1. **Professor in charge of topic:** Prof. Pekka Marttinen (pekka.marttinen@aalto.fi)

**Title of topic:** Machine Learning for Health

**Description:** Recent years have witnessed accumulation of massive amounts of health related data, enabling researchers to address problems such as: how to allocate health care resources fairly and efficiently, how to provide personalized guidance and treatment to a user based on time-series data from wearable self-monitoring devices, or how to use genomic data to understand disease or antibiotic resistance. Answering these questions requires new machine learning methodology to be developed. We have several interdisciplinary research projects ongoing, where the goal is to design new machine learning models and algorithms for applications in health and welfare, together with leading experts in the respective fields from Finland and abroad. Examples of applications include: analysis of electronic health records, mobile health, genomics, antibiotic resistance, epidemiology. Successful applicants for a summer internship are expected to have an outstanding record in computer science, mathematics, statistics, or a related field, and a strong interest to focus on one or more of the following topics: probabilistic machine learning, deep learning, bioinformatics, Bayesian modeling, causal learning, time-series modeling, likelihood-free inference.

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2. **Academic contact person for further information on topic:** Tommi Junttila (firstname.lastname@aalto.fi)

**Title of topic:** Developer for CS-A1140 Data Structures and Algorithms

**Description:** The course almost completely renewed in 2016 but now we want to further improve its programming assignment system. Potential tasks include

(i) porting selected assignments to C++ so that the students can

(voluntarily) do some of the assignments in a high-performance low-level programming language [this task includes porting both the code delivered to students as well as the grading code, and also testing and developing various C++ programming environments that could be offered to the students],

(ii) developing visualization helper tools for some assignments,

(iii) developing new regular and extra "challenge" assignments [including assignment description, student code package and grading code], and

(iv) developing a plugin system that allows students to (voluntarily) participate in a competition for the fastest solutions on some selected assignments in the course.

An ideal applicant should have experience preferably both in the Scala and the C++ programming languages and be able to write clear problem descriptions and instructions in English; experience in Python is an additional merit.

The position is targeted for Aalto students only as it might be continued as a (head) teaching assistant position in Autumn 2019.

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3. **Professor in charge of topic:** Mario Di Francesco  
   **Title of topic:** Mobile Computing and the Internet of Things  
   **Description:** This summer internship is related to current research on mobile computing and the Internet of Things in Mario Di Francesco’s group (https://users.aalto.fi/difram1/). The student involved in the summer inter will conduct a research and development task in one of the following topics: camera-display communications; edge and fog computing; architectures and protocols for the Internet of Things (IoT); performance of distributed applications. Multiple positions are available.

4. **Professor in charge of topic:** Rohit Babbar  
   **Title of topic:** Optimization for Large-scale Multi-class and Multi-label classification  
   **Description:** Supervised machine learning with large number of classes is relevant for many applications such as ranking and recommendation systems (http://manikvarma.org/downloads/XC/XMLRepository.html). Large-scale linear optimization plays a key role in building successful algorithms for supervised learning with large number of classes. The goal of the project to study various different schemes of large-scale optimization such as co-ordinate descent, and trust region Newton's method as implemented in Liblinear, and explore other optimization techniques such as proximal gradient method and mirror descent. The candidate must have basic understanding of optimization and implementation skills in python and c++.

5. **Professor in charge of topic:** Prof. Samuel Kaski  
   **Academic contact person for further information on topic:** Postdoctoral researcher Jukka Siren  
   **Title of topic:** Dimension reduction of summary statistics for likelihood-free inference  
   **Description:** Approximate Bayesian computation and other likelihood-free inference techniques are simulation-based methods for statistical inference with models for which the likelihood is not available in closed form. An approximation to the posterior distribution is obtained by considering simulated datasets that are close to the observed data according to some distance function, which is usually based on summary statistics that capture the relevant information about the parameters in the data. The summary statistics need to strike a balance in retaining most of the information in the data, while at the same time being low-dimensional to ensure computational efficiency of the method. However, in many problems the design of such low-dimensional yet informative summaries is difficult, and dimension reduction techniques need to be applied to a larger set of candidate summaries to produce the low-dimensional summaries. Widely used dimension reduction techniques for summaries include linear regression and partial least squares.

