ML Noobs - Kaggle Competition Presentation

Jeffrey Feng, Yujian He, Tat-Hei Tsin, Dennis Wu

Summary

- Team Member:
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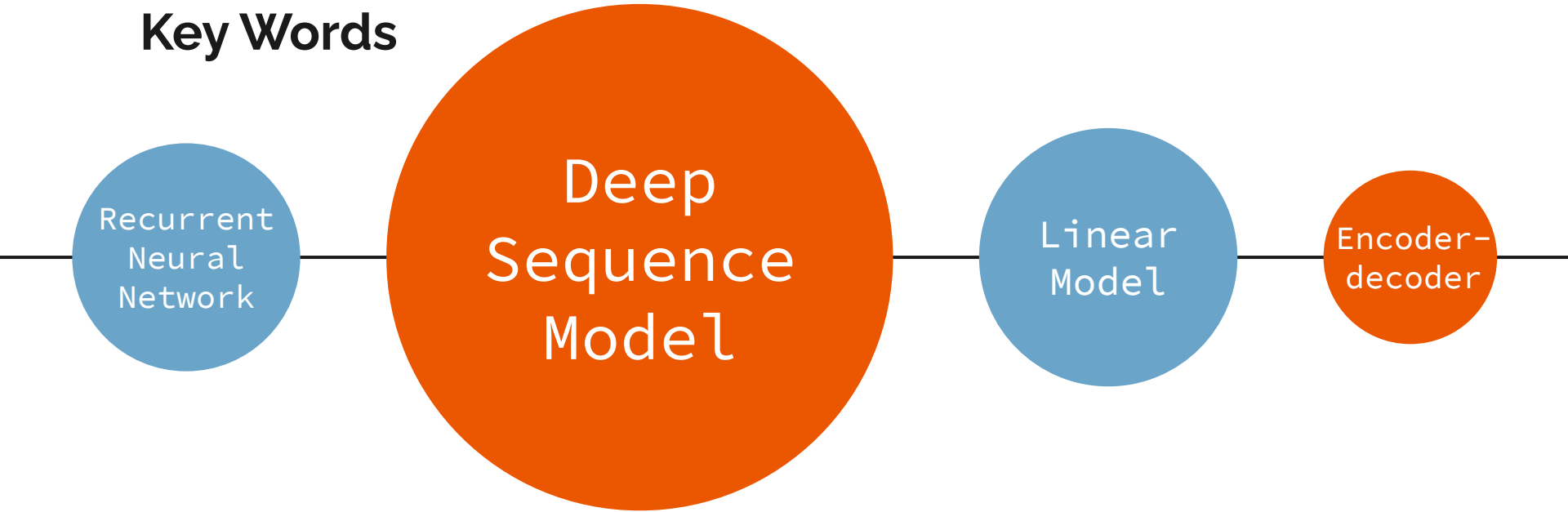
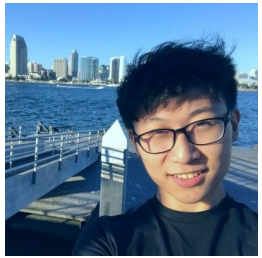
- We use linear regression as our base model to find the most efficient features, then put those features into our deep learning model later. Accuracy did not improve.
- Time Series data training using simple RNN model with different layers
- One take away: “Keep things simple” (our Linear regression is still the best solution!)

Key Words


Recurrent Neural Network
Deep Sequence Model
Linear Model
Encoder-decoder

Introduction

Team Introduction



Jeffrey Feng

- Third year student majoring in data science and cognitive science spec. ML

Yujian He

- Third year student majoring in data science and management science

Tat Hei Tsin (Dexter Tsin)

