

I. IDENTIFICATION DATA

Thesis title:	Neural Network Cascades to Incorporate Domain Knowledge for Hematopoietic Cell Classification
Author's name:	Jonas Nienhaus
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Collaboration of Institute of Imaging & Computer Vision, RWTH, and FEE
Thesis reviewer:	Jan Kybic
Reviewer's department:	Department of Cybernetics

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	challenging
<i>How demanding was the assigned project?</i>	
The candidate had to master deep learning techniques and tools, work with large datasets and perform a large number of experiments. The hypothesis being tested, i.e. whether it is better to employ one complex multiclass classifier or a hierarchy of simple classifiers, is an open research question.	

Fulfilment of assignment	fulfilled
<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>	
The thesis contains a very detailed introduction and state of the art description, as well as a large number of well documented and well discussed experiments relevant to the hypotheses being tested.	

Methodology	correct
<i>Comment on the correctness of the approach and/or the solution methods.</i>	
Recent state of the art techniques are employed. My only comment is about the "forwarded features" in Section 4.9.1, which are connected late in the network structure (close to the output) - I would be interested to know whether it might be more advantageous to use them in earlier layers.	

Technical level	A - excellent.
<i>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?</i>	
Judging from the textual description, the student mastered the employed techniques perfectly. (I did not examine the code.)	

Formal and language level, scope of thesis	A - excellent.
<i>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?</i>	
The thesis is written very clearly and in a very good English, it is well structured. The introduction and state of the art description are very good, suitable for almost any reader. For readers knowledgeable in the field, they could be shortened.	

Selection of sources, citation correctness	A - excellent.
<i>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>	

For a Master thesis, the bibliography is very extensive. The citations in the main text are sufficient. More references to existing work could be given in the introductory part.

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.

I liked the thesis very much, the student approached his task very thoroughly and with great diligence. The research question – whether a cascade of simpler classifier would perform better than one complex flat multiclass classifier – is far from trivial and the candidate made a true contribution by showing that a flat multiclass classifier works better. This negative result might be disappointing after all the effort invested into building cascade classifiers but I very much appreciate the scientific honesty of reporting it anyway. In a future work, it might be interesting to investigate, in what situation would cascade classifiers actually provide a better performance. [Results from the literary (e.g. Babbar, NIPS 2013) indicate that cascade classification works better if the dataset is balanced, if there are no rare classes.]

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.

This is one of the best theses I have reviewed – it is well written and shows a large amount of work which has been performed. The student has shown his very good understanding of state of the art methods and his ability of applying them to a real problem. The main contribution of this work is an extensive set of experiments comparing the performance of different configurations of cascade multiclass classifiers.

Questions:

1. Why were the “forwarded features” (Section 4.9.) not connected to earlier layers of the networks?
2. Can you compare the time complexity of learning the cascade versus flat classifiers? Do the simpler classifiers from the cascade exhibit less variance (i.e. more robustness) compared to the flat monolithic network?

The grade that I award for the thesis is .

Date: 13.11.2020

Signature: Jan Kybic