

## I. IDENTIFICATION DATA

<b>Thesis title:</b>	<b>Active Learning for Semantic Segmentation of Point Clouds</b>
<b>Author's name:</b>	<b>Aleš Kučera</b>
<b>Type of thesis :</b>	бачнейор
<b>Faculty/Institute:</b>	Faculty of Electrical Engineering (FEE)
<b>Department:</b>	Department of Cybernetics
<b>Thesis reviewer:</b>	Ruslan Agishev
<b>Reviewer's department:</b>	Department of Cybernetics

## II. EVALUATION OF INDIVIDUAL CRITERIA

<b>Assignment</b>	challenging
<i>How demanding was the assigned project?</i>	
<p>The work on the thesis assignment required from the student to have knowledge in such fields as semantic segmentation of point clouds and active learning. The student should not only to have general theoretical background in the topics, but also to apply them to real engineering tasks. The following main skills were needed: processing of sensory data (lidar point clouds), usage of deep learning frameworks to train neural networks for semantic segmentation, applying coordinate transformations, probability theory to implement uncertainty based data selection strategies.</p>	

<b>Fulfilment of assignment</b>	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>	
<p>The primary goal of the thesis was completed. The active learning strategy is implemented that allows to select most informative point cloud regions to reduce the labeling effort. The strategy is a novel method introduced in the thesis. Required comparison experiments were conducted that demonstrate performance of the method not only with a baseline strategy (random data samples selection), but also with the SOTA method (ReDAL [18] in the thesis). The methodology describing the introduced in the thesis (called Viewpoint Variance) approach is given in the "Methods" section. The "Experiments" section provides experimental setup and results description. The Viewpoint Variance outperforms the random selection point cloud regions (baseline) due to the informed data selection strategy which takes into account scene objects observability from different view-points. It also shows promising results being bench-marked along the ReDAL on large-scale automotive data set KITTI-360. The results are also provided on another data set, Semantic KITTI. However, the benefit of the method is less obvious there. One reason for this conclusion could be a less precise localization data (provided by lidar SLAM, SuMa) comparing for example to KITTI-360 (uses global scene optimization and loop closures). The accurate localization is required for the Viewpoint Variance method to work due to the semantic information fusion obtained from different sensor poses (view-points).</p>	

<b>Activity and independence when creating final thesis</b>	A - excellent.
<i>Assess whether the student had a positive approach, whether the time limits were met, whether the conception was regularly consulted and whether the student was well prepared for the consultations. Assess the student's ability to work independently.</i>	
<p>From the beginning of the work on the thesis, regular weekly meetings were established to monitor the progress as well as to discuss next steps to achieve long- and short-term goals. The student was prepared for each meeting and always had relevant questions and suggestions on how to proceed. The work was done gradually without major delays. The bachelor thesis project topic was discussed and have chosen based on the student's background (internship work that he has completed during summer) and motivation. The student has developed his skills as machine learning engineer. He has proven to be able to debug and find solutions during neural networks training and implementing the active learning pipeline by himself. Additionally he demonstrated his ability to work and select appropriate tools (Pytorch libraries and open-source state-of-the-art methods like ReDAL [18] and Superpoints [23])</p>	

**Technical level**

A - excellent.

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

Although before completion of the thesis several topics related to the project were new to the student (data selection strategies in active learning, point cloud clustering techniques), he was able to learn the necessary theory and apply the expertise to the assignment. Additional tools for progress tracking and documentation were used during the work on the project (like the version control system GitHub). This turned out to be a good practice for the student to communicate intermediate progress. As a part of the thesis submission, the code is released as open source.

**Formal level 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 student proved to have reasonable English writing skills. The necessary technical terms were used in a correct way and in a proper context. All required components and conducted experiments were described, as well as a description of state-of-the-art works and motivation to tackle the problem were given in the thesis. The summary of the work is given in the Introduction section. The theoretical background is given at the beginning of the thesis. It is followed by description of the relevant works. This section could be expanded and the relevant works influence on the thesis could be elaborated more in the supervisor's opinion. However, the contributions are clearly stated and the novel active learning data selection strategy (introduced in the thesis) is described.

**Selection of sources, citation correctness**

A - excellent.

*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?*

The thesis is inspired by the ViewAL [5] work. However, a different data selection strategy is built upon and applied to different sensor data type (point clouds instead of RGB-D images). The relevant works were cited for each sub-topic involved in the project. In general, the bibliographic citations meet the academic writing standards. Relevant previous work on the topic, their scope, limitations, and usage in the thesis are discussed in the "Related Work" section.

**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.*

The student showed to have proper personal motivation and dedication to work on the project. Possible future work on the project was discussed, and a publication target was established.