- Third year student majoring in Bioinformatics

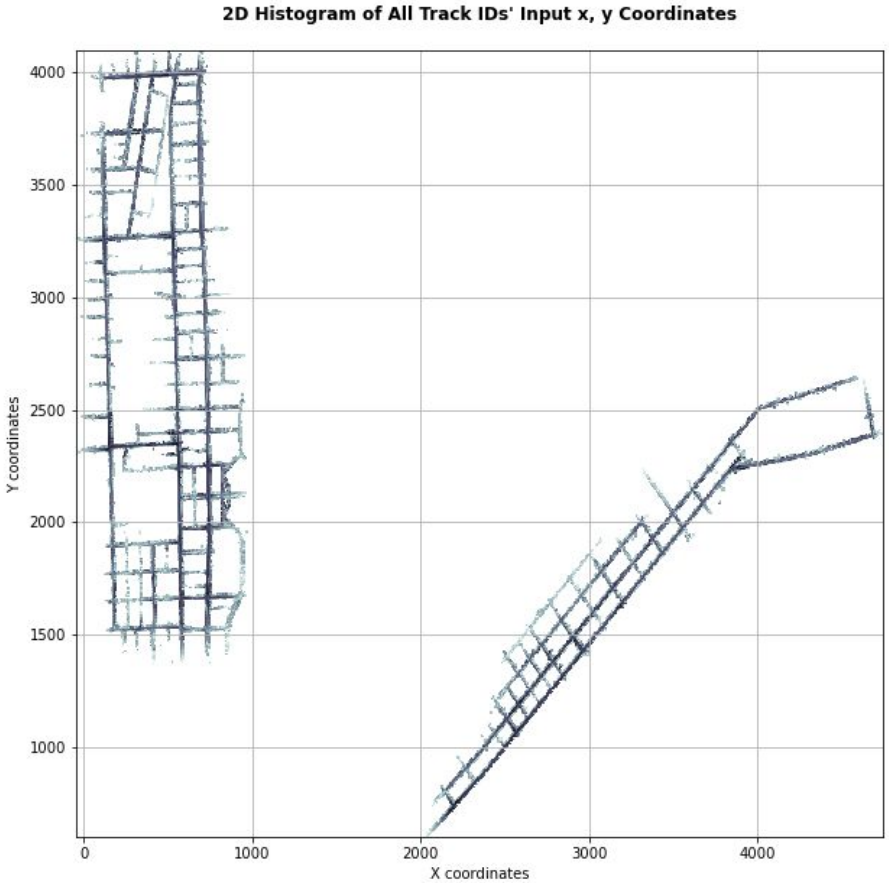
Dennis Wu

- Third year student majoring in data science

Methodology

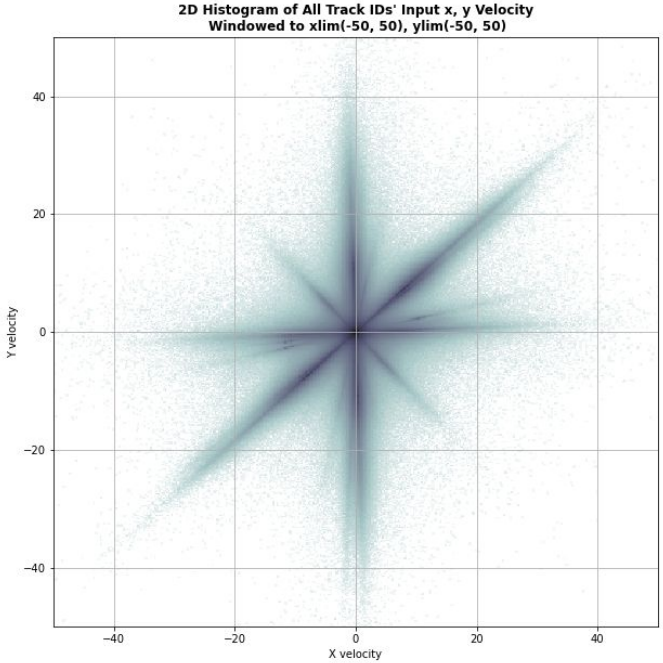
Data Processing

- We visualize the 2D map graph using the x, y coordinates of all tracks
- From the map, we can see the distribution of all agents positions

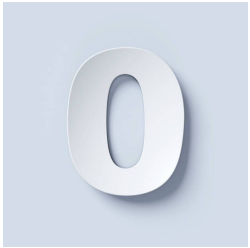


Data Processing

- This is the velocity of all agents with respect to x and y coordinates.



