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Data Driven Energy Informatics

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Introduction

In this research we explore deep learning models in order to create new possibilities of analyzing and processing data emerging form Internet-Of-Things (IOT) devices. The goal is to offer a method to reduce the number of personal vehicles on the roads, therefore to minimize the CO2 emission, using various deep learning models on traffic behavior.

Mechanisms will encourage citizens to take public transportation by providing a comfortable option of reaching their destination. An optimized public transportation (punctual arrivals and departures) leads to less congestion during peak hours, less fuel consumption resulting less CO2 emission. Yet, today's bus arrival time predicting applications are leaking (missing updates of bus delays, not considering traffic).

Research on predicting public transport travel time has been quite powerful in recent years [1],[2],[3],[4]. These works used approached such as Historical Based Models, Support Vector Machine, Regression models, Kaman-filter based models, Relevance Vector Machine, and Artificial Neural Networks.

Research questions

How analyzing and processing Big Data can help optimize learning the future behavior of a proposed object?

Which machine learning models offer better results in terms of accuracy and robustness? And how can these characteristics be improved?

What are the advantages of using Deep Learning? And what problems can a deep neural network solve?

Methods

The success of any prediction model depends on validity of datasets used for training. To ensure that research results will be fruitful, we must sanitize our dataset before it is fed to the network.

We contour two meaningful steps included here, data preparation (gathering, cleaning, transforming and organizing) and data mining (recognizing patterns in large datasets and extracting informations for further use) to remove irrelevant values and reduce dimensionality.

There are a few techniques to do that such as PCA (Principal Component Analysis), LDA (Linear Discriminant Analysis), T-SNE (t-Distributed Stochastic Neighbor Embedding).

The major advantage of dimensionality reduction is avoiding the Curse of Dimensionality. It also provides benefits such as space efficiency, computing efficiency and visualization.

On the other hand, the second decisive part of the research is implementing, training, testing the machine learning models for accuracy and robustness analysis. Frequently, we find uncertainties regarding a model's performance, therefore, a crucial step in the research is performance improvement.

All the models we use are implemented using Tensorflow, an open source software library for numerical computation using data flow graphs.

This research is currently, but not exclusively, focused on public transport forecasting problems but other energy informatics topics can be considered. We can use a model that carry out accurate results with specific structures and datasets for problems such classification, time series prediction, pattern recognition, sequence generation in the field of transportation, electrical engineering, drilling, fraud detection, robotics and so on. At this stage, the interest of this research is the travel time prediction, however the future interest could be perhaps in predicting energy demand of a city and/or insecurity detection in drilling.

The models evaluating the datasets produced results close to the actual values. Currently, a data fetching technique is being extended. This technique will provide even more relevant inputs for our future work and real time data to match the predicted values. All the models we are currently using are evaluated through the model testing module. The results from each model are used back in data collection module to reassess the required data sources for improving the results.

Certainly, in our future work we intend to further evaluate networks accuracy based on different public transit datasets across geographical boundaries and other sources that influence public transit.

Open questions in the research are related to XML response (relevant and irrelevant values in the datasets), additionally techniques applied for high accuracy and performance boost.

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