Team Name: 3D ClassifyPro

Project Title: 3D Object Classification

Project Summary: *Fill in your problem and background/motivation (why do you want to solve it? Why is it interesting?). This should provide some detail (don't just say "I'll be working on object detection")*

Our project focuses on 3D object classification using point cloud data, leveraging datasets like ModelNet. This task is motivated by the increasing importance of 3D data in various applications, such as autonomous driving and augmented reality. By implementing and building on advanced architectures such as PointNet, and using inspiration from other ideas such as PointPillars, our project aims to accurately classify objects captured in 3d environments. These architectures are known for their efficiency in processing point clouds, making them suitable for real-time applications. A successful implementation of these models can demonstrate their potential and effectiveness in real-world scenarios.

Approach: *Be specific about what you will implement and what existing code you will use. Describe what you actually plan to implement or the experiments you might try, etc. Again, provide sufficient information describing exactly what you'll do. One of the key things to note is that just downloading code and running it on a dataset is not sufficient for a description or a project! Some thorough implementation, analysis, theory, etc. have to be done for the project.*

In this project, we will implement the PointNet architecture on the ModelNet40 dataset for 3D object classification. We will start by pre-processing the dataset to format it appropriately for these models. Using existing implementations of PointNet and PointNet++, we will modify and extend the code to include additional layers and fine-tuning techniques aimed at improving classification accuracy and to determine the effect of different architectures on the accuracy. We will work on adding layers inspired from other Point cloud classification models, such as PointPillars, to learn how to integrate new designs into an existing model codebase. We will compare several different modifications to determine the impact, and we will analyze the results and compare them against baseline models. Further work will also be done to visualize the outputs intermediate layers, such as the activation maps, and convolutional kernels, and

gradient based imagery on the point clouds to see both the internals of the model and the impact of different network designs.

Resources / Related Work & Papers: *What is the state of art for this problem? Note that it is perfectly fine for this project to implement approaches that already exist. This part should show you've done some research about what approaches exist.*

The state of the art in 3D object classification has been significantly advanced by methods such as PointNet and PointPillars. PointNet, introduced by Qi et al. in their 2017 paper, revolutionized the field by directly processing raw point clouds without requiring voxelization or other preprocessing steps. PointPillars, proposed by Lang et al. in 2019, further enhanced 3D object detection by utilizing a novel encoder that converts point clouds into a pseudo-image for efficient processing. Additionally, the ModelNet dataset, introduced in Wu et al.'s 2015 paper, provides a comprehensive benchmark for evaluating 3D shape classification methods. Other notable approaches include VoxelNet, which uses a voxel-wise feature learning network, and Dynamic Graph CNN, which captures local geometric structures. These resources and papers highlight the evolution and current best practices in 3D object classification, providing a robust foundation for implementing and evaluating these cutting-edge techniques in this project.

Datasets: *This is crucial! Deep learning is data-driven, so what datasets you use is crucial. One of the key things is to make sure you don't try to create and especially annotate your own data! Otherwise, the project will be taken over by this.*

Primary dataset: ModelNet

Another possible data set from PointPillars: The KITTI Vision Benchmark Suite (cvlibs.net)

Group members: Hanyu Zhang (hzhang637@gatech.edu), Alex Hinds (ahinds9@gatech.edu), Eric Zarsky (ezarsky3@gatech.edu), Li Zhao(lzhao337@gatech.edu)