Data Processing (continued):



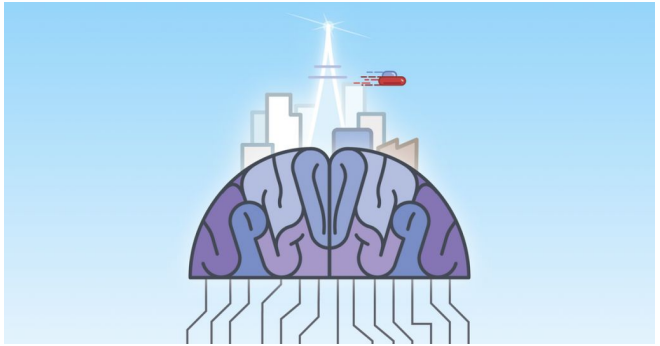
- In order to remove redundant data for more efficient implementation, for each scene, we **dropped all the car where car-mask == 0**. This lead to 1812171 instances, where we can later split into smaller batches.
- According to physics, and our validation, the x, y coordinates along should cover the weight of the velocity, which should be able to estimated by using distance difference over time, so we **did not use the velocity variables**;
- Other variables, such as the lane information, were not included in the model;

Data Processing:

- The only variables we used are the x and y locations.
- However, instead of the normalized location value or the raw location values, we find the **difference between the current location and the previous location**, resulting in (19 - 1) difference in x values, and (19-1) difference in y values;
    - We saved the initial values for x, y location for the testing data.

Deep Learning Model

- Multi-layer linear model
- LSTM
- Encoder-decoder



Deep Learning Model: multiple linear layers

- The idea is inspired by the top team presentation on Tuesday, 6/1/2021, where they used 2 linear layers with a sigmoid layer.
    - Hidden units: 36 + i -> 18 -> 6 -> 1
- We confirmed that compared with other optimizer, **torch.optim.Adam** performed the best by obtaining the fastest convergence.
- Our batch size of 512 is large, because we have 1812171 instances.

```
[Epoch 1,  3540] loss: 0.12302844
[Epoch 2,  3540] loss: 0.12289178
[Epoch 3,  3540] loss: 0.12291648
[Epoch 4,  3540] loss: 0.12286522
[Epoch 5,  3540] loss: 0.12287612
[Epoch 6,  3540] loss: 0.12283727
[Epoch 7,  3540] loss: 0.12280002
[Epoch 8,  3540] loss: 0.12282911
[Epoch 9,  3540] loss: 0.12287485
[Epoch 10,  3540] loss: 0.12282326
[Epoch 11,  3540] loss: 0.12277096
[Epoch 12,  3540] loss: 0.12275954
[Epoch 13,  3540] loss: 0.12277921
[Epoch 14,  3540] loss: 0.12274584
[Epoch 15,  3540] loss: 0.12277067
[Epoch 16,  3540] loss: 0.12278083
[Epoch 17,  3540] loss: 0.12277364
[Epoch 18,  3540] loss: 0.12275211
[Epoch 19,  3540] loss: 0.12280717
[Epoch 20,  3540] loss: 0.12276342
```

Deep Learning Model: multiple linear layers

- **Auto-regression**: used the 18 input x, 18 input y to predict the first x output, using the first linear regression classifier we have made from the training set.
- We used 19 input x (19 input from the real input, and 1 output from the prediction), 18 input y, in total 38 features to predict the first y output.
- We used 19 input x, and 19 input y, (38 features) to predict the second x output.

