Project Proposal

Effect of stop skipping on passenger travel time on the Washington Metro

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Background

Stop skipping (or stop skipping) is a method sometimes used in public transit systems to decrease travel times for passengers. It is a form of express travel that avoids stations with low ridership during certain times to improve overall operating speed. Skip stop systems have been used by metro systems in Santiago and Seoul (Freyss, M. et. al; Suh et. al.) The Washington Metro (WM) has used stop skipping previously to make up for delays, but in normal operation does not skip stops.

Purpose/Overview

The purpose of this project is to model the effects of a skip stop system on passenger travel times in the Washington Metro. This will be accomplished by applying a version of existing skip stop models on passenger ridership data from the Washington Metro and identifying which stations to skip to best reduce travel times.

Previous Research

Past research has focused on developing mathematical models to optimize skip stop systems but also on the efficacy of the skip stop practice in general. In Korea, it was found to have a decrease in total travel time (including waiting) by nearly 8 percent. When considering only time spent on the train, the decrease in time was closer to 12 percent. It is important to note that

although overall trip times were decreased, waiting times did increase as a result of the skip-stop method. (Suh et. al, 2002). Newer research has developed genetic algorithms (widely used in operations research) to model the skip-stop process (Lee, 2012). The choice of train taken by passengers has also been used in performance analysis of skip stop (Cao, 2016). In addition, a continuous approximation model has recently been created that takes into account continuous variables such as the station density on a linear track to figure out which stations should be skipped. This model also takes into account the energy cost associated with running a skip-stop system (Freyss et. al, 2013). Both of these methods utilize an objective function that calculates the cost of the skip-stop method. These objective functions are then minimized to find the best set of skip-stops.

Principal Objectives

One principal objective will be to create a model (based on existing research) that predicts what stops should be skipped at what times based on passenger traffic and their origin and destination to optimize the amount of time taken on a trip. Another principal objective is acquiring data for origin and destination times and the subway motion variables like speed, acceleration, etc. (which are utilized by some of the skip-stop models). The subway motion variables are partly available online but for more accuracy can be directly sourced from WMATA (the agency that controls the Washington Metro) through a data request. As a governmental organization, this specific data should be available publicly. The number of passengers originating from and arriving to a pair of stations has already been downloaded from a public blog by WMATA. This is a spreadsheet with more than 1 million data points collected over a month that should suffice for

training a model. The final primary objective for this project is to test the quality of the predictions and its impact on the passenger travel time.

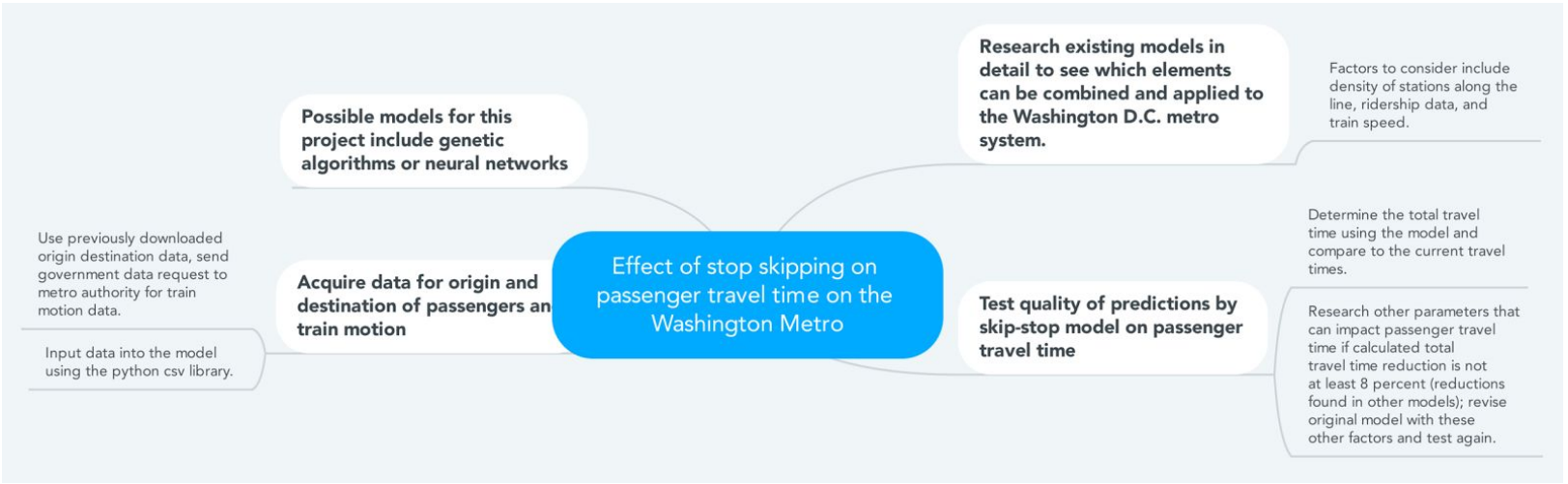
Secondary Objectives

Secondary objectives for this project are identifying which type of model should be used as a to predict the stops that should be skipped. For the time frame of this project, focusing on a section of the Silver Line to test stop-skipping would likely be more feasible than modeling the entire metro system as a whole. The model will be programmed in Python due to its abundance of libraries such as sci-kit learn and numpy. Another secondary objective will be to create a visualization of the cost function for the model. Possible libraries for this are Plot.ly or matplotlib. An important secondary objective for acquisition of data is transferring it into Python, which will be accomplished by using the csv module. The origin destination data file is too large to be viewed in its entirety in Excel, so it must be accessed in the csv format. For testing the quality of the predictions (a primary objective), the total system travel time will be calculated and compared to the existing travel times.

Diagram/Overview

- Effect of stop skipping on passenger travel time on the Washington Metro
    - Possible models for this project include genetic algorithms or neural networks
    - Research existing models in detail to see which elements can be combined and applied to the Washington D.C. metro system.
        - Factors to consider include density of stations along the line, ridership data, and train speed.

- Acquire data for origin and destination of passengers and train motion
    - Use previously downloaded origin destination data, send government data request to metro authority for train motion data.
    - Input data into the model using the python csv library.
- Test quality of predictions by skip-stop model on passenger travel time
    - Determine the total travel time using the model and compare to the current travel times.
    - Research other parameters that can impact passenger travel time if calculated total travel time reduction is not at least 8 percent (reductions found in other models); revise original model with these other factors and test again.



Time Table for project

Week One: Acquire data and pre-process (file format conversion, importing csv files into Python). Send request to WMATA for data.

Week Two-Four: Research existing models on skip-stopping, identify elements that could be used from these models to apply to this project. Consider ways to simplify these models (i.e. excluding parameters like energy cost, etc.) to fit within one year time frame of this project.

Week Five: Develop model based on past research and adapt to the Washington Metro system. Ideally, any required government metro data would have been approved and sent by this point.

Week Six-Seven: Test model for the difference between travel time using the model and the current travel times.

References

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