Rose’s Favorite Team

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Presentation Summary

1. Team introduction
2. Task
3. Our approach
    a. Methodology
    b. Experiments
4. What have we learned
5. Future work

Introduction

Team Introduction

Yong Liu:

- Senior, DSC

Zimo Peng:

- Junior, CE

Ruijia(Brooks) Niu:

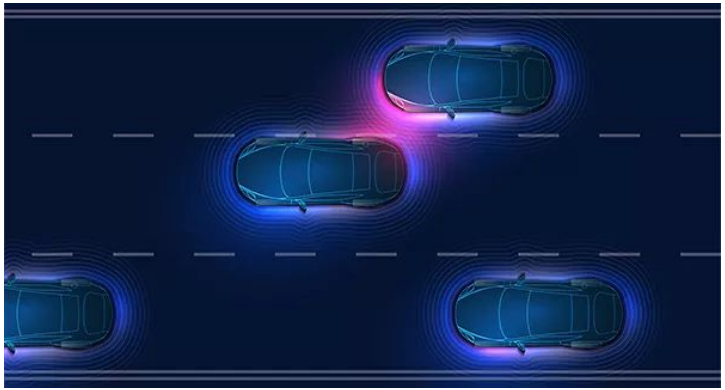
- Junior, CS & CogSci

Binghong(Leo) Li:

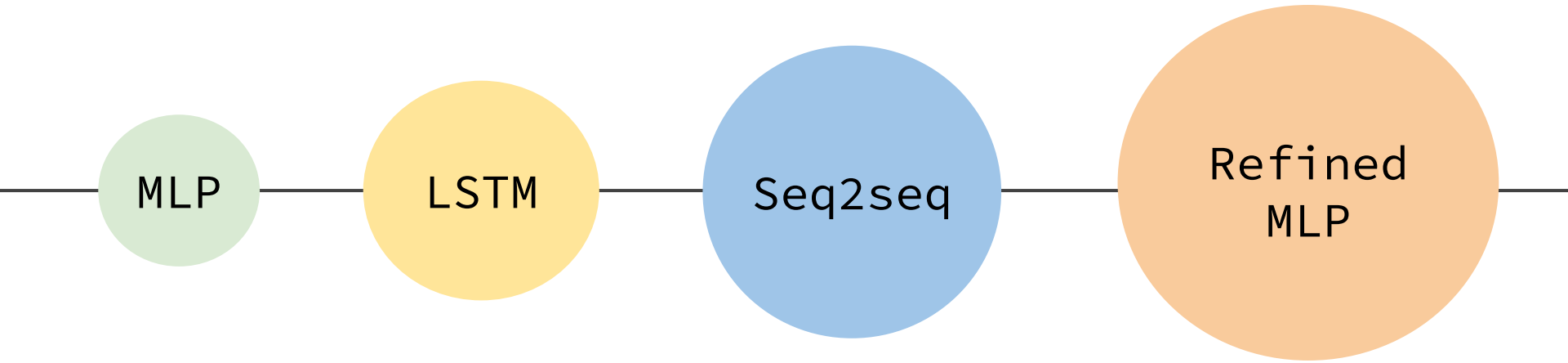
- Junior, CS

Task - motion forecasting

- Autonomous vehicle motion forecasting challenge
- Argoverse motion dataset
  - Six cities
  - 5 seconds of 50 inputs
  - 6 seconds of 60 outputs
- Details:
  - Predict the positions of a tracked AV 6 seconds into the future, given an initial 5-second observation
- Significance
  - Traffic system design
  - Reducing accidents
  - Safety and effectiveness of autonomous vehicles



