

Developing a graphical tool for free-energy calculation analysis

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Background and significance

Predicting the thermodynamic and kinetic properties of the binding interaction of a drug to its target is of primary relevance to shed light on its mechanism of action and develop new medications [1,2]. This information can be obtained from advanced calculations such as funnel-metadynamics, FM [3]. Using a funnel-restraint potential, this method enhances the exploration of the ligand bound poses and its solvated states leading to an accurate description of the protein-ligand binding free energy surface (Fig. 1). This approach allows investigating further important aspects of the binding process, such as the presence of alternative binding modes and the role of the solvent. Albeit very recent, FM has proven successful in studying complex ligand/protein, ligand/DNA and peptide/membrane binding interactions [4,5,6].

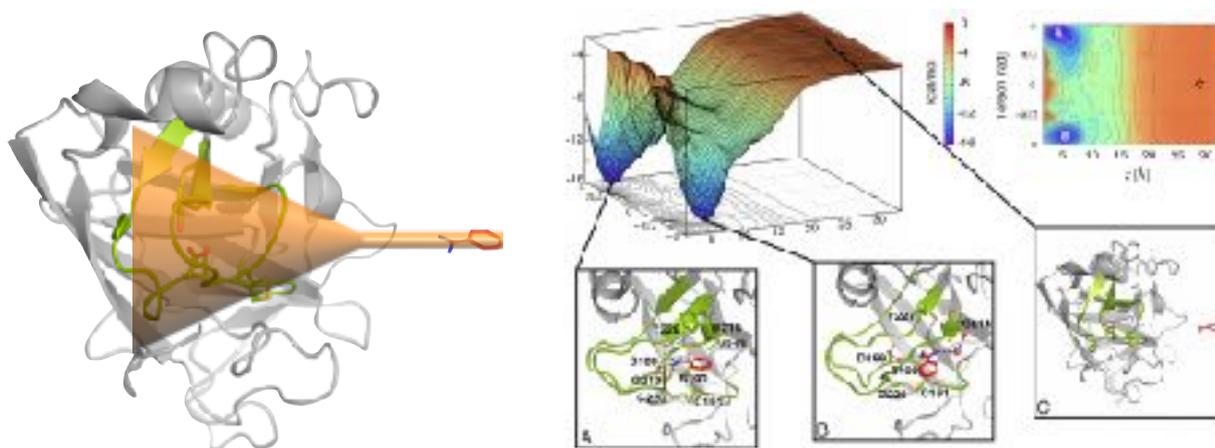


Figure. (Left) The funnel-potential applied to the benzamidine/trypsin system. (Right) The free energy surface of the benzamidine binding to trypsin with the most relevant states reported as insets (see ref. 3).

Aim of the project

To date, the implementation of FM is not completely automated and this can discourage people to use the technique. The aim of the present project is to develop a graphical interface to analyse the trajectories and the free energy profiles generated by FM calculations. In particular, in the first part of the project i) to each frame of the trajectory the corresponding value of the collective variables (CVs) used to compute the free energy surface (FES), will be calculated and assigned. This will allow monitoring the evolution of the calculation in the free energy landscape. In the second part, ii) the student will develop a code able to save the coordinates of the system within a given CVs interval by interacting graphically with the FES. These modules will be implemented in the widely used molecular visualisation program Visual Molecular Dynamics (VMD). This work will extend the functionality and the use of FM with impact in drug design. Knowledge in C/C++ and python programming is required.

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Can We Benefit from Wearable IoT Devices Keeping Our Privacy and Security at the Same Time?

Advisors: Prof. Miroslaw Malek, Dr. Alberto Ferrante

Co-advisor: Jelena Milosevic

Contact: alberto.ferrante@usi.ch

The rise of IoT mobile applications is almost exponential and this particularly applies on wearable devices such as fitness trackers and smartwatches. With their increased usage to track our sleep, walk and running activities as well as heartbeat, the sensibility of the data stored is much higher than perceived by most common users, so as the need to keep this data secure and private.

We are all aware that wearables today offer amazing features, but are security and privacy there and if yes, up to which extend? The answer to this question is the goal of this project. Namely, the student is expected to analyze the most commonly used applications for wearable devices with respect to their privacy and security features. The student is expected not only to analyze these application in theory, but also to develop a methodology, based on network sniffers (e.g., Snoort), to study the data flow generated by these devices and applications.

Execute Me if You Can: Discovery and Execution of Malicious Payloads in Android Apps

Advisors: Prof. Miroslaw Malek, Dr. Alberto Ferrante

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Android OS is the most used OS for mobile devices. Its widespread usage attracted also the interest of attackers to get into a possession of valuable information stored on devices, which is reflected in the increase of malicious software, commonly called *malware*. In order to enable further adoption and usage of mobile devices, their security and resistance to malware needs to be improved. Malware is classified in families, that are groups of malware applications with similar characteristics (e.g., installation method, trigger mechanism, and malicious activities). One of the currently existing research problems in mobile malware detection is the analysis of existing malware samples with relation to the families to which they belong.

The main goal of this project goes in this direction. Namely, the student is expected to analyze a set of malware applications belonging to different families and to derive, for each family, the triggering methods and the activation mechanisms of their malicious payload. For each family, a method for detecting that the malicious payload has been executed should also be derived.

Liquid Web of Things

The study and creation of networks composed by smart things scattered around us is nowadays a hot research field. While users own multiple Web-enabled devices able to run modern Web browsers supporting HTML5 standards such as computers, laptops and mobile phones, they also own other Web-enabled devices such as micro controllers, sensors, actuators and smart objects are few of those hardware that can access the Web but cannot display it on a browser. The goal of the Liquid software is to enhance the user experience while using multiple heterogeneous devices, allowing users to seamlessly migrate their applications from a device to another and to make applications adaptable to a dynamic set of devices. Liquid.js for Polymer is a framework that allows the creation of Web liquid component-based applications, liquid.js extends traditional Web apps with the so-called Liquid primitives needed for migration and cloning among multiple devices. While in principle any Web-enabled device may be the target of a liquid primitive, right now liquid.js is limited to devices that run exclusively Web browsers supporting the HTML5 standard. Liquid.js aims to work on any set of heterogeneous Web-enabled devices despite their capability or incapability of running Web browsers. During this UROP the student is required to build adapters for smart things, allowing these devices to forward output or receive input data from devices connected to the distributed liquid infrastructure created by the liquid.js framework. Building these adapters requires at first a design phase in which the student will have to analyse how the liquid infrastructure and the adapters are going to communicate with each other. We expect the student to know how to program in Javascript both in the server-side (nodejs) and client-side. The adapter artifacts built by the student will be implemented using Javascript and other languages known by the student.

More information: Andrea Gallidabino, <http://design.inf.unisi.ch/research/liquid-software>

ASQ

ASQ (<http://asq.inf.usi.ch>) is a Web platform for delivering interactive lectures in traditional brick and mortar classrooms. It allows presenters to pose questions inside HTML slides and receive answers from the audience. ASQ has grown from an ambitious student project with support for multi-choice and text question types to a platform that scales to hundreds of students, featuring its own plugin system, support for tracking student feedback in real-time and a revamped cockpit view for live statistics.

ASQ has been successfully used both at USI and other universities from which we have gathered a lot of valuable feedback. We are looking for motivated students that will help us make ASQ an indispensable tool for Professors, teachers and presenters in general. There are a lot of different areas to work on from data analysis and visualization to live programming and Web presentation development tools. For next summer we are looking to extend as with:

- Peer Assessment
- TA Assessment
- Offline Exercises
- Visual Diagramming Question Type

Contact: Vasileios Triglianios, <http://asq.inf.usi.ch>

UALAC in summer: Usability and Accessibility for LAC

Project **UALAC in summer** is part of a larger project Anch'ioLAC, currently run in collaboration with FIPPD, "Fondazione Informatica per la Promozione della Persona Disabile", a charity providing ICT solutions for the well being and growth of people with disability. The aim of Anch'ioLAC is to design, prototype, test, develop and evaluate tools to make visiting a museum a more engaging and rewarding experience for people with a range of disabilities, mostly, but not exclusively, of cognitive nature.

