MASTER THESIS

Machine Learning on Embedded Systems

Filtering of Rail-track Switches using Ensemble Learning

The Christian Doppler Laboratory Embedded Machine Learning does research on Deep Neural Networks (DNN) in resource-constrained embedded devices. It studies how energy consumption and resource usage can be minimized while keeping high accuracy. The solution space is characterized by architecture parameters, DNN optimization and transformations, implementation platform configurations, and mapping options. This design space is huge, poorly understood, and it is rapidly evolving.

Besides other fields, ensemble learning is applied to many applications in the intelligent transportation area (such as pedestrian, vehicle type recognition, traffic flow prediction, and object detection), where often embedded systems platforms are used. Ensemble learning describes the training of multiple weak models and combines their output to generate a more accurate final model. The weak models possess high bias or high variance, whereas the final model tries to achieve low bias and low variance to improve accuracy. There are three types of ensemble learning approaches: bagging, boosting, and stacking. The bagging approach trains multiple weak models in parallel, boosting approach trains them in sequence, and stacking trains them in sequential as well as parallel ways. Bagging and boosting use deterministic approaches to aggregate the weak models, whereas stacking trains a meta-model to aggregate the output of weak models.

This thesis project aims to use a stacking approach to filter rail-track switches (if present) using two weak models and a meta-model. Because embedded systems platforms often have limited computational resources, the developed solution needs to be deployable and executable in real-time on such platforms.

This thesis project consists of the following steps:

- Select one of the state-of-the-art datasets, e.g., RailSem19.
- Train/test a weak model, e.g., DeepLabV3, to segment rail-tracks.
- Train/test to weak model, e.g., YoLoV3, to detect switches if present.
- Encode the switch detection result into a binary image and combine it with rail-track segmentation.
- Optimize/compress the models to deploy them on an embedded systems platform, e.g., Nvidia Jetson.
- Train/test a meta-model to filter switches.

This thesis offers you an excellent opportunity to get into the hot topic of deep learning. It allows you to become an expert in configuring neural networks. Moreover, you acquire critical skills in using neural networks in embedded systems and resource constraints.

Some of the M.Sc. projects may be combined with a part-time position.

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