

## I. IDENTIFICATION DATA

<b>Thesis name:</b>	Axion-Like-Particle Search Using Machine Learning for the Signal Sensitivity Optimization with Run-2 LHC Data Recorded by the ATLAS Experiment
<b>Author's name:</b>	Ondřej Matoušek
<b>Type of thesis :</b>	bachelor
<b>Faculty/Institute:</b>	Faculty of Electrical Engineering
<b>Department:</b>	Department of Cybernetics
<b>Thesis reviewer:</b>	Boris Flach
<b>Reviewer's department:</b>	Department of Cybernetics

## II. EVALUATION OF INDIVIDUAL CRITERIA

<b>Assignment</b> <i>Evaluation of thesis difficulty of assignment.</i>	<b>ordinarily challenging</b>
Overall, the level of difficulty of the task was normally challenging. On the one hand, the application domain required the student to become familiar with the basics of particle physics and the specifics of hadron collision detectors. On the other hand, the machine learning concepts required to solve the task, were moderately challenging.	
<b>Satisfaction of assignment</b> <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>	<b>fulfilled</b>
The submitted thesis meets the task assignments.	
<b>Method of conception</b> <i>Assess that student has chosen correct approach or solution methods.</i>	<b>correct</b>
The proposed method is technically correct, however, with minor exceptions. It remains unclear for me, whether the used network architecture is already optimally chosen. The thorough analysis of the trained model is on the other hand very convincing.	
<b>Technical level</b> <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>	<b>B - very good.</b>
The technical level of the thesis is adequate.	
<b>Formal and language level, scope of thesis</b> <i>Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.</i>	<b>B - very good.</b>
The thesis is in most parts well structured and clearly written.	
<b>Selection of sources, citation correctness</b> <i>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.</i>	<b>B - very good.</b>
The references are adequate. Existing work is clearly distinguished from own results of the student.	

#### 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.*

The presented thesis is mostly well written, clearly structured and technically correct. However, there remain a few open questions and issues.

- (1) Is the analysis of the feature distributions (section 4.3.1) used in the design of the classifier network?
- (2) The proposed network is essentially a binary classifier. Why are you using two outputs, softmax and cross entropy? Equivalently, you could use one output, sigmoid and binary cross entropy.
- (3) The presented learning curves (figure 4.6) show no overfitting and at the same time quite large loss values. Have you tried to use larger architectures?
- (4) What do you mean by "optimising the capabilities of a (trained) classifier"? (section 4.4.2)
- (5) It might seem that computing Shapley values for individual features will require re-training of the network for different feature combinations. How is this avoided?
- (6) Do you see a way how to formalise the task of model optimisation w.r.t. additional object states (here signal mass) which are available at training time but are not part of the classifier input?

### III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

*Summarize thesis aspects that swayed your final evaluation. Please present apt questions which student should answer during defense.*

The thesis presented by Ondřej Matoušek clearly and without any doubts fulfils the criteria of a bachelor graduation work.

I evaluate the submitted thesis with classification grade B - very good.

Date: 6.6.2023

Signature: Boris Flach