Dynamic Demand Prediction for Sustainable Bike Sharing Systems

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Literature Review

Due to the vastly growing number of bike sharing systems, bike sharing demand prediction has been investigated by a number of authors in the last 15 years. While classical machine learning approaches such as regression and boosting have been used in the early developments, in recent years, deep learning approaches have been found to give significant advantages in the forecasting domain [1].

Based on the literature, we compare the following recent machine learning approaches to bike sharing demand prediction, selected according to publishing date and impact, and identify open problems.

3. Modeling bike-sharing demand using a regression model with spatially varying coefficients [2]:

4. Modeling Bike Availability in a Bike-Sharing System Using Machine Learning [2]:

Taxonomic Table and Tabular Comparison

We organize the used models into a tree based on the dominant design features.

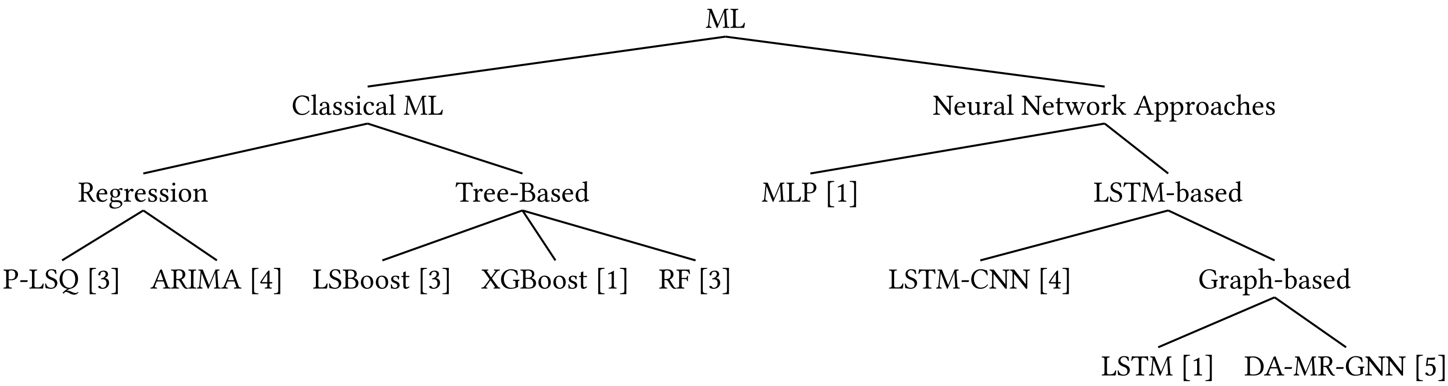

Figure 1: An overview of the employed ML approaches

Directions for Future Research

As noted in [1], there is no single standard benchmarking dataset for the specific objective of bike sharing demand prediction, making it difficult to obtain a precise ranking of the models. Notably, the New York Citibike data has been used in multiple approaches [1], [5], but the precise data used still changes. As given in [1], several studies have suggested that XGBoost performing as well most of the state of the art approaches, having also won the 2014 Kaggle competition [6], however the best approach was found to depend strongly on the dataset and modeling.

Notably [1] suggests, that well-performing deep model architectures in traffic prediction are likely to show good performance in bike-sharing demand prediction. In this line of work, [5] combines well performing spatio-temporal GNN approach, known from traffic prediction [7] and [8], with a domain-adversarial network. However, little work has been done on the extent that performance of traffic prediction carries over to bike-sharing performance and adaptation of successful models from other adjacent fields, (e.g. models in [7], [8]), appears to be a promising research direction.

For the development of accurately prediction approaches the most important factors are:

- The data used: Essential is the features incorporated and the size, diversity and quality of the dataset. Because all compared approaches use recorded data from bike-sharing systems, the quality of the data is uniformly high, however, the size varies. We propose to classify features:
- The architecture of the model: In order to achieve intelligent prediction, usually deeper models perform significantly better. Special modules of neural network architecture, such as Memory Components (RNNs, LSTMs, GRUs), Convolutions (CNN, GNN) or attention components strongly influence what the model is able to learn.

Approach	Target Variable	Spatial Features Incorporated	Spatial Architecture	Temporal Features
Temporal Architecture				

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