# ESTIMATING UNCERTAINTY USING GENERATIVE MODELS IN OBJECT DETECTION

**H.J.M., van Genuchten**
ID: 1297333
Artificial Intelligence and Data Engineering Lab
Eindhoven University of Technology
h.j.m.v.genuchten@student.tue.nl

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**ABSTRACT**

Write abstract

## 1 Overall aim and goals

- Create a generative model to model the uncertainty of various scenes
  i.e. Detecting weird combinations of objects within a scene
- Use uncertainty to make more efficient use of human labelers.
- Design a system which can make efficient use of uncertainty of previous stages.

### 1.1 RQ

Current Ideas for possible RQs

- Is uncertainty a good indicator for active learning?
- Is uncertainty a good indicator for relabeling?
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### 1.2 Motivation and Challenges

Artificial Intelligence solutions are increasingly put in new and challenging scenarios. Yet, often AI models are only able to give a distinction between a small set of answers even when the actual answer is outside of this set or the model has never seen anything like it before, and will gues an answer . Uncertainty Quantification (UQ) can enable a system to detect when a prediction might be of lesser quality, and allow it to preemptively react to that. Either by stopping or requesting human intervention. Furthermore, understanding when models are uncertain, allows for more effective data sampling and labeling by making use of active learning schemes . The later is especially useful in industries where labeling is expensive or timeconsuming. .

Add citation

Add citation of OoD

Add citations active learning usage

Add citation of label cost

Uncertainty Quantification is especially difficult in the case of Object Detection. It requires both localization (often by using regression) and classification [5].

### 1.3 Broad Literature Analysis

This project covers broader research areas, each will be covered separately in subsections 1.3.1 and 1.3.2. Related work in the combination will be described in subsection 1.3.3

### 1.3.1 Uncertainty Quantification

The ability to distinguish certain and uncertain outputs from machine learning models is useful for various reasons. It can be used for active learning [10, 8, 1], which makes better use of limited labeling capacity.

[4] distinguishes two kinds of uncertainty. Aleatoric uncertainty, the uncertainty that is caused by imprecise input data (i.e. $x$) and epistemic uncertainty, the uncertainty that is caused by the model.

Neural Networks (NN) have proven to be excellent at a broad range of tasks. However with

Uncertainty Quantification (UQ) is an important factor to increase the trust in automated processes based on machine learning. Their exist a various amount of methods both post-hoc and built-in .

Reliable uncertainty estimation of Artificial Intelligence Models is important in safety critical situations. Expressing explicit uncertainty with Deep Neural Networks (DNN) can

Add post-hoc citations

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### 1.3.2 Object Detection

There are two main paradigms within Object Detection, One-Stage [11, 2, 9] and Multi-Stage detectors [7, 6]. Single stage detectors directly detect a set of bounding boxes and their respective classes, whereas Multi-Stage detectors often first identify interesting patches which are then classified.

Expand difference between one-stage and multi-stage

DiffusionDet: [3]

### 1.3.3 In combination

The combination of Uncertainty Quantification and Object Detection is especially difficult as Object Detection is both a regression and a classification task.

Describe the multi-faceted problem (i.e. both classification and regression)

[5]

Distinction between backbone and head, and some examples

## 1.4 Formulation of the problem and objectives

Let $x \in \mathbb{R}^{HxWxC}$ be the input image which contains objects $O_i$, which are a combination of a bounding box coordinates: $B_i = (x_{center}, y_{center}, x_{width}, y_{height})$ and a class $c \in C$. Our goal is to create a probabilistic model which

[5]

Talk about "bag of freebies", these allow for better accuracy for the same inference speed at the cost of training time

Formulate model

Formulate (uncertainty) Metrics

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