   During the summer you will take part in designing new dimension reduction techniques, improving existing ones, and implementing them in the software ELFI (Engine for Likelihood-free Inference). The exact topic will be decided together, and could be for example optimal...
6. **Professor in charge of topic:** Prof. Samuel Kaski (samuel.kaski@aalto.fi)

**Academic contact person for further information on topic:** Postdoctoral researcher Neda Marvasti (neda.marvasti@aalto.fi)

**Title of topic:** Buying process estimation in online B2B marketing

**Description:** The goal is to identify the buying state of a buyer company by only monitoring its online behavior on a seller company’s webpage. This is a very challenging and interesting topic from business to business (B2B) marketing point of view, and the goal is to solve this problem using machine learning methods. In this work, you will develop and implement a probabilistic model for this problem; a starting point is existing models. Requirement: Solid background in statistics and machine learning, good programming skills (Python and/or R and C/C++). Link to a webpage with further information: [http://research.cs.aalto.fi/pml](http://research.cs.aalto.fi/pml)

7. **Professor in charge of topic:** Prof. Samuel Kaski (samuel.kaski@aalto.fi)

**Title of topic:** Human-in-the-loop machine learning and human-AI collaboration

**Description:**

Humans are increasingly interacting with machine learning based adaptive systems, both in industrial settings and as end-user consumers. How to optimally combine the strengths of humans and machines is one of the most interesting scientific questions at the moment. We are developing new approaches and applications for interactive human-in-the-loop machine learning and human-AI collaboration, with the aim of increasing the performance and efficiency of the systems and for improving the user experience. This project lies at the intersection of machine learning, human-computer interaction, and cognitive science. As a summer intern you work as a member in a project involving one or more of the following machine learning methodologies, depending on the open research questions in the project and your interests: reinforcement learning, inference in simulator based models, probabilistic modelling and programming, and deep learning. Position requires programming skills in Python.

Link to a webpage with further information: [http://research.cs.aalto.fi/pml](http://research.cs.aalto.fi/pml)
8. **Professor in charge of topic:** Prof. Samuel Kaski ([samuel.kaski@aalto.fi](mailto:samuel.kaski@aalto.fi))  
**Academic contact person for further information on topic:** M.Sc. Joonas Jälkö ([joonas.jalko@aalto.fi](mailto:joonas.jalko@aalto.fi))  
**Title of topic:** Privacy-preserving machine learning  
**Description:**  
We develop methods for learning from data given the constraint that privacy of the data needs to be preserved. This problem can be formulated in terms of a concept called differential privacy, and we have introduced ways of doing the learning such that performance actually improves, in contrast to in alternative methods. A couple of “minor” problems still remain; come to solve them with us! Requirements: strong background in math, especially in probability, decent skills in programming, and/or a very steep gradient in the learning curve.  
Link to a webpage with further information: [http://research.cs.aalto.fi/pml/](http://research.cs.aalto.fi/pml/)

9. **Professor in charge of topic:** Prof. Samuel Kaski ([samuel.kaski@aalto.fi](mailto:samuel.kaski@aalto.fi))  
**Academic contact person for further information on topic:** M.Sc. Iiris Sundin ([iiris.sundin@aalto.fi](mailto:iiris.sundin@aalto.fi))  
**Title of topic:** Probabilistic machine learning for precision medicine and data-driven healthcare  
**Description:**  
We are looking for a summer trainee to join us in developing new probabilistic modelling and machine learning methods needed for genomics-based precision medicine and predictive modelling based on clinical data. The goal is to develop probabilistic modeling, Bayesian inference and machine learning methods for disease risk prediction, prognosis, and personalized medicine. During the internship, you will develop non-parametric probabilistic models and Bayesian inference techniques to make personalized predictions for treatment outcomes, taking into account available side information and structure in the data. You will work closely with the machine learning experts in the Probabilistic Machine Learning research group here at Aalto. In addition, you will have a chance to join our collaboration with the top research groups on machine learning for healthcare and bioinformatics. Good programming skills will allow you to get hands-on experience on the practical applications of machine learning in medical data. Students with strong background in mathematics and interest in model development are especially encouraged to apply. Link to a webpage with further information: [http://research.cs.aalto.fi/pml/](http://research.cs.aalto.fi/pml/)
10. **Professor in charge of topic:** Prof. Samuel Kaski ([samuel.kaski@aalto.fi](mailto:samuel.kaski@aalto.fi))