UALAC in summer focuses on the existing web site for LAC and starting from the work made by the UALAC group in their Web Atelier project, asks a student with excellent Web Design skills to help on these two most crucial aspects:

- **Usability:** a site needs to be useful, usable and used, we want you to evaluate how the current LAC web site scores in each of these aspects with particular attention to disable visitors and their caretakers. The way content is presented and organised has an impact on how inclusive the site will look to different communities and associations, well beyond adherence to accessibility guidelines. This is why we will facilitate meetings and focus groups with associations and experts to provide you with advice on usability aspects for special need visitors. You will provide a critical evaluation and implement examples as proof of concepts of possible solutions to improve overall site usability. You will have to be able to empathise, be critical and count on strong technical skills. Being able to speak Italian is essential as most of the experts you will meet will not necessarily be able to communicate in English.
- **Accessibility:** there are a number of freely available checkers to test adherence to accessibility guidelines as defined by W3C even if it looks there is not one specific to Swiss regulation. You should use these as fit and get familiar with their syntax and semantic as much as to be able to interpret reported errors and problems. Then you should provide solutions and implement them as proof of concept. You will need excellent technical skills and the ability to be critical while tuning in with the available tools.

Remember, the web site for LAC has to be in tune with LAC not only in terms of look and feel but also as overall experience.

You will work closely with Alessio Vairetti from Comunicazione_LAC and possibly with another student with excellent skills similar to yours.

Highly committed, hard working, enthusiastic and imaginative members of the original UALAC group who worked on this topic in the first semester for their Web Atelier project are invited to apply as **UALAC in summer** will benefit from building on their skills and experience.

UMOB: How Do Users Interact with a Search Engine on MOBILE devices?

Recent years have witnessed a dramatic rise in usage of mobile devices among all types of users worldwide. Given the fact that many users have internet access on their mobile devices, therefore, it is critical to develop an Information Retrieval (IR) system that is specifically designed for a mobile device. To this end, we are going to perform a thorough and comprehensive user study in the attempt to track and understand how users interact with their devices and express their information needs while they are on the go. Such study will enable us to anticipate users information needs and understand more accurately the users information needs when they submit a query on their mobile devices given their context and history of interaction with their personal device. Mobile devices are equipped with a number of sensors such as GPS, light sensor, microphone, gyroscope, etc. Having the data from all such sensors together with users interaction and usage patterns provides us with a wealth of information and consequently will give us a very unique opportunity to analyze users search behavior deeply.

Through this project, the applicant should co-design and develop a mobile app to track users' behavior and analyze the data gathered in this experiment. The tasks consist of:

- Design and development of an Android app which volunteers will install on some mobile devices we will provide them with to track all their activities as agreed before we start the experiments. More in details, we aim at tracking all sensor data on the mobile devices for a limited period of time. In the meantime, the users interaction with their preferred search engine will also be monitored. The interactions consist of the queries they run on the search engine, the users scrolling behavior with the result page, the result(s) that they perceive as relevant to their query, and their overall satisfaction of their search experience.
- The applicant will be free to use any open source and free available implementations or codes as parts of the project as long as he/she can integrate them in the system.
- After the applicant manages to prepare and test the Android app, we will recruit some volunteers who will be provided with Android mobile phones. After the experience period finishes, we will gather the data and analyze them in order to answer the research questions. We expect the applicant to be engaged in data analysis.

The work is expected to be a part of a research paper in one of the top tier conferences in IR. This project is a very unique opportunity for the applicant to gain a very valuable experience in app development and data analysis that gives him/her a taste of a typical research experience in IR. The applicant is required to have a solid background in programming and problem solving. A background in data analytics or information retrieval is a plus. The project will be done with of Prof. Crestani with supervision of his PhD student.

Professor: Prof. Fabio Crestani

Assistant: Mohammad Alian Nejadi

Exploit parallel computing on Model Checking

Formal Verification and Security Lab

Natasha Sharygina, Matteo Marescotti

January 31, 2017

The *Satisfiability Modulo Theories* (SMT) problem is the decision problem of determining whether a logical formula is satisfiable, given that some of the variables have an interpretation with respect to combinations of first-order background theories. The expressiveness of SMT makes it suitable for a vast range of application domains, including *model checking*, and for that reason it has recently attained significant interest from both industry and academia.

The computational cost of model checking techniques can be really high, in fact they strongly rely on SMT solvers which despite being highly optimised, they suffer from the intrinsic high complexity of the NP-complete *Boolean Satisfiability Problem* (SAT). The introduction of the background theories on SMT can only make the problem harder. Moreover, model checkers provide SMT solvers with an abstraction of the problem, often obfuscating original source code schemes that could help understand and solve more quickly.

The goal of this UROP project is to exploit parallel computing both on SMT solving and model checking in such a way that both sides actively communicate useful information and converge quickly. The work, including implementation and experimentation, will be carried out as an extension of the novel parallel version of SMT solver OpenSMT, and the C model checker HiFrog, both developed by the Verification Group at USI.

