A pioneering use of Artificial Intelligence to manage traffic

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Abstract

This paper is an update of the 2022 paper that outlined the experience of implementing a Simplifai System in Kirklees. Since then, the Simplifai System has been deployed with other Local Authorities in the UK, this paper will mainly draw on the experience from the deployment in Hull.

In Hull dynamic information from the traffic control system is combined with the configuration information about the traffic signal operation to create base models (AI readable digital twins) for each area that are used either separately or in combination to simulate past, present and future traffic scenarios.

On 7th February 2024 a patent was granted (GB2598661) for the invention entitled 'Traffic strategy system and method for implementing the same'. The methodology for creating the AI readable models and the creation of strategies to meet goals is now protected by the patent. This paper outlines some of the elements that are covered by the patent the impacts of using the techniques.

The project has been funded by the Department of Transport with additional funding from Simplifai Systems shareholders and Bridge AI through Innovate UK Project – Connecting the North.

Keywords:

Artificial Intelligence

Data Integration

Digital Twin

Goal centred Traffic Control

Introduction

The project in Hull started in March 2023 and has resulted in a deployment in 5 regions of Hull shown on the map below (deployment areas are ringed in black).

Figure 1 – Areas of deployment in Hull (ringed in black)

The coloured dots on Figure 1 show the locations of the existing traffic data collection loops, the flow and speed information from these locations are fed into the Simplifai System from Yunex automatically. Additional information about the operation of the traffic signal system is also fed in automatically from the Yunex System.

In addition to the data from Yunex data is also used from the following sources:

- Bus open data from the Department for Transport
- Inrix speed and journey time data supplied by Clearview
- Event information from Data Thistle
- National Highways Information supplied by KL Systems

Background to the Simplifai Systems AI

The original concept formed between KAM Futures (Simplifai Systems predecessor) and Huddersfield University was to develop “Autonomic Road Transport Support Systems”. The concept was initially tested in Manchester using the TfGM Aimsun traffic model which proved the concept. This work resulted in the filing of the patent GB2598661 (and patents being filed in US and China).

Kirklees deployment

The solution developed in Manchester was updated to provide a solution for the post Covid recovery and this was implemented in Kirklees as part of the DfT Traffic Signals Maintenance Fund Round 1.

The desired outcome was to demonstrate that, through better access to data and analytics related to traffic use, improvements can be made to reduce transport's impact on the environment and improve the reliability of the transport network. A series of products were delivered for use by traffic operators in Kirklees. These include:

- Data Lakehouse
- Analytical tools
- Managing planned events tools
- Managing real-time operations tools
- AI model representations

One notable implementation in Kirklees was to create traffic signal plans for the largest event in Kirklees in 2023 – a Muse concert at the John Smith Stadium. This was the first time a large concert occurred on a weekday at the stadium, hence the need to create bespoke plans for the event. The plans were successfully implemented before and after the event to create free flowing traffic before and after the event on the key route network in the vicinity of the stadium (Wakefield Road).

The key challenge addressed with creating plans for this event was to transpose the additional demand created by a similar event on a Saturday (Green Day Concert) onto the typical afternoon and evening peak traffic pattern for a weekday in June for every significant road link in the area.

The modelling involved calculating flows for 59 individual links for a period of 27 hours in 15 minute segments resulting in 6,372 individual flow predictions for the period. The graph below shows the comparison between the transposed predicted data and the actual flows after the event when summed across all the links in the region. The overall volumes in the forecast were 99.64% accurate, however, the prediction was based on a Saturday Concert, on the Tuesday Concert attendees arrived slightly later and left slightly earlier than at a Saturday Concert.

The overall impact on delays as a result of implementing the plans for the Muse Concert was an 8% reduction in delay before the event and a 68% reduction in delay after the event. If this impact was scaled up to the management of all the events at the stadium, the overall benefit in relation to reduced delays by improved event management would be of the order of £60k per annum.

