MSc projects in machine learning with medical and commercial partners. For more info please contact Zaid Al-Ars at z.al-ars@tudelft.nl.

Project 1.
Facial Imaging and Diagnosis System for Neurological Disorders
==========
MSc project in collaboration with Haga Hospital and Erasmus MC

A number of neurological disorders (such as Bell's palsy and strokes) are acute diseases that have a visible effect by causing unilateral muscle weakness of the face. Bell's palsy can affect any person, and attacks about 5000 patients yearly in the Netherlands. A preceding viral infection or auto-immune response are considered to trigger Bell's palsy and patients are treated with anti-viral drugs and corticosteroids. Most patients recover, but at least one-third have severe residual deficits with a considerable impact on daily life. There are two important unmet problems with Bell's palsy in current clinical practice.

First, there are other neurological disorders that start with acute facial weakness (including brain diseases as stroke), which may mimic Bell's palsy. Early accurate diagnosis however is crucial to be able to initiate treatment as soon as possible. At present, clinicians are diagnosing Bell's palsy by visually examining the facial muscle movements in patients but the accuracy of this approach is unknown. Second, monitoring of the facial weakness in time is required to evaluate the effect of treatment and clinical recovery, but at present there are no methods to quantify the weakness. The facial weakness is now evaluated visually by clinicians during clinical examination, which lacks accuracy and reproducibility and have a high inter-observer variability.

Our hypothesis is that the accuracy of the diagnosis and clinical monitoring of Bell's palsy and related neurological disorders can be improved by imaging of the facial weakness. We anticipate that all facial movements can be quantified, and that patterns of facial weakness can be recognized for early diagnosis of different diseases. This project will develop a face imaging system to support doctors and researchers worldwide in the diagnosis, treatment evaluation and follow-up of patients suffering from these diseases.

Project 2.
Privacy Protection in Medical Imaging Systems Using Federated Machine Learning
==========
MSc project in collaboration with Philips Healthcare

Interventional X-Ray (iXR) medical imaging equipment allow for real-time monitoring of patients during surgical interventions. These systems have been used for a decade already to reduce the need for performing intrusive surgeries in operation theaters. However, due to the harmful nature of X-Ray, these systems use ultra-low intensity radiation, which results in low-quality noisy images. A sophisticated collection of advanced image processing algorithms have been developed to improve the quality of the images presented to surgeons.

With the rise in their capabilities, machine learning (ML) algorithms promise to improve the quality of the iXR images even further. In addition, new machine learning algorithms have dramatically improved state of the art in image processing, like object detection and recognition. In this project, we will apply Federated Machine Learning (FML) techniques as a method to enable ML models to learn on patient images while protecting the privacy of patients. Instead of centralizing patient data on one server in the cloud, FML allows for training ML algorithms locally within imaging equipment at the patient side in real time, which negates the need to collect patient data. FML starts by downloading a pre-trained model from the cloud to the imaging equipment. The model is then retrained on streaming local patient data on the imaging equipment itself. Subsequently, only the updates that were introduced in the retrained model are sent back to the cloud (without the original patient data). All model updates sent by all the patients are then aggregated together and used to update the pre-trained model in the cloud, which is then sent back to the imaging equipment to perform more effective predictions.

Project 3.
Fraud Detection for Insurance Claims
==========
MSc project with Nationale Nederlanden

Insurance fraud represents a challenge the sustainability of the insurance system, as it diverts resources from genuine claims in need of compensation, it funds fraudulent activity, and it increases the cost of insurance to society at large. Studies indicate that the amount of detected fraudulent claims is much smaller than the total committed fraudulent activity, where the total amount of fraud is estimated to represent up to 10% of all claims expenditure in Europe. Due to the sheer number of claims submitted each day, it would be far too expensive for insurance companies to have employees check each and every claim for signs of possible fraud. Instead, many companies use automated systems to identify suspicious claims for further investigation. With the recent developments of powerful machine learning (ML) algorithms, insurance companies are seeking state-of-the-art solutions to improve the capabilities of their automated fraud detection systems.

This project will start by investigating the characteristics of insurance claim datasets and identify important features to be used in fraud detection. Then, a number of ML algorithms will be analyzed for their capabilities and shortcomings in detecting fraudulent claims. Based on the analysis, a proposal is made for the algorithms most suitable in the field as well as recommendation to include new features to improve the quality of the results. The work will be done and discussed in close collaboration with insurance claim experts to assure the practical viability.