We are looking for a motivated student who wants to improve his/her knowledge on software verification and cloud-based parallel computing. This project will give the student an excellent overview of a quickly developing field while being sufficiently approachable. Prior knowledge of C++ language is required. The knowledge of POSIX threads API of C language is highly recommended before beginning. Prior knowledge in SMT modelling is not required, though is a plus.

The project is from Prof. Natasha Sharygina and the Formal Verification Lab. The student will be coached while:

1. Getting familiar with the current research and implementation state.
2. Implementing and debugging the core functionalities.
3. Designing and running a set of experiments.

UROF 2017 - Implementation of Geometrical Algorithms

The Farthest Line-Segment Voronoi Diagram

The **Voronoi Diagram** is a *geometric data-structure* that encodes distance information among different objects. It finds applications in diverse areas of *Computer Science*, such as *Robotics*, *Computer Graphics*, *etc.*, as well as in other sciences, such as *Biology*, *Chemistry*, *etc.* Despite having been widely studied, with thousands of publications, they still attract the interest of the scientific community, with their numerous generalisations, variations and applications

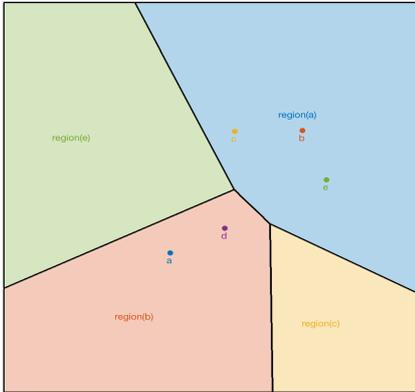


Figure 1: Farthest Point VD

In the simplest case, we are given a set of *point-sites* S on the Euclidean plane \mathbb{R}^2 . The **Voronoi Diagram** (VD) is a partition of the plane into regions. Each region corresponds to one *site*, such that all points of \mathbb{R}^2 belonging to that region are closer to that *site* than any other. A variation of the Voronoi Diagram, is the **Farthest Point Voronoi Diagram** (FVD). Similarly, the plane is now partitioned into regions, where each of them corresponds to a *point-site*. But now, all points of \mathbb{R}^2 in that region are farther from that *point-site* than any other (Figure 1).

During this project we consider a generalization of FVD, the **Farthest Line-Segment Voronoi Diagram** (FSVD), where the sites now correspond to line-segments (Figure 2). The student is expected to get familiar with existing algorithms and implement them, using C++ programming language and the CGAL scientific library. Moreover, we are interested in visualisations of such generalised Voronoi Diagrams. The visualisation will be done using the IPE drawing editor, by creating the respective *ipelets*.

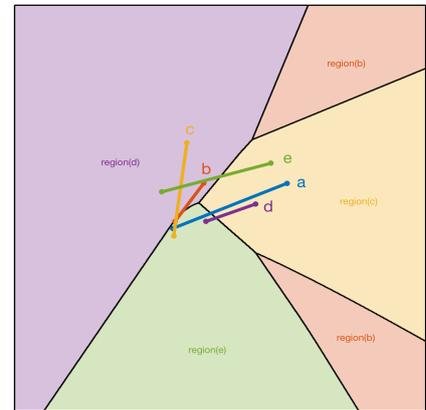


Figure 2: Farthest Line-Segment VD

Prerequisites:

- ▷ Good background in **Algorithms and Data Structures**.
- ▷ Experience in programming with C++.
- ▷ **Eagerness** to discover new things and tackle potential difficulties.

Benefits:

- ▷ Gain experience in **scientific programming**.
- ▷ Work within a **research group** on an **intriguing problem**.
- ▷ Acquire **profound knowledge** in several **algorithmic aspects**.

Contact:

- ▷ **Prof. Evanthia Papadopoulou**, SI-209, evanthia.papadopoulou@usi.ch
- ▷ **Ioannis Mantas**, Open Space 2nd floor, ioannis.mantas@usi.ch
- ▷ **Martin Suderland**, Open Space 2nd floor, martin.suderland@usi.ch

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Imagine you are the owner of the "DuckRonalds" burger company and you want to open a few branch stores in **Lugano**. Unluckily, your main antagonist "PurgerDing" has been informed of your business plans and he is actually determined to open stores in Lugano too.

