CSE 151B Final Project Presentation

Control Z

2022.5.31

Overview

- Team members
- Methodology
  - Data processing
  - Deep learning model and engineering tricks
- Experiment
- Future work

Team ***Control Z***

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3rd Year

Data Science, App. Math

Yacun Wang

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Data Science, Prob & Stats

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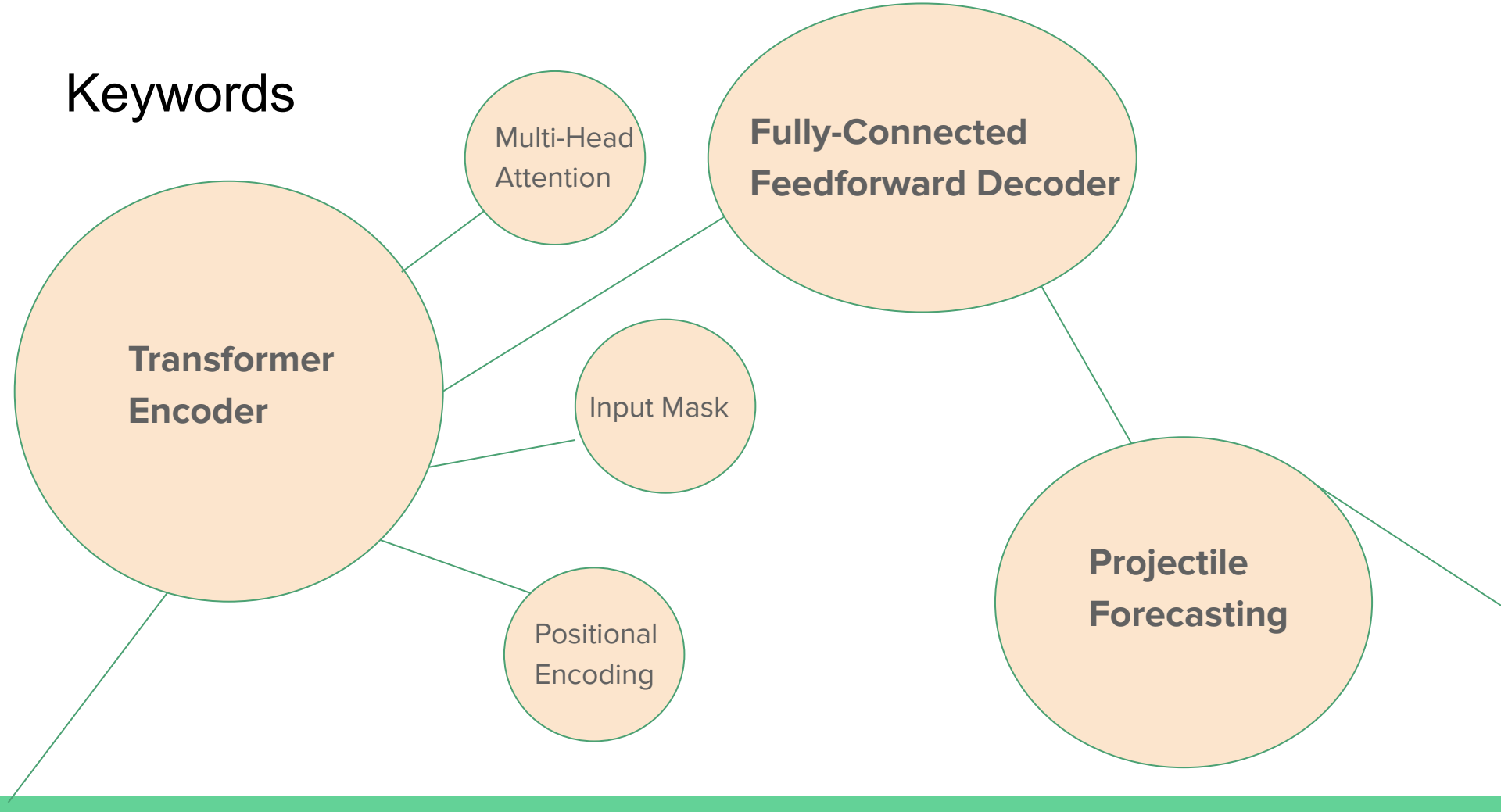
3rd Year

Data Science

Keywords


Multi-Head Attention
Fully-Connected Feedforward Decoder
Transformer Encoder
Input Mask
Positional Encoding
Projectile Forecasting

