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ANALYSIS OF TRAVEL TIME RELIABILITY ON LONDON UNDERGROUND

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INTRODUCTION

Public transport has become an essential tool in the day-to-day life of the urban population and has progressively become an indicator of the level of growth of a city, contributing to its international reputation. Therefore, the transit agencies thrive to provide an efficient and predictable service for its users. This invariability in attributes of a network performance is defined as reliability. Developing means of quantifying and characterising reliability on the London Underground is the main purpose of this research.

THE LONDON UNDERGROUND

The London Underground, serving a megalopolis of 8.3 million individuals and 270 stations over 402 kilometres is an impressive transport infrastructure that contributes to the international stature of the city of London. With 20 millions trips on a daily basis, it is an extremely congested and complex network that requires constant monitoring and maintenance to sustain a satisfactory service. Its fusion to the Transport for London group in 2003 led to the introduction of the Oyster Card fare system, an Automatic Fare Collection (AFC) system.

USING "BIG DATA" THROUGH AFC

By introducing an AFC system, which consists of smartcards that are tapped at a fare gate at entry and exit station recording both times, TfL has provided accurate data, very useful towards monitoring the performance of the Underground. By dissecting this data, potential issues are highlighted and solutions are developed to enhance the passenger's experience. The study relies on this data to assess the reliability of London Underground as a function of the distribution of travel time and time of day.

METHODOLOGY

The Reliability Factor, introduced by Chan (2007) and improved later by Uniman (2009), is used as a reliability metric in the study: It's the amount of time a passenger must add to his usual travel time to guarantee with a 95% level of significance that he will arrive on time:

$$RF = JT(Quantile\ 95) - JT(Quantile\ 50)$$

Reliability will be investigated on several levels to investigate its variability through different aspects.

Step 1: Journey Time Distribution Analysis → **Step 2:** Reliability Factor as function of dispersion of distribution → **Step 3:** Reliability factor in terms of time of a day on a line

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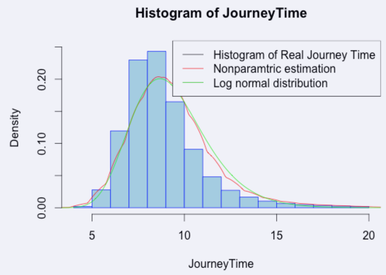
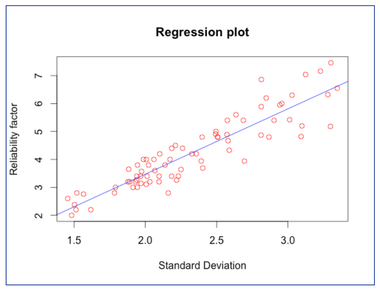
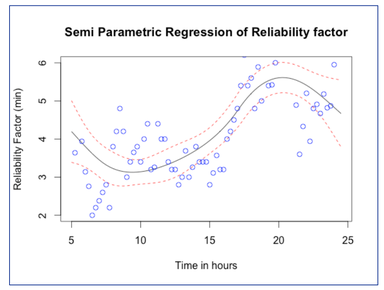
RESULTS AND CONCLUSIONS

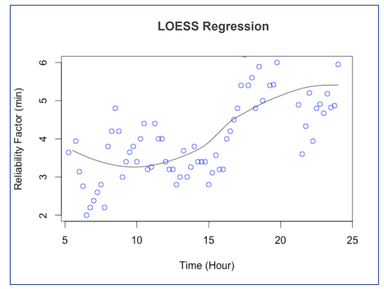


JOURNEY TIME DISTRIBUTION

Journey time distribution between two stations along the same line, when fitted with a nonparametric distribution, has been found to be well captured by the log-normal parametric distribution. On the other hand, if an interchange or several paths are optimal between an Origin and a Destination, this result does not apply as the distribution is more disperse and nonparametric distributions are to be used. The journey time is inherently less reliable through the intervention of numerous factors in the choice of path (speed of lines chosen, number of stops, headways) and the state of the interchange station (congestion, walking distance)







REGRESSION MODELS

Along the Victoria and Jubilee lines, the reliability factor follows similar regression models. Reliability obeys a linear relationship to the dispersion of journey time distribution and a cubic spline relationship to time of day. The compactness of journey time distribution, namely the standard deviation, is confirmed to be a direct indicator of the reliability and these results were reproduced for any two Origin-Destination pair in zones 1 and 2, whether or not an interchange is part of the journey. Fluctuations of reliability along time of day along a chosen line are more complex and follow the pattern of peak and off-peak time, which is well captured by the cubic smoothing spline, a semi-parametric regression model. These findings could be used by TfL to evaluate which lines need reliability improvements. In addition, the regression models could be combined to generate at a specific time, on a designated line, a single reliability measurement that could be provided to users through journey planners.

Log-normal distribution of journey time → Linear Regression of RF with dispersion → Cubic Spline Regression of RF along the day

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Multivariate analysis to produce one reliability metric for users

REFERENCES

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Uniman, D., 2009. Service Reliability Measurement Using Smart Card Data: Application to the London Underground. Master's Thesis. Cambridge: Massachussets Institue of Technology.