**Academic contact person for further information on topic:** Postdoctoral researcher Markus Heinonen ([markus.o.heinonen@aalto.fi](mailto:markus.o.heinonen@aalto.fi))

**Title of topic:** Bayesian deep learning

**Description:** In this summer project the goal is to explore Bayesian deep learning, which studies how we can embed performance-boosting neural networks into statistical models, or how to encode depth into Bayesian models. Possible summer topics include: (1) continuous-time flows, where arbitrarily powerful distribution estimators are developed with dynamical models, and (2) development of deep convolutional Gaussian processes, whose first version were developed by us with impressive performance on image classification. You will work as part of the PML research group that has several active complementary research projects on deep Bayes. You will learn how to utilise modern techniques such as probabilistic programming, Tensorflow, GPU’s during the summer project. Requirements: strong background in math, statistics or computer science and eagerness to learn the rest. Link to a webpage with further information: [https://research.cs.aalto.fi/pml](https://research.cs.aalto.fi/pml)

11. **Professor in charge of topic:** Prof. Samuel Kaski ([samuel.kaski@aalto.fi](mailto:samuel.kaski@aalto.fi))

**Academic contact person for further information on topic:** Postdoctoral researcher Henri Pesonen ([henri.3.pesonen@aalto.fi](mailto:henri.3.pesonen@aalto.fi))

**Title of topic:** Simulator-based Inference

**Description:** We are looking for a summer trainee to join the Aalto Probabilistic Machine Learning Group to do both basic and applied research in simulation-based inference. The summer project contains theoretical investigations and also hands-on application of the methods within our software package ELFI – Engine for Likelihood-free Inference. Students having strong background in mathematics and interest in modelling and inference are especially encouraged to apply. Skills and interest in Python programming are considered a plus. Link to a webpage with further information: [http://elfi.readthedocs.io](http://elfi.readthedocs.io)

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12. **Professor in charge of topic:** Arno Solin ([arno.solin@aalto.fi](mailto:arno.solin@aalto.fi))

**Title of topic:** Real-Time Probabilistic Learning and Sensor Fusion

**Description:** My research group is looking for motivated, skilled, and open-minded summer students with an interest in real-time inference and application of probabilistic machine learning methods to practical applications. Depending on the background and interests of the student, this project can be either more applied or leaning more towards theory and methods development.

This project builds on recent progress in real-time inference and sensor fusion (see, e.g., [https://youtu.be/L-E9fnrsrVl](https://youtu.be/L-E9fnrsrVl) and [https://youtu.be/myCvUT3XGPe](https://youtu.be/myCvUT3XGPe) and related publications on [http://arno.solin.fi](http://arno.solin.fi)) and the interest is in extending and validating this framework further. The student would get hands-on experience in Bayesian method, Gaussian processes, state-space
modelling, and coding (primarily Python). Successful applicants are expected to have an outstanding record in computer science, mathematics, statistics, or a related field, and familiarity with some of these topics mentioned above.

13. Professor in charge of topic: Pekka Orponen pekka.orponen@aalto.fi

Title of topic: Algorithms for the design of RNA nanostructures

Description: The area of DNA nanotechnology [1] employs DNA as generic building material for assembling nanoscale objects with dimensions in the order of 10-100 nanometres. For instance, our group recently demonstrated, together with a biochemistry team from Karolinska Institutet, a general technique for rendering almost arbitrary 3D wireframe designs into biomolecules folded from a single long DNA strand [2].

For several reasons, there is increasing interest in the DNA nanotechnology community to move from DNA to RNA as source material. This is however very challenging, because RNA has remarkably much richer and less well understood folding kinetics than DNA. Thus a current focus of our group is to develop algorithmic methods and tools to support the task of designing complex 2D and 3D RNA nanostructures. Some preliminary results of our work are described in the summary [3].

The topic of this internship project is to learn about the present combinatorial models of RNA folding and develop algorithmic methods for designing RNA sequences that fold into desired 2D or 3D shapes. Simulation studies will then be used to screen the proposed designs, towards a possibility of eventual validation by laboratory experiments.

The project requires familiarity with basic algorithm design techniques, facility with combinatorial thinking, and good programming skills. Previous knowledge of biomolecules is not necessary, although it is an asset. The work is performed in the context of research project “Algorithmic designs for biomolecular nanostructures (ALBION)”, funded by the Academy of Finland. For further information, please see the research group webpage at http://research.cs.aalto.fi/nc/.

