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Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Peled, I., Pereira, F. C., & Winther, O. (2018). Traffic Prediction with Convolutional Long Short-Term Memory. Poster session presented at hEART 2018: 7th Symposium of the European Association for Research in Transportation, Athens, Greece.

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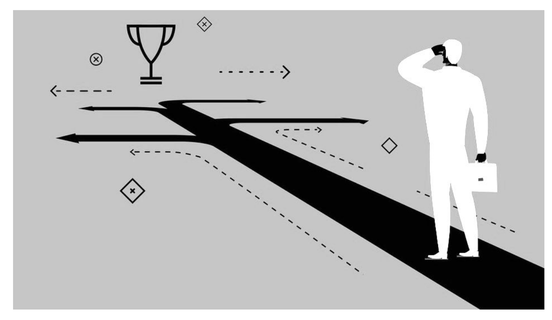
Traffic Prediction with Convolutional Long Short-Term Memory

Inon Peled, Francisco C. Pereira, Ole Winther

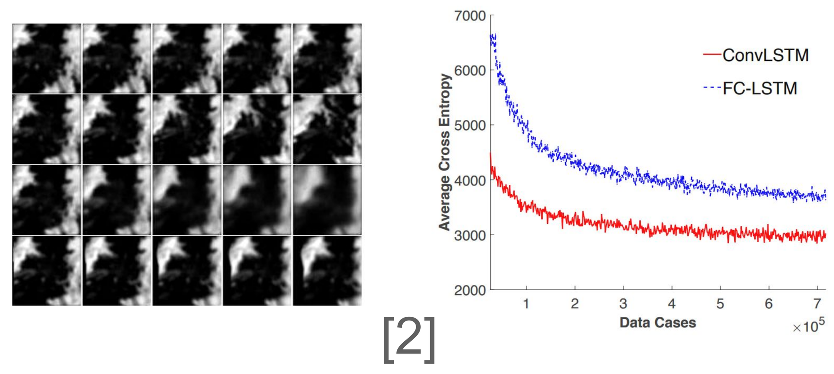
Background and Motivation



Accurate prediction of traffic admits many benefits: reliable travel planning, early detection of congestion, effective response by road practitioners, and more.

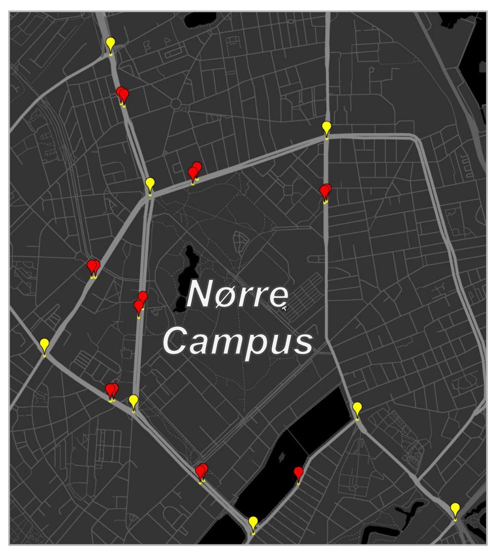
Recurrent Neural Networks (RNNs) with Long Short-Term Memory (**LSTM**) have been successfully applied to **time series prediction** [1]. Recently, [2] showed that *Convolutional* LSTM (**Conv-LSTM**) outperforms classic LSTM in predicting time series data on a **2-dimensional spatial grid**.

In this work, we study the applicability of **Conv-LSTM to prediction of traffic on a road network**.



[2]

