Using scores from the model architecture for unknow object detection in autonomous driving: Preliminary results

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Abstract. For robots to successfully perform assigned tasks in uncontrolled environments, having a perception system that can provide information beyond encountered scenarios is crucial. The main goal of the object detection learning phase is to find a model that can detect objects across a range of context by combining information within labeled data. The model generates a large number of object proposals that we filter to obtain the best detections. However, there is still valuable information within unselected proposals. To make this information available for other systems, a first approach could be to use the scores from the model architecture, that contain meaningful information. Those valuable insights can be use to make more informed decisions for controlling robots. They can also help to guide the learning phase towards a model that achieves superior performance in unpredictable environments.

1 Introduction

In robotics and specifically in autonomous driving application, the perception and the control systems are often separated. The goal of the perceptions is to transform raw data from sensors into meaningful information, which are used by control systems to perform tasks in the best possible way. The effectiveness of the task is heavily correlated with the quality of information provided by the perception system. To have a robot that can successfully perform in an open environment that is much more complex than a controlled lab, we need perception systems to handle new events outside of the scope of what it has seen during development and learning phases. In object detection, this task is ensured by the model that should generalize on available labeled data. However, a significant drop in performance can be observed when object detectors are used with new objects [2]. Showing that current models does not generalise well enough to detect unknow objects.

A closely related work entitled ORDER [5] addresses the problem of detecting unknown objects in real-world road scenes. Based on the ORE (Open World Object Detector) method [1], which is a modification of the Faster R-CNN architecture using contrastive clustering and self-labeling, the approach improves the detection of small known and unknown objects or when there are intra-class bounding box scale variations.

Konan *et al.* [3] use the one stage FCOS architecture. The avantage of the separation between the localization and classification within the model make it easier for open-world object detection. By incorporating an IOU score into the head predictions and masking the unknown objects, they were able to improve recall for novel classes.

We present a preliminary work that tackles the problem of detecting unknown objects by using scores generated by the FCOS architecture. This model and its advantages [3] make it easier than the one proposed by ORDER [5] to implement open world detection.

2 Method

Due to the variety of object sizes and the quantity of small objects in autonomous driving scene, we use the FCOS [4] architecture based on RetinaNet. This state-of-the-art object detector is anchor-box free and uses pyramidal feature maps that allow the detection of multi-scale objects. It is also well suited for open world detection [3]. This model does not use anchor boxes

Fig. 1: Illustration on 4 differents images using our method, the green boxes are the proposal with a high centerness score but a low class score, thus classified as unknown objects

but generates bounding box proposals for each element of the feature map. Each proposal includes box coordinates, a classification score, and a centerness score provided by the neural network head. One particularity of this model is the use of a centerness score to improve the selection of object proposals. To measure the centerness of a proposal, FCOS uses a score that measures the spatial distance between a pixel and the center of the object it represents. The filtering of the best object proposal is done by multiplying the centerness with the classification score. This centerness has the characteristic of being class free (all objects are treated independently from their semantics). It represents the quality of the box proposal to be on the center of the object. Our work is based on the assumption that we can use this centerness score to detect new objects. Assuming the model accurately extends the concept of centerness to all objects, we could infer the presence of an object in any area with a high centerness score. Subsequently, the classification score will indicate whether the object is a known entity or a novel object that should be classified as unknown.

In our firsts experiments, the proposed method was able to detect some unknown objects (as illustrated in Figure 1), indicating that centerness score can potentially help to detect novel objects and categorize them as known or unknown. However, the centerness score was not originally intended for this purpose so it is insufficient. To improve this score, additional data augmentation methods could be implemented, such as introducing randomly placed objects on the road (from datasets or simulation). Alternatively, new score metrics that are not class dependent, such as geometric scores that have been previously used in object detection before the era of neural networks, could be incorporated.

3 Conclusion

We have presented a preliminary work on using scores from the model architecture to detect novel objects in autonomous driving. Our work presents a promising direction towards improving the perception systems of autonomous robots in uncontrolled environments. By using the unknown object detect and their corresponding scores, we could add knowledge to the model, thus improving the learning phase. Those new informations could also affect the control systems of robots, allowing them to make better decisions.

References

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