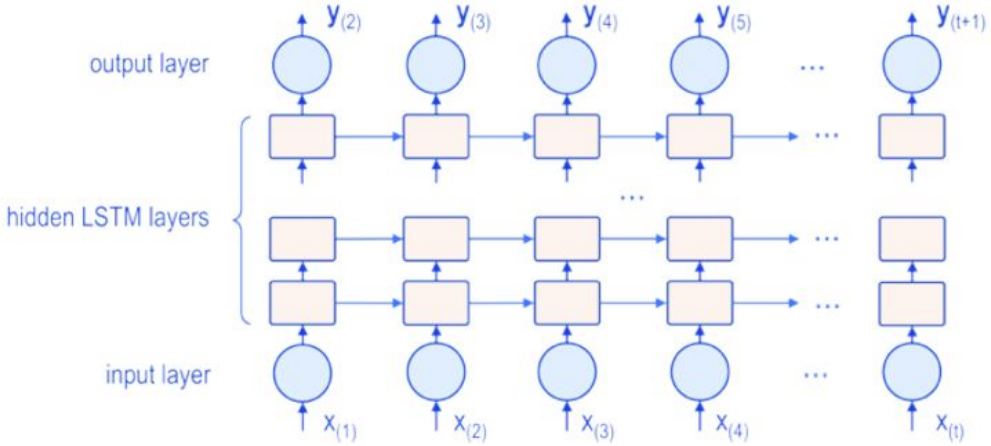
Deep Learning Model: LSTM

First try in recurrent neural network:
Multi layer LSTM

- 3 layer stacked LSTM
- 2048 hidden dimensions
- LSTM -> Dropout -> Linear -> output
- Predict velocity + distance

Second variation:

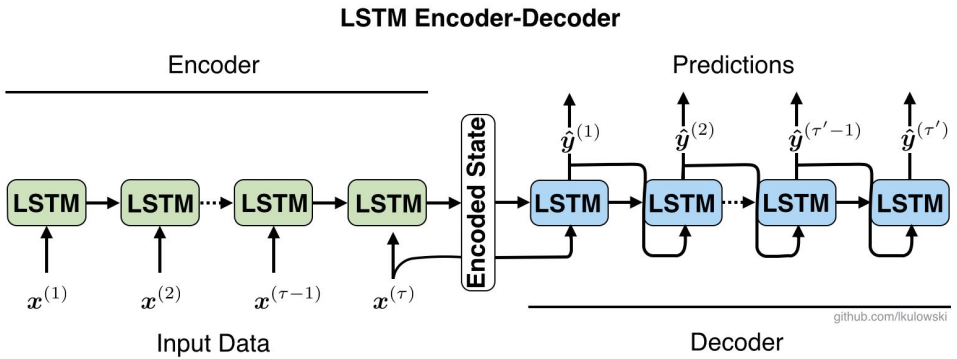
- LSTM -> Dropout -> Linear -> dropout -> linear -> prediction



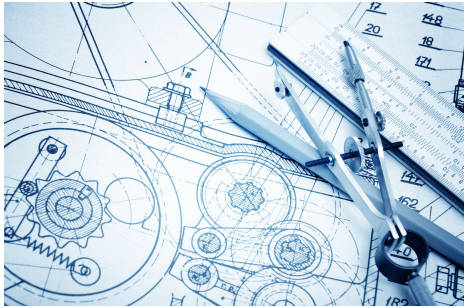
Deep Learning Model: Encoder-decoder

Encoder-decoder model:

- Two sequences of LSTM models: one for input and one for output
- Trained with input data on the encoder
- Extract the last hidden state of the encoder model
- Fit the hidden state to be the initial state of the decoder
- Use methods like teacher forcing to increase accuracy of the decoder model



