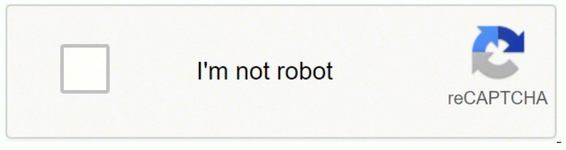

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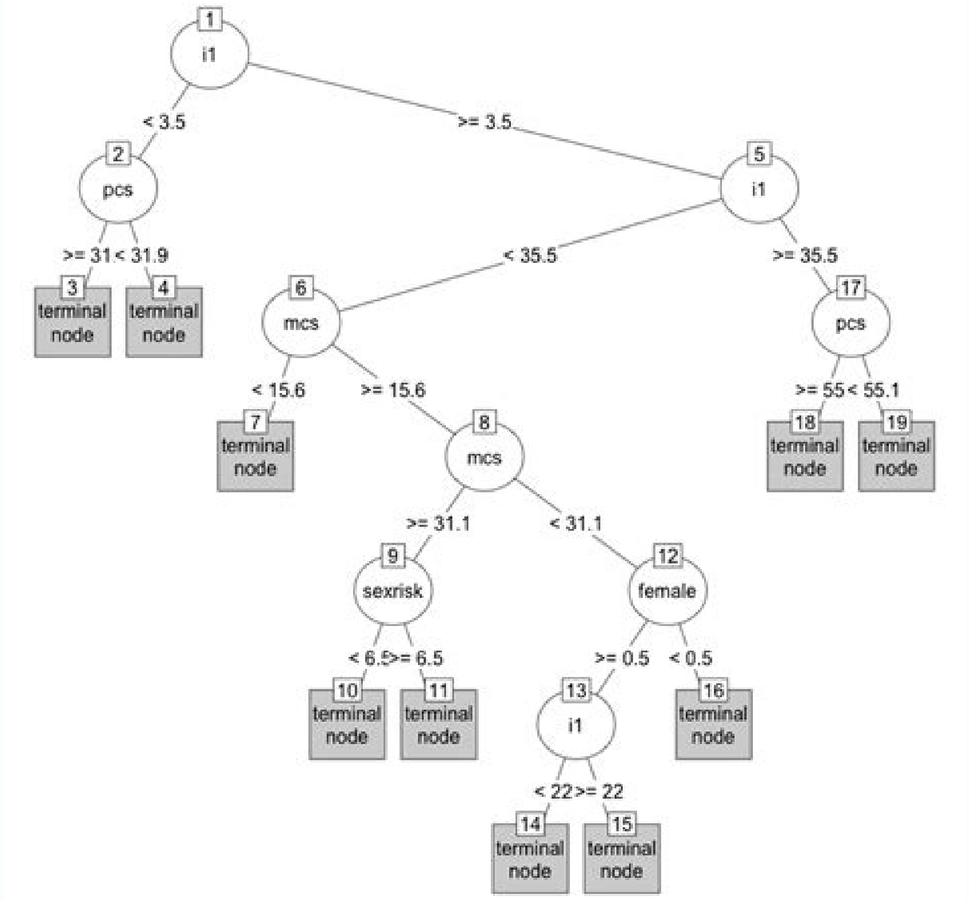

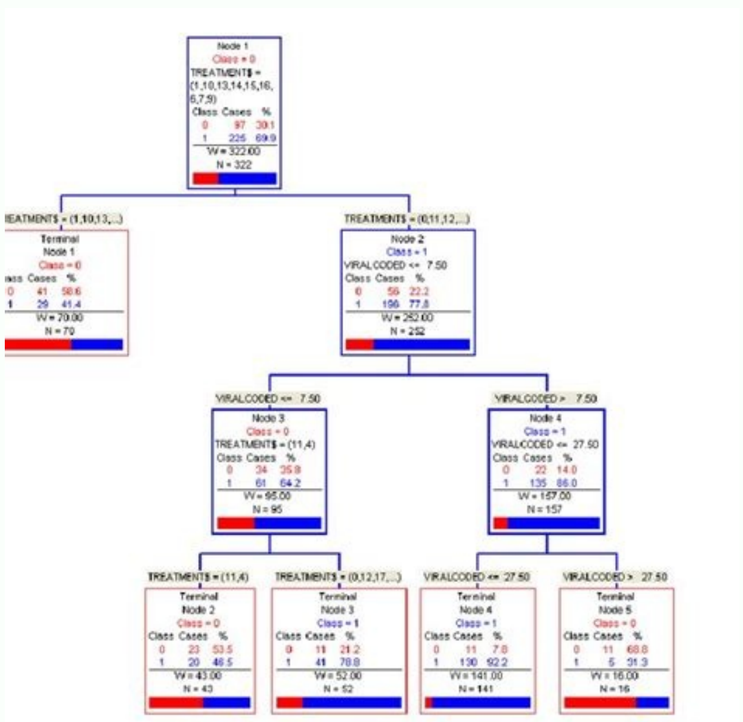

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Short-Term Traffic Volume Prediction Using Classification and Regression Trees