Well, **it is straightforward**. You have to cover a larger area of Lugano than "PurgerDing"...

Let the game begin!

→ **Where** should you open the stores in order to do that?

→ What **strategy** should you follow if you were the first to open the stores? What if you were second?

→ What if you were opening branch stores **in turns** and not all of them **simultaneously**?

→ How should the **shape** of the city of Lugano affect your strategy?

→ What if "Dubway", with the *polenta-burger*, is joining and you now are **three competitors**?

→ What if the historic town centre and the area around USI had more importance?

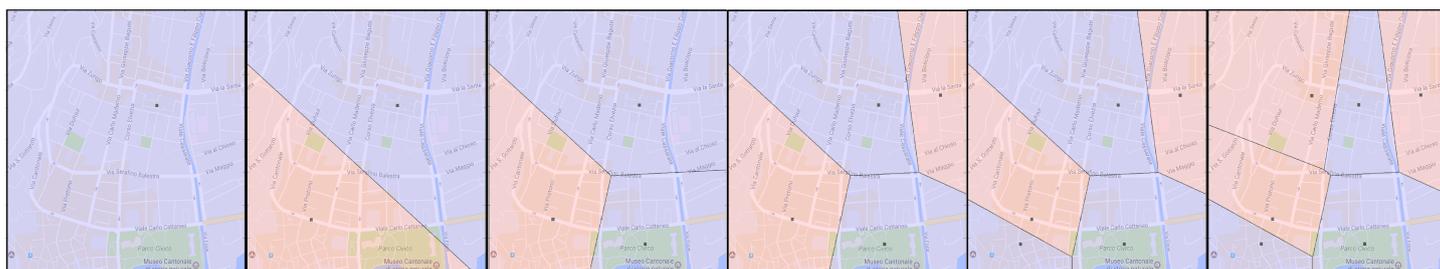


Figure 1: "DuckRonalds" and "PurgerDing" on a 3 round game in Lugano.

The above framework can be modelled with the **Voronoi Game** which is actually a *Competitive Facility Location* problem. The Voronoi Game is a fascinating problem combining aspects of *Computational Geometry* and *Game Theory* drawing its motivation from real life applications. Calculating the area covered by players can be done by finding the **Voronoi Diagram**, the well-known *geometric data-structure*, which efficiently encodes proximity information among different sites.

During this project the student is expected to work on special instances and variations of the Voronoi Game. These include different shapes for the *arenas*, weighted regions, special *rules*, etc. Initially, the student will **implement** the framework of such instances and variations. Then, **devise** efficient strategies for the competitors. Finally, **evaluate** the strategies which could be both experimental or theoretical.

Prerequisites:

- ▷ Good background in **Algorithms and Data Structures**.
- ▷ Experience in programming with **Java**.
- ▷ **Eagerness** to discover new things and tackle potential difficulties.

Benefits:

- ▷ Work within a **research group** on an **intriguing problem**.
- ▷ Acquire **profound knowledge** in several **algorithmic aspects**.

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Development of a Personal Assistant

Personal assistants are a new paradigm which are gaining increased popularity in recent years. Microsoft Cortana, Google Now, and Apple's Siri are examples of personal assistants that are increasingly supporting users proactively to get things done. These systems seek to provide the right information to the users at just the right time. Based on previous observed behavior of a user they try to anticipate the user's information needs in the near future. The previous observed behavior of a user, in addition to the user's current context, provides hints that can be used by a personal assistant to predict the user's information needs automatically, before the user even asks.

We are aiming at taking this assistance to a more personalized level by also recording various aspects of one's life, for example, a person's social interactions. We have gathered a dataset of all meetings of certain individuals which could be used to predict a person's information needs in relation to the meetings. In order to predict the possible topics/information needs of a future meeting, we could make use of other sensor readings such as biophysical sensors, smartphones, GPS locations and the full audio of previous meetings.

In this UROP project, we are planning to teach the student the basics of personal assistants and relevant information retrieval technologies, define a small project in this area (e.g. analysis of when a person will forget something, predict a person's next state with respect to the topics she is going to talk about or the next app that she is going to use) and work with the student to produce a personal assistance app. A good candidate for this project should have a strong motivation to learn new information retrieval concepts, have python programming and Android programming skills.