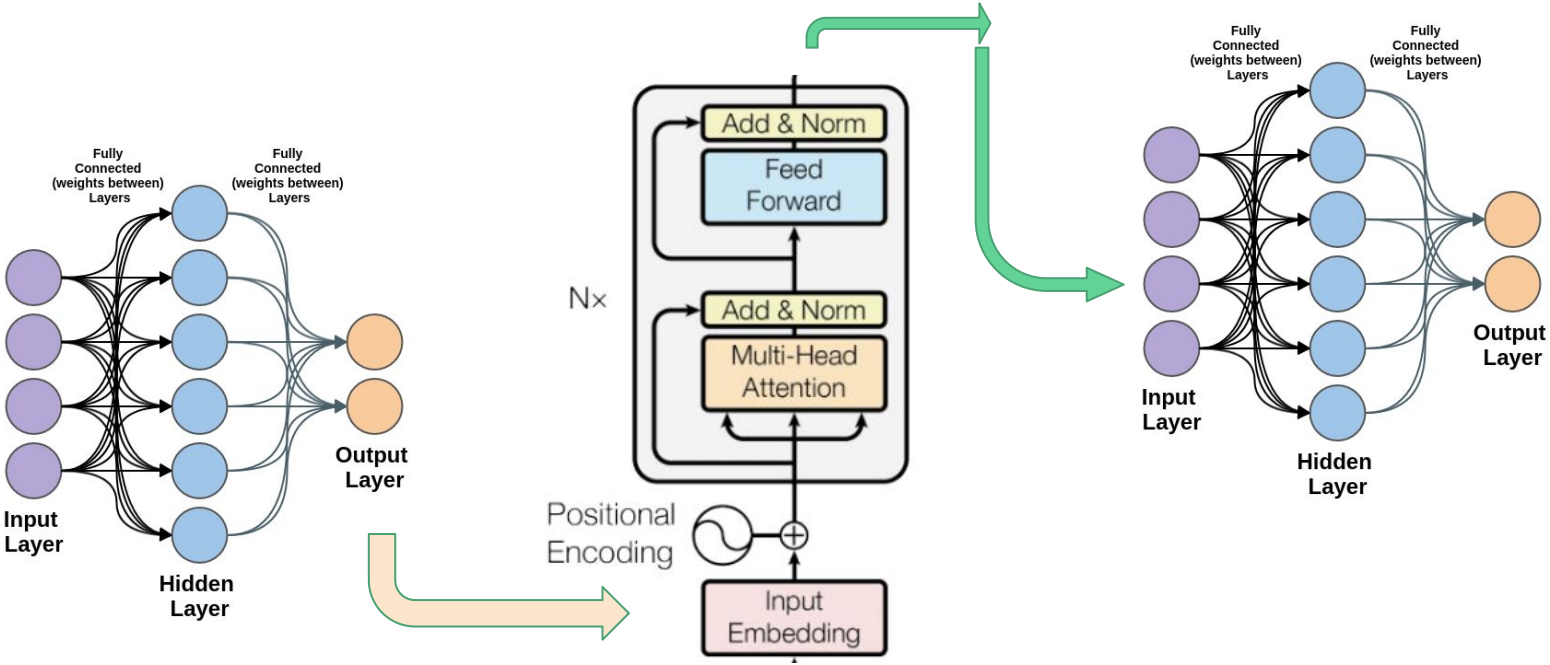
Methodology

Data Processing/Engineering Tricks

- Translation
- Rotation
- Reason: Consistent Scale of Parameters in Linear Layers

Deep Learning Model

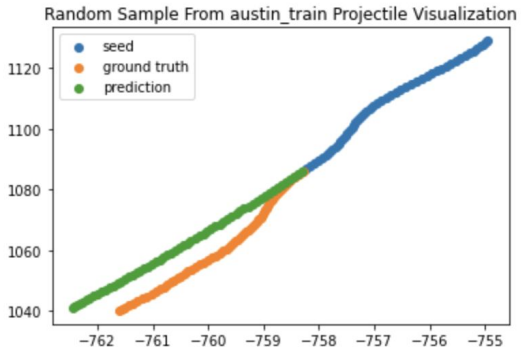
- MLP Embedding + Transformer Encoder + MLP Decoder