Yanyan Xu, Qing-Jie Kong and Yuncai Liu

Abstract— **Accurate short-term traffic flow prediction plays a fundamental role in intelligent transportation systems (ITS), e.g. advanced traffic management systems (ATMS). To generate accurate short-term traffic volume, nonparametric models have gained credit from quantities of researchers. On the basis of the common thought that future traffic states can be predicted according to the similar states in the historical traffic data, this paper presents a novel nonparametric-model-based method to predict the short-term traffic volume. The applied nonparametric model is the classification and regression trees (CART) model. In the application, the CART model first classifies the historical traffic states into plentiful categories. Afterwards, the linear regression model is built corresponding to each traffic state pattern. Finally, the model predicts the short-term traffic state through clustering the current state vector into the most congenial historical pattern and regression model. In the experiments, the proposed method is tested by using the** 15 **minutes average traffic volumes on freeways and is compared with the classic nonparametric methods k-nearest neighbors (*k*-NN) model, and the parametric method Kalman filter model. The results indicate that the CART-based prediction method outperforms the *k*-NN and Kalman filter methods in both the mean absolute percentage error and the mean absolute scaled error.**

I. INTRODUCTION

In the last several decades, the flourishing development of information technology has promoted the emergence and evolution of intelligent transportation systems (ITS) in modern traffic. As a major component of ITS, advanced traffic management systems (ATMS) focus on making efficient policies to reduce traffic congestion and to raise the road utilization ratio. Among the numerous elements of ATMS, short-term traffic flow prediction is always an essential technique but is difficult to be solved. Also, in traveler information service systems (TISS), accurate short-term traffic flow prediction can provide reliable guarantee of optimized guidance for travellers [1].

Since the early 1980s, based on the elaborate historical data, an increasing number of researchers attempt to predict traffic flow in less an hour instead of day time. In these works, the proposed methods mainly involve two categories: parametric-model-based and non-parametric-model-based techniques. At the beginning of ITS study, several forms of parametric models were applied into short-term traffic flow prediction, including autoregressive integrated moving average (ARIMA) models [2], [3], Kalman filtering [4], etc., as well as their alterations, e.g. subset autoregressive moving average models [5], seasonal ARIMA [6]. However, such parametric prediction models can not achieve satisfying outcomes, due to their unstable approximations to the nonlinear traffic conditions such as extreme peaks and rapid fluctuations.

Along with the evolution of the intelligence computation technologies during the last decade, various sorts of non-parametric algorithms were proposed to settle the issue of short-term traffic prediction. The nonparametric algorithms can often generate more stable and accurate prediction results than the parametric methods, owning to their plenty use of the historical traffic states [7]. One basic implementation of nonparametric regression is the k nearest neighbors (k-NN) algorithm [8], which predicts the short-term traffic state using its k most analogous historical states. In addition, with the rapid progress of data mining and machine learning since 1990s, a increasing number of intelligent algorithms were employed to build the relationships between the future traffic state with the states in the data sets. For instance, Dougherty *et al.* [9] developed an artificial neural network (ANN) approach to forecast the short-term inter-urban traffic. Fuzzy logic-based method was also applied into the traffic flow prediction [10]. As advanced machine learning methods, SVM [11], Gaussian Processes [12], etc., have also been extensively used in short-term traffic flow prediction.

The aim of this work is to find an accurate and efficient model to predict the traffic flow at a single location. Despite studying spatio-temporal models is much more popular among the researchers at present, the traffic flow prediction at a single station should not be ignored on whether freeways or urban road networks. In contrast with the spatio-temporal methods, the data fed into the single-location prediction model is easy to acquire and the model is more practical. Moreover, a number of algorithms based on the spatio-temporal model originate from the single-location model. For instance, Min and Wynter [13] exploited a multivariate spatial-temporal autoregressive model on the basis of Vector-ARMA technology. Their model took into account the spatial characteristics of the road network in a way that reflects not only the distance but also the average speed on the links. Additionally, boundary points or locations that serve as entrances to a network are isolated without any upstream detectors. This point was exemplified in Xu *et al.*'s [14] work, which assumed the future input flow rate

