Bike-Sharing Demand Forecasting that Explicitly Accounts for Weather Data

Abstract:

Bike Sharing is a sustainable mode of urban mobility, not only for regular commuters but also for casual users and tourists. Bike sharing is an innovative bike sharing model, that saves on start-up cost, prevents bike theft, and offers significant opportunities for smart management by tracking bikes in real-time with built-in GPS. The primary objective of this paper is to understand the mobility patterns and imbalance of a bike sharing by analyzing its historical trip and weather data. Resulting outcomes provide insights to assist the system operator to make more informed decisions. Researchers have studied mobility patterns by analyzing historical trip and weather data of station-based bike sharing systems using data visualization and or generalized linear models. However, none of these studies considered interaction between independent variables or study imbalance as a dependent variable.Rental Bike Sharing is the process by which bicycles are procured on several basis- hourly, weekly, membership-wise, etc. This phenomenon has seen its stock rise to considerable levels due to a global effort towards reducing the carbon footprint, leading to climate change, unprecedented natural disasters, ozone layer depletion, and other environmental anomalies.

In our project, we chose to analyses a dataset pertaining to Rental Bike Demand Washington, D.C, comprising of climatic variables like Temperature, Humidity, Rainfall, Snowfall, Dew Point Temperature, and others. For the available raw data, firstly, a through pre-processing was done after which a Here, hourly rental bike count is the regress and. To an extent, our linear model was able to explain the factors orchestrating the hourly demand of rental bikes.

What is Bike Sharing?

Bike Sharing systems are a means of renting bicycles where the process of obtaining membership, rental, and bike return is automated via a network of kiosk locations throughout a city. Using these systems, people are able rent a bike from a one location and return it to a different place on an as-needed basis. Bike sharing is an emerging urban transportation option based on collective paid use of public bicycles available at distributed stations.
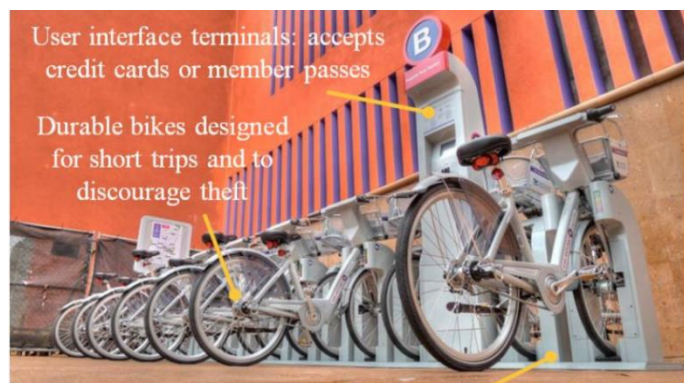
Introduction

Public bike-sharing systems were suggested at the beginning of the millennium but have been gaining momentum only in the last decade. The main premise of implementing bike-sharing systems is to promote sustainable mobility in urban areas. They offer a convenient and easy-to-use service for residents for short-distance trips. Moreover, they are capable to improve first/last mile connection to other travel modes, reduce traffic congestion and energy consumption and decrease environmental impacts of daily travels. Furthermore, communities who organize a bike-sharing program increase physical activity and encourage remarkable health benefits to the users. Bike-sharing system as a sustainable and affordable travel mode is not without its challenges for both users, e.g., perceived lack of safety, and operators. In this context, bike repositioning or rebalancing has been recognized as an important operational challenge. Bike demand is basically non-stationary, meaning that it varies over time and space. The fluctuating demand may cause the uneven distribution of bikes across different stations where some stations may be totally saturated while concurrently others may lack bikes. This can be related to the "tidal flows" of bike-sharing trips, with certain areas in the city encountering a deficit of bike availability. For instance, during the morning rush hour, residential areas generate a high number of commuting trips towards the areas of employment. This could possibly lead to the problem of insufficient bikes in those areas in that period.