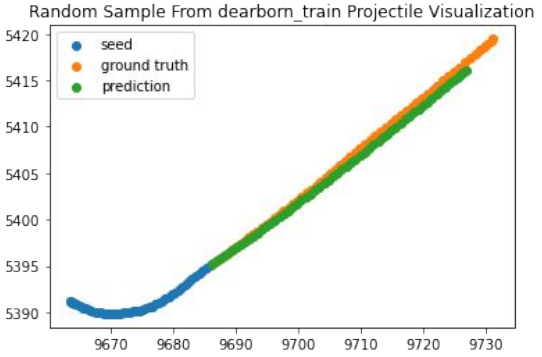


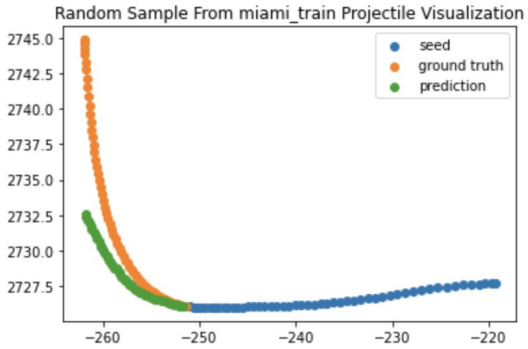
Training and Fine Tuning

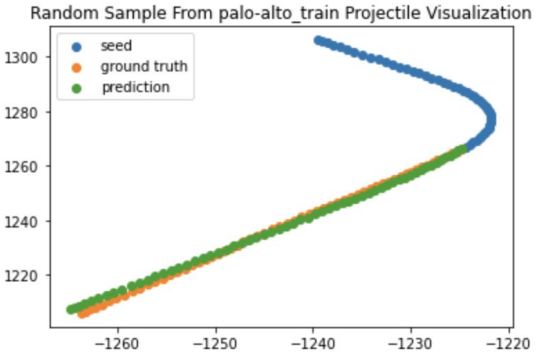
- Optimizer: Adam
- Optimizer Scheduler: Plateau Learning Rate with patience 2
- Training Steps:
  - Train on entire dataset (~200K agents in total)
  - Save the model after 100 epochs
  - Load Model and Fine Tune on each city (Idea of Transfer Learning)
- Performance (Private Leaderboard)
  - Train by City: 17.27773
  - After Total Training: 15.09957
  - After Fine Tuning: 15.04929

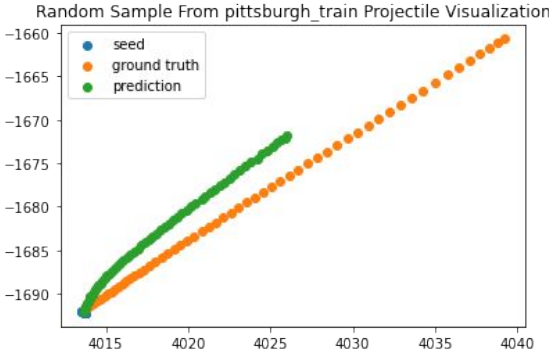
Sample Results

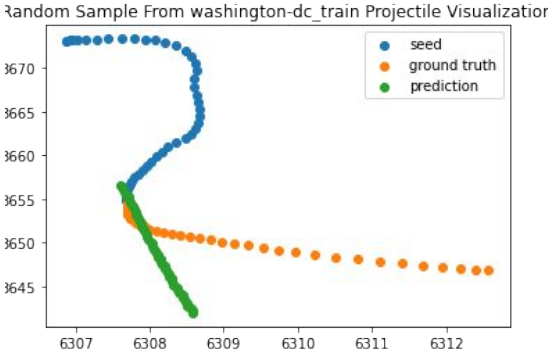






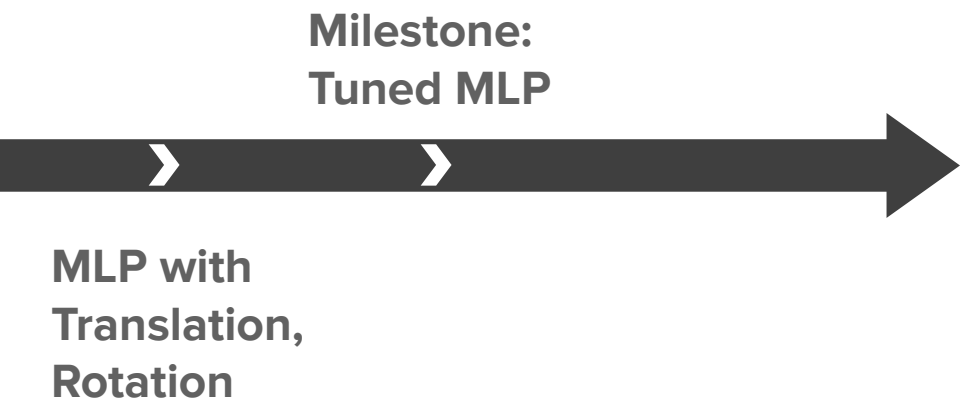






Experiments

Experiment Timeline



Experiments 1: Multi-Layer Perceptron

- Advantages
  - Run time
  - Easy to train (inputs and outputs are flattened)
  - Relatively transparent (for debugging)
- Disadvantages
  - Model is too simple (baseline model, underfitting)
  - Relatively poor model performance
- Temporary Result: Satisfactory