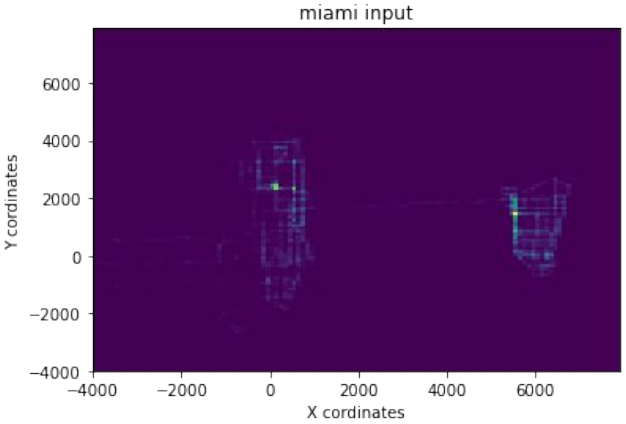
Mental Journey

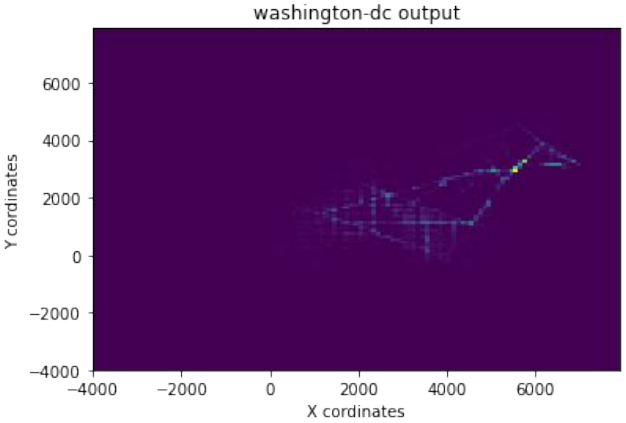


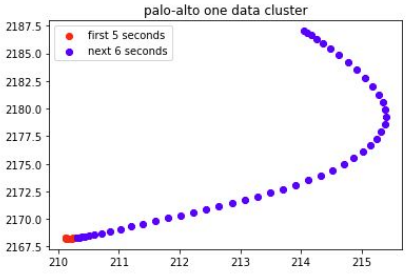
Methodology

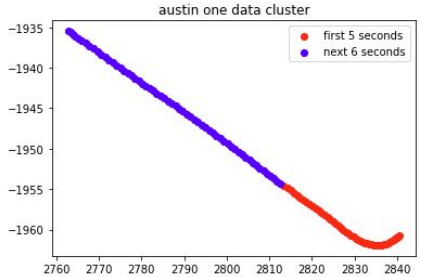
Data Interpretation

1. Understanding the Data
    a. Heat map
    b. Visualization via random sampling
2. Constructing Data Loaders
    a. MLP
        i. Flattened data
    b. LSTM
        i. Length 110: 109 to 1 correspondence
    c. Seq2Seq-LSTM
        i. Pure displacement, (20% of total data)









Engineering Tricks

Feature Engineering:

- Velocity, acceleration, Jerk, and even more

Data Normalization:

- Standardization, didn’t go so well :(
- Translation (all starting at origin)
- Rotation (all starting with same direction)
- Fixed Min Max, didn’t finish

Deep Learning Model

	MLP	LSTM	Seq2seq
Training Time	Under 10 min (total)	4 hours (total)	3-4 hours (total)
Final Loss	19.3 (final private)	137.23 (validation)	37(final private)
Num of Parameters	8	6	11

Experiments

Baseline MLP

- At the beginning we tried the simple MLP without any data processing techniques.

$$Input = \{c_{x_i}, c_{y_i}\}_{i=1}^{50}$$

$$Output = \{c_{x_i}, c_{y_i}\}_{i=1}^{60}$$

Cx refers to the first coordinate and Cy refers to the second coordinate

- We use **scikit learn MLP package** with these parameter:

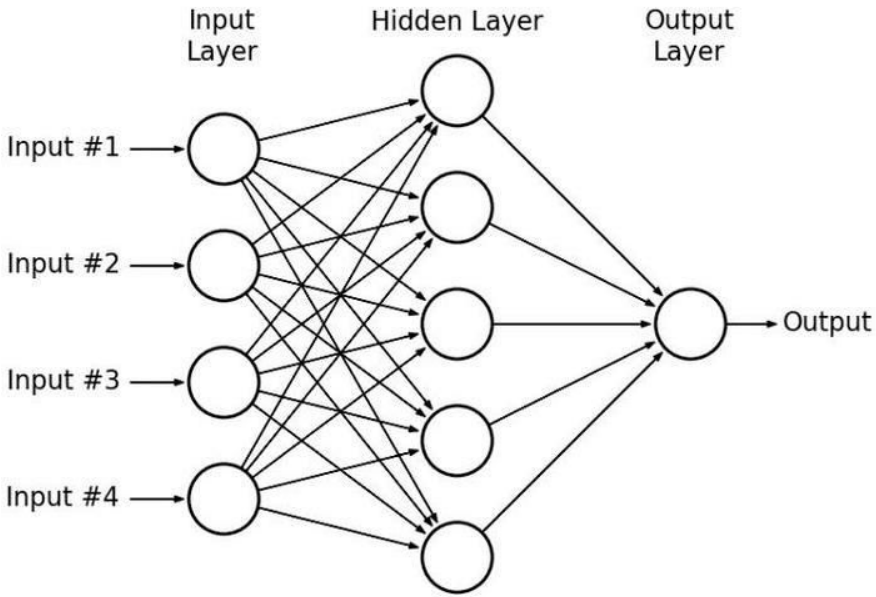
Activation function: ReLU

Optimizer: Adam **Learning Rate**: 0.0005

Validation fraction : “0.2”