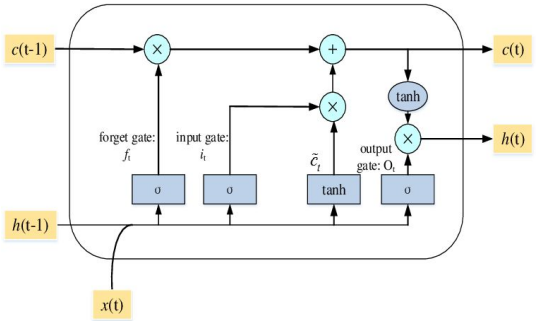
Engineering Tricks



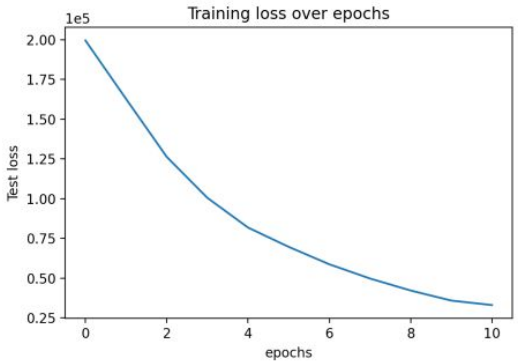
- The very simple linear regression model (we will introduce that in experiment 1) takes <15 mins to predict 60 columns , while the DL models take much longer than that.
  - We can then use linear regression performance to evaluate which variables/features are important for the prediction task. We used this trick to confirmed that difference in location work better than location, and itself is better than location and velocity combined.
- Teacher forcing
  - When coding for our encoder-decoder model and iterating through the decoder, we would have a portion of data from real world data and another portion of data from our prediction in order to increase the training rate/ accuracy of the model

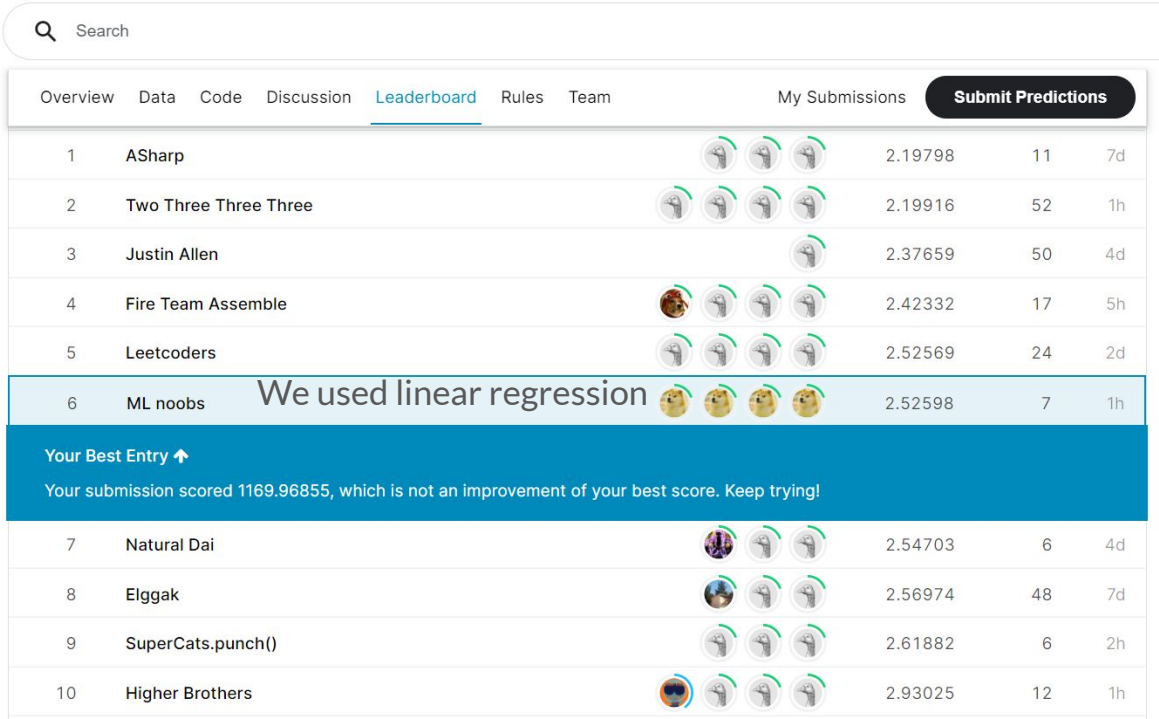
Experiments

Experiment 1: basic LSTM model



- The basic LSTM model does not work well!
  - Tried dropout rate tuning
  - More hidden states
  - More stacked LSTM
- Results are unsatisfactory:
  - RMSE around 800