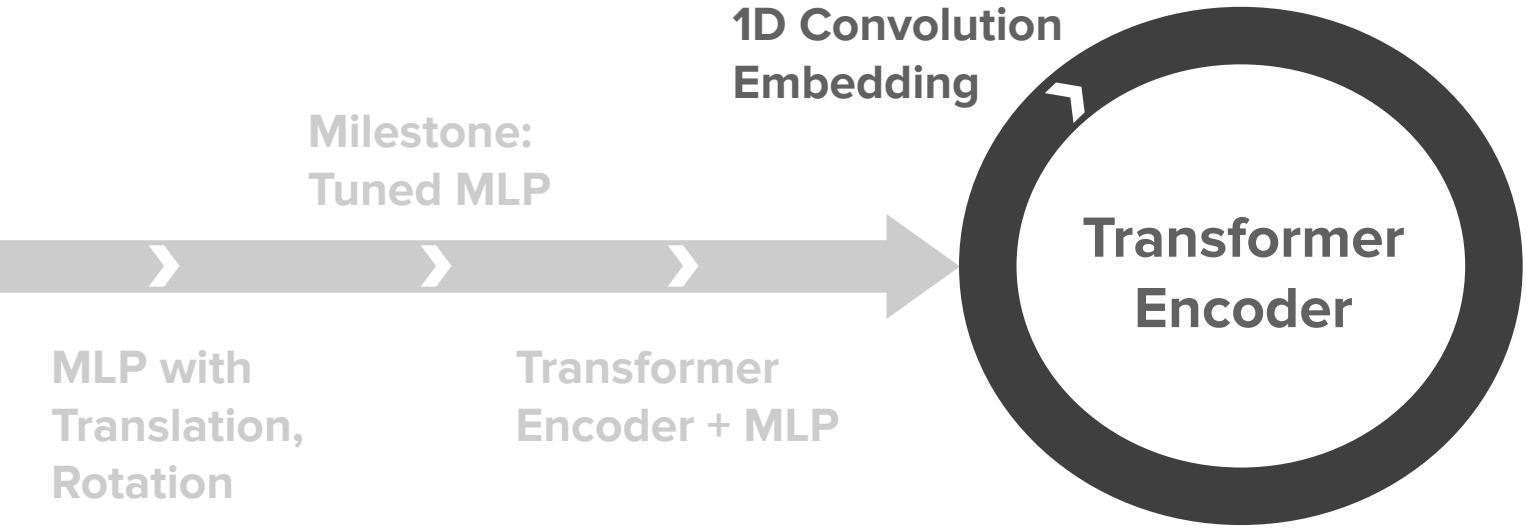
Experiment Timeline

Milestone:
Tuned MLP

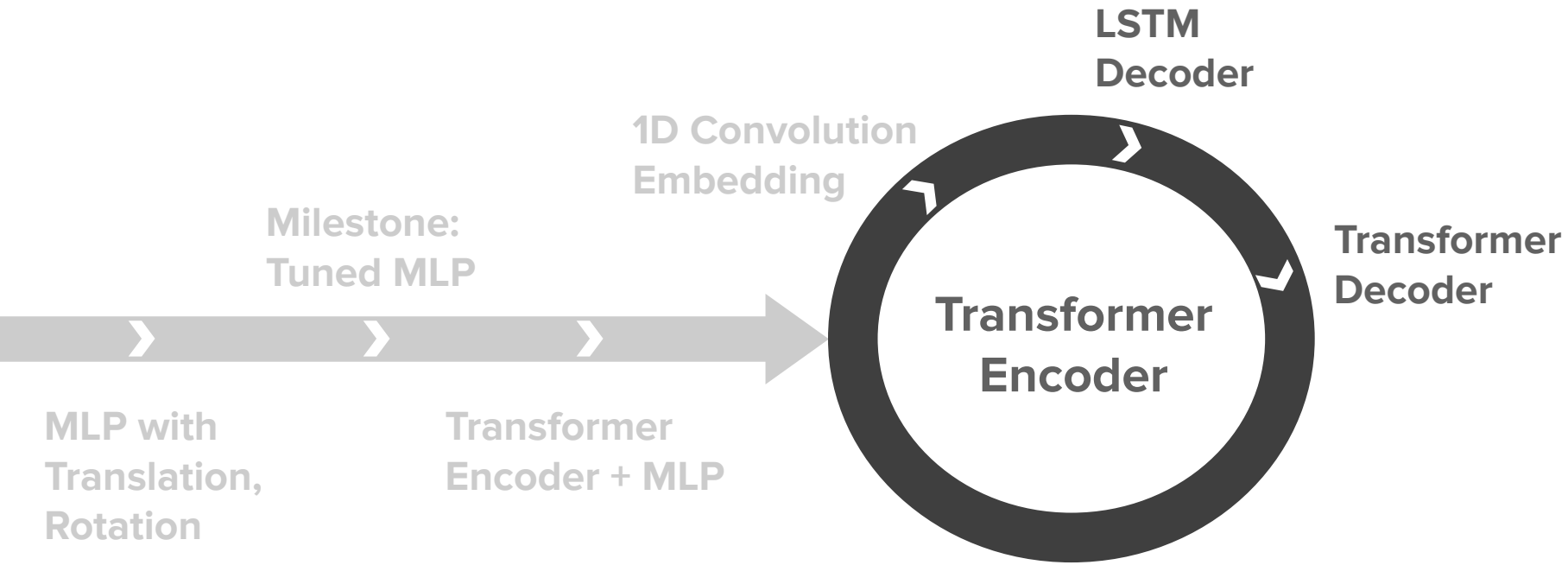
MLP with
Translation,
Rotation

**Transformer
Encoder + MLP**

