties.These properties are monitored constantly during the execution of the models in order to ensure the expected behaviour.In case failures are detected, or are expected to happen, mitigation procedures could be fired. We will use case-studies from the field of process modelling to ease the development process. There is possibility for a period of research stay at the University of Malaga (Spain).

Supervisors:

• Adrian Rutle• Volker Stolz• Alejandro Rodríguez Tena

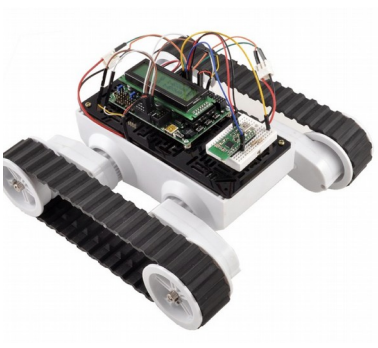




Robot programming and Modeling

Simulations based on models have proven successful in many areas such as automotive and aerospace industry, where the final goal is to create physical systems with the same behaviour as the models. However, as those systems get more sophisticated, the need for better modelling languages and simulation tools, as well as automatic transformation from the models into the target technologies, has become paramount. The goal of this Master Thesis is to build better tools and abstractions for modelling of scenarios involving autonomous, heterogeneous robots with collaborative behaviour and distributed communication, including automatic code generation into different target platforms, like Ardupilot, ROS, etc. The idea is to define a language for definition of workflows where actions are specified graphically.The ICT Engineering group also owns a set of Arduino robots, CrazieFlie drones, an ErleRobotics drone, Rovers, etc. See also https://github.com/FabianSchuessler/DroneProject and http://ict.hvl.no/master-thesis-robot-programming-and-modelling/

In this Master thesis, a prospective student should improve the modelling environment by performing the following tasks. Introduce additional useful abstractions for robot behavior on a platform-independent level. Allow for the customization of the behavior and code, based on the target platforms and the available hardware of the robots (sensors, motors, and actuators). Additionally, students may be interested in distributed cooperative systems of robots, or formal verification of the models according to correctness, energy consumption, or time constraints.


Runtime monitoring of Business Processes

Runtime Verification is an interesting technique to ensure that programs do not do any harm: the program is combined with a monitor that specifies permitted behaviour, and e.g. terminates an application when it attempts anything else. The big advantage is that the program and the monitor can be developed independently, and that monitoring does not suffer from the same intrackabilities like model checking (exhaustive verification).

We will look at existing business process frameworks, and develop behaviour specifications for case studies. We will investigate how monitors can be best managed and integrated into the running processes. One possible application area could be health-care processes, which for example have certain requirements on data privacy.

We will also look into editing support for specifications, e.g. based on Dwyer\'92s concurrency patterns.

Related work:* EU COST action on Runtime Verification: http://cost-arvi.eu * Business Process Model and Notation: http://www.bpmn.org * http://patterns.projects.cis.ksu.edu

Supervisors:

- Volker Stolz
- Adrian Rutle

Modelleringsverktøy for dagens Programvareutvikling

Modellering er en viktig aktivitet i ingeniørdrevet programvareutvikling. Det brukes for å analysere faglige domener og prosesser, for spesifikasjon av programfunksjonalitet og ikke minst for dokumentasjon. Modellbasert programvareutvikling (MDSE) tar denne tanken et steg videre ved å automatisere repeterende aktiviteter som for eksempel koding slik at modellering blir den sentrale aktiviteten i utviklingsprosessen.
Enda viktigere er at MDSE gir domeneeksperter og kunder større påvirkningsmuligheter og innsikt i alle fasene i programutviklingen. For å gjøre modellering mer tilgjengelig for denne gruppen, trenger vi gode modelleringsverktøy. Men for tiden er flesteparten av slike verktøy integrert i utviklingsmiljø (IDE: Integrated Development Environments), som er komplisert og vanskelig å bruke.
Målet med dette prosjektet er å utvikle et moderne, åpenkildekode modelleringsverktøy som er enkelt å bruke samtidig som det har godt nok uttrykningskraft til å støtte forskjellige grafiske modelleringsspråk som UML og BPMN.
For å være lett tilgjengelig må verktøyet utfylle følgende krav:

- Verktøyet må være nettbasert. Dette betyr at brukeren kun trenger en nettleser.
- I utgangspunktet kan verktøyet støtte et enkel sett med objekter, for eks. linjer og bokser. Men det må også være mulig å konfigurere verktøyet slik at mann kan tegne mer avanserte diagrammer som BPMN og UML.
- Verktøy skal være gøy å bruke. Dette betyr at bruk av funksjonalitetene skal være ergonomisk.

I dette prosjektet kan du

- Utvikle din egen webapplikasjon med Client-Server-Arkitektur. Du kan gjerne også vurdere å bruke nylige Microservice Arkitektur.
- Bruke nylige og moderne web teknologier får å lagre en grafisk modelleditor med høy brukervennlighet.
- Forske på brukervennlighet for webapplikasjoner og ergonomisk brukergrensesnitt.

Samtidig får du mye innsikt i den teoretiske bakgrunnen til modellering.
Oppgaven kan skreves på norsk eller engelsk.

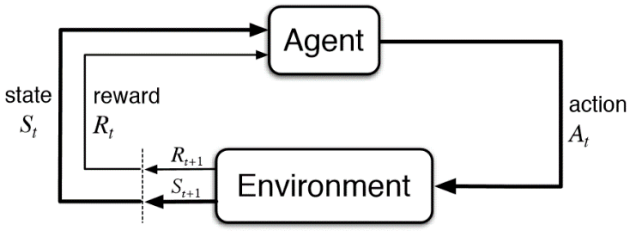
Veiledere: Patrick Stünkel og Adrian Rutle

Automatic software repairing using Machine Learning

Bug fixing and software repairing are gaining increasing importance since programming environments are becoming more and more complex. The difficulty of keeping programs free of errors grows together with the size of working teams and number of changes during the development process.
To handle this complexity, models are used to support software development. Therefore, the correctness and accuracy of such software models are of the utmost importance to maintain good quality during the development of software systems.
Automation can be an excellent solution to ease the complexity of this process by periodically checking if a model is free of errors and repairing them when they occur.
Machine Learning has already achieved human performance in repetitive tasks and we believe, it could be successfully applied in automatically fixing software errors, both at coding and modelling levels.
The biggest challenge for using Machine Learning in automatic repairing, especially within modeling, is the lack of historical data available publicly. Most ML algorithms need great amounts of datasets in order to achieve high-quality results. Therefore, it would be really interesting to research to what degree Unsupervised Learning and Reinforcement Learning algorithms can be applied in software repair, since this type of algorithms do not need labelled data or even not training data at all.
Therefore, our focus will be on researching how Machine Learning can automatically repair bugs in software models, trying to achieve the best performance posible. For this, we will work with different algorithms, and apply different techniques to boost the algorithms performance. For this we will use Eclipse Modeling Framework.

Supervisors:

Adrian Rutle – Angela Barriga – Rogardt Heldal



Safer Refactorings

Refactorings are a common tool of the trade for programming. Alas, some seemingly intuitive refactorings do NOT preserve the original semantics. We look at particular refactorings, and suggest to encode the assumptions necessary for their correctness in the form of assertions. Refactorings are a common tool of the trade for programming. In general, they are assumed to be equivalent transformations of a program, to improve the quality of the source code with regard to a concrete or subjective software metric, such as coupling. Alas, some seemingly intuitive refactorings do NOT preserve the original semantics. Especially for OO programs, proving a particular refactoring as correct is a complex, if not even infeasible task, e.g. in the presence of virtual method calls. We look at particular refactorings, and suggest to encode the assumptions necessary for their correctness in the form of*assertions*.