The service quality has positive and significant effect to increase the bike-sharing popularity, attract more users, and improve the overall economic performance of bike-sharing systems. The bike imbalance issue may cause reduced service reliability, user dissatisfaction and decrease attraction and user engagement in bike-sharing program which may fail to meet the expectations of sustainable transport system implementation. Therefore, it is of great importance to understand and predict travel demand to support planning and day-to-day operation of bike-sharing systems. Accurate and reliable trip demand predictions across the city over different times of day allow system operators to better plan bike redistribution and fleet rebalancing. Hence, application of advanced predictive models has recently received a lot of research interest, as revealed by a recent literature review by Albuquerque et al. on Machine Learning techniques' contributions applied to bike-sharing systems to improve urban mobility. While optimization algorithms can support such operation, they must rely on relevant travel forecasting demand able to anticipate where bikes will be required in the short-term.

This is typically the missing component since bike-sharing demand combines both regular and irregular use patterns and fluctuates according to various events. Moreover, the recent COVID-19 pandemic drastically impacted all features of daily travel for all transport modes. It has become even more challenging to anticipate plausible travel behaviors at all forecasting horizons with the high uncertainty related to post-COVID activity systems. In this context, proposing tools able to forecast pickups while accounting for changing spatial-temporal patterns is critical for network operators that must ensure good fit between provided services (shared bike availability) and evolving demand.

Considering the current ecosystem, bike-sharing can play a vital role in reducing the impact of carbon emissions and other greenhouse gases- major contributors in climate change. Sustainable and clean transport system, if successful, can provide a greener alternative to the traditional car-pool system, and help in reducing traffic congestion, too.

In addition to the environmental benefits, the sharing systems will impart healthier habits among commuting public, who in the hustle of tasking daily routine, often are unable to integrate optimum level of physical activity, which results in a barrage of ailments.

HISTORY OF BIKE SHARE INITIATIVES:

The first bike-share programs began in 1960s Europe, but the concept did not take off worldwide until the mid2000s. In North America, they tend to be affiliated with municipal governments, though some programs, particularly in small college towns, center on university campuses.

The typical bike-share has several defining characteristics and features, including station-based bikes and payment systems, membership, and pass fees, and per hour usage fees. Programs are generally intuitive enough for novice users to understand. And, despite some variation, the differences are usually small enough to prevent confusion when a regular user of one city's bike-share uses another city's program for the first time.

ECONOMIC BENEFITS

1. Bike Sharing Increases Urban Vibrancy.

Several recent studies have shown an increasing demand for an urban lifestyle, especially among the younger demographic so sought after by policy makers.5 A variety of efforts are underway in the Miami Valley to help meet that demand so the Dayton region can position itself for future economic prosperity. Bike sharing would not only be complementary to those efforts, but could be a game-changer for connecting the areas in and around downtown Dayton, while increasing street traffic, the visibility of people, and overall vibrancy. The community enjoying the outdoors downtown is a powerful image that combats almost every negative perception someone might have for the city. Greater utilization of our streets could transform perceptions of downtown almost overnight.

2. Bike Sharing Benefits Local Businesses.

A bike share system not only replaces trips users would have made via another form of transportation, but it also encourages completely new trips. For example, Capital Bike share users report approximately 4% of their total trips were ones they would not have made at all if not for the availability of the bike share. Furthermore, bike sharing makes users more likely to patronize businesses in the bike share service area. More than eight in ten respondents of the Capital Bike share survey said they were either much more likely (31%) or somewhat more likely (52%) to patronize an establishment that was accessible by Capital Bike share. Investing in Bike Infrastructure Creates Jobs. In addition to the jobs that would be created through implementation of a bike share system, research shows that investing in bike infrastructure is an effective job creator relative to investments in other forms of transportation. A 2011 study looking at 58 separate projects found that $1 million invested in bike infrastructure produced 11.4 jobs, against 10 jobs for the same amount invested in pedestrian projects, and 7.8 jobs for road-only projects.

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ENVIRONMENTAL BENEFITS

1. Reduction in Emissions.

Increased cycling offers many environmental benefits for a community. For every mile driven, cars produce almost a pound of CO2. Considering that 40% of all car trips are less than two miles (i.e. very bike able), the savings in pollutants emitted could be substantial. A person who cycles to a job four miles away saves approximately 2,000 miles of driving and 2,000 lbs. of CO2 emissions each year. This equates to nearly a 5% reduction in the average American's carbon footprint.

2. Bike Shares Have Minimal Carbon Footprint.

The bike share stations under consideration for Dayton are solar powered, therefore they have a minimal carbon footprint. Additionally, some systems use bike pulled trailers to help with redistribution of bikes, so even the operations can be environmentally friendly.