Experiment Timeline



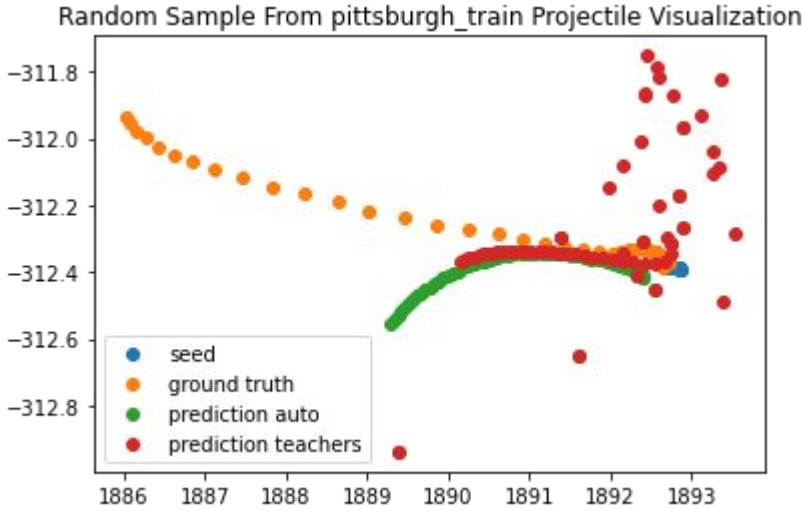
Experiment Timeline



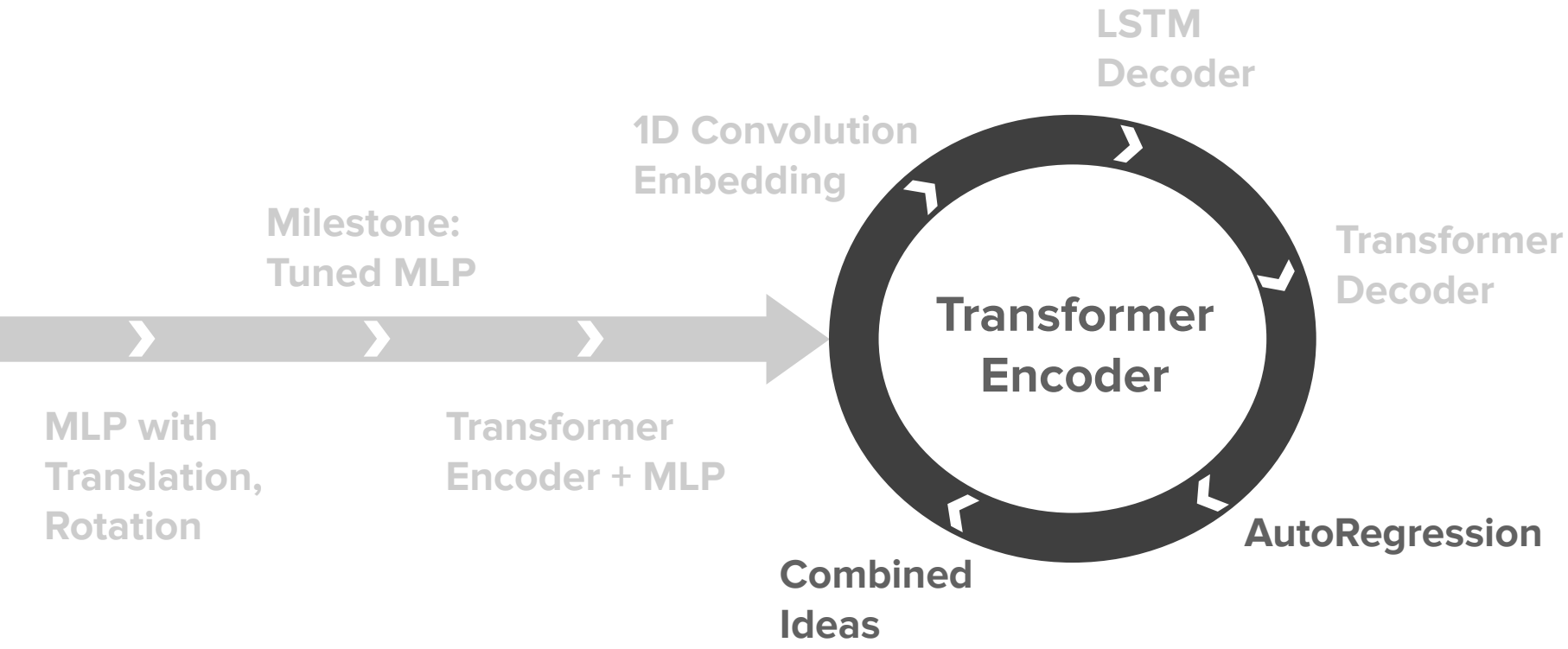
Experiments 3: Sequential Output NN Layers