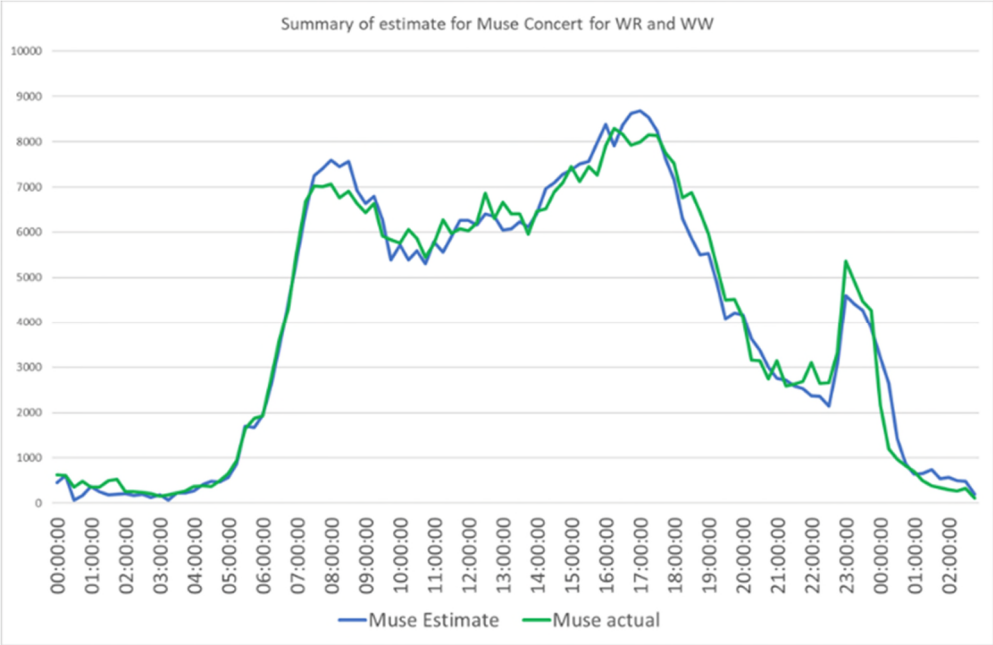

Figure 2 – Comparison of predicted and actual traffic volumes for all modelled links in Kirklees for the Muse Concert June 2023

Hull Deployment

The work in Hull has build upon the work in Kirklees through the deployment of the AI Technology.

Figure 1 above shows the location of the deployment in Hull on five corridors. The regions typically contain between 3 and 6 junctions covering one or more SCOOT Regions. However, in addition to this a deployment has been created that combined 2 of the regions to include 10 junctions from 5 SCOOT Regions with 39 separate stages to help manage the main route from West to East to the North of the City Centre.

Challenge

During periods of heavy congestion, the network presents either high journey times through the area or 'gridlocks' causing delays, and can be a disincentive to promoting public transport use.

The objective was to use Artificial Intelligence to identify and create a range of optimised traffic control plans for different circumstances, with the most appropriate plan being selected in real time to implement improvements to traffic flow within the different areas of Hull.

Solution

Hull City Council engaged Simplifai, who worked with UTC supplier Yunex Traffic, to deliver a pioneering use of AI to manage traffic on the five location shown in figure 1. The first deployment was on the Anlaby Road corridor (bottom left ringed area on Figure 1) in the city. The solution has been applied to improve bus reliability by reducing journey time impacts.

Simplifai accessed real-time and historical data on traffic movements to develop an AI simulation model and analyse the data to identify network constraints and the causal relationship with the trigger points leading to heavy congestion. Additional datasets were accessed to support analysis of bus delays and congestion hotspots – DfT Bus Open Data Service.

INRIX data accessed via Clearview Intelligence was used to verify journey times both before and after implementation of the optimised traffic signal plans.

Outcome on Anlaby Road Corridor

The AI-optimised traffic signal plans deployed delivered an average improvement of 16.89% during the AM peak and a 7.03% improvement during the PM peak (which coincided with a 40% increase in traffic due to parallel road works).

Using a conservative economic value of @£12 per congestion hour the application to the Anlaby Road alone is delivering an AM saving of £124,687 p.a. and a PM saving of £56,112 p.a. offering significant value for money for the taxpayer.

Improvements to public transport

In addition to being used to improve journey times in the peak periods in the system has also been used to mitigate the impacts of a major disruption to bus services in Hull (the closure of the main route for buses into and out of Hull to the East of the City Centre).

Challenge

The challenge was to use Artificial Intelligence (AI) to optimise the performance of bus diversion routes during the closure of one of the major links between the East and West of Hull, the Drypool Bridge, which impacted the primary eastern bus routes from the city. Previously, planned closures had caused significant delays to bus journey times, creating heavy congestion and a disincentive to promoting public transport use.

The objective was to use AI to identify and create a range of optimised traffic control plans for different circumstances, with the most appropriate plan being selected in real time to manage journey time performance during bridge closures.

Solution

In September 2023, AI tools were used to assess the impact of a two-day bridge closure in Hull. The two-day closure had a significant impact on bus journeys in the Eastern part of the city that were using the planned diversion routes. As a result, the Simplifai System was deployed in readiness to create contingency plans for the traffic signals, in preparation for the planned long-term closure of the bridge that was expected in the Summer of 2024.

The bridge was subject to a routine inspection in April 2024, which resulted in a 16-day emergency closure. As the Simplifai System had been configured to produce contingency plans, it was used to implement plans created to mitigate the issues during the afternoon peak period when the buses had experienced long delays during the September closure.

The DfT Bus Open Data Service datasets were accessed to support analysis of bus delays and congestion hotspots.

Outcome

The use of the AI meant that the plans to mitigate the bus delays could be produced quickly in response to an emergency closure, e.g. for the next period of peak time traffic when the delays were predicted to occur.

The key impact, resulting from the deployment of the new traffic signal plans, was the significant reduction in bus journey times; during the 2-day closure delays of up to an hour were reported, these delays were reduced to a more manageable increase of less than 15 minutes during the 16-day closure.

Innovate UK – Bridge AI Project

In May 2024 Simplifai Systems started an Innovate UK / Bridge AI Project 'Connecting the North'. The main aim of the project is to build on the successful deployments of the Simplifai Technology in the North of England and scale the technology for deployment at scale anywhere in the World. Simplifai Systems will present the early results from the first phase of the project at the JCT meeting in September.

References

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