Supervisors: Prof. Fabio Crestani
Seyed Ali Bahrainian

A Mobile Privacy Assistant for Sharing Personal Memories

Recent improvements in mobile technologies (better and richer sensors, cheaper and faster storage) allow us to record different aspects of our daily activities, e.g. work meetings, discussions during coffee breaks, family moments, etc. Within the EU research project [RECALL](#), we investigated how such data captured from mobile and wearable devices can serve as “memory cues” to help individuals remember certain past events – e.g., a set of images can help one remember an evening with friends or pictures showing white board content can help one remember what was discussed in the last work meeting.

Having already developed the RECALL system for collecting and storing such personal memories, now we are interested to understand how such data can be safely shared with others without violating users’ privacy.

The goal of this project is to develop a mobile application for allowing users to control (at some extent) how such data is shared with others. For example, one can specify that they want to share all their work-related data with work colleagues, or data captured during last hiking trip with close friends, etc. We envision the following three functionalities/features of the Mobile Privacy Assistant app:

1. an interface for allowing users to specify what parts of their captured data can be shared with which people and under what conditions;
2. create a model for storing users privacy specifications from step (1) – using e.g. JSON or XML – such that they can be easily processed by other components of our RECALL system
3. since this app will not have any list of friends that a user can share data with, we envision to start out by connecting it with the user’s social network accounts (e.g. Facebook, LinkedIn) and use their APIs to retrieve user’s social connections together with their classification (e.g. “friends”, “family”, “colleagues”).

The app development will be done in Android, hence it is preferred if the student has already some basic Android programming skills (if not then willingness to quickly learn it).

<http://uc.inf.usi.ch/studentproject/a-mobile-privacy-assistant-for-sharing-personal-memories/>

Personalized Public Displays: Designing Interactive Display Applications for Active and Walk- by Content Personalization

Public display systems are increasingly becoming part of the urban landscape, with systems being deployed in venues such as railway stations, shopping malls, city squares, and universities. Most public displays today are simple slide-show systems that broadcast content based on a pre-selected schedule. However, public displays envisioned in the near future will provide a platform for running diverse interactive applications with highly personalized content. These applications will allow viewers to express their preferences both explicitly through interactive touch interfaces (active personalization) and implicitly using mobile handsets (walk-by personalization).

The aim of this project is to explore the development, deployment, and actual use of web-based interactive display applications that can show highly personalized content such as content from online social platforms on public displays. The main focus of this project is on 1) designing and implementing minimum three **web-based applications** that can show personalized and user generated content (e.g., Facebook stream) and show such a content on public displays based on a set of personalization parameters, 2) implementing **mobile interfaces** for the developed apps that can be “loaded” into an existing Android-based “controller app” prototype (called “Tacita”) that allows users to set the personalization parameters, and 3) extending the existing Tacita application with the **indoor localization** using Bluetooth Low Energy (BLE) devices that will support implicit walk-by personalization.

<http://uc.inf.usi.ch/studentproject/personalised-public-displays-designing-interactive-display-applications-for-active-and-walk-by-content-personalization/>

Personalized Public Displays: Uncovering Personalization Needs

With the significant price drops of large LCD panels, public displays are increasingly dominating the urban landscape. It is not hard to imagine that in the near future, public displays will shift from showing predefined still images or videos to becoming more interactive and highly personalized. By providing custom content to individual passers-by such as upcoming bus schedules, relevant news items, and even personalized messages (e.g., Twitter, Facebook, or Google+ posts), public displays may increase their utility and become more appreciated in our environment. However, showing such a contextualized and personalized content increases privacy concerns and may impact the use of public displays.

The main goal of this project is to explore, uncover, and understand personalization needs of potential and actual users of public displays. The project will start with an online survey/questionnaire for assessing current understanding of personalization needs of public displays in a university environment. Following the initial survey, the student will conduct in-depth interviews with the student community members using snow-ball sampling method or conduct interviews next to the displays at the point of interaction. The main task is to identify different “work roles” of the community members and uncover their information needs and technologies used while “on the go” on-campus. The initial survey and in-depth interviews will be followed by an extensive data analysis looking into personalization needs and concerns of the display users and understanding what technologies are used, when, and how to satisfy the information needs on-campus. A possibility to strengthen the data analysis would be to conduct a second set of interviews after installation and initial use of implicit personalization extensions into the existing display system. These personalization extensions will allow users to personalize display applications and their content using a mobile application called “Tacita”.