While this does not directly preclude the developer from applying wrong refactorings, it makes the necessary assumptions explicit.

A prospective student would familiarise himself with refactoring as they are implemented in common IDEs (Eclipse, IntelliJ, NetBeans, MS Visual Studio) and from literature (Design Pattern-book, see below). In a survey, each refactoring/pattern is classified whether it produces an equivalent program with regard to effects commonly found in OO programs, such as so-called aliasing (above), or virtual method calls.

Some of the necessary infrastructure (code for analysis of Java fragments within Eclipse, finding candidates through heuristics etc.) has already been used in an earlier Master's thesis which was deemed Very Good in 2014, see below.

Bibliography:

Design Patterns: Elements of Reusable Object-Oriented Software, Gamma, Helm, Johnson, Vlissides

Refactoring. Improving the Design of Existing Code, Schäfer, Fowler

Challenge proposal: verification of refactorings, Schfer, Ekman, de Moor, PLPV'09

Automated Composition of Refactorings, Erlend Kristiansen, Master's thesis UIO, 2014.

Supervisors:

Volker Stolz, E 2^9

Refactoring at scale

Refactoring is an important activity of software developers. It improves code quality and understandability, but can also subtly change the behaviour of your existing program. We have so far tried in two very successful Master theses to make a small number of refactorings for Java automatic (website, published in NIK'14), and safer (slides, published in ISoLA'16). What is missing now is an experiment at scale! Research questions include:

- can we automate more refactorings (beyond Extract-and-Move-Method)?
- can we do so at scale (incremental or concurrent processing of large code bases)?
- can we integrate automated refactorings into code review systems like Gerrit?

  A prospective student should…
- …like programming and programming languages;
- …be willing to learn about grammars, programming language semantics, and types/ static analysis;
- …have an interest in software quality metrics (coupling, cyclomatic complexity,…);
- …independently set up and run experiments (e.g. check out open source-projects from GitHub, apply automated refactoring, collect results e.g. in Jenkins/Sonar/…).

  Supervisors:
- Volker Stolz, E 2^9

COEMS (EU Horizon 2020)

HiB is a partner in the EU Horizon 2020 project COEMS – Continuous Observation of Embedded Multicore Systems, which has recently been funded with 3.9M EUR across five academic and industrial partners. The ability to observe the internals of an execution of a computer-based system is a fundamental requirement for ultimately ensuring correctness and safe behaviour. Within COEMS, a novel, FPGA-based, observer platform with supporting verification methods for software systems is created. COEMS tackles the issues of detection and identification of non-deterministic software failures caused by race conditions and access to inconsistent data. It gives insight to the system's actual behaviour without affecting it, allowing new verification methods.
Within the project, the following thesis topics are available:

- ZedBoard-based development of a monitoring prototype. Think of a ZedBoard as an Arduino, instead that of peripheral sensors and motors you connect an FPGA: data needs to be collected from the FPGA, processed locally, and either exported (e.g. through a web-interface), or synchronized to remote cloud storage via the network.
- Visualization of common correctness-problems in software. The FPGA will monitor software running on a multicore processor for performance metrics, timing constraints and common defects, such as deadlocks, race conditions, or user-specified properties. To demonstrate the system and evaluate the performance, a prospective student identify relevant performance measurement- , timing- , and bug categories, and develop short examples for each. These will then be used by a test-suite that will demonstrate how COEMS technology discovers the bug (especially so-called "Mandelbugs" that occur non-deterministically).
  Visits to project partners in Germany (University of Lübeck and Accemic, Bavaria) are possible through the ERASMUS program.
  See also: http://prosjekt.hib.no/ict/master-thesis-topics-coems-eu-horizon-2020/

  Supervisors:
  - Volker Stolz - volker.stolz@hvl.no

Data driven Smart city (several proposals)

Smart cities are the goal of many cities around the world. It is still a new concept and we do not really know what it means and how can we benefit from it? This is a very exiting master thesis looking into these issues.

This master thesis will be done in several steps. Firstly, investigate how you can contribute to making Bergen smarter using sensors, actuators and analysis on the data. This can be a smarter building, infrastructure, electricity etc. As part of the project, you need to build one or several quick prototypes to demonstrate how this can be done. Finally, make one more complete prototype of the idea and evaluate it.

Several students can choose this proposal since several independent projects will be created. Today, we have two projects at the company Rainfall that are situated in Media City. The plan is that these projects or similar project will be continued. Some of the goals of Rainfall is to make the building complex Media City smarter and support the companies within the complex to have innovative solutions when it comes to the internet of things. For example, that could be air quality, tracking equipment etc.

Rainfall is a consultancy and competence center in Bergen with 44 employees. They are working on the development of IT solutions and digitalization at customers. We work out in consultancy assignments and have an in-house department that does project and service delivery. Our focus areas are digitalization (app and software development), visualization (web, mobile, VR and ar), data management (AI, ML and BI) as well as engineering (project management and testing). An important task for us is to ensure new and proper expertise in keeping a current profile with our customers.

There are two concrete suggestions from our collaboration with Rainfall now:

- Big Data Analytics for Air Quality Monitoring - a task in using different data sources for air quality analysis. (Building on a task from 2018).
- Smart House AI Assisant- AI Personal Organizer Shopping List (Multiple Users). See separate proposal.

We will also have one internal project in this area here at HVL as well. In the past, master students have also found their own companies to work with during the first half a year of the project.

This is a quite an open master thesis; require independent students that have both good social and technical skills and analytic. It is a strategically important area for many cities around the world. HVL wants also to put more focus on this area, so there might be a lot of potential for collaborations. We at HVL have also interest in seeing this area being more developed here in Bergen.

Learning outcome: In this master thesis there are endless possibilities, the only limitation is the students themselves. One should get better skills about how to make innovative solutions and be in the technology front.

Contact: Rogardt Heldal (rohe@hvl.no), Reza Arghandeh (rajo@hvl.no) or oystein.tomassen@rainfall.no

Smart House AI Assistant - AI Personal Organizer Shopping List (Multiple Users).

The purpose of the task is to map and apply Azure AI services to support creating a smart shopping list that can reach people's needs. The purpose is to create an effective everyday life (for users) and support for sustainable households (environment and consumption). We want to build a solution that can be connected to sensors and a smart kitchen (cooking cabinet, fridge and freezer).

Features that can be considered:

1. Prepare consumption and recommend purchasing
2. Detect consumption of goods and inventory
3. Suggest product purchases based on articles that are put on purchases (e.g. suggestions for previous groupings of foods purchased at the same time and suggestions for recipes, such as roof cuts = roof dinner with soft drinks)
4. Suggest foods that provide composite nutrition (e.g. household does not use foods that provide a source of C vitamins)
5. Advice on packaging (e.g. chip bag is a residual waste and not plastic)
6. Resource management (financial overview, number of households, deviation of distribution key as purchases to guests, or increased consumption according to normal budget)

There must be selected at least two data sources in addition to the application's own data for the practical implementation of the task. Data that may be associated with is, for example:

7. Approximate price of articles
8. About date plotting

Data correlations should be visualized in a report interface. Data analysis and modelling provides response to consumption patterns. Setup of IoT infrastructure is outside of the task (can be incorporated).

Background

We live in a consumer society, where food is an important driver of our environmental impact. We consume foods with a large amount of packaging, low levels of utilization (throwing a lot) and without thought for nutrition. It is time-consuming to make purchases, plan the menu as well as maintain a good nutritional profile to ensure access to essential nutrients.

The solution is a basic function of cloud usage for logistics, which can further be linked to IOT. It can be transferred to major infrastructures for Smart Care etc.