Attempts: Transformer Decoder, LSTM Decoder

- Advantage:
  - Predict 1 time step at each iteration
  - Use predicted information in future predictions
- Main Problem:
  - Teacher Forcing vs Feeding Previous Predictions
  - Severe Overfitting Issue: Train Loss 0.5, Validation Loss 40
  - Very slow training
  - Bad predictions

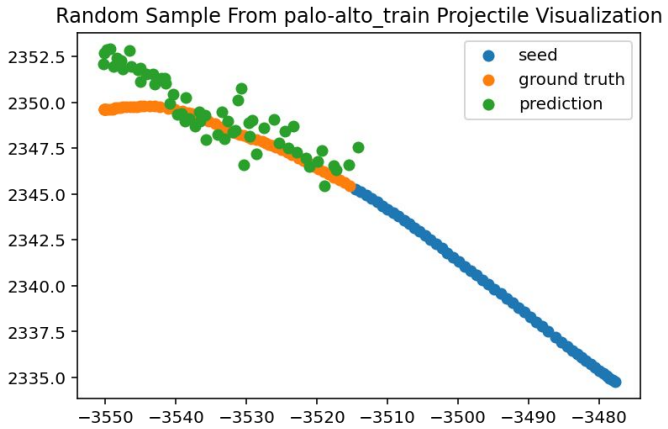


Experiment Timeline

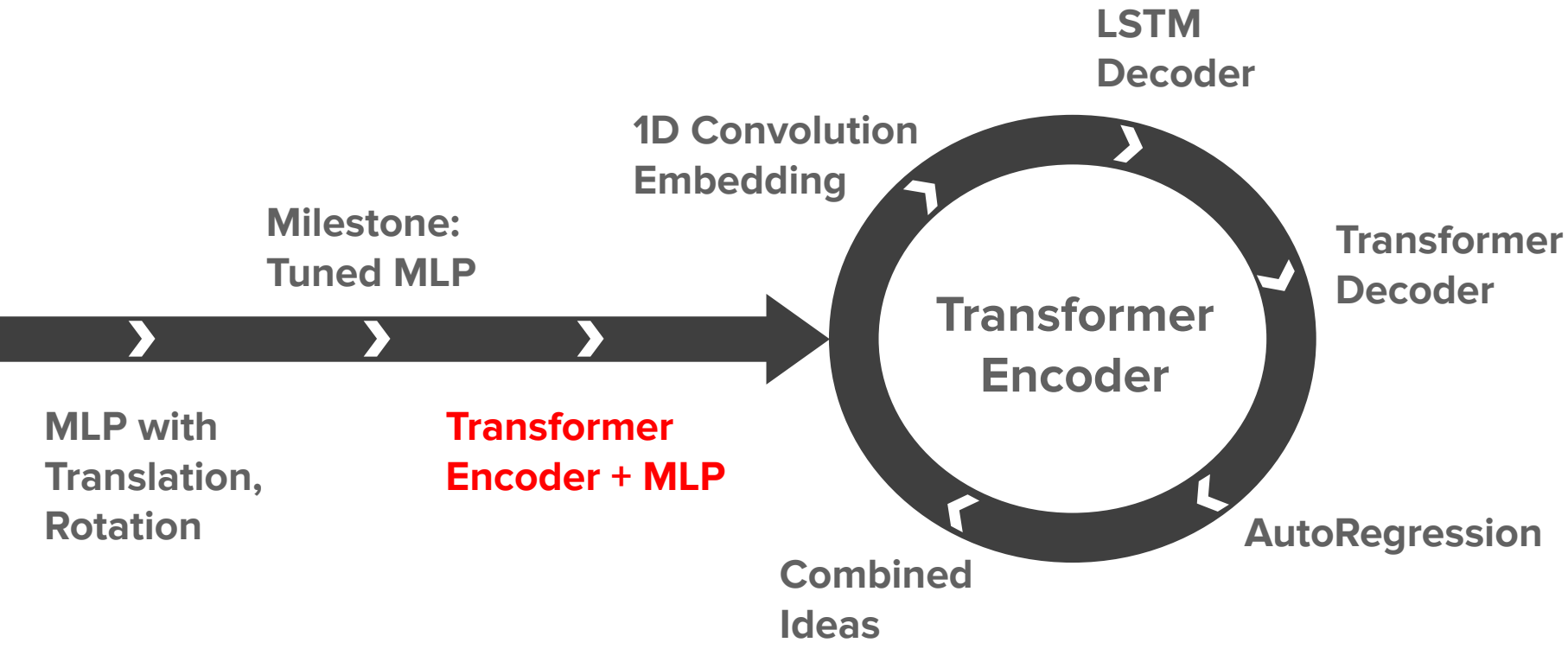