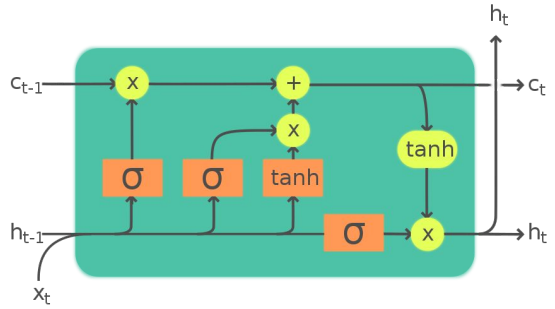
5-layers with (32, 32, 64, 64, 128)

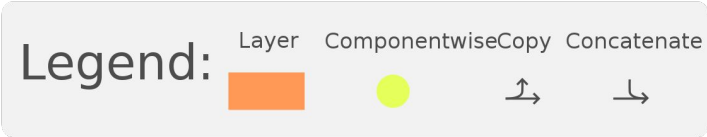
initial MSE-loss: 830

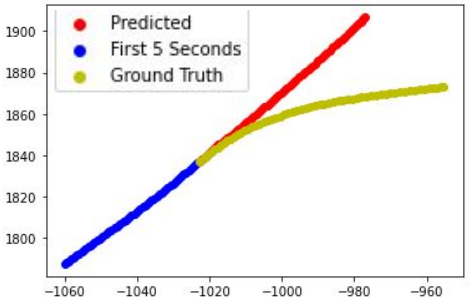


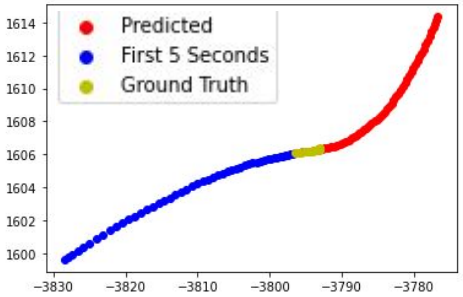
LSTM

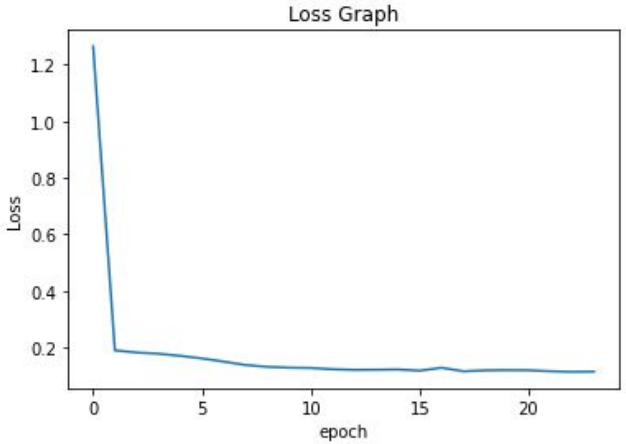
- Trained separately for each city
- **Adam Optimizer**
- **Shifted displacement (loss ~150)**
- **Early stopping**
- **Austin as baseline**





