Attention-based Neural Networks for Multi-modal Trajectory Prediction

Topic: DS algorithms with a view towards Machine Learning and Artifical Intelligence

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Abstract. Trajectory prediction is of great importance in wireless and intelligent networks. Accurate forecast of users' trajectories can provide efficient handover management, continuous network connection, and generally better network quality of service. A trajectory is defined as the sequence of location logs, e.g., GPS coordinates or cellular antenna IDs, over time. We present a trajectory predictor based on Transformers Neural Networks acquiring the self-attention mechanism [1]. Mobile objects' mobility patterns are influenced by their nearby neighbors. Thus, learning spatio-temporal dependencies among neighbor-trajectory users can help to better predict their trajectories [2]. In this direction, unlike our previously proposed mobility predictor (based on LSTM and CNN) designed for single agents [3], [4], [5], where agents were acting in isolation, we now propose the INteractive TRAnsformers ReinFORCEd (INTRAFORCE) social-aware neural network. We further employ a reinforcement learning agent to design the highest-performance transformers neural architecture based on the multi-modal trajectory scenario. Evaluations show that using the Orange dataset [4], our transformer-based predictor can remarkably increase the accuracy and decrease the training time and computations concerning our models based on LSTM and CNN [4]. Furthermore, on ETH+UCY datasets [6], INTRAFORCE achieves the least Mean Square Error compared to numerous state-of-the-art mechanisms on this popular dataset.

Keywords: Trajectory Prediction, Transformers Neural Network, Reinforcement Learning, Social-aware Mobility Prediction.

References

[1] A. Vaswani, N. Shazeer, N. Parmar, J. Uszkoreit, L. Jones, A. N. Gomez, L. Kaiser, and I. Polosukhin, "Attention is all you need," *CoRR*, vol. abs/1706.03762, 2017.

[2] A. Alahi, K. Goel, V. Ramanathan, A. Robicquet, L. Fei-Fei, and S. Savarese, "Social lstm: Human trajectory prediction in crowded spaces," in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, June 2016.

[3] Z. Zhao, N. Emami, H. Santos, L. Pacheco, M. Karimzadeh, T. Braun, A. Braud, B. Radier, and P. Tamagnan, "Reinforced-lstm trajectory prediction-driven dynamic service migration: A case study," *IEEE Transactions on Network Science and Engineering*, 2022.

[4] N. Emami, L. de Sousa Pacheco, A. Di Maio, and T. Braun, "Rc-tl: Reinforcement convolutional transfer learning for large-scale trajectory prediction," 2022.

[5] N. Emami and T. Braun, "Reinforcement-supported artificial neural network-based trajectory prediction," 2021.

[6] L. Leal-Taixe, M. Fenzi, A. Kuznetsova, B. Rosenhahn, and S. Savarese, "Learning an image-based motion context for multiple people tracking," in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, June 2014.