Contact: Rogardt Heldal (rohe@hvl.no), Reza Arghandeh (rajo@hvl.no) or oystein.tomassen@rainfall.no

Identifying patients at increased risk for deteriorating health, using machine learning

Due to faster hardware and improve algorithm, machine learning has become a feasible technology.

At Haukeland University Hospital, we have more than 10 years of structured patient data, that can be used to train a machine learning model to recognize early signs of deteriorating health. The model will allow us to find and engage at-risk patients and their primary care physicians, and direct effort to prevent deterioration, at least in some cases.

We have an in-progress project to pilot such an approach for diabetes patients, and we want to implement that into regular practise. We also want to explore the same approach for other patient groups.

This project requires good knowledge in statistic or machine learning as well as good programing knowledge.

Contact: Rogardt Heldal (rohe@hvl.no)
Or Magnus Alvestad (magnus.alvestad@helse-bergen.no)

Web-Novel: To build a tool for collaborative building books: Web-Novel

To write a book is typically done by one person or at least a small team. What about taking this to a new height, collaborating book writing, WebNovel. To create a place where authors and readers can meet to make small texts (stories) that are connected to each other.

A potential stakeholder could be a publisher. A publisher is a connection between authors and readers. The readers can choose their reading path. The authors can write a chapter as a bridge or a continuation of the existing path. Also, readers can make their own texts. There are two options when it comes to publishing the text. Firstly, the publisher will review all texts before insert to the web. In this case, the publisher can communicate with the author to improve on the text. The second option is to permit direct insertion of text. In this case, there is a group with permission to remove inappropriate texts. Another stakeholder could be a teacher in a class, where students write a book together.

A master thesis (http://strys.xyz) on this project has finished in May 2018. The idea is that this thesis will continue this work. The code for this project will be given. Also, the student that did this project will be part of the supervisor team.

The job will be to understand the code and what has been done so far. The way forwards depend very much on the candidate, it is much freedom in this project. One could extend the databases, better use of server and web pages (or cloud). It will also be essential to be able to use a mobile app for the system. One could have support for things such as multi-language, support for tagging (possibility to track the development of persons, items, places) and search (possibility to find if it exists a text, e.g. "Dirac" exist). Some analyses can be done here using statistics, which reading path is most often read, what reading path is highest rated. One can also find which text is the newest, and one might want to follow a particular author.

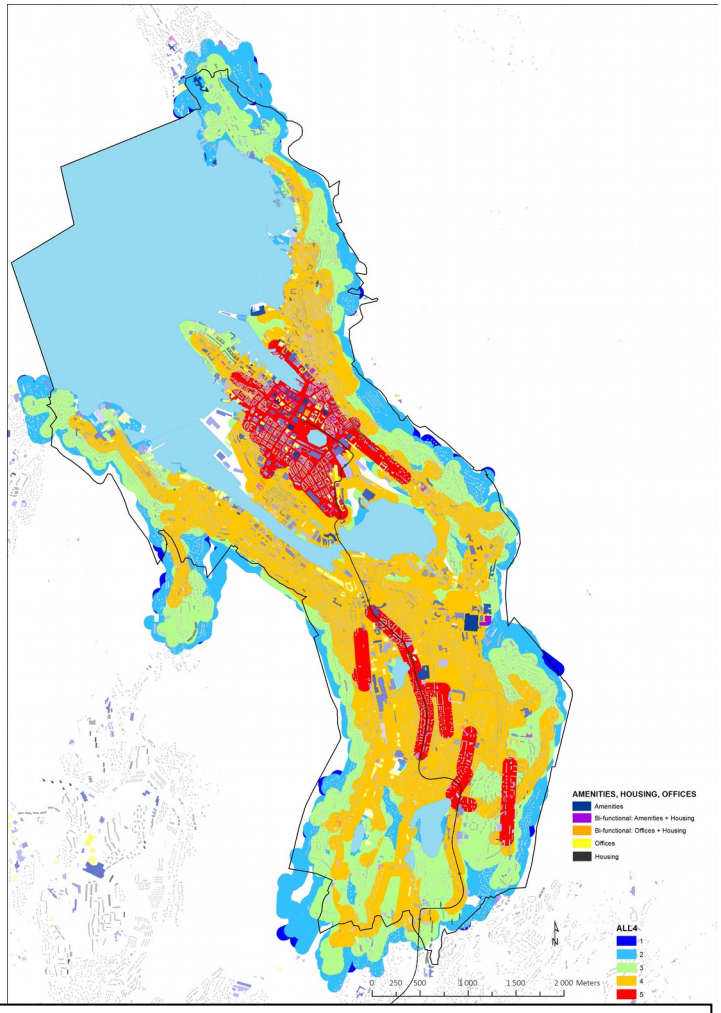
One should extend the system in small iteration with a lot of user test. The final system needs to be evaluated in a larger group. It is vital that the graphical user interface will be good so that it triggers new users to use the system; get addicted. This is a new and crazy idea. However, we do not know precisely how to make a business from it. So, an extra task is to come up with ways that this could take off.

All the technology for this master thesis should be known: Database, App and Web. The critical point is to make a usable system and also find candidates to test it on.

Contact: Rogardt Heldal (rohe@hvl.no)

Modelling the natural urban transformation process

Nowhere is the implementation of 'sustainability' more potent and more beneficial than in the city. One of the biggest global challenges of the twenty-first century is to transform our cities into compact, self-sufficient living environments. But what are the driving forces that steer this natural process, and in what ways can we apply this knowledge to develop our cities with urban qualities?



Research has shown that the configurational pattern of streets is guiding in the distribution of movement patterns as well as the allocation of functions such as shops, businesses and other public attractors. However, there is a knowledge gap when it comes to the relationship between the spatial layout of a built environment and energy usage for transport and buildings. Various modelling and simulation programs are in place and under development today, but they lack (inter)operability. From a scientific point of view, there is a strong demand for digital platforms that are capable of providing operable means to combine the spatial parameters that affect the energy performance of urban environments. More precisely, no tool exists today that successfully combines street network configuration with density, functional mix, public transport and energy usage for transport and buildings into one model. The aim of this project is to develop such a software toolkit

that enables spatial modelling of these parameters through the use of Geograpic Information Systems (GIS) – and subsequently visualise the output to make it suitable for analysis and design by researchers and practitioners.

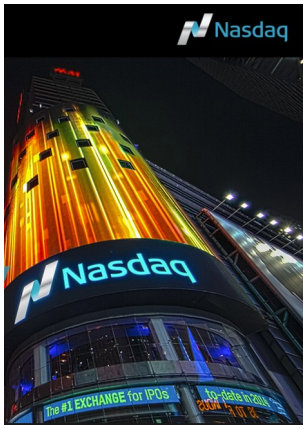
Do you take an interest in our built environment? Do you have the programming skills to build an analytical tool that can model the natural urban transformation process? Then this project might be just for you!

Contact: Rogardt Heldal (rohe@hvl.no) or Remco.Elric.de.Koning@hvl.n

Model-free calculation of forward prices in the energy market

Forward contracts are a common contractual form of purchase and sale of power for future delivery. In Norway, these contracts are traded on Nasdaq, former Nordpool.

For market participants, it is important to calculate prices of the contracts that are acquired or those who are expected to acquire.



Such a price calculation must be consistent in the sense that the same input gives the same price. In addition, arbitration freedom is sought.

A model-free calculation of forward prices is based on historical prices and the prices in the market. Estimated prices must be consistent with market prices, so that it is possible to use these for value calculation for the current market picture.

A model-free price calculation is thought to be done by supervised machine learning. Historical prices and market data will be given as part of the assignment.

