Proposals from Annecy:

Physically inspired deep learning models, application to thermal imaging.

Prof. Pr. Alexandre Benoit

Uncooled thermal imaging sensors are relevant for embedded systems for a variety of applications, from industrial control to environmental monitoring. Emancipation from the classical colour sensors, thermal imaging present challenging behaviours including time evolving response with respect to the sensor temperature as well as the incoming flux brought by the observed scene. Hopefully, physical models that represent the sensor behaviours are identified but its parameters are difficult to estimate along time. The proposed project aims at exploring machine (deep) learning models able to perform a continuous estimation of the physical parameter enabling for image quality improvement and stability along time and context.

Prerequisites: knowledge and experience with image processing, machine learning, python

Duration: 4-6 months

Keywords: machine learning, deep learning, physical models, image quality, image processing

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On the distance between machine learning models, from performance levels to the detection of bias, attacks and relevance

Prof. Pr. Alexandre Benoit

Machine learning models, and especially deep learning models are developing fast but are subject to numerous factors that impact on their performances, bias and thus user confidence. Sensitivity to initial conditions (initial parameters, data ordering, model structure) play a major role in the results variability. Also, the discrepancy between the training data and the ones used in the development phase as well as attacks (Byzantine, backdoor) can induce bias that can impact on the model relevance. Thus, going beyond task performance metrics, model comparison metrics become relevant. This can be performed by comparing model responses as well as comparing model structures and parameters. The proposed project aims at exploring distance metrics enabling machine (deep) learning model comparison that would allow for model quality measure, and/or attack detection.

Prerequisites: knowledge with machine learning, deep learning, python

Duration: 4-6 months

Keywords: machine learning, deep learning, physical models, image quality, image processing

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Frugal & Efficient implementation of statistical learning algorithms for Synthethic Aperture Radar land-cover classification

Associate Prof. Ammar Mian

Synthetic Aperture Radar images are images produced by an active sensor onboard Earth's observation satellites. By emitting an electromagnetic wave and analyzing the backscattering of the signal, an image can be produced in all weather conditions. The drawback of such a method is a high level of noise that needs to be taken into account in the processing of the resulting images. Moreover, given the spatial and temporal dimensions involved, the quantity of data to process is of very high dimensionality. To deal with the noise, statistical learning algorithms have been the state of art for clustering but they suffer from an increased computation cost since they require the estimation of multivariate probability parameters and computation of distance metrics that involve costly linear algebra operations.
The proposed project aims at investigating methodologies to perform a faster estimation by working on several aspects: investigate algorithms that are designed for such scenario (Fast K Means, etc), use of on-line stochastic optimization approaches to reduce computation complexity of the estimation phase and finally study the implementation of those algorithms in a low-level language, possibly on GPU devices.

Prerequisites: Unsupervised clustering, Optimization, Programming in C/Cuda/Rust.

Keywords: Frugal machine learning, unsupervised classification, Statistical learning