<http://uc.inf.usi.ch/studentproject/personalized-public-displays-uncovering-personalization-needs/>

Detection of Social Engagement Interaction using Smartphones

Recent improvements in mobile technologies (better and richer sensors, cheaper and faster storage) allow us to record different aspects of our daily activities, e.g. work meetings, discussions during coffee breaks, family moments, etc. Within the EU research project RECALL we are investigating how such data captured from mobile and wearable devices can serve as “memory cues” to help individuals remember certain past events – e.g., a set of images can help one remember an evening with friends or pictures showing white board content can help one remember what was discussed in the last work meeting.

We are interested to understand how such data can be safely shared with other co-located people – e.g. with all the colleagues that participated in the meeting – in order to construct a better representation of what really happened in an event. Hence, our bigger goal is to build a solution for peer2peer exchange of captured memory cues or moments.

The goal of this bachelor project is to develop an Android mobile app that uses audio data (and/or other mobile sensors) to detect when two people are socially interacting (e.g. speaking). This will be used as a trigger to decide when to start our peer2peer moment sharing. If time permits the student can also experiment and try to construct a solution for detecting the presence of nearby peers using audio signals.

The project requires solid Android programming skills, preferably some knowledge on how to work with audio data and willingness to quickly learn new things.

<http://uc.inf.usi.ch/studentproject/detection-of-social-engagement-interaction-using-smartphones/>

Measuring fluid conductivity to discover presence of chemicals

Advisors: Prof. Cesare Alippi
Co-advisor: Mauro Prevostini
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This project aims at measuring a fluid conductivity by generating electrical stimulations by means of two electrodes placed in the fluid. De facto the system is a capacitance-based sensor. A low cost measurements of fluid conductivity may enable the possibility to identify interesting properties of the fluid under investigation. For instance, the detection of possible defects in wine production due to the presence of unwished chemicals arising during the seasoning stage is a relevant application scenario that can be cast in this framework.

The need to perform chemical analysis of the wine is derived from two different requirements: from one side, to satisfy the product monitoring needs in compliance with law requirements; on the other, by knowing the wine composition we can intervene and introduce suitable treatments, as requested by modern wine-making technologies.

The sulphur dioxide (SO₂) is a gas used in the wine cellar as additive. It can be used on musts as well as on wines. De facto, it acts as an antioxidant and, thus, protects both must and wine from the contact with oxygen which would, for example, oxidize the colouring substances conferring the wine colour. Being toxic for humans, the law determines the limits: 200 mg/l for white wines, 150 mg/l for red ones. Moreover, if the SO₂ concentration is above 10mg/l the wine producer has to indicate the current value on the bottle of wine label.

Therefore wine producers have to constantly measure the SO₂ presence in the barrel and, since this is a time consuming operation, it would be very appealing to get this information automatically during seasoning.

The possible prototype developed within this project might be tested in a real scenario at a wine cellar.

Exploring kernel extensions for agreement protocols

Prof. Fernando Pedone

In this project, the student will design kernel extensions to integrate the Paxos protocol inside Linux. Paxos is one of the most fundamental agreement protocols, used by many production systems (e.g., Microsoft, Google). Implementing Paxos efficiently is challenging and several approaches have been proposed in recent years. This project will explore performance improvements from in-kernel implementations of Paxos.

Requirements from the student: good knowledge of C and operating systems.

Extending finite element framework MOOSE to `complex<T>` type

Introduction: The software package MOOSE is a wrapper of the finite element (FE) package `libmesh`. While MOOSE provides several simplifications and extensions of the wrapped library, it does not provide support for complex type variables. This functionality is actually fundamental when working with problems in the frequency domain, in that it allows to reduce the computational load for some FE solvers.

Goal: The objective of the project is to make MOOSE compatible with `complex<T>` variables. It has to be realized creating a new branch of MOOSE, finding at compile-time the incompatibilities between MOOSE and `libmesh`, and fix them. Once this first target is achieved, the project may continue in a bachelor or master project, testing and validating the performance of several solvers in the context of FE problems which require complex-type variables.

Requirements: Knowledge of C/C++ and good programming skills. Knowledge of MATLAB is a plus.

Location: During the project, you will be working together with the researchers at the ICS (USI Lab). You will have the chance to get familiar with one of the most important finite element software framework and several of the most important libraries used in numerical linear algebra.

Assistant: Marco Favino

Professor: Rolf Krause, Head of Institute of Computational Science.