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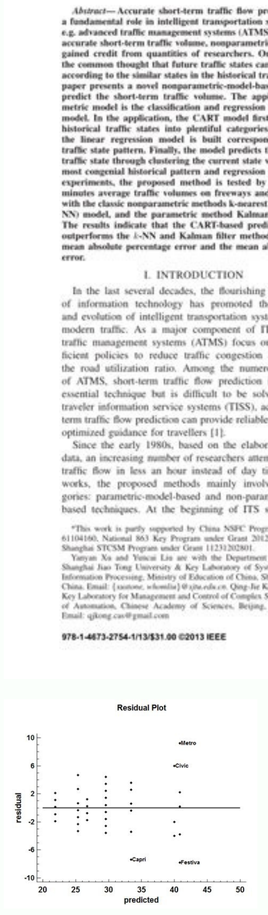

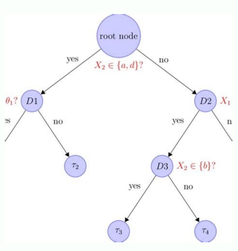

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The methodology used to construct structured tree rules is the focus of this monograph. Unlike many other statistical procedures, which moved from paper and paper to calculators, the use of trees in this text was unthinkable before computers. Both practical and theoretical sides have been developed in the study of the authors' tree methods. Classification and return trees reflect these two sides, covering the use of trees as a method of data analysis, and in a more mathematical framework, demonstrating some of their fundamental properties. Background. Introduction to the Classification of the Tree. Correct sized trees and honest estimates. Division rules. Strengthening and interpretation. Medical diagnosis and prognosis. Classification of Mass Spectrum. Return trees. Bayes and Partition Rules. Optimal Pruning. Construction of trees of a learning sample. Consistency. Bibliography. Index of notation. Table of contents. DOI link for Classification And Regression TreesClassification and Regression Trees book Native cypress trees are evergreen, coniferous trees that, in the United States, grow mainly in the west and southeast. Learn more about the various types of cypress trees that grow in the United States with the help of these descriptions. Monterey and Gowen CypressMonterey Cypress are native to the Monterey Bay area of California. Coastal winds often malform Monterey cypress trees and flatten crowns. The needles of the Monterey cypress are deep bluish green and the trunk is light grey to dark brown with ridiculous bark. Gowen cypress is another coastal plant native to California that can be planted as a shrub or large tree. Gowen cypresses prefer alkaline soil. The foliage of Gowen cypress is dark green, with cones growing less than an inch in diameter. The bark of Gowen Cypress is brown The CiprÃ © s Macnab grows in Northern California. Its cones grow around half an inch of diameter and have horny projections. The cortex of the macnab cyprÃ © s often has a one On the reddish brown bark. Like the Gowen cypress, the Macnab cypress is often cultivated as a bush and has light green foliage. The ciprés Modoc is isolated to some areas of Oregon and California, including the Siskiyou mountains. Also called ciprés Siskiyou. Bald Cipresa Calvo cypress trees grow in the south-eastern region of the United States, but the tree has grown to the north as Milwaukee. The ciprés Bald is a relative of hardwoods and sequoias, which could explain its high growth pattern. This species can grow on land or in swamps. When they grow in water or near it, the bald cypress produces growing roots with high knees that make for interesting features. The Montezuma varieties of calvo cypresses grow in Mexico and need soil flooded to grow. Calvo cypresses prefer acid soil and lose their foliage for a short time each year. Arizona CypressArizona cypress grows in Southwest America and in some parts of Mexico. The plant is a beautiful grey tree growing in pyramidal shape, like a holiday tree. In fact, the Arizona cypresses are sold as Christmas trees in some places. The bark becomes more fibrous as it ages, giving trees a heated look. The cypress treeThe cypress trees make good windshields in the coastal areas. Trees are also useful as privacy screens. Some species are very fast, so they are useful in filling a landscape, blocking the views of the structures and creating living limits. MORE FROM QUESTIONSANSWERED.NET HeungSoon/CC0/Pixabay People have an innate curiosity about the natural world around them, and identifying a tree for their leaves can satisfy that curiosity. In addition, many people use trees for landscaping, so it is beneficial to know which species to look for when buying arbustibles. People who acquire properties sometimes find treesthey prefer to sell for wood or move to another location. In each of these situations, the ability to quickly and accurately identify the trees for their foliageUseful. Learning the basics of leaf identification Like any other form of research, leaf identification goes more smoothly with some basic guidelines. There are categories or families of leaves that will help you narrow your research to specific types of trees. For example, some trees, such as Maple and Oak, have individual leaves, while others, such as Walnut and Ash, have a compound with many small leaves that come from the same branch to form a cluster or frost. The shape of the individual leaves (soul, sinuate, heart-shaped, ovoid and others) can also help identify the type of tree. Armed with this basic information about the leaves, anyone can refer to a book or electronic resource that provides a lot of information about each species, navigating the source more quickly thanks to prior classification. Field guides are the classic source for identifying all kinds of things in nature, including trees. These have long been a useful resource for scientists conducting research, as well as travelers and new residents who are unfamiliar with the new terrain. Field guides typically focus on the most common species and sometimes target a specific region. They include illustrations that help readers identify the species in question, as well as information about where it grows, what conditions it requires to thrive, and other useful facts. One of the main benefits of a field guide has been historically portability, as they are relatively compact books, presenting a variety of information in a condensed format. Using Mobile Apps If portability and accessibility have made field guide books a favorite for centuries, mobile apps that identify leaves, trees, and other natural elements take portability to the next level. With the Smartphones and other compact mobile devices, you can perform extensive research almost anywhere. with the caveat that the devices require electricity at some time to maintain a load, are abundantly useful for short expeditions and andResearch near home. An application can guide users through a step-by-step process that starts by asking where they are located, what type and shape the sheet is, and then presents several options to choose from, matching a sample of the sheet in question. Choosing trees for homeowners, landscapers and others who want to find the best species to plant have a different set of criteria that guide your research. Choosing trees that will stay on site for years requires research, and helps you learn the most prevalent species in the area to determine which will thrive. Mature trees that are already growing well in a given area provide a good indicator of which species are best for local conditions. There are still considerations for the site, such as the full size of the mature tree, that come into play when deciding where and how many to plant. But reducing the field of trees to choose from makes the research simpler and more convenient. Management of mature trees Sometimes trees may have a barrier and need to be relocated or removed. Moving large trees is a specialized task that requires sophisticated equipment and experience to ensure that the tree survives. Local research for tree estimates can help landowners and landscapers make the best decisions about where and how to move grown trees. In some cases, the trees are too big or there is not a good place to relocate them and

