Decision Support for Planning Multi-Modal Urban Travel

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Introduction.

Traffic congestion is becoming a serious environmental threat that must be resolved quickly. Great Britain has become a role model in the battle against global pollution. The Prime Minister, Tony Blair, has acknowledged that a 20% reduction in carbon dioxide emissions in Great Britain is a credible target for the year 2010 (Brown, 1997). However, significant measures are necessary to attain this target. Road vehicles and industry are the main sources of pollutant emissions. In the United Kingdom, road vehicles are responsible for over 50% of the emissions of nitrogen oxides and over 75% of carbon monoxide emissions (DETR, 1998). This clearly indicates that the cumulative emissions of road vehicles must be curtailed.

One of the most effective ways of reducing emissions is to persuade drivers of private vehicles to use public transport instead. However, this can only be accomplished if the level of service that is afforded with alternative modes of transport is comparable to that of the private vehicle. This paper focuses on one aspect of this 'quality of service', the issue of flexible provision of information about public transport and assistance with planning travel. A multi-objective optimisation algorithm that balances the concerns of travel time, uncertainty about traffic delays, inconvenience of parking and inconvenience of making connections is presented and evaluated.

Travel Information Systems

Traditionally travel information systems have been specific to a particular mode of transport. For instance, bus travel information has been provided at bus stops to potential bus travellers while traffic information (radio broadcasts) have been directed at drivers. While fulfilling its intended objective, such an approach to urban travel support does little to encourage multi-modal travel in the cities and does not take into account the specific requirements of individual journeys.

The research reported in this paper takes a fundamentally different approach and rather than aiming at maximising the efficiencies of the use of individual modes of transport taken in isolation, it considers a broader multi-modal travel framework. This means that the travel requirements are defined in terms of journey as and the mode of travel is just one of the decision variables. The journeys can be considered singly or can be concatenated (with user defined time-gaps between the stages) to reflect a realistic travel pattern (outward and return journey pattern). The possibility of the evaluation of combined journeys reflects the fact that the choices made at the earlier stages of a combined journey restrict the range of options that are available at the later stages.

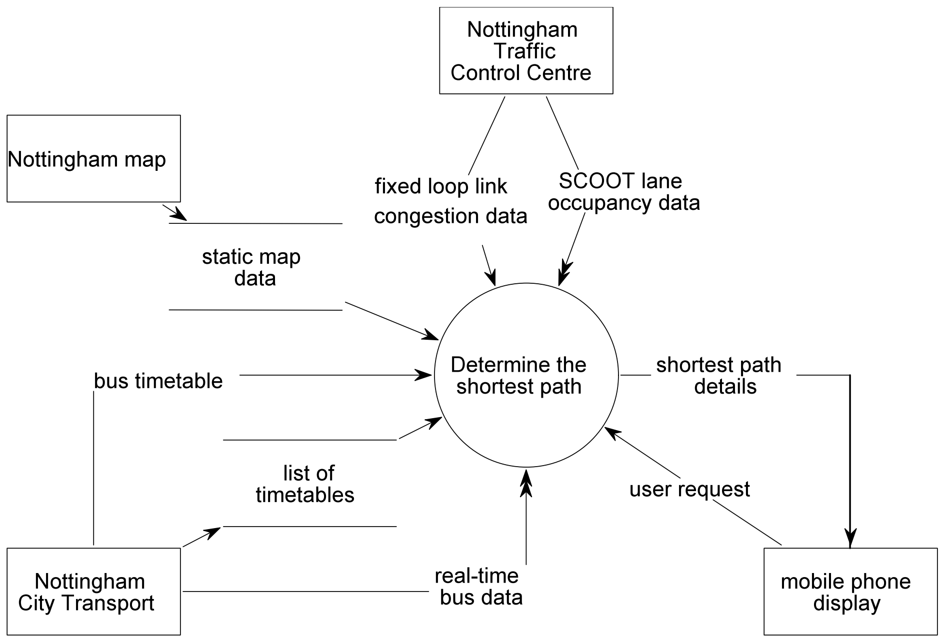
An important feature of our approach is that it recognises the individual nature of journeys. The enquirers are allowed to specify their relative priorities such as the importance of the short journey time or the importance of timely arrival at the destination. Although the answers may be highly subjective, it must be remembered that these preferences make people opt for one mode of transport or another. In this sense, the multi-modal travel optimisation offers a good mapping onto human decision making.

Dynamic guidance is of the greatest benefit to travellers, as new routes and travel modes can be suggested as conditions change (McDonald and Montgomery, 1996). In general, any road user would benefit from having a reliable system for the evaluation of optimal dynamic route guidance. The system will aid the road users by providing access to information that is not readily observable form the current location of the traveller, yet is relevant because of the planned journey. The wide use of such a system will reduce the amount of congestion within the city, by the choice of departure time and shorter routes as suggested by the route guidance system.

Traveller information solutions aimed at PC users have already been developed. However, with the access limited to the home/office or the few available travel information terminals, the accuracy and the relevance of the advice is limited. At the other end of the spectrum, travel information systems incorporated in top-of-the range cars, offer excellent static travel information but are limited regarding the real-time traffic and public transport data provision and as such do not contribute directly to mode switching decisions by drivers (Bargiela et al., 1999). To eliminate these constraints, our project uses a mobile phone for communication between the user and the system. Thus, the system is easy to use and not prohibitively expensive.