The success of the calculations can be measured in three ways:
1. Compared to an existing model-based calculation (different types will be available)
2. Compared with the prices actually used just after the current market images

3. Compared to statistical targets for deviations from actual prices

Contact: Rogardt Heldal (rohe@hvl.no) and John Grieg (jgrieg9@gmail.com)

Simulation and testing of car robotics

Today's cars are very complex software mechatronic systems and it is common to have more variants of the software than one can potentially build physical test cars for. This revolution of the automotive business has driven the industry to develop new methods for testing and verification, including virtual methods and modeling of test environments.

Hopefully, one can catch most of the mistakes in the code using testing on models – with virtual platforms, models of environment, electronics and mechanics. However, one also needs to test the code in a physical car afterwards. The crucial question is, how much do you need to test in the physical car and what do you not need to test again due to simulation and testing. We do not have cars to test on here at HVL, but we have Arduino car robots. We have good contact with Jonn Lantz at Volvo that has worked with this technology for many years.

This might be a difficult master thesis, so it needs a very motivated student with a good computing science background. It can also be a very rewarding master thesis, since one learns a completely new way of working that are getting more and more popular in the industry today.

Contact info: Rogardt Heldal (rohe@hvl.no)

State of architecture in Healthcare

To build a large and complex system, architecture is a crucial part. The architecture is built based on the requirements and the final system is often built based on the requirements and the architecture.

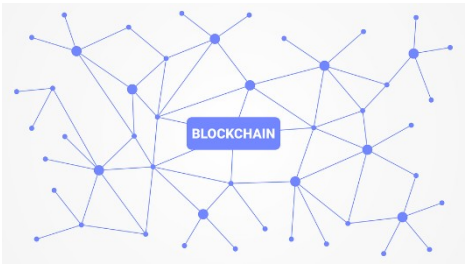
If one has no architecture it is very hard to divide the work and knowing what parts to build. On the other hand, if one is to detailed in making the architecture it might be too complex and it might be very hard to understand. One wants to build just enough architecture to make the process agile, but at the same time one wants to build enough architecture to permit teams to work autonomously.

In previous works, we have gained good knowledge of the architecture in several domains building embedded systems, such as cars, telecom, and trucks. In these domains, there are a lot of challenges such as deciding on the correct abstraction level, what tools to use, how to communicate the architecture etc.

Are there similar problems within the healthcare? This is the purpose of this thesis, to find out the state of healthcare systems architecture based on literature studies and interviews. This master thesis does not contain any programing, but a lot of data collection and analysis.

Contact: Rogardt Heldal (rohe@hvl.no)

Blockchain Technology



Blockchain technology is fueling an emerging industry that may have potential to disrupt entire sectors like finance and logistics.
The basis of this technology was laid in 2009 with the invention of Bitcoin. Since then, several innovations have taken place, like the introduction of smart contracts on the Ethereum blockchain, alternatives to the linear structure in the Bitcoin blockchain like DAGs, new privacy constructs based on zero-knowledge proofs, quantum resistance, alternative consensus mechanisms like proof-of-stake, etc. ...
Also, the ecosystem and number of applications based on blockchain technology has increased exponentially. Bitcoin was intended to be electronic peer-to-peer cash, while the technology has leaked into applications like general proof of identity and ownership, platforms for building decentralized applications, etc. ...
On the economy-side, all these new blockchains have associated coins / tokens, and thus represent a new asset class, cryptocurrencies. At the time of writing, there are over 1800 different coins / tokens listed in the main index, with a total valuation of about $200 billion (no. milliarder). There is also an evolving industry around handling these coins, like wallets, exchanges, custodian solutions, ...
All in all, there are a lot of things going on in this relatively new area, and there are new needs and possibilities for research, including:

- The application of a blockchain solution in a specific domain
- Analysis of a specific area, like privacy, decentralization, quantum resistance, smart contract languages, scalability, ...
- New wallet solutions to make cryptocurrencies more accessible, convenient and secure to hold / use.
- Using machine learning to say something about the price movement of an asset.
- Combining blockchain technology with other areas like IoT or machine learning

If you think this is an interesting area that you want to investigate, and you have ideas for a project / master's thesis, contact me for a talk.
Supervisor(s):

Assistant Professor Lars-Petter Helland, E404, lars-petter.helland@hvl.no

Grid Computing and High Volume Data Processing

High volume data processing: Simulation and monitoring of the data readout from the ALICE experiment at CERN

The ALICE experiment at CERN handles data rates of several GB/s. New readout electronics is under development in order to meet increasing rates in the upcoming runs. We can offer master projects in program development for monitoring, control and simulations of this readout electronics. The ALICE experiment at CERN in Switzerland is set up to reconstruct decay products from heavy ion collisions in the LHC accelerator. Such collisions produce denisities and pressures equivalent to the conditions shortly after the Big Bang.. Measuring these collisions requires a huge detector system. The ALICE detector consists of several subdetector systems, measuring different parameters of the collision. One of these subdetectors is the ITS detector system (Inner Tracking System). The ITS detector consists of several layers of silicon planes. During Long Shutdown 2 (starting in 2018), the whole detector system will be replaced by new pixel planes. The new pixels will be served by a new readout chain, based on a readout card being developed by ALICE; the CRU ("Common Readout Unit"). The system will run embedded Linux. New drivers and new control and test applications need to be developed. Development can take place on standard Linux machines. Master projects can be offered in simulation of the new system, and in development of monitoring and control software for the new card. Detailed project specification will be agreed together with the prospective students. You must be prepared to take part in travel to CERN during your master project period.

Supervisors:

- Kristin Fanebust Hetland (Høgskulen på Vestlandet, room E407, e-mail Kristin.Hetland [AT] hvl.no)
- Håvard Helstrup (Høgskulen på Vestlandet, room E513, e-mail Havard.Helstrup [AT] hvl.no)
- Johan Alme (Institutt for fysikk og teknologi, UiB, e-mail Johan.Alme [AT] uib.no)

Simulation and readout of proton CT (medical physics)

It has recently been decided that Norway will offer particle therapy as cancer treatment. Opposite to photons (x rays and gamma) particles (protons and heavier ions like carbon) have a definite range in tissue. Thus the radiation can be concentrated in specified areas (i.e. the cancer itself), even if surrounded by tissue not to be harmed. The strong focus of the radiation produce a need for exact measurements of the position of the patient, down to millimeter precision. Proton CT is a method to use the particle beam itself (which is also used for treatment) to produce instant position measurements.
The detectors and readout electronics to be used for the proton CT prototype will be based on similar deviced developed for the ALICE experiment at the CERN LHC accelerator. We can offer programming tasks both within modelling/simulation of the readout chain, and readout/monitioring of the measured data. Prototype detectors will be installed at UiB and/or Haukeland University Hospital. The development will also take place in close collaboration with developers in the ALICE collaboration.

Supervisors:

- Kristin Fanebust Hetland (Høgskulen på Vestlandet, room E407, e-mail Kristin.Hetland [AT] hvl.no)
- Håvard Helstrup (Høgskulen på Vestlandet, room E513, e-mail Havard.Helstrup [AT] hvl.no)
- Johan Alme (Institutt for fysikk og teknologi, UiB, e-mail Johan.Alme [AT] uib.no)

"GRID Computing" - distributed processing on a global scale

The ALICE experiment records data from heavy ion collisions at CERN in Switzerland. Offline processing of experiment data takes place using Grid technology. This technology may also be used for other compute-intensive research and industry. The group at HiB takes part in the operation of the Nordic Tier1 centre, which is one of the primary computing centres with storage resources and direct connection to CERN. Grid research work includes testing av development of different middleware technologies, and commissioning, monitoring and development of tools for efficient Grid operations.

The projects are conducted as a cooperation between Høgskulen på Vestlandet, Universitetet i Bergen, Nordic e-Infrastructure Collaboration, CERN and several member institutes of the ALICE collaboration.