Online sources:

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14. Professor in charge of topic: Pekka Orponen

Academic contact person for further information on topic: Dr. Vinay Gautam, vinay.gautam@aalto.fi

Title of topic: Simulation of kinetically-controlled DSD systems

Description: One of the goals of DNA nanotechnology is to design enzyme-free DNA-based molecular systems with programmable dynamic behaviours. The invention of the DNA Strand Displacement (DSD) reaction [1] provides a basic building block which can be cascaded in a variety of ways to implement DNA-based reaction networks. In general, Chemical Reaction Networks (CRN) can be used to describe arbitrary dynamic behaviours, which can be translated into a set of DSD reactions.

Although a variety of DSD systems have been demonstrated both theoretically and experimentally, one of the main bottlenecks that has limited the scale of DSD systems is the undesired triggering of displacement reactions causing leakages at various levels, which result in unreliable and unpredictable behaviours.

Our on-going project is investigating an alternative implementation of CRNs using kinetically-controlled robust designs of DSD reactions. The task of this internship project is design a dynamic simulation framework, something similar to Microsoft’s Visual DSD [2] with a very basic set of functionalities based on ordinary differential equations of the modified DSD reaction systems.

The project requires good programming skills and some understanding of ordinary differential equations. Previous knowledge of biomolecules and stochastic simulation is not necessary, although it is an asset. The work is performed in the context of research project “Algorithmic designs for biomolecular nanostructures (ALBION)”, funded by the Academy of Finland. For further information, please see the research group webpage at http://research.cs.aalto.fi/nc/.

Online sources:

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15. Professor in charge of topic: Pekka Orponen

Academic contact person for further information on topic: Dr. Vo Hong Thanh, thanh.vo@aalto.fi

Title of topic: Stochastic simulation for computational biology and biotechnology
**Description:** The topic of this internship project is to learn about the stochastic approach for stochastic processes with applications to computational biology and biotechnology. Biological processes at the nanoscale are inherently stochastic. Molecules driven by random walk move around in a solution (for instance, the inside of a cell or a test tube) and experience a series of collisions with each other. A collision between molecular species forms a reaction if it satisfies specific reaction conditions, e.g., activation energy. The result of a reaction can be the forming of new chemical bonds, breaking existing ones or sometimes both, ultimately leading to the production of necessary molecular species to help perform the activities of the biological system. Stochastic processes provide a powerful framework to study the stochastic nature of biological systems. Each biological event is modelled as a stochastic process and the temporal dynamics of the system is then studied by the stochastic simulation technique ([https://en.wikipedia.org/wiki/Stochastic_simulation](https://en.wikipedia.org/wiki/Stochastic_simulation)).

The project aims to develop computational methods for simulating and analysing stochastic dynamics of biological processes such as regulatory biochemical reactions or the folding of RNA sequences. The project requires familiarity with basic probability and algorithm design techniques, together with good programming skills. Previous knowledge of biochemistry is not necessary, although it is an asset. The work is performed in the context of research project “Algorithmic designs for biomolecular nanostructures (ALBION)”, funded by the Academy of Finland. For further information, please see the research group webpage at [http://research.cs.aalto.fi/nc/](http://research.cs.aalto.fi/nc/).

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**16. Professor in charge of topic:** Harri Lähdesmäki ([harri.lahdesmaki@aalto.fi](mailto:harri.lahdesmaki@aalto.fi))

**Title of topic:** Bayesian deep learning for personalised medicine

**Description:** We are looking for several summer internship students to work on probabilistic machine learning and deep generative models for biomedical and health applications. Our on-going research projects involve several important clinical challenges, such as (i) personalized prediction of immunotherapy efficiency for cancer patients using e.g. modern single-cell data, (ii) time-series analysis of multi-omics data from biomedical studies, (iii) (semi-)supervised analysis of extremely large-scale heterogeneous health data from Finnish biobanks, and (iv) novel cancer diagnostic methods using cell-free DNA. Your work would include familiarising yourself with one of these projects (based on your preference), contribute to developing statistical/deep learning methods, and apply them to exciting real-world data from our national or international collaborators. Applicants are expected to have good knowledge of machine learning/statistics, programming, and interest in developing/applying probabilistic methods for bioinformatics and biomedicine. Research work can be continued after the summer. For more information and relevant recent work, see ([http://research.cs.aalto.fi/csb/publications](http://research.cs.aalto.fi/csb/publications)) or contact Harri Lähdesmäki ([harri.lahdesmaki@aalto.fi](mailto:harri.lahdesmaki@aalto.fi)).