### 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.

The grade that I award for the thesis is A - excellent.

Date: 2.6.2023

Signature:

## I. IDENTIFICATION DATA

<b>Thesis title:</b>	Active Learning for Semantic Segmentation of Point Clouds
<b>Author's name:</b>	Aleš Kučera
<b>Typ of thesis:</b>	bachelor
<b>Faculty/Institute:</b>	Faculty of Electrical Engineering (FEE)
<b>Department:</b>	Department of Cybernetics
<b>Thesis reviewer:</b>	Ing. Michal Neoral
<b>Reviewer's department:</b>	Department of Cybernetics

## II. EVALUATION OF INDIVIDUAL CRITERIA

<b>Assignment</b>	<b>CHALLENGING</b>
<i>How demanding was the assigned project?</i>	
The assignment presented for review is notably <b>challenging</b> for a bachelor thesis, and its level of complexity would be suitable even for a master's thesis. The chosen topic, focusing on the optimal selection of point cloud data samples, addresses an important problem within the field.	

<b>Fulfilment of assignment</b>	<b>FULFILLED WITH MINOR OBJECTIONS</b>
<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 <b>satisfactorily fulfils the assigned task overall</b> . Most of the primary goals have been achieved, with adequate coverage of the assigned tasks. However, <b>one specific goal</b> , namely "Use of localization data to provide consistent predictions for objects observed from different positions", <b>has not been fulfilled</b> . It is difficult to determine the significance of this unfulfilled task in relation to the overall goals of the thesis without further context. Nevertheless, all other assigned tasks have been adequately addressed, indicating a solid level of completion and adherence to the assignment requirements.	

<b>Methodology</b>	<b>CORRECT</b>
<i>Comment on the correctness of the approach and/or the solution methods.</i>	
The approach and solution methods employed in the thesis are <b>correct and appropriate</b> . The student effectively utilized the methodology outlined in the assignment, including the suggested matrices and the evaluation of models. The description of the matrices and evaluation process is accurate and well-documented.	

<b>Technical level</b>	<b>A - EXCELLENT</b>
<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>	
The thesis is technically sound, with <b>no notable issues</b> . The student demonstrates a commendable level of expertise in their field of study, effectively applying their knowledge and skills to address the research problem. The explanations provided by the student are clear, allowing for a thorough understanding of the work conducted.	

## Formal and language level, scope of thesis

**C - 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 showcases language that is both **clear and easily understandable**, with a **high level of English** proficiency.

However, there are some concerns regarding the organization of the thesis. While the language used is generally clear, there are instances where the splitting of text and figure descriptions appears chaotic. For example, in Section 6.1, part of the figure description is provided, but the usage of such description is not referenced in Figure 6.3. Additionally, more than **half of the figures and tables are not referenced in the text**. Although the reader can infer their relevance from their placement, the lack of explicit references adds unnecessary effort and confusion.

The thesis is divided into seven chapters, but this division does not contribute effectively to the overall readability. The "Related work" chapter is short, and fragments of text that would be more appropriately placed within this section are dispersed throughout other chapters, undermining the clarity and logical organization of the thesis.

Therefore, while the language proficiency is satisfactory, there is a need for improvement in terms of properly referencing figures and tables, ensuring coherent placement of figure descriptions, and reorganizing the content to enhance overall readability and logical flow.

## Selection of sources, citation correctness

**B - VERY 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?*

The thesis lacks adequate reference to earlier work on the topic (short *Related works*), leaving out the wider context and failing to distinguish the student's original work from existing research in the field. While the selection of sources is generally sufficient, especially for references that mention reputable journals or conferences, there is a need for improved referencing to provide a more comprehensive understanding of the research landscape. The bibliographic citations generally meet the required standards. However, **some citations only include authors' names and titles**, making it difficult to assess the quality of the source without further investigation. Enhancing the referencing to include more detailed bibliographic information would improve the overall quality and credibility of the thesis.



# THESIS REVIEWER'S REPORT

## 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 thesis successfully fulfils the assigned task, with satisfactory completion of goals and adequate coverage of assigned tasks. The approach and solution methods employed in the thesis are correct, and the student demonstrates expertise in their field of study. The technical level of the thesis is sound, showcasing a solid understanding and application of relevant concepts. However, there are areas for improvement in terms of the scope and organization of the thesis. The referencing of earlier work on the topic could be enhanced. Overall, the thesis shows promise but would benefit from addressing these areas to enhance its overall quality and impact.

### Questions:

- What are the reasons for not fulfilling assignment task (f)?
- Why is there a lack of discussion regarding this matter in the text?

The grade that I award for the thesis is **B - VERY GOOD**.

Date: 5th June 2023

Ing. Michal Neoral