The Nordic Tier-1 centre, coordinated by *Nordic e-Infrastructure Collaboration*, uses ARC as internal middleware. The ALICE experiment uses AliEn to coordinate its offline analysis. An important task for the Bergen group is to contribute to interface development between these two systems. Such an interface may be based on virtualisation. We use the virtualisation tool CernVM as a possible technology for such an interface. We also look into using containers and cloud techniques and making interfaces between grid and cloud systems (OpenStack, Docker).

We can offer 1-2 master projects within this field. Detailed project definitions will be made in cooperation with the prospective student. You must be prepared to take part in travel to CERN during your master project period.

Supervisors:

- Bjarte Kileng (Høgskulen på Vestlandet, room E418, e-mail Bjarte.Kileng [AT] hvl.no)
- Kristin Fanebust Hetland (Høgskulen på Vestlandet, room E407, e-mail Kristin.Hetland [AT] hvl.no)
- Håvard Helstrup (Høgskulen på Vestlandet, room E513, mail Havard.Helstrup [AT] hvl.no)

Machine learning based search for Dark Matter using data from the ATLAS experiment at CERN

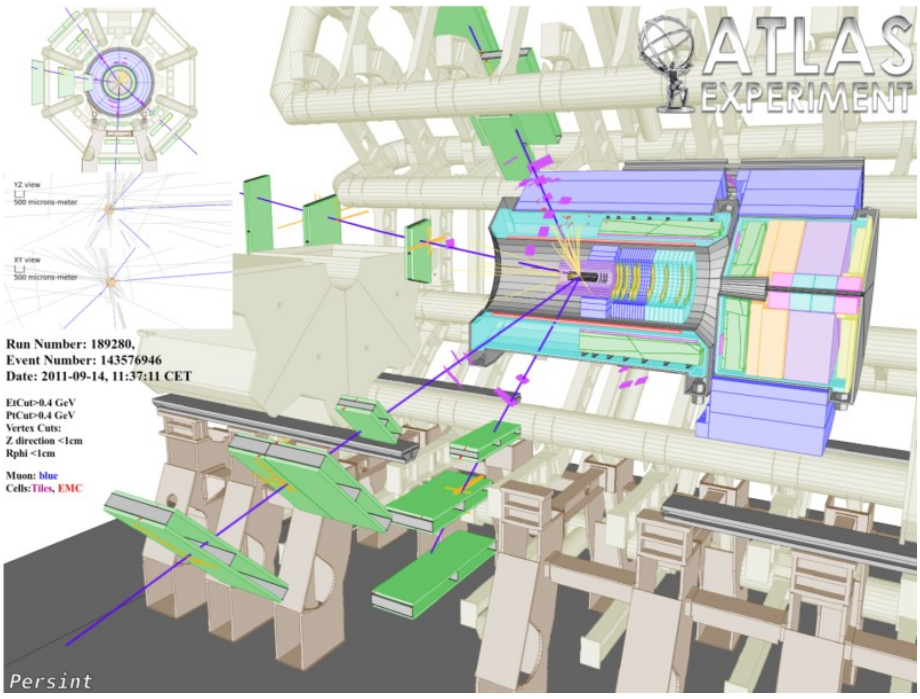
The ATLAS experiment at CERN in Switzerland is one of the largest and most complex experiment in particle physics ever built. By colliding protons from the accelerator the Large Hadron Collider, we recreate the conditions of the early universe - corresponding to a millionth of a millionth of a second after The Big Bang. Through analysis of large and complex data sets recorded by the ATLAS detector we hope to address one of the major mysteries of our universe: the nature of Dark Matter.

If you are curious about the universe and want to take part in one of the world's largest research projects, you are very welcome to join our research group. As a master student in our group you will work together with master students and researchers at HVL, UiB, UiO and at CERN analysing data to search for Dark Matter. Knowledge about particle physics is not required before starting the project ("Curiosity is more important than knowledge" A.E.). Your work will be to apply different machine learning techniques to improve upon existing analyses developed to search for "New Physics" in data from the ATLAS experiment. The data which you will be analysing is being recorded at the moment, and has never been looked at before. Thus, you will be working at the frontier of particle physics research.

Working on this project you will have to possibility to visit CERN, and you are encouraged to spend some of your time there.

Supervisors:

- Therese Sjursen, Therese.Sjursen@hvl.no, E316
- Trygve Buanes, Trygve.Buanes@hvl.no, E312



Computer Graphics

About us

People

Harald Soleim, harald.soleim@hvl.no

Atle Geitung, atle.geitung@hvl.no

Daniel Patel, daniel.patel@hvl.no

We are part of the research group: http://prosjekt.hib.no/ict/research/computer-graphics/

Activities

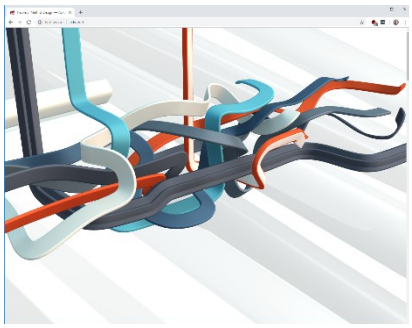
- Master and bachelor projects
  - In collaboration with leading industry and health care
    CMR, GexCon, Stormfjord, Kongsberg SIM, Tobii, BB Visuals, APITeq, OSC, Cambridge, Vizrt, Vimond, Helse Vest, Fysioterapi (HVL) and more
- Courses
  - DAT253 – Advanced Computer Graphics
  - DAT155 – Computer Graphics

The **DAT253** course covers 3D printing, game engine programming (Unity3D), Virtual Reality, and real-time ray tracing. It is an advantage, but not necessity, that the student has already taken an introductory course in computer graphics and is comfortable with mathematics. The student will in the course:

- Perform a CT scan of an object
- Create software in Unity3D for rendering the scan and extracting its surface geometry
- Create a Virtual Reality solution for manipulating the geometry
- 3D print the result
- Create a photorealistic ray tracer in Unity

It is an advantage if the student has already taken an introductory course in computer graphics.
For more information: http://prosjekt.hib.no/ict/dat253-advanced-computer-graphics/

Efficient transfer and playout of 3D content to web browsers



This master project is given in cooperation with Vizrt.
External supervisor: Rolf W. Rasmussen (Vizrt)

Summary

Design mechanisms for efficient transfer and playout of 3D content to web browsers.

1.1 Background

Today almost all audio-visual content for the Internet is delivered as video files and video streams. Video consisting of a sequence of frames containing pixels have become the standard interchange format between content producers and content players. However, pure video can only be played out exactly as authored. Video does not offer the ability to adapt and modify the content between initial authoring and final playout.
By rendering portions of the content near the end-user, the content delivery system will gain the ability to:

- Incorporate the latest data from dynamically changing data sources
- Obtain the latest content corrections that haven't had time to pass through a full authoring and video publishing pipeline.
- Have content react to user input through custom integrations with its hosting environment.

The common approach to doing so is to create a media compositor running in a web browser situated at the location of the media consumer, and have that compositor run a rendering engine that renders the portions of the media that should be allowed to easily change and adapt. Most rendering engines for the web fall into one of these two categories:

- Scene-tree based renderers using the dynamic nature of JavaScript
- Ports of existing rendering engines that were designed for local playout of content.

