

I. IDENTIFICATION DATA

Thesis title:	Computation scheduling in neural network inference on embedded hardware
Author's name:	Eldar Iosip
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Dept. of Computer Science
Thesis reviewer:	Petr Pošík, Ph.D.
Reviewer's department:	Dept. of Cybernetics

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	extraordinarily challenging
<i>How demanding was the assigned project?</i>	
The assignment required the student to analyze undocumented parts of third party code, identify the possibilities to improve the execution of computations by better scheduling of operations, and implement some example schedules. That is IMHO a very demanding task.	

Fulfilment of assignment	fulfilled with major objections
<i>How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.</i>	
Based on the thesis title and on the requirements listed in the assignment, I must state that the main goal, custom scheduling, was not fulfilled.	
<ol style="list-style-type: none"> 1) Requirement 1 wants the student to get acquainted with NN applications for autonomous vehicles (pedestrian detection, vehicle recognition). The student shall also survey the existing libraries and existing trained models for these applications. This requirement is fulfilled by sections 2 and 3, although I would expect more focus to particular trained models and automotive applications. 2) Requirement 2 wants the student to create a data flow graph for several trained models and compare them. The graphs shall be useful for the scheduling. I consider this requirement fulfilled to a very small extent only. There is only a single data flow graph describing the YOLO model (Fig. 6.3), but no discussion of existing data flow graphs, nor their comparison from the scheduling point of view. 3) Requirement 3 expects the student to extend at least 2 different libraries with the support for scheduling. Several different schedules should have been created and tested. I consider this requirement unfulfilled. The thesis does not describe any extensions/modifications of existing libraries allowing custom scheduling. I also did not see any custom schedules proposed or implemented. 4) Requirements 4 task is to create a simple framework enabling the measurements of several physical characteristics during the computation on embedded HW (computation time, energy consumption, temperatures, etc.). This requirement was fulfilled as exemplified by sections 6.3.2-6.3.4 of the thesis. 	
Most of the thesis describes the internals of TensorFlow library, which is IMHO a logical step necessary to make further progress. It simply seems that there was insufficient time to make this progress. I expect that making modifications to the internals of a library like TensorFlow may require a significant effort in compiling the final product and installing and configuring all the dependencies. It is well possible that the student spent a lot of time by solving these issues, and the lack of time to make further progress is the consequence of this. The thesis also makes an impression that the actual scheduling was never a part of it; the scheduling is mentioned only as a future work, already in the introduction. If the thesis supervisor confirms that he agreed on reduced requirements with the student due to these issues, the evaluation of this point shall be changed accordingly.	

Methodology	correct
<i>Comment on the correctness of the approach and/or the solution methods.</i>	
The methodology chosen to fulfill the thesis goal is IMHO correct, only the required time is longer than expected.	

Technical level

C - good.

Is the thesis technically sound? How well did the student employ expertise in the field of his/her field of study? Does the student explain clearly what he/she has done?

The main part of the thesis, sections 4 and 5 describing the individual parts of TensorFlow toolchain, are IMHO elaborated very well, and make the impression that the student understands the internals, and is able to describe them clearly and systematically. On the other hand, this proves his analytical (or reverse engineering) skills; other software engineering or programming skills remain unclear.

Formal and language level, scope of thesis

B - very good.

Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?

The thesis is written in a very good English, with only a few typos. The content is presented well and has a logical structure. The only exception is Sec. 6, which made a messy impression to me.

The text contains some wrong references to sections ('??' on pages 9, 21, and 39). Table 6.1 on page 29 also makes the impression that the lines for Modes 1 and 3 are not formatted correctly.

Selection of sources, citation correctness

C - good.

Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?

I did not find any violation of citation ethics. The thesis contains list of references and provides ample links to online sources throughout the text in the form of footnotes. My only objection is that a lot of items in the list of references are incomplete (not clear whether it is a conference or journal article, who is the publisher, etc.).

Additional commentary and evaluation (optional)

Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.

Please insert your comments here.

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

Summarize your opinion on the thesis and explain your final grading. Pose questions that should be answered during the presentation and defense of the student's work.

The part of the work documented in the thesis text makes a good impression. My evaluation is mostly based on the fact that I consider a large part of the assignment unfulfilled or fulfilled only partially. In this respect, I suggest to base the final decision more on the evaluation of the thesis supervisor. If he confirms that he and the student agreed on a reduction of the requirements during the project, and that the work is valuable in its present state, I have no problem with changing my evaluation. Since I am currently not aware of any such agreement, I must decide as follows.

The grade that I award for the thesis is **E - sufficient**.

Question: The thesis topic assumes that the execution of the computations may be actually improved by providing a custom schedule. Could the student provide some particular examples of cases where a changed schedule may result in an improvement, either with respect to speed, or with respect to energy consumption?

Date: **23.1.2020**

Signature: Petr Pošík