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17. **Professor in charge of topic:** Harri Lähdesmäki

**Academic contact person for further information on topic:** Markus Heinonen (markus.heinonen@aalto.fi), Mikko Arvas (mikko.arvas@veripalvelu.fi), Harri Lähdesmäki (harri.lahdesmaki@aalto.fi)

**Title of topic:** Big Blood Data Prediction - machine learning for blood donation

**Description:** Blood donation is a crucial life-saving voluntary activity, but recent research implies that it does not suite everybody. The goal of this project is to develop a classifier to identify persons who’s health and wellbeing is minimally impacted by blood donation. A collaboration of Aalto University and Finnish Red Cross Blood Service (FRCBS) funded by European Blood Alliance aims to develop a prototype of such a classifier for the European blood banking community. Your job would be to initiate the development of the prototype under joint supervision of Aalto and FRCBS. In the project you will familiarize yourself with common blood biomarkers as well genomics data and modern machine learning techniques. If successful the project could have immediate European wide impact and beneficially impact on health of numerous blood donors. Research work can be continued after the summer.

The project requires good knowledge of mathematics, statistics, and programming (e.g. R, Python, Julia..) as well as interest in molecular biology and/or health.


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18. **Professor in charge of topic:** Harri Lähdesmäki

**Academic contact person for further information on topic:** Cagatay Yildiz (cagatay.yildiz@aalto.fi), Markus Heinonen (markus.heinonen@aalto.fi), Harri Lähdesmäki (harri.lahdesmaki@aalto.fi)

**Title of topic:** Bayesian inference for nonparametric (deep) differential equations

**Description:** Recently proposed nonparametric differential equation models make it possible to learn arbitrary continuous-time dynamics from data without any prior knowledge. These models can also be used to implement state-of-the-art deep learning methods. These high-capacity models can, however, suffer from over-fitting. Building on our research group’s recent results, your work involves developing and implementing Bayesian inference methods (MCMC, variational inference) for robust inference of nonparametric differential equations. The work will include non-parametric probabilistic modelling, deep learning and automatic differentiation. The goal of the summer internship is to contribute to development of Bayesian methods for inferring non-parametric differential (deep) equation models from data and to implement these methods in e.g. TensorFlow.

The project requires good knowledge of machine learning, mathematics, statistics, and programming. Research work can be continued after the summer. For more information and relevant recent work, see [http://research.cs.aalto.fi/csb/publications](http://research.cs.aalto.fi/csb/publications) or contact any of the academic contact persons listed above.
19. Professor in charge of topic: Harri Lähdesmäki

Academic contact person for further information on topic: Markus Heinonen (markus.heinonen@aalto.fi), Harri Lähdesmäki (harri.lahdesmaki@aalto.fi)

Title of topic: Solving Fokker-Planck-Kolmogorov equations with deep learning

Description: Recently in machine learning there has been emerging interesting towards dynamical models, such as RNN’s, ResNet’s or stochastic differential equation models. Fokker-Planck or Kolmogorov equations describe how the dynamics of such continuous-time stochastic dynamical systems evolve. For general nonlinear dynamics the equations are intractable and warrant expensive numerical approximations. In this project we seek to sidestep the numerical approximations by solving the equation using deep machine learning instead, where we learn a neural network that predicts the system state. This work requires good knowledge of math and programming (Python preferred), as well as some knowledge of dynamical models. We will employ Tensorflow or other autodiff platforms for efficient exploration and learning of the neural networks.

Research work can be continued after the summer. For more information and relevant recent work, see (http://research.cs.aalto.fi/csb/publications) or contact any of the academic contact persons listed above.

20. Professor in charge of topic: Harri Lähdesmäki

Academic contact person for further information on topic: Cagatay Yildiz (cagatay.yildiz@aalto.fi), Markus Heinonen (markus.heinonen@aalto.fi), Harri Lähdesmäki (harri.lahdesmaki@aalto.fi)

Title of topic: Auto-Differentiation Meets Differential Equations: A Tensorflow Extension

Description: The automatic differentiation technique in machine learning has revolutionarised deep learning by allowing automatic gradients and optimisation of arbitrarily complex network structures. Recently there has been emerging interests in deep learning using inherently dynamical models such as ResNets or RNN’s, or even infinitesimal models such as continuous-time differential equations. However, the standard autodiff methods are inoptimal for these models. In this project we propose to extend automatic derivatives to differential equation system settings using existing forward/backward sensitivity analyses, and implement them into the Tensorflow package. This work requires good knowledge of math and Python programming, algorithmic mindset and knowledge of statistics or dynamic models being advantageous.