Neither of these types of rendering engines are well suited for playing out content to web browsers due to performance deficiencies. The deficiencies are noticeable in several places:

- Inefficient data transfer
- Inefficient rendering
- High startup cost

1.2 The thesis

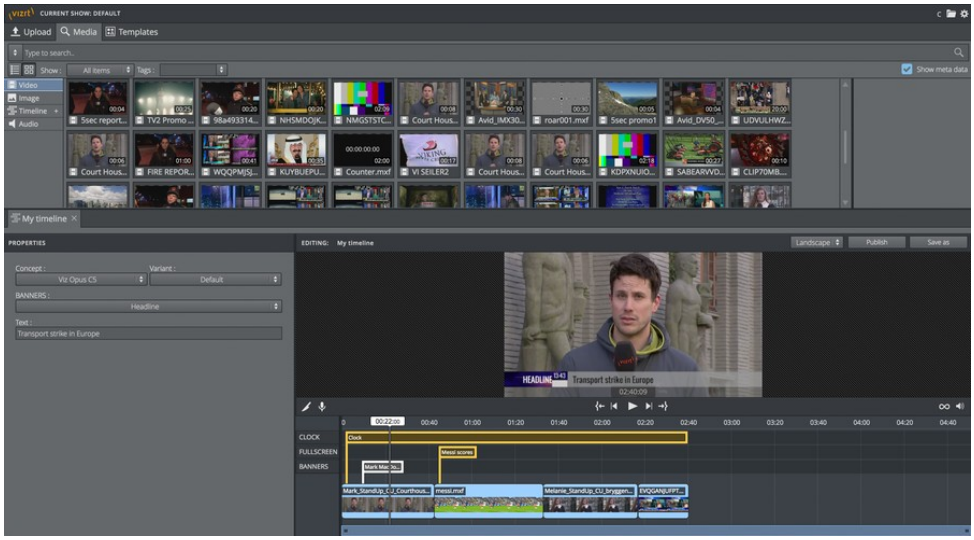
Design an architecture that optimizes for minimal time to first rendered frame.
Techniques and technologies:

- Data oriented programming
- WebGL, WebAssembly
- Zero-copy serialization formats

Assistance for journalists editing video

This master project is given in cooperation with Vizrt.
External supervisor: Gisle Sælensminde (Vizrt)

Video editing is often time consuming, it very often takes 2-3 times as much time as the length of the raw material. Thus, journalists use much time editing videos, even in cases where the end result is short. The topic of this project is to develop tools for reducing the time it takes to edit videos.



The raw material often contains a lot of uninteresting parts, like journalists waiting for the person to be interviewed, failed attempts and other material where it is obvious to anyone that it never should be a part of the final video, yet this must be watched to find the good content.

A tool for this task must be able to identify which part of the video material that is likely to be interesting, and which parts that can be safely cut away. This can be done by using machine learning techniques on the raw material. The criteria for good content may be:

- There are persons in the picture
- There are people talking in the audio track.
- Stable camera motion or stable focus on a person or object

In the same way, good clipping decisions can be places where the person talking change, where there is a pause in the talking or change from music to speech or vice versa.

Which parts are interesting and good places to cut can also potentially be learned from the content that real journalists have chosen to include versus the parts that was not used in the end.

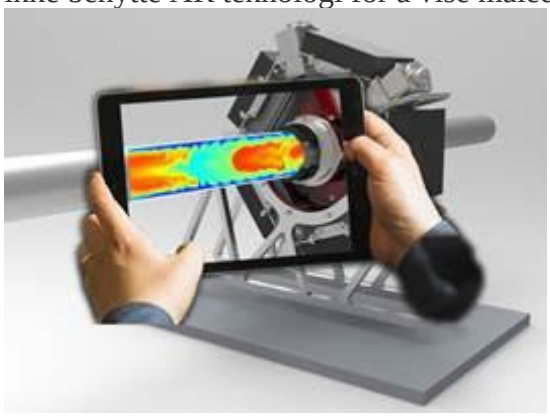
In addition to identifying good parts of a video and good places to cut, it would also be valuable to find ways this information can be presented to the users of video editing tools and find ways it can be used to guide the users to be able to do good clipping decisions in shorter time.

Visning av måledata fra gamma tomograf ved bruk av augmented reality (AR)

This master project is given in cooperation with CMR.
External supervisor: Dag Magne Ulvang (CMR)

1.3 Background

Institutt for fysikk og teknologi ved Det matematisk-naturvitenskapelige fakultet på UiB har en gamma tomograf som benyttes til å ta tverrsnittbilder av flerfasestrømning i rør, dvs. blanding av gass og væske.
Målingene fra instrumentet vises i dag på en PC som står ved siden av instrumentet, men hvorfor ikke benytte AR teknologi for å vise måledata direkte inne i røret, som vist i denne illustrasjonen:



1.4 The thesis

Masteroppgaven kan ha som mål å løse en eller flere av følgende problemstillinger:

1. Live streaming av måledata fra instrument til tablet
2. Rekonstruksjon av gamma tomografi snittbilder fra rådata (GPU)
3. Rekonstruksjon av volumetriske datasett basert på tidsserier av snittbilder (GPU)
4. «Tracking» og visualisering av volumetriske datasett ved bruk av AR på en tablet e.l.

Verktøy for visualisering og sammenstilling av (statisk og dynamisk) romlige økosystemdata

This master project is given in cooperation with Havforskningsinstituttet i Bergen.
External supervisor: Sam Subbey (samuels@hi.no, 46836823)

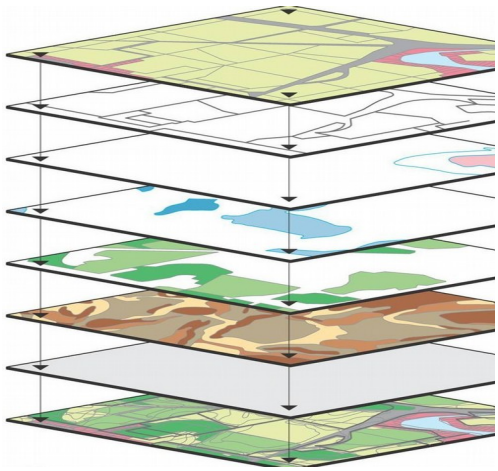
1.5 Oppgavemål

Målet med oppgaven er å lage et verktøy som gjør det mulig å visualisere og sammenstille romlig data av ulike oppløsninger fra forskjellige kilder over tid.

1.6 Bakgrunn

Kunnskapsinnhenting, forskning og overvåking er helt nødvendig for å få til en helhetlig forvaltning av havressurser. Derfor har Havforskningsinstituttet (HI), fra år til år, drevet med stadig større overvåkings aktivitet. Gjennom å koble f.eks. data fra de oseanografiske og biologiske undersøkelsene som gjennomføres på de samme toktene, skaffer vi oss unike tverrfaglige kunnskap om havet. Per dags dato har HI data over observasjoner, målinger, modellresultater og annen data som er samlet inn over flere år, med jevne eller uregelmessige tidsintervaller. Siden innsamlet data kommer fra ulike kilder, og har forskjellige oppløsninger (både i rom og tid), er det utfordrende å sammenstille økosystem data.

Oppgavebeskrivelse



I denne oppgaven ønsker vi å lage et verktøy som gjør det mulig å sammenstille romlig data fra forskjellige kilder som har ulike oppløsninger i rom og tid. Verktøyet må kunne lage flere overlappende lag med romlige data (se figur). Dette må gjelder både dynamiske og statiske data. Det skal være mulig å lage tid/rom begrensning av det som visualiseres. Videre, må det være mulig å fryse et eller flere data-lag i tid. Vi ønsker å kunne bruke verktøyet til å besvare en del økologiske spørsmål, som for eksempel, finnes det kobling mellom endring i temperaturfordeling og utbredelse av fisk i rom og tid? Prototype av verktøyet skal være basert på data tilknyttet loddebestanden i Barentshavet.

