

# Master's Thesis

## Runtime Prediction for OpenCL-Kernels in heterogeneous System using Machine Learning

### Motivation

Modern computer system consists a large number of heterogeneous processing units (PU). For the efficient usage of such system, the programmer must know different programming models for different hardware architectures. To relief the uses from the complexity, library based runtime system are developed by many current research institutions. Compute Kernels, such as BLAS and cuBLAS, Intel MKL, are developed by architectural experts to gain maximum performance. In addition, runtime scheduling system enables dynamic kernel selection. To achieve best result, information about implementation variance, such as execution time and cost for data transfer must be collect and know beforehand. Typically, these data is collected in a library, which produces extra overhead during runtime. In this thesis, we target this overhead and try to predict runtime by using advance machine learning technology.

This Project is a cooperation between TUM and KIT in Karlsruhe, Germany.

### Background

For the runtime system HALadapt, a machine learning based runtime prediction was already developed in an earlier work. First, static code analysis is done and metrics such as number of operations, number of memory accesses, etc. is collected. These information, combined with knowledge of application runtime, is used as training data for the machine learning model. With the previous work, we have found out that the variance of prediction is relatively high, making such prediction less useful for standard CPU application. In this thesis, similar methods and measurements is to be collect and analysed for OpenCL-based applications.

### Work Packages

- Analysis of Existing Prediction Data and Machine Learning Model
- Adaptation of new Prediction Model, Generation for Training Data
- Training and Cross-Validation
- Evaluation with new, independent data
- Demo and Documentation

### Requirements

- Fundamental Knowledge in Concepts of Machine Learning
- Knowledge in Data Mining is a plus
- Knowledge in Performance Evaluation is a plus
- Knowledge in OpenCL programming is a plus

### Contact

Informatik 10 - Lehrstuhl für Rechnertechnik und Rechnerorganisation (Prof. Schulz)

**Dai Yang, M. Sc.**

FMI Raum 01.04.036,

Tel. +49 89 289 18450

d.yang@tum.de



**Bundesministerium  
für Bildung  
und Forschung**