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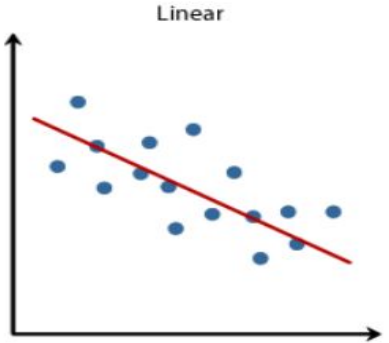
1 ASharp 2.19798 11 7d
2 Two Three Three Three 2.19916 52 1h
3 Justin Allen 2.37659 50 4d
4 Fire Team Assemble 2.42332 17 5h
5 Leetcoders 2.52569 24 2d
6 ML noobs 2.52598 7 1h
We used linear regression
Your Best Entry
Your submission scored 1169.96855, which is not an improvement of your best score. Keep trying!
7 Natural Dai 2.54703 6 4d
8 Elggak 2.56974 48 7d
9 SuperCats.punch() 2.61882 6 2h
10 Higher Brothers 2.93025 12 1h

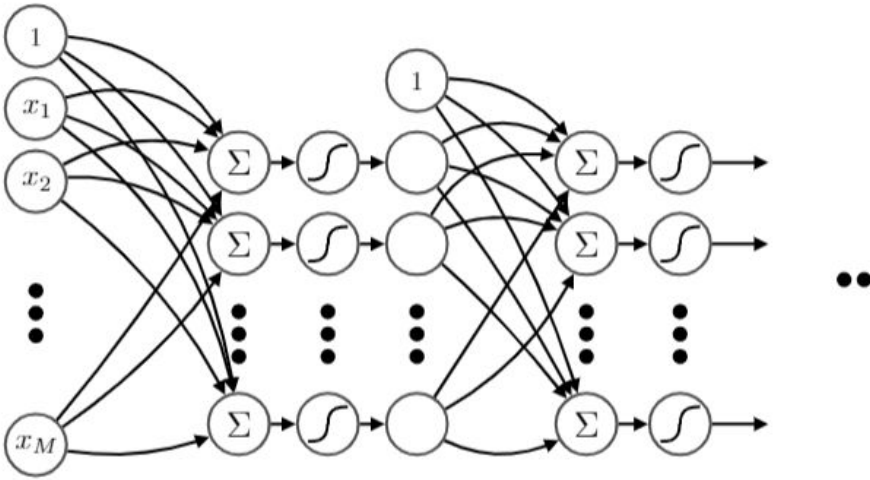
Experiment 2: Closed form Linear Regression

- Also used auto-regression
- Very simple implementation: utilized sklearn.linear_model.LinearRegression()
- The accuracy of the model is surprisingly well on the test set, achieved leaderboard position #6 as of 5/16 with RMSE of 2.52598.



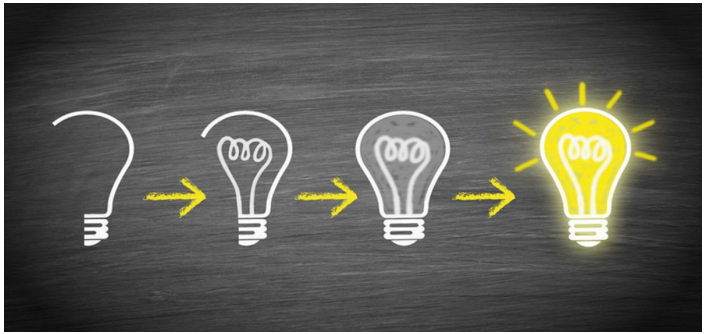
Experiment 2 vs. Multiple-Layer DL model

- The closed form solution beats the MLDL mode by a lot!
  - The best MSRE with closed form solution is 2.52 on the kaggle competition, while the number increased to 10 for the MLDL model;
  - This is potentially due to the design of our multiple-layer deep learning model and if we have train it properly to match the power of closed form linear regression solution.



Discussion

What have you learned



- Keep Everything Simple
  - Sometimes complex model would worse your prediction
  - Linear Regression and Linear Model Master
- Data Visualization is Important
  - Getting know the data is much more important than training model
- Always Learn from your Mistakes
  - We can correct our mistakes through the error and improve the model in a good manner
- Be Creative
  - We used the difference between the current location and the previous location to train in our model

Future Work

- Multi-layer linear model
  - Improve the model design by adding more validations and convergence check (since we are creating 60 models, using same number of epochs for them might not work well)
- LSTM
- Attention based seq2seq model

$$\mathbf{o} = \sum_{i=1}^{n} b_i \mathbf{v}_i.$$