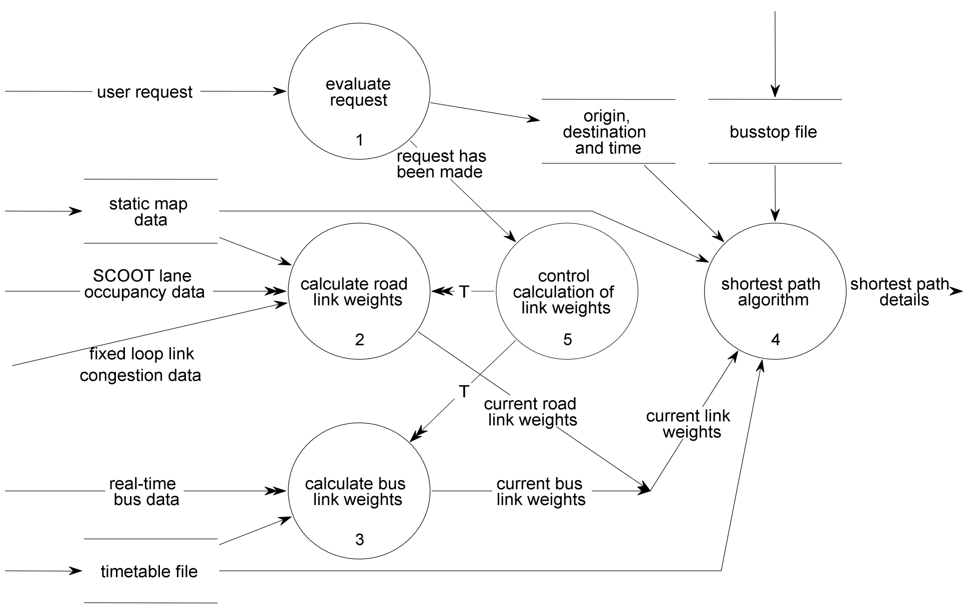
The system must be capable of simultaneous data acquisition, processing and dissemination of the traffic/travel advice in real-time to a full spectrum of end users. Traffic/travel information is inherently diverse and is characterised by varying levels of information granularity: from detailed lane occupancy data through to video traffic surveillance to travel times of specific journeys using various modes of transport. Recent advances in telecommunications have made it feasible to access all of these important sources of information.

The mobile phone small message service (SMS) allows the user to choose starting and finishing points of a journey and to make appropriate travel requests. The route to the requested location will be evaluated using a combination of static, current and predicted data. The integration of data concerning traffic flows, public transport and individual journey plans thus makes it possible to perform multi-modal optimisation of travel. So that the users' reaction to the information provided is appropriate, the data contains accurate, up-to-date information about the traffic conditions (Peytchev and Bargiela, 1999). Human Computer Interaction issues will be careful considered during the design stage. (Rahman and Mutter, 1999; Shneidermann, 1998).



Route Guidance

There are many methods of path finding that are appropriate for use within the spectrum of route guidance. However, route guidance of multi-modal transport has a number of implications that ensure the deviation from the standard methods, such as Dijkstra's shortest path algorithm (Dijkstra, 1959). Dijkstra's algorithm does not allow for time-dependent links, which is a necessary property of bus routes. Dreyfus (1969) has considered a number of methods incorporating time-dependent links. These will be further analysed to determine the suitability for use within our context of multi-modal route guidance. The definition of optimality will also be considered – constraints, such as an upper bound on the number of bus changes on a single journey, may be deemed appropriate.



The input data from the urban network that will be used consists of estimated travel times across the network's links. Some of this data will be static; some will be real-time. Nottingham Traffic Control Centre continues its kind agreement of allowing the Simulation and Modelling Intelligence group to have access to its Traffic Control System (SCOOT) data, providing the necessary current traffic information. There are a number of issues to investigate with regard to storing information. The appropriateness of storing set paths, or calculating paths on demand will be investigated.

The guidance system should be tested on a suitable simulator before being implemented in the real world (Peytchev and Bargiela, 1994; Peytchev and Bargiela, 1995). Any route guidance system must consider the inherent implications for the rest of the urban traffic network. It must be ensured that the movement of traffic from one area of the network does not result in the pollution of another area of the network. Investigation into induced traffic has already shown that road improvements will normally result in a traffic growth of 10% in the short term and 20% in the longer term (Goodwin, 1996).

Expected Results

Studies have shown that the acceptance of route guidance is strongly correlated to any previous experience of the system (May et al., 1992; Bonsall and Joint, 1991, Bonsall et al., 1992). The simulation will be used to test how the use of the route guidance system will enhance the progression of the traveller (Bonsall and Palmer, 1995; McDonald et al., 1995), and that a further improvement in travel time may be gained by the choice of multi-modal urban travel.

Most of the general public support the government's aim of tackling pollution and congestion and are consequently in favour of positive measures to improve public transport. So, the demand for passenger transport is likely to rise in the short term, as the quality, reliability and value for money of public transport improves and the cost of motoring increases. The co-operation between different public transport operators in different modes is increasing, and so inter-modal cohesion is improving. The general public are travelling more and the public transport network will capture some of the increased demand, particularly if there is greater inter-modal cohesion.

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