State of the Art This chapter will discuss the 3D LiDAR datasets available and classify them based on the type of a
Among 3D LiDAR datasets, [?] classifies the available public datasets into three classes based on the data acquisiti

Typically static datasets produce highly dense point clouds leading to rich geometric representations.
The last type of 3D LiDAR dataset is the synthetic dataset. As the name suggests, these datasets are generated fro
The datasets belonging to each acquisition type are summed up in Table ??. Most of the datasets from Table ?? ar

[h!]

| acquisition mode | dataset | frames | total points (in million) | classes | scene type |
|---|---|---|---|---|---|
| 7*static | Oakland[?] | 17 | 1.6 | 44 | outdoor |
| | Paris-lille-3D[?] | 3 | 143 | 50 | outdoor |
| | Paris-rue-Madame[?] | 2 | 20 | 17 | outdoor |
| | S3DIS[?] | 5 | 215 | 12 | indoor |
| | ScanObjectNN[?] | - | - | 15 | indoor |
| | Semantic3D[?] | 30 | 4009 | 8 | outdoor |
| | TerraMobilita/IQmulus[?] | 10 | 12 | 15 | outdoor |
| | TUM City Campus[?] | 631 | 41 | 8 | outdoor |
| | DALES[?] | 40 (tiles) | 492 | 8 | outdoor |
| 7*sequential | A2D2[?] | 41277 | 1238 | 38 | outdoor |
| | AIO Drive[?] | 100 | - | 23 | outdoor |
| | KITTI-360[?] | 100K | 18000 | 19 | outdoor |
| | nuScenes-lidarseg[?] | 40000 | 1400 | 32 | outdoor |
| | PandaSet[?] | 16000 | 1844 | 37 | outdoor |
| | SemanticKITTI[?] | 43552 | 4549 | 28 | outdoor |
| | SemanticPOSS[?] | 2988 | 216 | 14 | outdoor |
| | Sydney Urban[?] | 631 | - | 26 | outdoor |
| | Toronto-3D[?] | 4 | 78.3 | 8 | outdoor |
| 1*synthetic | SynthCity[?] | 75000 | 367.9 | 9 | outdoor |

3D LiDAR dataset

We chose the Semantic3D dataset as the in-distribution (ID) training dataset from the available datasets. S3DIS is
3D Semantic Segmentation Models
This section will discuss the methods available for 3D semantic segmentation. The discussion includes a brief peek
Traditional Approach Traditional methods involve a complex feature extraction and passing these features to a clas
Deep Learning Approach Deep learning-based models are efficient at segmentation and can be divided into three ty
Let us look briefly into the point-based methods. Point-based methods usually utilize fully connected layers or trad
The other flavours of point-based methods include projection onto a d-dimensional lattice or making the point clou
In projection-based models, let us discuss the models that project the data onto a 2D range image. The first of thi
We now discuss the projection-based models which involve bird eye view projection. These models are relatively ne
Table ?? illustrates the detailed summary of each model and the number of parameters. Finally, graph neural netw
Uncertainty Estimation Methods This section will discuss existing methods to estimate uncertainty in deep neural
[?] argues that there are two kinds of uncertainties, they are epistemic and aleatoric uncertainty. Epistemic uncerta
ensembles can be found in Section ??.
Because of the higher computational complexity and resource intensiveness, there exist multiple flavours of the dee
Other methods include snapshot ensembles [?] which iterate over multiple local optima in the optimization landsca
Bayesian Methods Existing neural networks are trained in maximum likelihood, resulting in point estimates for the

Here $\theta$ represents network parameters (weights), $p(\theta)$ represents prior distribution over $\theta$, and x and y represent the inp

Here $\theta$ represents trained network parameters, x and y represent the training set, and $x_t$ and $y_t$ represent the test set. T
VI is an approximation method where the posterior probability $p(\theta|x, y)$ is approximated by specific distributions r
Another widely known example for VI is Monte Carlo Dropout (MC-Dropout), in which the dropout layers are refo
Out-of-Distribution detection This section will discuss the difference between OOD, Anomaly using an example and
OOD/Anomaly/Distributional shift [h!] 0.333 [height=0.15width=0.95]images/intro$_ood_anomaly/old_ship.jpg$ 0.333
Let us time travel back to $18^{th}$ century and assume that we had implemented a DNN model to detect ships. The d
An anomaly can be defined as the patterns that do not conform to the expected training behaviour as proposed in
In the case of OOD, the input is drawn from an unknown distribution of unknown data, which is not near to the tr
OOD Detection Methods This subsection will discuss the existing OOD detection methods for 2D classification and
The most widely used benchmark datasets for 2D classification are CIFAR-10 vs SVHN [?], CIFAR-10 vs LSUN [?]

[?] has proposed a threshold-based OOD detection method using the Mahalanobis distance as a confidence score. The M

where $h(x)$ is final layer activations, $c$ is the constant and $h^{-}(x)$ is ReAct output of $h(x)$. The score from this ReAct fu
The OOD data samples have higher uncertainty than ID samples, allowing us to use the uncertainty estimation me
In recent years, OOD detection for the task of 2D semantic segmentation has been in limelight. [?] proposes the ad