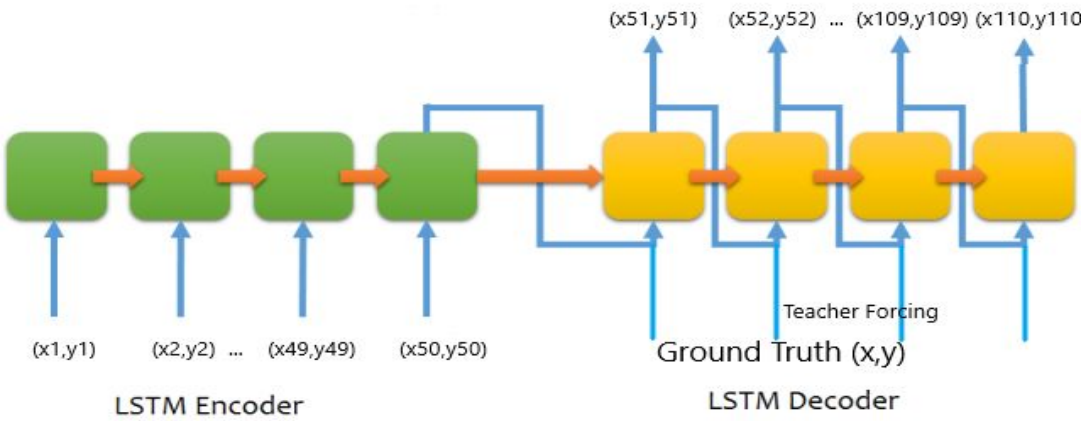


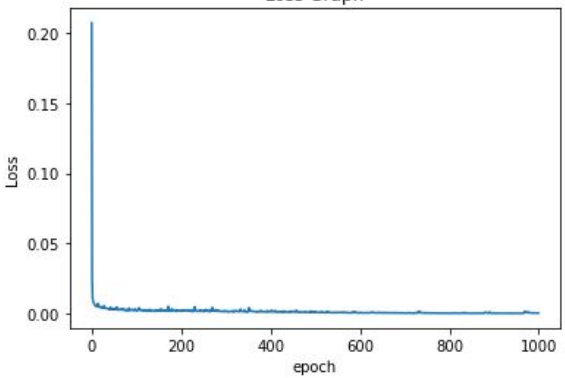


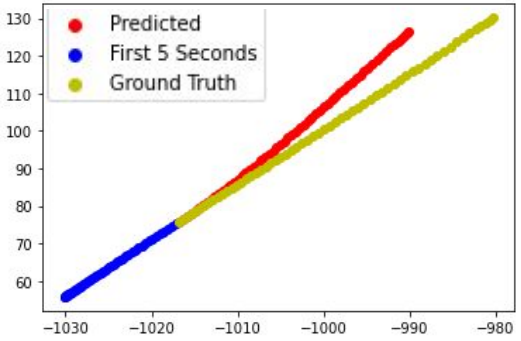


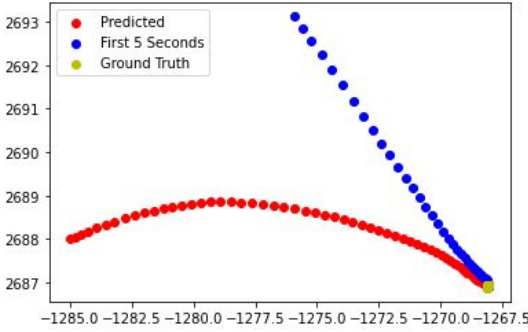
Seq2Seq
LSTM Implementation

- **Shifted & Rotated displacement (Loss ~35)**
- **Mixed Teacher Forcing ~0.5**
- Used 20% of data to train the model (per city)









Final Submission - Refined MLP

$$Input = \{c_{x_i}, c_{y_i}, v_{xl}, v_{yl}, a_{x_j}, a_{y_j}, j_{x_k}, j_{y_k}\}_{i,j,k,l=1}^{50,49,48,47}$$ Total length: 388

$$Output = \{c_{x_i}, c_{y_i}\}_{i=1}^{60}$$ Total length: 120

+ **Data Normalization**

  Activation function: ReLU

  Optimizer: Adam ;**Learning Rate:** 0.001

  Validation fraction : “0.3”

  4-layers with (32, 64, 64, 128)

  final MSE-loss: 19.3

	Loss
Naive MLP (Raw data)	800-850
Adding velocity and acceleration	200-250
Coordinate translation	22-25
Trajectory Rotation	19.3

Loss value progressions	
Approaches	**MSE Loss**
Naive MLP (Raw data)	800-850
MLP Adding standardization attempt (failed)	> 2000
LSTM (80% data)	200-300
MLP Adding velocity to data	150-250
MLP Adding Jerk to data	100-200
MLP Adding derivatives beyond jerk to data	> 300
Seq2Seq with LSTM (20% translated & rotated data)	30-40
MLP Adding Coordinate translation	22-25
MLP Adding Trajectory Rotation (**FINAL**)	19.3
MLP Adding path length normalization	Unfinished

Future Work

- Trying More Advanced Models (Transformer, Autoregressive model, Add attention to seq2seq)
- Training the MLP model with all data at first, then finetune according to each city
- More Features

Discussion

What we have learned

1. Power of Teamwork
2. Simplicity is the ultimate sophistication
3. Do not underestimate the complex model’s ability to learn
4. Start Early Start Often
5. Finding a correct direction is crucial

Thank You!