Travail de Fin d'Etudes : The use of learning algorithms for modeling of transport phenomena

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THE USE OF LEARNING ALGORITHMS FOR MODELING OF TRANSPORT PHENOMENA

Joan Estrada Peñas / 2019-2020

Graduation Studies conducted for obtaining the Master's degree in Civil Engineering

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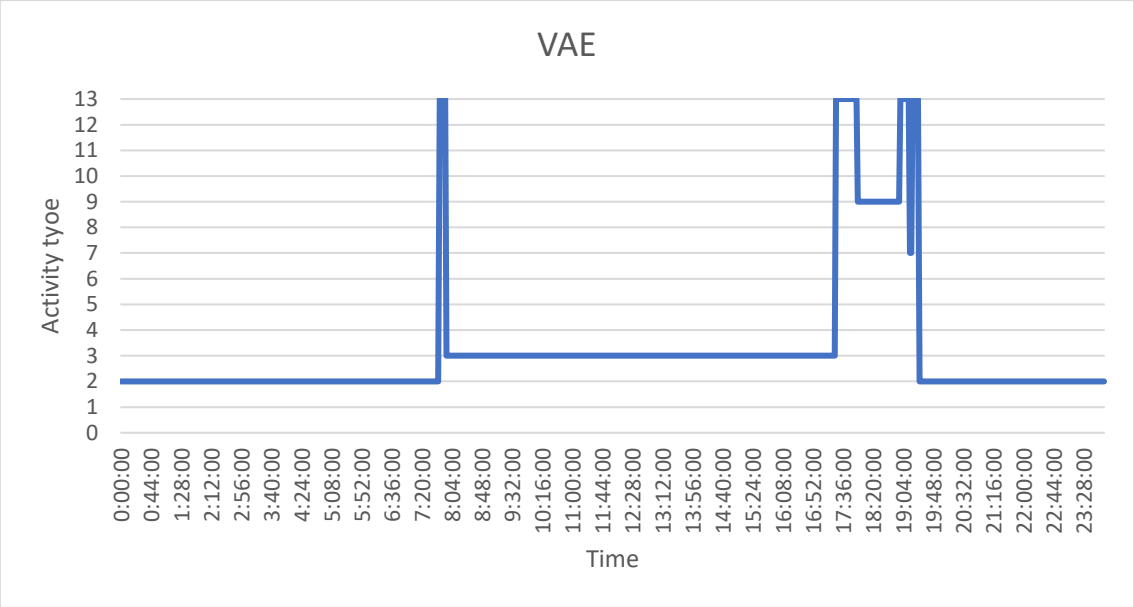
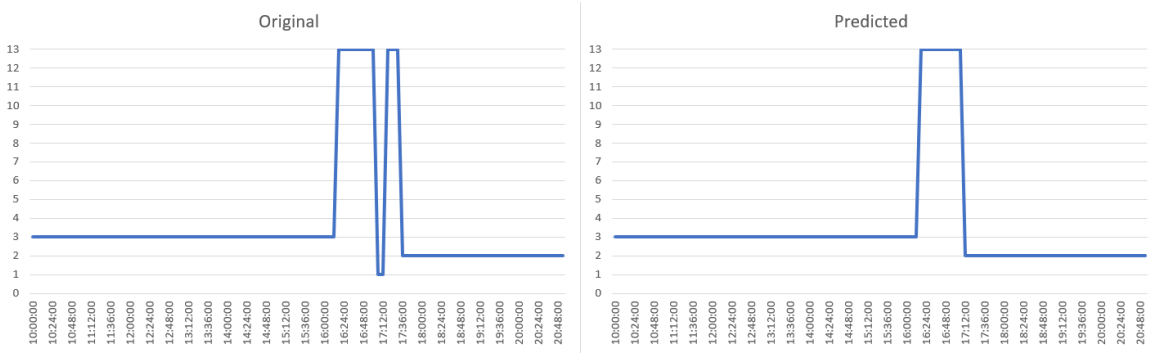
From the 1990s to the present day, transportation modeling has experienced great development thanks to numerous studies that have tried in one way or another to predict traffic flows, synthesize populations, simulate transportation demand, etc. Within the transport models, the activity-based ones are the most popular nowadays, due to the great flexibility and high level of detail it provides. At the same time, in the last ten years, another field dedicated to data processing has had a great development, machine learning. Machine learning includes a wide range of algorithms and statistical models that computer systems use to perform specific tasks without using explicit instructions, relying on patterns and inference instead. It consists on optimization models calibrated on the basis of sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed. This project aims to bring together the two worlds. First, a review of the state of the art in transportation models is presented, comparing trip-based and activity-based models. On the other hand, a review of the state of the art of Neural Networks is also made, presenting the current most efficient and developed models. To continue, a theoretical explanation of two Neural Network-based chosen models is made, the first one consisting of a Variational Autoencoder (VAE) and the second consisting of an Autoencoder based on Long Short-Term Memory (LSTM) cells. Finally, both models are applied to a dataset stemming from the 2010 Belgian Household Daily Travel Survey (BELDAM) in order to calibrate the frameworks. The model consisting in a Variational Autoencoder will be used to generate full daily activity sequences. The model based on LSTM cells will be used to predict an individuals' next steps in an activity sequence, knowing the activities he/she has done before. The VAE achieves a very good performance both in the training phase and in the inference phase. Results show very good metrics compared to the original population, and it is also able to outperform a simpler model based on a Frequency Analysis of the dataset. On the other hand, the model based in LSTM cells it is able to train correctly with considerably good results, but when new predictions are done, results are not very accurate in some cases.



Activity sequence generated by the Variational Autoencoder



Comparison between the original sequence and the predicted one by the LSTM model