Experiments 4: Time Series Forecasting

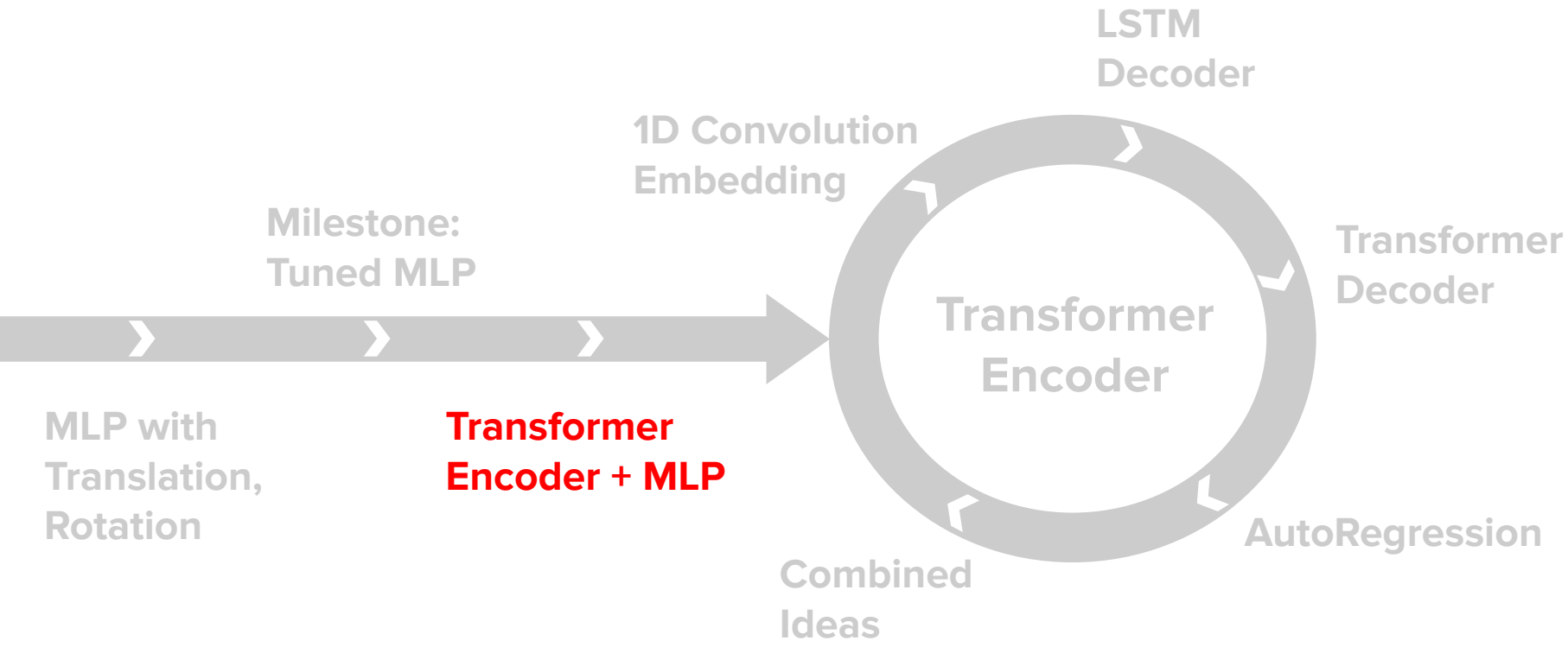
- Main Idea: Autoregression
  - Set a number of predictions on each step (e.g. step = 20)
  - Discard the oldest time steps, concatenate latest prediction
  - High Expectation: Encoder has less burden to predict (e.g. 20 vs 60)
- Main Problem: Similar to Sequential Outputs
  - Inaccurate Information fed when iterating
  - Scattered Predictions
  - Very slow training



