Machine Learning Engineer Nanodegree

Capstone Proposal

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Proposal

Domain Background

The project is related to automotive domain. Now a days, Self Driving Car is gaining so much popularity and many companies are proposing there ways of doing it the correct way. Predicting the driver's behavior comes handy while solving such problem. In this activity, the car mimics the driver's behavior and take actions accordingly.

A recent trend in a gear shift schedule design is to focus on better interpretation of the driver's intention and estimation of road environment[2]. Traditional gear shift schedules are typically designed as a static map on the plane of the driver command (throttle/pedal position) and vehicle speed. This project attempts to predict the gear shifts using Machine Learning by interpreting the driver's intention and the environment. It is classification problem.

Problem Statement

Driver's behavior can be inferred in many ways. One of the ways is to find out which gear should the car be driven in different circumstances. This project solves this problem by taking n number of parameters into consideration and predicting the gear position. This project uses variety of machine learning models to find out the best suited algorithm which infers the gear position in an efficient way.

Dataset and Inputs

This project will use Car Trip Data Log[2] publicly available dataset on Kaggle. This dataset contains data acquired from a driver's driving a vehicle through various conditions. The collected data will be used in an attempt to predict driver's behavior in order to improve gearbox control.

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[1] Optimal Gear Shift Schedule Design for Automated Vehicles: Hybrid System Based Analytical Approach, Chaozhe R. He, Wubing B. Qin, Necmiye Ozay, and G´abor Orosz

[2] The dataset is available at https://www.kaggle.com/vitorrf/cartripsdatamining.

Below are the features available in this dataset. Out of which Shift number is the target variable for this project. Out of these 17 features, from 2^{nd} to 8^{th} we have vehicle parameters and from 9^{th} to 17^{th} we have driver informed parameters.

Id	Feature name	Type (continuous numerical or categorical)	Data distribution (uniform or skewed)
1	Time (in seconds)	Continuous numerical	Not Applicable
2	Vehicle Speed (in m/s)	Continuous numerical	Left Skewed
3	Shift number(0 = intermediate position)	Categorical	Not Applicable
4	Engine Load (% of max power)	Continuous numerical	Left skewed
5	Total Acceleration (m/s^2)	Continuous numerical	Uniform
6	Engine RPM	Continuous numerical	Left skewed
7	Pitch	Continuous numerical	Uniform
8	Lateral Acceleration (m/s^2)	Continuous numerical	Uniform
9	Passenger count (0- 5)	Discrete numerical	Not Applicable
10	Car's Load (0-10)	Discrete numerical	Not Applicable
11	Air Conditioning Status (0-4)	Discrete numerical	Not Applicable
12	Window Opening (0-10)	Discrete numerical	Not Applicable
13	Radio Volume (0-10)	Discrete numerical	Not Applicable
14	Rain intensity (0-10)	Discrete numerical	Not Applicable
15	Visibility (0-10)	Discrete numerical	Not Applicable
16	Driver's wellbeing (0-10)	Discrete numerical	Not Applicable
17	Driver's Rush(0-10)	Discrete numerical	Not Applicable

Solution Statement

This project will attempt to predict the Gear Position based on other parameters. A multivariate LSTM network will be built that can be trained on the training data. The model will be trained to predict the Gear Position at a particular time and circumstances.

The deep learning network will be built using Keras.

Benchmark Model

This project will try to predict the Gear Position accurately above 85% of the time. This represents an ambitious but more attainable goal. Model accuracy will be judged based on predictions made on the test dataset. A Benchmarking model could not be found for this activity hence, the project will try to achieve the described metrics.

Evaluation Metrics

The evaluation metric for the model will be number of errors between original gear position and predicted one. The model will be evaluated on per class micro averaged precision and individual class precision,

1. Precision (Class 1) = TP1/ (TP1 + FP1)
2. Micro Averaged Precision = (TP1 + TP2) / (TP1 + TP2 + FP1 + FP2)

For the purposes of this project, there will be no partial credit given for identifying nearer gear position. If the gear position is not equal to the original one, it will be treated as error.

Project Design

The first stage of the project will be to download and preprocess the Car Trip Data Log. The validation of the data would be done based on time and feature plot Ex. Vehicle Speed vs Time.

Next step is to prepare the dataset for the LSTM. This involves framing the dataset as a supervised learning problem and normalizing the input variables. I will frame the supervised learning problem as predicting the gear position at the current time given the driver inputs and vehicle inputs at the prior time step.

As we will see, some of the parameters are discrete in nature, so we need to one-hot encode them before using.

Next step we will fit an LSTM on the multivariate input data. First, the data will be split into train and test sets.

We will then define the LSTM architecture with some hidden layers and a dense layer of 6 neurons with softmax activation function, categorical cross entropy loss and one of the optimizer.

After training the model for certain number of epochs. The model will be cross validated and the results would be obtained.

After acceptable results on cross validation set, the model will be tested on the test set and metrics would be obtained and visualized.