Research work can be continued after the summer. For more information and relevant recent work, see (http://research.cs.aalto.fi/csb/publications) or contact any of the academic contact persons listed above.
21. Professor in charge of topic: Aki Vehtari

Academic contact person for further information on topic: Aki Vehtari Aki.Vehtari@aalto.fi

Title of topic: Robust and Assisted Bayesian Modeling Workflows

Description: You will participate in a research project in which we will develop theory and methods for assessing the quality of Monte Carlo and variational inference methods, and develop tools for a principled and robust Bayesian modeling workflow. To guarantee wide applicability of the project results in data science industry and academic research, the novel methods will be evaluated on a range of practical machine learning models and implemented as part of the leading open-source probabilistic programming systems. Prerequisite is Bayesian data analysis course or similar knowledge.

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22. Vastuuprofessori: Lauri Malmi (Lauri.Malmi@aalto.fi)

Kontaktihenkilöt: Ari Korhonen (ari.korhonen@aalto.fi), Otto Seppälä (otto.seppala@aalto.fi), Juha Sorva (juha.sorva@aalto.fi)

LeTech-ryhmä palkkaa useita kesätyöntekijöitä seuraaviin tehtäviin:

A+-oppimisympäristön kehittäminen
Sähköinen tenttiminen ohjelmoinnin opetuksessa
Plagioinnin tunnistaminen ja nykyisen Radar-järjestelmän kehittäminen
Ohjelmoinnin peruskurssien oppimateriaaleihin liittyvien tehtävien ja vuorovaikutteisten komponenttien ja niihin perustuvan sisällön kehittäminen suomeksi ja englanniksi
Tarkemmat toimenkuvat sovitaan valittujen henkilöiden kiinnostuksen ja taustan mukaan.
Hakijoilta toivotaan ohjelmoinnin peruskurssien suorittamista hyvin arvosanoin sekä kiinnostusta oppimateriaalin tai oppimisympäristöjen kehittämiseen.

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23. Professor in charge of topic: Aristides Gionis

Title of topic: Discovering controversial discussions in social networks

Description: Controversial discussions in social media are rapidly becoming a topic of interest, as they seem closely linked to current trends in polarization of public opinion and the subversion of democratic processes. Signed networks --- graphs where each edge is labeled with either a positive or a negative sign --- can be useful to model these discussions, as the signs of the edges can represent friendly or hostile interactions in a social network. The goal of this project is to study algorithms to detect and visualize polarized discussions in social media, modeled as signed graphs, and analyze their structure and dynamics.

Required skills: Design and analysis of algorithms, machine learning, linear algebra, good implementation skills and familiarity with processing large-scale data

Data Mining group website: http://research.cs.aalto.fi/dmg/
24. **Professor in charge of topic:** Aristides Gionis  
**Title of topic:** Election of non-polarized representatives  
**Description:** Clustering algorithms are useful to discover a small set of representatives of a large set of data points. For example, we can consider the task of electing a small committee of individuals to represent the different ideological positions found within a large group of people. If the topics to be discussed are controversial, the opinions held by the different subgroups found in the population might be polarized, and therefore the representatives forming the committee might have trouble reaching consensus. The goal of this project is to study variants of clustering algorithms that can find non-polarized groups of representatives in a variety of scenarios, such as the election of committees or the summarization of news contents to promote non-extreme viewpoints.  
Required skills: Design and analysis of algorithms, machine learning, linear algebra, good implementation skills and familiarity with processing large-scale data  
Data Mining group website: http://research.cs.aalto.fi/dmg/  

