



SUPERVISOR'S OPINION OF FINAL THESIS

I. IDENTIFICATION DATA

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| Thesis name: | Bayesian Learning of Binary Neural Networks |
| Author's name: | Tejas Bhatnagar |
| Type of thesis : | bachelor |
| Faculty/Institute: | Faculty of Electrical Engineering (FEE) |
| Department: | Department of Cybernetics |
| Thesis supervisor: | Shekhovtsov Oleksandr Mgr., Ph.D. |
| Supervisor's department: | Department of Cybernetics |

II. EVALUATION OF INDIVIDUAL CRITERIA

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| Assignment | challenging |
| <i>Evaluation of thesis difficulty of assignment.</i> | |
| <p>The assignment was chosen after a discussion with the student: a more theoretically oriented one with a perspective of publication. It combines two topics beyond the bachelor program: binary neural networks and Bayesian learning. At the same time it was feasible because the methods were prepared and the main task was to re-derive them for own understanding, implement and compare in a small synthetic experimental setup. Part 2 of the assignment and the analysis of the cold posterior effect could be extraordinary challenging, depending on the depth of exploration.</p> | |

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| Satisfaction of assignment | unfulfilled |
| <i>Assess that handed thesis meets assignment. Present points of assignment that fell short or were extended. Try to assess importance, impact or cause of each shortcoming.</i> | |
| <p>The thesis satisfies the assignment minimally. No comparison was conducted even for the baseline methods (maximum likelihood and Bayesian predictive by exhaustive enumeration), which are rather straightforward to implement. Variational methods were not implemented. The plan for the experiments was to make randomized draws from the synthetic model and perform a statistical comparison of methods, this is missing altogether. The reason, I believe, is that Tejas had many other goals, and probably have achieved something else. Importantly, he did not complete the DLE course, where many elements needed for the project were taught. Altogether, he seemed never dived into the problem to understand it comprehensively, and apparently the opportunity which this project was in the beginning has turned into a 'suffering'.</p> | |

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| Activity and independence when creating final thesis | D - satisfactory. |
| <i>Assess that student had positive approach, time limits were met, conception was regularly consulted and was well prepared for consultations. Assess student's ability to work independently.</i> | |
| <p>The student did had a positive approach. We had regular consultations on the literature, methods, derivation of Variational Bayesian learning. I believe though he could not devote enough time to it to keep all the concepts in the head and was often coming to consultations unprepared. The most progress was achieved when he was actually at the office and I was helping with coding or derivation. The final thesis contains an overview of common methods for training binary neural networks, which was not a prerequisite for the work. , but is a positive initiative.</p> | |

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| Technical level | C - good. |
| <i>Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.</i> | |
| <p>The thesis presents a derivation of Variational Bayesian learning and its mixture extension, which requires knowledge in optimization, pattern recognition, statistics and deep learning. However the work is oftentimes inaccurate and incomplete, in particular the general notion of Bayesian learning is not introduced.</p> | |

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| Formal and language level, scope of thesis | D - satisfactory. |
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Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.

The formal notation is often used with typos and mistakes. It is clear that the thesis was rushed with no time to verify correctness and polish the language. For example, the Bayes Theorem in formula (3.11) lacks the prior. For example, "the log likelihood of this probability" is an unclear use of formal notions in the text.

Selection of sources, citation correctness

E - sufficient.

Present your opinion to student's activity when obtaining and using study materials for thesis creation. Characterize selection of sources. Assess that student used all relevant sources. Verify that all used elements are correctly distinguished from own results and thoughts. Assess that citation ethics has not been breached and that all bibliographic citations are complete and in accordance with citation convention and standards.

Positive: some additional sources were used for the overview of binary neural network training methods.

Negative:

- The papers we discussed in detail during consultations (e.g. Blundel et al. Weight Uncertainty in Neural Networks, Graves: Practical Variational Inference for Neural Networks) are not discussed.
- Reference [13] is not relevant for the project and is cited incorrectly as designing special architecture, which it is not.
- The assignment text says that Meng et al [8] have a critical flaw in their experiments, rendering the method as not Bayesian learning (we have discussed). The thesis just happily lists [8] as Bayesian in 2.4.4. and uses it in 4.1 (as Khan et al.) to draw some conclusions.
- The mixture algorithm is not motivated, in particular the discussed works on learning an ensemble are not cited.

Additional commentary and evaluation

Present your opinion to achieved primary goals of thesis, e.g. level of theoretical results, level and functionality of technical or software conception, publication performance, experimental dexterity etc.

III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

In the project task we were aiming for an excellent research-level work but ended up with a thesis barely getting over the satisfactory threshold. It is not clear whether it was the complexity of the topic or the lack of efforts on the side of the student that led to this. I will therefore recommend not the worst grade and abstain from questions.

I evaluate handed thesis with classification grade **D - satisfactory**.

Date: **24.8.2022**

Signature: