

Assessment of the bachelor thesis by Nikita Sokovnin

## Recognizing Unknown Objects for Open-Set 3D Object Detection

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The goal of the thesis was to investigate the detection and recognition of unknown objects in an open-world setting. It is an important and challenging problem in machine learning, much less studied than object detection and recognition in a closed-world setting. The thesis focuses on a particular scenario when a standard pre-trained object detector provides individual observations clustered in 3D and analyzed to study, formulate, implement and test unknown object detection.

The thesis presents four contributions. First, the thesis reviews several approaches to representing observations of objects of unknown classes and gives an operational definition of unknown. Secondly, YOLACT, a state-of-the-art object detector, is investigated. It is shown that the background class, which is not used in the standard use, is useful but not always sufficient for detecting unknown objects. Furthermore, it has been observed that more complex patterns in YOLACT output may also indicate that the observed object has not been seen during the YOLACT training. Third, the thesis constructs a complete pipeline for data augmentation based on 3D reconstruction, agent motion simulation, and image rendering. It shows that the data augmentation based on simulation can be used to provide training data for updating YOLACT when a new class is encountered. Finally, an "unknown object" classifier is proposed and evaluated on a new real data set. It is demonstrated that unknown objects can be detected and that YOLACT detector can be updated to learn new classes with almost no human supervision.

Nikita Sokovnin was a very motivated, capable, and hard-working student. He was able to review a large body of literature and extract key principles. He mastered many different tools from object detection and machine learning, and 3D vision. He implemented a functional data augmentation and training pipeline for 3D object detection and unknown object classification, and YOLACT detector update. This is going beyond a standard BSc thesis.

Nikita Sokovnin presented professional research work and fulfilled all the goals set in the assignment. He mastered advanced techniques in the field and contributed several new results.

I believe that this work is *excellent (A)*.

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