25. **Professor in charge of topic:** Juho Kannala juho.kannala@aalto.fi  
**Title of topic:** Internships and thesis positions in computer vision and deep learning  
**Description:** Computer vision is a rapidly developing field that is at the forefront of recent advances in artificial intelligence. Our group has broad research interests within computer vision. We are pursuing problems both in geometric computer vision (including topics such as visual SLAM, visual-inertial odometry, optical flow, image-based 3D modeling and localization) and in semantic computer vision (including topics such as object detection and recognition, and deep learning). We are looking for students interested in both basic research and applications of computer vision. Students with good programming skills and strong background in mathematics are especially encouraged to apply. The precise topics of the research will be chosen together with the students to match their personal interests. Examples of our recent papers include https://aaltovision.github.io/PIVO/, https://aaltovision.github.io/pioneer/, https://arxiv.org/abs/1808.04999 and https://arxiv.org/abs/1810.08393. For more papers and further information visit: https://users.aalto.fi/~kannalj1/
26. Academic contact person for further information on topic: Senior university lecturer Juha Sorva (juha.sorva@aalto.fi) and University teacher Otto Seppälä (otto.seppala@aalto.fi); please contact both.

Title of topic: Developers for improving the course Programming 1 (O1)

Description: CS-A1110 Programming 1 is a good course. It could be still better. We are constantly looking to improve the course design, the programming assignments, automatic feedback, O1’s custom libraries, and the A+ course platform (https://plus.cs.hut.fi/o1/2018/).

We are now hiring people to join O1’s development team. Here are some examples of what the team does: developing unit tests that provide feedback to students; configuring and maintaining O1 on the A+ platform; improving O1’s custom multimedia library and its documentation; contributing new features to both the A+ user interface and the server backend.

The work would be full time in the summer and part-time during the fall term. In your application, please indicate the minimum and maximum number of hours that you would like to work during Fall 2019.

We require applicants to have a good basic programming skills from Aalto’s introductory-level programming courses or elsewhere; further programming experience is a plus. Knowledge of specific technologies is not a requirement: we can try to tailor each team member’s job to what they know and are interested in learning. Nevertheless, make sure to document any experience you have in the following areas: Scala; unit testing, ScalaTest; web programming (esp. Django + Python, HTML + CSS + JavaScript); databases; containers (e.g., Docker).

In addition to technical ability, we appreciate strong communication and language skills. We hope to receive applications from people who are enthusiastic about education and programming and committed to high quality.

This job could be for you whether you are a BSc-level or MSc-level student or looking for a postgraduate position.

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27. Professor in charge of topic: Antti Ylä-Jääski (antti.yla-jaaski@aalto.fi)

Title of topic: Smartphone app on 3D Augmented Reality eSports gaming

Would you like to develop 3D Augmented Reality eSports game with Unity on smartphone? We have earlier developed a prototype AR game in our research project, check the YouTube video below. In this project we want to continue this to make it visually more appealing and develop it towards eSports with activity detectors. Reasonably good SW development skills are required. Please contact prof Antti Ylä-Jääski (antti.yla-jaaski@aalto.fi) if you are interested.

https://www.youtube.com/watch?v=6ufbRTAGUd8

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28. Vastuuprofessori: Antti Ylä-Jääski

Kontaktihenkilö: Sanna Suoranta (sanna.suoranta@aalto.fi)

Tehtävä: Ohjelmointi Y1:n harjoitustehtävät


Tehtävä vaatii hyvää ohjelmointitaitoa. Ohjelmointitaidon lisäksi olennaista työssä on pystyä keksimään uusia innostavia tehtäväideoita, eli tehtävä ei ole pelkästään tekninen. Tehtävä sopii sekä kandiopiskelijalle että kandidaatin tutkinnon jo tehneille.

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29. Professor in charge of topic: Juho Rousu

Academic contact person for further information on topic: Sandor Szedmak, sandor.szedmak@aalto.fi

Title of topic: New generation of learners for complex nonlinear systems.

Description: One of the most challenging problem of the contemporary machine learning is to capture the structure of the complex, nonlinear systems. There are some well known methods which address these type of problems, e.g. deep neural networks, kernel methods, but they have their own limits. Deep neural networks require very large dataset to train and the results provided are hardly interpretable. For the kernel methods processing the large dataset are the real challenges. Both of those approaches could require complicated, time consuming parameter tuning as well. Learning via polynomial functions could be a good candidate to overcome on those limitations. They are very general, precisely defined, and can be computed with high efficiency. For example, functions realized by the deep neural networks can be accurately approximated by polynomials.