1.7 Tilleggsinformasjon

Arbeidet skal utføres med kontorplass ved HI (Nordnes) i forskningsgruppen «Fiskeridynamikk»

Samarbeid med en bred gruppe av forskere (oseanografer, biologer og dataingeniører) blir sentralt

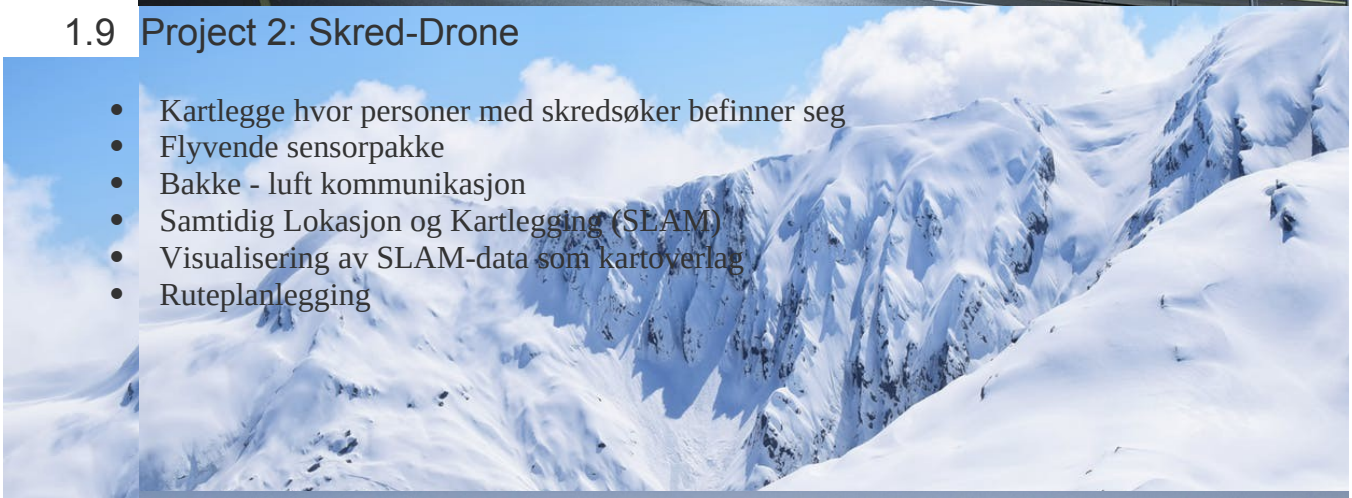
Projects from CodeLab Bergen AS

Master projects in cooperation with CodeLab Bergen AS (www.codelab.no)

1.8 Project 1: Automatisk gatelys

Doppler-rader
Bevegelses-sensor
Sensor-fusion
Mesh-nettverk
DALI protokoll

1.9 Project 2: Skred-Drone



- Kartlegge hvor personer med skredsøker befinner seg
- Flyvende sensorpakke
- Bakke - luft kommunikasjon
- Samtidig Lokasjon og Kartlegging (SLAM)
- Visualisering av SLAM-data som kartoverlag
- Ruteplanlegging

1.10 Project 3: Tinfo

- Tekst-innhøsting fra feks Twitter
- Ekstrahere geografisk lokasjon fra tekst
- Natrulig tekstprosessering (NLP)
- Visualisere i kartoverlag
- Webløsning

1.11 Project 4: Diagnoseverktøy for leger

- Digitalisering inn mot helse
- Forenkle metodikk for å stille diagnose
- Data innsamlingsverktøy for forskningsstudier
- Kols, Astma, Hjerte, Smerte, Diabetes osv.

VR-assistert terapi for ungdom med psykose

This master project is given in cooperation with Helse Bergen, Haukeland universitetssykehus. Helse Vest IKT will also be a partner.
External supervisor: Guri Elise Holgersen, guri-elise.holgersen@helse-bergen.no, 907 37 908

1.12 Background

De siste 10-15 årene har det vært en betydelig økning i bruk av Virtual Reality i behandling av psykiske lidelser. Vårt prosjekt er å utarbeide et VR-assistert terapi-program for ungdom med psykose. Målet med behandlingen vil være å øke pasientens tro på å mestre sosiale situasjoner, som igjen vil gi et høyere funksjonsnivå og en økt selvfølelse. Pasienten vil få mulighet til å trene seg på sosiale situasjoner i en virtuell virkelighet, med behandler tilstede.

I behandlingen vil pasientene få fire ulike VR-situasjoner å velge mellom:

- Spørre en fremmed om noe
- Starte en samtale med en fremmed
- Gå på date
- Snakke til en gruppe

Det ikke finnes VR-assisterte terapiprogram som omhandler trening av sosiale ferdigheter for ungdom med psykose. Det finnes to programmer utviklet for voksne.

1.13 The thesis

Videreutvikle de virtuelle miljøene med hovedvekt på gamification.

Hypotese: Gamification av scenarioene vil gi ungdommene ytterligere mestringsfølelse og økt tro på å mestre sosiale situasjoner.

1.14 Hvorfor delta i vårt prosjekt?

- En mulighet til å bidra i utviklingen av en behandling som ikke bare vil være innovativ i norsk sammenheng, den vil også være unik på et internasjonalt nivå.
- Prosjektet bidrar til utvikling av helsetjenesten, med vekt på teknologi, og vil fornye, forenkle og forbedre helsetjenesten
- Mulighet for samarbeid med utviklere ved King's College, London

1.15 Prosjektets eier

Klinikk psykiske helsevern for barn og unge Haukeland universitetssykehus

Sample simulator – Methicillin-resistant Staphylococcus aureus, MRSA

This master project is given in cooperation with Helse Vest

The thesis

Develop a medical VR simulator for training of health personnel to take samples from the correct area on the patient, as well as to actually take the sample in a proper manner, with the applicable test equipment (f.ex cotton swabs). The simulator should be in a hospital room where the patient is lying on a bed, where the player can move around the patient to perform the tests. We can provide CAD-models from one of the hospital rooms. The patient model need to have a certain level of realism, and be able to move arms and other parts to be able to take the tests. Instructions or guidance for the medical personnel performing the simulation should be given during the simulation. Also a performance metric for how well they performed the task should be part of the simulator, for example a scoring system on the different stages of simulation.

The tests to be performed are as follow:

1. Both nasals
2. Throat, including tonsils
3. Perineum
4. Wounds, eczema, puss, scars from infection or active skin desease if applicable
5. Around injection sites for foreign objects (catheter, trakeostoma etc)
6. Urine catheter, if applicable

Figur 1: Example from an emergency trauma simulator (RCSI Medical Simulator), for illustration and inspiration

Otherwise, also this video & simulator from the US Health government illustrates MRSA, for inspiraton (https://health.gov/hcq/trainings/partnering-to-heal/index.html).

VR Walk – Game One

This master project is given in cooperation with SimArena, HVL & Barnas Energisenter,

HUS.

External supervisor: Lars Peder Bovim, lpb@hvl.no, 976 82 402 (SimArena)

1.16 Background

During sprint 2018, three bachelor students from Computing, HVL, have developed VR Walk at SimArena, HVL. They have developed a virtual environment with challenges such as change in path width, “collecting coins” and avoiding obstacles.

1.17 The thesis

VR Walk – Game One will be the next step and is proposed as a masters project with two main aims.
Aim 1: Develop a meaningful game emphasising walking. The easiest levels will involve still standing movements proven necessary for walking. This as an adaption to VR, introduction to controls and gameplay, and for including children and youth in early phase of rehabilitation. Later levels focus on challenges while walking, such as answering questions, collecting coins and hitting targets.* The player is to collect points for the different challenges, and are to be able to upgrade their player and/or surroundings during the breaks. For motivational purposes, each player should be able to save their character and proceed in their next training session.
Aim 2: Make the set-up from VR Walk compatible with other VR headsets, screen setup of 1-3 screens (with avatar)** and a range of different treadmills on the marked (e.g. Woodway, and Trackmaster).
* Depending on choice, you will be given a detailed description of content, or you may take active part in developing and planning content and gameplay.
** An eight-camera Qualisys Motion capture system (www.qualisys.com) will be available for animating if wanted.
VR Walk – Game One is a collaboration project between SimArena, Western Norway University of Applied Sciences (HVL) and Energisenteret for Barn og Unge (EBU), Haukeland University Hospital (HUS). We will target inactive and/or unmotivated children and youth, as well as children and youth in rehabilitation settings. However, the results might also be presented and suggested used in other settings and is planned as intervention in a possible PhD-project at HVL.
If this project is of interest and you want to test VR Walk, or you have any questions, feel free to contact my directly or via Harald Soleim and Atle Geitung at the Computing Department.