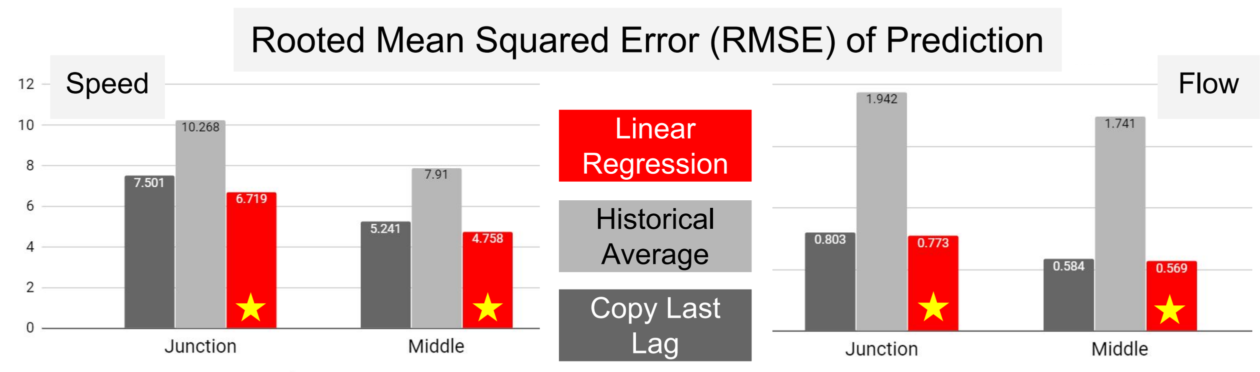
Data



Speeds and relative **flows** from Android devices.

- Around University of Copenhagen, January-June 2015.
- Averaged every 5 minutes in several middle-of-roads and junctions.
- **Goal:** predict speed and flow in next 5min, given last hour.
- January..May for training, June for testing.

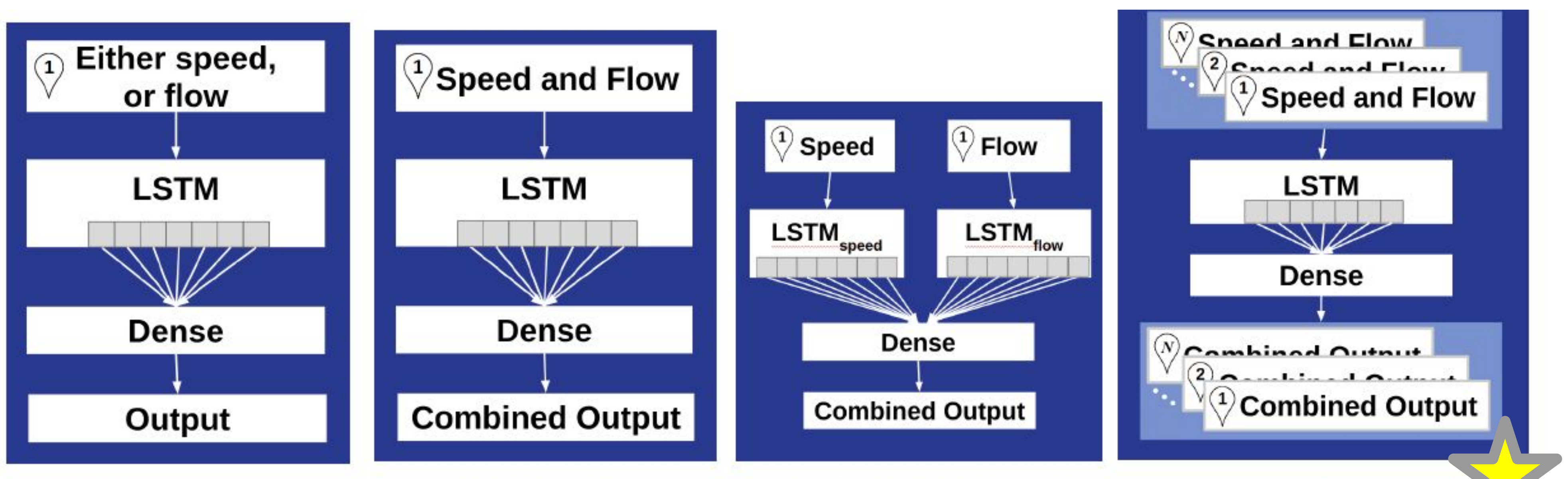
1) Baseline Models



LR consistently outperforms the other baselines.

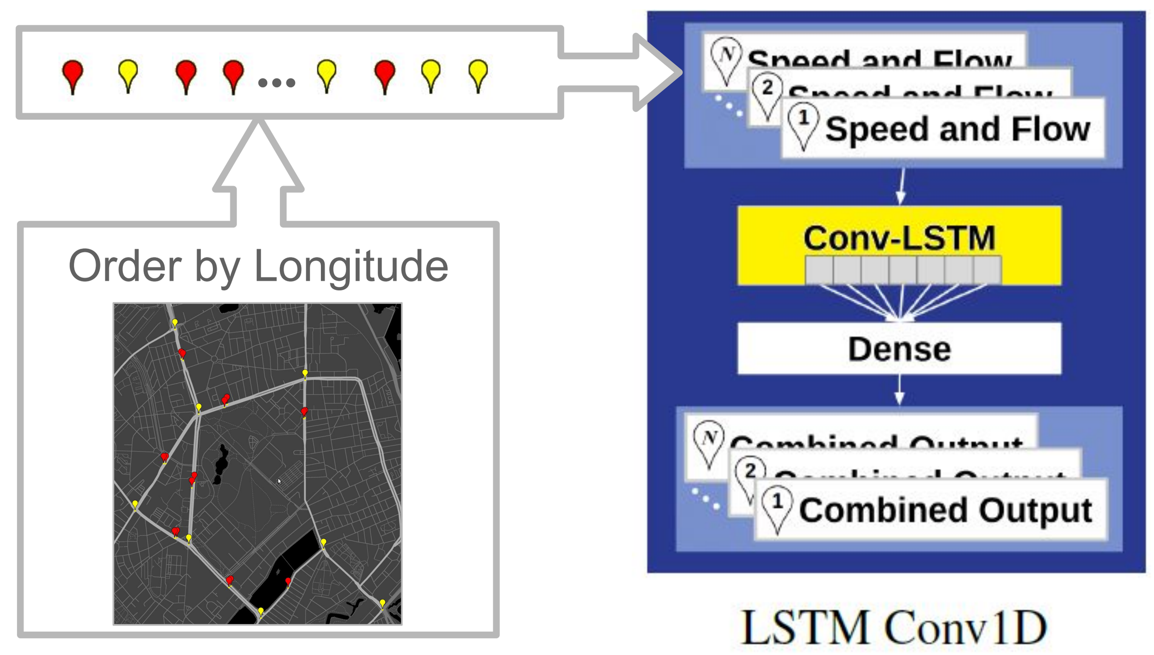
2) RNN Models with Classic LSTM

Iteratively improve architecture, with exhaustive search for best hyper-parameters.



LSTM Separated — LSTM Combined — LSTM Mixture — LSTM Grouped

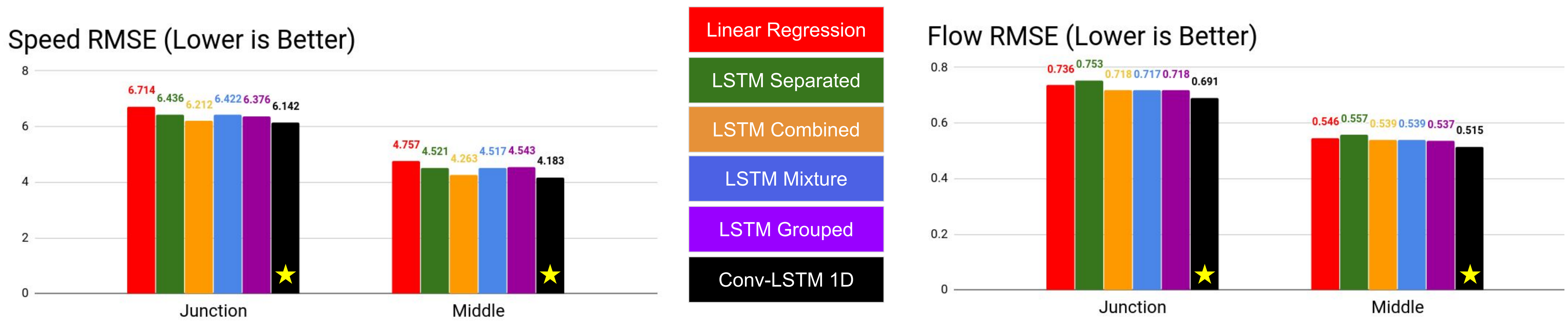
3) Conv-LSTM, 1-Dimensional Grid



LSTM Conv1D

A 2D grid would otherwise be sparse, with opposing traffic directions in same cells.

Results



Conv-LSTM 1D outperforms all other models.

Consistent results also under Mean Absolute Error (MAE), Pearson Correlation Coefficient ρ, and Coefficient of Determination R^2.

Conclusions

1. **Similarly to LR**, RNNs perform better in *middle-of-roads* than in *junctions*.
2. **Unlike LR**, RNNs benefit from *combining* flow and speed.
3. **Conv-LSTM** takes advantage of **spatio-temporal correlations**, and outperforms classic LSTM for traffic data too.

References

[1] "The unreasonable effectiveness of recurrent neural networks", http://karpathy.github.io/2015/05/21/rnn-effectiveness/.

[2] Chen et al., "Convolutional LSTM network: A machine learning approach for precipitation nowcasting," CoRR, vol. abs/1506.04214, 2015.