Experiment Timeline



Experiment Timeline



Experiment Results

Models	Test MSE (All Cities)
MLP	21.73365
TCN Embedding + Transformer Encoder	19.81492
Transformer Encoder + LSTM Decoder	~49 (Pittsburgh Only)
Transformer Encoder + Transformer Decoder	Failed to Converge
Transformer Encoder + Autoregression	~21.5 (Palo-Alto Only)
MLP Embedding + Transformer Encoder + MLP Decoder	**15.04928**

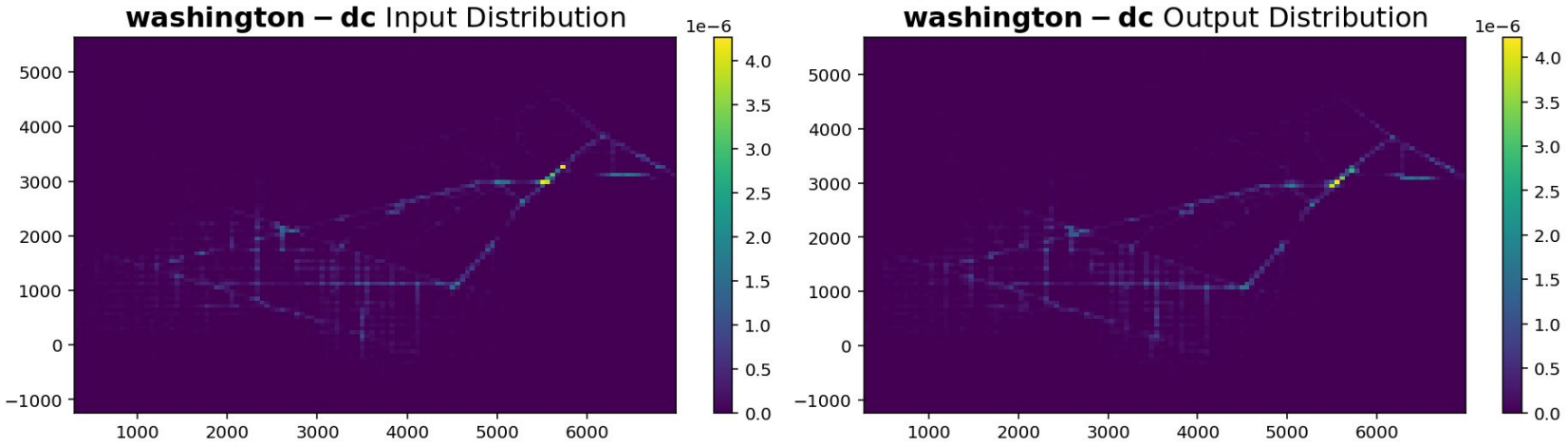
Discussion

What have we learned

- Team work
- Look up past models from documentations
- Start simple
- Test models on subsets of data, but the more training data the better
- Improve performance through doing researches on the internet
- Training efficiency matters!
- Attend lectures and ask questions!

Future Work

- Roadmap: Road2Vec, Trajectory2Vec
- Other models (such as Equivariant Neural Networks)



Questions?

References

- https://www.espn.com/mens-college-basketball/team/_/id/28/uc-san-diego-tritons
- https://nsf.gov/discoveries/disc_summ.jsp?cntn_id=303877&org=NSF&from=news
- https://clusterpower.ro/a-neural-network-improves-forecasts-for-severe-storm-hazards/
- https://www.biocatch.com/blog/behavioral-biometrics-primer-dynamic-fraud-detection
- http://techmalinda.lk/projects.php
- https://www.sbdaresearch.com/
- https://www.shiksha.com/mba/articles/students-speak-group-discussion-topics-blogId-30775
- https://www.mdpi.com/2220-9964/6/11/321
- https://austingwalters.com/classify-sentences-via-a-multilayer-perceptron-mlp/
- https://wallpaper.dog/ai-wallpapers