harvesting the trees for wood is the best course of action. When selling mature trees for wood, it is essential to know the type of tree, as there are different prices and applications for different types of wood. After identifying the type of tree, resources such as the U.S. Forest Service (FSS) are able to identify the type of tree. UU. It can provide guidance for how and where to sell the wood. More about questionnaireSwered.net QuestionsSwered.net QuestionsSwered.net 20/12/2021 · The Classifier package handles supervised classification by traditional ML algorithms running in Earth Engine. These classifiers include CART, RandomForest, NaiveBayes and SVM. The general workflow for classification is: Collect training data. Assemble features which have a property that stores the known class label and properties storing ... Decision tree types. Decision trees used in data mining are of two main types: . Classification tree analysis is when the predicted outcome is the class (discrete) to which the data belongs.; Regression tree analysis is when the predicted outcome can be considered a real number (e.g. the price of a house, or a patient's length of stay in a hospital). Decision tree classifier. Decision trees are a popular family of classification and regression methods. More information about the spark.ml implementation can be found further in the section on decision trees.. Examples. The following examples load a dataset in LibSVM format, split it into training and test sets, train on the first dataset, and then evaluate on the held-out … 19/01/2018 · 2 Types of Classification Algorithms (Python) 2.1 Logistic Regression. Definition: Logistic regression is a machine learning algorithm for classification.In this algorithm, the probabilities describing the possible outcomes of a single trial are modelled using a … Classification and Regression Trees (CART) is only a modern term for what are otherwise known as Decision Trees. Decision Trees have been around for a very long time and are important for predictive modelling in Machine Learning. As the name suggests, these trees are used for classification and prediction problems. This is an introductionary post about the fundamentals … 21/12/2020 · Softmax regression, along with logistic regression, isn’t the only way of solving classification problems. These models are great when the data is more or less linearly separable. When the data is not linearly separable, however, we turn to other methods such as support vector machines, decision trees, and k-nearest neighbors. 13/01/2013 · The CART or Classification & Regression Trees methodology was introduced in 1984 by Leo Breiman, Jerome Friedman, Richard Olshen and Charles Stone as an umbrella term to refer to the following types of decision trees: Classification Trees: where the target variable is categorical and the tree is used to identify the "class" within which a ... 05/10/2020 · A fast, scalable, high performance Gradient Boosting on Decision Trees library, used for ranking, classification, regression and other machine learning tasks for Python, R, Java, C++. Supports computation on CPU and GPU. - GitHub - catboost/catboost: A fast, scalable, high performance Gradient Boosting on Decision Trees library, used for ranking, classification, … Classification tree (decision tree) methods are a good choice when the data mining task contains a classification or prediction of outcomes, and the goal is to generate rules that can be easily explained and translated into SQL or a natural query language. A Classification tree labels, records, and assigns variables to discrete classes. Classification trees can also provide the …

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