Project in Applied Mathematics, FMAN40

This document contains information about the project course in Applied Mathematics and suggestions for projects.
The list of suggested projects is brief. More projects may be posted/updated on the web-page:
`http://www.maths.lth.se/matematiklth/personal/kalle/projekt/`
There you will also find information of dates, deadlines and such.
For further information and for material contact the supervisors of the project.

1. **Image analysis of jellyfish images for modelling of jellyfish**
   In an ongoing collaboration with the vision group at the department of Biology, we would like to model the visual processing and motor feedback of jellyfish. In this project the aim is to perform feature detection on image sequences of jellyfish to measure their motion, while controlling their visual input.
   Contact: KÅ, MO.

2. **Tracking multiple objects using multiple cameras**
   To automatically explain what's going on in a scene by extracting trajectories of everyting moving in the scene is of interest in several cases. It can be used to assess traffic safety, study how people utilize public places, provide safety systems for industrial robots. We have several datasets which could be used in this project including a month recording from an intersection in Minsk from 6 cameras.
   Contact: HA, MN.

3. **Material analysis of asphalt**
   The centre for mathematical sciences are involved in a project together with PEAB asphalt in Helsingborg. There is an interest in material properties and how e g the bitumen mixtures, chemical additives, the shape and material properties of the stones. The goal of the project is to develop automatic methods to estimate the shape distribution of the stones.
   Contact: KÅ.

4. **Systematized pan/tilt/zoom-camera**
   When recording events using pan/tilt/zoom-camera there are physical limits as to how the camera can move. This puts restrictions on what kind of camera motions are possible. Also, if a mistake is made during the recording of an event, it's hard to fix that after the event is over. An alternative is to place several fixed cameras at the same location and zoom them in on different parts of the scene of interest. The images from all those cameras can be stitching together and a synthesized ptz-camera image can be generated by cropping and scaling it. If the original videos from the static camera is saved this can be performed offline and allow a producer to experiment with different camera-motions after the event was recorded.
   Contact: HA.

5. **Study pigs in a pen**
   With increasing volume of animals in agriculture is desired to develop more methods to help the farmer to analyze the animals. This project is focused on the study of pigs in the box using the surveillance camera. Using image analysis it is desired to see if a system can find some behaviour and get the decision support information, such as see if pigs start fighting or see how the group choose placements at different climatic conditions in the box. Finding and/or segmenting out pigs in the box is a first step in this project
   Contact: MN

6. **Stochastic Monte Carlo Simulation of Vehicular Traffic**
   We examine, construct and apply stochastic microscopic processes in order to describe vehicle interactions on a given roadway geometry. Through this project we learn to appraise and differentiate between Cellular Automaton or purely stochastic processes as well as simulate them using Metropolis or Arrhenious dynamics. We focus on three different aspects of the modeling method: a) constructing the

mathematical infrastructure b) simulating the dynamics using Monte Carlo and c) validating the results against reality.
Contact: ASo.

7. **Registration of medical images**
   The goal of this project is to test and implement methods for registration of medical images, i.e. estimating the transformation between two images or between an image and a model scene. The transformation could e.g. be a rigid transformation or a projective transformation. Using features such as SIFT and robust matching algorithms such as RANSAC robust and accurate registration can be achieved.
   Contact: NCO.

8. **Digit recognition**
   We have a quite large set of images of digits (1-9). These are taken from many different types of fonts, sizes, quality etc. There is thus a larger (and more realistic) variation of a digit within the set. The aim of this project is to use this database to develop and test robust classification algorithms for digit recognition. The resulting system could incorporated with the sudoku and/or kakuro reader in order to improve the system.
   Contact: KÅ

9. **Detection of traffic congestion**
   The centre for mathematical sciences and the division of road and traffic technology are working together on algorithms for automatic analysis of road user behavior. One interesting sub-problem is to automatically detect traffic congestion from images. We have access to numerous images taken from cameras owned by the road and traffic authority.
   Contact: HA, MN.

10. **Background/foreground-segmentation**
    Stationary cameras that are observing objects moving against a more or less stationary background can be detected by so called background foreground segmentation algorithms. The goal of the project is to develop such techniques and evaluate them.
    Contact: MN, HA.

11. **Analysis of mammography-data**
    The project is aimed at analysing mammography data with deep convolutional neural networks in order to see if modern machine learning techniques can improve on current state-of-the-art in the analysis of such data.
    Contact: KÅ.

12. **Deep learning for the analysis of rat speech**
    Rats speak in ultrasound range. By studying so called sonograms of the sounds made it is possible to distinguish distinct words and to cluster such words. There is, however, considerable variation that makes such clustering and classification difficult. The goal of the project is to use deep convolutional neural network representations to improve on current state-of-the-art of such clustering and classification.
    Contact: KÅ.

13. **Kakuro reader**
    Kakuro is similar to sudoku. It's like a crossword puzzle with integers 1 to 9. The project is aimed at developing a kakuro reader and solver.
    Contact: KÅ.

14. **Classification of prostate cancer**
    Today the classification of prostate cancer is done manually based on ocular inspection of histological samples, but using image analysis this could be automated. We have an ongoing project together with

Skåne University Hospital, and a large dataset is available. The aim of this project is to develop an algorithm to determine whether an image contains cancerous cells or not, using for example deep learning.
Contact: IA.

15. **Own suggestion**
    You are free to come with your own suggestions on projects. Contact the project coordinator and get your project approved.
    Contact: MO.

Contact persons (supervisors):

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