The task is to explore the learning methods built on the polynomial functions. In the last couple of years several relating methods are introduced, e.g. factorization machine, polynomial networks, thus this exploration could yield a useful synthesis of potential methods. The work will build on the strong foundation provided by Algebraic Geometry and Algebraic Statistics.

Prerequisites: knowledge in linear algebra, basics in machine learning, e.g. deep learning, kernels. Some basic knowledge in abstract algebra is advantageous.

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30. **Professor in charge of topic:** Hong-Linh Truong, linh.truong@aalto.fi

**Title of topic:** Knowledge Graphs for Engineering Analytics of IoT Big Data Systems

**Description:** The internship topic will focus on the development of a system for capturing knowledge about performance of IoT big data systems. In particular, the work will focus on the following aspects:

- Establishing knowledge graphs for IoT big data system components, types of data and infrastructures
- Integrating with incidents monitoring and analytics systems to capture knowledge about IoT Big data systems

Strong skills in native cloud programming and big data with strong understanding about performance and monitoring are required. The internship should be able to work with various open source software for big data systems (e.g., Hadoop, Spark, and MQTT), knowledge graphs and big data services (e.g., Grakn, TigerGraph, Azure Cosmos) and public cloud systems like Google Cloud and have good knowledge about DevOps (e.g., CI/CD with Jenkins) and Infrastructure-as-Code (e.g, such as Docker containers and Kubernetes).

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31. **Academic contact person for further information on topic:** Dr. Matti Siekkinen (matti.siekkinen@aalto.fi)

**Title of topic:** Cloud accelerated extended reality (VR/MR)

**Description:** We are working on a system (PoC ready) that enables cloud accelerated graphics rendering for mobile extended reality. We are looking for several students to join our team as software developers/research assistants to help us improve our core technology and streamline the solution into a product. Relevant technologies and software platforms include game engines (both Unity and Unreal), mobile AR SDKs (ARCore, maybe ARKit), cloud platforms and tools, and real-time streaming (e.g. WebRTC).

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32. **Academic contact person for further information on topic:** Jaakko Kotimäki (jaakko.kotimaki@aalto.fi)

**Title of topic:** Developers for cloud infrastructure integration

**Description:** We are looking for new system administrators and developers to join the CS department's IT-team. Our team work closely with CS researchers and teachers, providing them with IT services, solutions and infrastructure to enable top-level research and teaching.

The work will focus on enhancing and integrating the backend of CS department teaching infrastructure to cloud-based solutions. The main teaching systems are [https://jupyter.cs.aalto.fi/](https://jupyter.cs.aalto.fi/) and [https://plus.cs.aalto.fi/](https://plus.cs.aalto.fi/), and the integration is done with containers (Docker) and Kubernetes/OpenShift.
The work would be full time in the summer and part-time during the fall term. In your application, please indicate the minimum and maximum number of hours that you would like to work during Fall 2019.

We are looking for people who know their way around Linux/Unix systems and Python/shell-scripting. We can tailor the job based on your skills and what you want to learn. However, any prior knowledge of databases, containers, virtualization and web programming is a plus.

We have a multinational team, so fluent English language skills and communication is a must.

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33. Professor in charge of topic: Lauri Malmi (lauri.malmi@aalto.fi)

Academic contact person for further information on topics: Jaakko Kantojärvi (apluslms-jobs-cs@aalto.fi)
Send applications to: apluslms-jobs-cs@aalto.fi

We are looking for enthusiastic individuals to develop microservices in the open-source A+ learning management system. A+ is used extensively on our courses. These topics cover future development, thus a bit more experience is preferred. There are entry level topics for A+ development under different courses too. More about the job: https://www.aarresaari.net/advert-3-54369

Topic 1: Django developers (2 people) - An online course material CI/CD tool for A+. New service to take care of course material building and deployment to other services. Requirements: Web Software Development course.

Topic 2: Python library developer - Further development on a course material building library. The library validates input, uses Docker/Kubernetes for build tasks and packages data for deployment. Requirements: adequate skills with Python.


Topic 4: Rails developer - Fixing bugs and implementing new features to rubric style manual assessment service. Requirements: some experience with Ruby on Rails

Topic 5: Actor developer (Elixir or Scala+Akka) - Developing next generation distributed assessment cloud. Goal is to build distributed, fault tolerant and responsive assessment service, which uses a mix of persistent and temporary containers to grade submission. Requirements: ambition to solve problem of distributed task runner with back pressure.

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