*Picture taken from VR Walk

Extending BergenPhilLive with virtual concerts

This master project is given in cooperation with Bergen Philharmonic Orchestra (BFO).
External supervisor: Ingeborg Ekeland (BFO)

1.18 Background

I Bergen Filharmoniske Orkesters digitale strategi slås det fast at man skal være offensiv i bruk av digitale løsninger som støtter og styrker vårt kjerneprodukt. Vi skal implementere løsninger som

bidrar til at vi øker vår kundeverdi, og som gir opplevelser og begeistrer et større publikum gjennom digitale kanaler. Et sentralt element i denne strategien er strømmetjenesten Bergenphilive som når ut til et stort publikum.

1.19 The thesis

Testing og utforskning av VR-teknologi passer godt inn i denne strategien og vi er derfor på generell basis interessert i et mulig samarbeid med Høgskulen på Vestlandet om hvordan slik teknologi kan anvendes i vår sammenheng.
Det er et ønske å se på muligheten i å bevege seg til ulike steder i Grieghallen under en konsert og få en virkelighetstro opplevelse på det stedet hvor man er. For eksempel at man setter seg ned ved siden av tubaisten og får et audiovisuelt riktig opplevelse fra den plasseringen, også når man snur på seg. Dette sannsynligvis vil kreve både en 3D-modell av Grieghallen og orkesteret, og også 3D-lyd av orkesteret fra ulike posisjoner. Aktuelle teknologier vil være å jobbe med VR og/eller AR og/eller 360-bilder fra en spillutviklingsplatform, men dette vil selvsagt være en del av oppgaven å finne ut av. Prosjektet vil opplagt også kreve håndtering av 3D-lyd. I forhold til lyd, har BFO god kompetanse og kan hjelpe med opptak og domenekunnskap i samarbeid med studenten.
Denne muligheten vil gi publikum muligheter for nye måter å oppleve en konsert på og den vil også gi folk som ikke kan gå på konsertene, en mulighet til å oppleve den mer virkelighetstro enn en 2D-video med stereolyd (2D-lyd).

Communication and Security

Communication simulation

The goal of this master project is to program a simulation tool for a communication system using message passing decoding.
Focus will be on implementing graph algorithms
Speed and efficiency of the code are also important for the implementation
Results from the simulation can potentially have important impact on the project.

Taint analysis in the development process

The goal of this master project is to apply a technique called taint analysis to do security analysis of application code.
Several possible approaches exist already
Implement tool to automate process and handle eg. use of external libraries
High practical value in development process

FullFlow

This task is part of a project called FullFlow.
FullFlow is an effort to create an infrastructure for exchanging patient data between patients and health care providers.
A pilot of the system is under construction.
This task is concerned with security and authentication aspects of the technologies involved.
The candidate will be working with the company InfoDoc.

Security in banking

This project covers different security challenges within the banking industry.
Several projects in cooperation with Skandiabanken and Sparebanken Vest.

IT in Healthcare

Analyse av og opptrening i forhold til øyemotoriske problemer

For å mestre de visuell oppgavene vi skal gjennomføre i hverdagen, kreves en sterk, samkjørt og presis øyemotorikk. Begge øynene må bevege seg sammen for å unngå dobbeltsyn og for å oppnå stereo-syn. Samtidig må vi ha en god visuell oppmerksomhet til alle kanter slik at vi kan oppfatter elementene rundt oss.

Mange mennesker har en svak øyemotorikk og begrenset visuell oppmerksomhet. Dette går i stor grad ut over leseferdighetene, og ca. 20 % av elevene i skolen kan ha lesevansker pga. synsforstyrrelser, men blir gjerne diagnostisert som dysleksi. Nevrologiske skader eller sykdommer gir også i stor grad øyemotoriske vansker og redusert visuell oppmerksomhet. Ved å styrke øyemuskulaturen og den visuelle oppmerksomheten kan man imidlertid bli bedre lesere, øke utholdenheten og oppnå bedre funksjonsnivå på en rekke områder.

Ved HVL har vi utviklet et digitalt system for identifikasjon av øyemotoriske problemer. Dette systemet kan nå tas i bruk, men bør videreutvikles for å bli enklere å bruke. Vi har også under arbeid et system for opptrening av synsfunksjonen ved å styrke øyemuskulaturen og/eller den visuelle oppmerksomheten. Systemet skal brukes til opptrening i hjem, skole og rehabilitering og må kunne kjøres på ordinære datamaskiner. Fokus er å bruke grafisk databehandling og spillteknologi, -design og –metodikk for å utvikle et digitalt støttet treningsopplegg som bidrar til å styrke øyemuskulaturen og vekke den visuelle oppmerksomheten i synsfeltet.

Videre er vi i gang med å utvikle en telemedisinsk løsning slik at synspedagogen og den som blir testet kan befinne seg på ulike steder, og samhandle over nett.

Veiledning: Samarbeid mellom Data og synspedagog Gunvor Wilhelmsen, HVL-AL
Kontakter: Carsten Helgesen, carsten.helgesen@hib.no, rom Q207, tlf 91585123
Atle Geitung, atle.geitung@hvl.no, rom E416
Ilona Heldal, ilona.heldal@hvl.no, rom E422

Oppgave 1: Videreutvikling av oppdaging av øyemotoriske problem

Målet med denne oppgaven er å videreutvikle systemet for å oppdage / identifisere øyemotoriske problemer. Aktuelle tema vil være å forbedre datakvaliteten ved bruk av øyesporing, forbedring av

brukergrensesnitt, bedre visualisering av måleresultater etc.
Stikkord: synsforstyrrelser; oppdage øyemotoriske problemer; brukergrensesnitt; visualisere måleresultater.

Oppgave 2: Videreutvikling av opptreningssystem

Målet med denne oppgaven er å videreutvikle opptreningssystemet. Aktuelle tema kan være bruk av VR-teknologi, forbedring av spillopplevelse, utvidelse av treningsrepertoar etc.

Stikkord: synsforstyrrelser; rehabilitering; digitalt treningssystem; grafisk databehandling; spillteknologi, spilldesign.

Oppgave 3: Telemedisinsk løsning for identifikasjon av og opptrening for øyemotoriske problemer.

Målet med denne oppgaven er å videreutvikle den telemedisinske løsningen som er under arbeid. Aktuelle tema kan være digital samhandling, brukeropplevelse, nettverkstekniske vurderinger etc.

Stikkord: synsforstyrrelser; rehabilitering; digitalt treningssystem; telemedisin.

Oppgave 4: Automatisk tolkning av data fra øyesporing.

Målet med denne oppgaven er å undersøke i hvor stor grad det er mulig å automatisere tolking av data fra øyesporingsbasert identifikasjon av øyemotoriske forstyrrelser. Hensikten er at systemet skal kunne skille mellom måleresultat som indikerer at alt er normalt, og de som indikerer potensielle problemer. Kanskje det også er mulig å si noe mer om hva måleresultatene viser – hvilke forstyrrelser det er snakk om?

Stikkord: øyemotoriske forstyrrelser; øyesporingsdata; maskinlæring; dataanalyse.