MATHEMATICS MATTERS

On your bike: accurately measuring cycling numbers

Official estimates suggest the number of cycle journeys in the UK could be declining. With a leading transport charity arguing otherwise, mathematics is being used to paint the true picture of cycling in the UK in order to secure important government funding.

Cycling in the UK has seen somewhat of a revival over the past few years. With Bradley Wiggins's maiden Tour de France victory sandwiched between outstanding Olympic cycling medal hauls in Beijing and London, the sport is riding high.

It is hoped that such success will see more Brits getting on their bikes up and down the country. An increase in cycling, for both commuting and leisure purposes, could help tackle the on-going rise in obesity, as well as contributing to the fight against climate change by helping reduce carbon emissions.

The drive towards more cycling is not new, though. In 1995 the National Cycle Network (NCN) was established to provide safe, often traffic-free routes for cyclists and walkers. Today, the network weaves through over 13,000 miles of the country, passing within a mile of 57% of the population.

However, for the Network to continue to be a success, and expand even further, continued investment is needed - both in the National Cycle Network itself, and in wider initiatives to support sustainable and active travel. A significant potential source of sustainable transport funding in England is the Local Sustainable Transport Fund. Run by the Department for Transport, the £600 million scheme allows local authorities nationwide to invest in carbon-cutting travel alternatives. But the investment is evidence-based: success has to backed up with hard numbers, otherwise cycling initiatives risk losing their slice of the pie.

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The trouble is the current method of measuring the use of cycling nationally suggests the number of bike journeys is flat-lining or even declining. Yet this does not seem to tally with local estimates on the ground which suggest uptake is on the rise – it is thought up to one million people a day travel along some part of the NCN.

Approximations for the number of cycling journeys currently emerge from the National Road Traffic Estimates (NRTE), in which all road use is categorised by vehicle type and road category. As two-thirds of the NCN is part of the road network, most cycle journeys take place on Britain's minor roads. With those minor roads comprising 87% of the total 245,000 mile road network, it is impossible to count every single journey. Instead, random sampling takes place and the results are extrapolated to give an estimate of overall usage.

This method works well for motor vehicles, but not so well for bicycles as their use is more variable. People are more likely to cycle in the warmer, lighter summer months and in the colder, darker winter months cycling levels decline. Cycling is also more likely to be affected by rain. The NRTE data are not sufficiently comprehensive for cycle traffic to reveal these variations, which are smaller for motor vehicles. As overall cycling use levels are lower than those of motor vehicles, any discrepancies are amplified in the extrapolation process. Advocacy

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organisations, like sustainable transport charity Sustrans, think this partly accounts for difficulties in providing estimates which mimic reality.

In an attempt to tackle the problem, Sustrans has been working with London South Bank University (LSBU) and the University of Bolton (UoB) to improve the method of producing estimates. If mathematics can help prove the success of the National Cycle Network, it presents a flagship example of the benefits of investing further millions into local sustainable transport.

Use is being made of the additional 2,000 bike counters in place along the NCN. These counters use an induction loop which registers a change in magnetic field as a bicycle is ridden over it. However, only ninety-seven of the counters have a continuous record sufficient for analysis. Gaps in the data result from some counters having only been temporary, funding being withdrawn for continuous monitoring or equipment failure and maintenance issues. The aim is to understand patterns of use, using mathematical techniques to fill these missing gaps.

To do this, the researchers are working to group the complete data sets into different types of cycle usage. This can be done by looking at the shape of the graph (profile) describing the rise and fall of journeys over the course of a day, week or year.

For example, the profile for a counter on a route mostly used for commuting would see peaks in weekday mornings and early evenings. Routes used for access to schools would see a similar peak in the morning but an earlier peak for the return leg as schools tend to finish before offices. Conversely, a route mainly used for leisure would see significant spikes at weekends. Routes may exhibit a mixture of uses.

Knowing what the profiles of different types of routes look like will allow researchers to use these patterns to estimate missing data with more accuracy than for an overall 'average' counter. By overlaying the general shape of the group profiles onto the incomplete counter profiles, they can work out which group they belong to. This can then be used to accurately fill in the gaps in the data – mathematics will allow useful data to be drawn from a larger number of counters. Use of a wider range of counters will allow estimates of cycle use to be made for more extensive proportions of the NCN and hence this will give a much more accurate reflection of cycling levels along it.

With many predicting a further spike in the number of cycle journeys after Team GB and ParalympicsGB's success in the velodrome, mathematics is helping ensure that accurate sampling allows continued investment in Britain's cycle networks.

TECHNICAL SUPPLEMENT

Cluster analysis has been used as part of the initial exploratory stage. Prior knowledge about the location and type of route exists, but the study has been data driven. The data were explored using ratios of month to average month, day of week to average day and hour to average hour using hierarchical and non-hierarchical methods. The seasonal patterns were the most significant aspect of the variability. Counters were able to be grouped into twelve distinct route types by year, week and day and this may provide a useful basis for route classification.

The overall aim of the work is to develop a model of the variability in cycle use from count data and a variety of model types are being considered. The strong effect of seasonality means that data are needed over significant periods of time. Based on classifications from the cluster analysis, data sets will be introduced which can be matched to a particular route type, but which have missing data.

Finally, analysis will be performed on counters aggregated by route type. The resulting models will be a step forward from current methodology where routes types for cycling characteristics are not considered.

References

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