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REGIONAL GRAPHIC

Identifying functional urban regions within traffic flow

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In this work, community detection algorithms are applied to a topological representation of the road network formed through observed routing behaviour. The resulting communities provide an insight into how areas of the city may be grouped as functional regions, shaped purely on their shared usage.

Keywords: Functional regions; community detection; network analysis

City regions have long been noted as important in the way in which we recall, describe and manage urban areas. Yet often the definition of urban regions is proscribed through the consideration of geographic or aesthetic features alone, with little reference to common function or usage. Where functional representations of regions have been previously developed (Goddard, 1970) the primary focus has been placed on connections between origins and destinations, rather than considering connectivity based on route choice across urban space.

The work presented here represents an alternative perspective on the regionalization of urban areas, based on local patterns of connectivity established through observed movement behaviours. These functional urban regions are extracted by applying community detection algorithms to a network constructed from the route choices during 1.5 million minicab journeys.

Method

Community detection algorithms were developed to identify clusters within network datasets. These methods are most often applied within social network research in the identification of cliques, where a cluster demonstrates high interconnectivity, with lower connectivity with the rest of the network (Fortunato, 2010). The aim of its application here is to identify similar characteristics in traffic flow, where strong coupling between clusters of nodes indicates shared common usage, and a lower association with other nearby locations.

The network representation utilized for this study was created by tracking the movements of minicabs between road junctions over the course of 1.5 million journeys within London in the UK. In tracking each route, the successive utilization of two nodes increases the weight of the connection between the nodes, and so increases the likelihood of their association within a single region.

The resulting image, developed using Gephi (Bastian, Heymann, & Jacomy, 2009), presents the regions formed through the application of the Louvain method of community detection to this network (Blondel, Guillaume, Lambiotte, & Lefebvre, 2008). Each region is assigned its own colour, with the colour is only used to distinguish regions rather than to indicate any particular measure.

Results

The visualization presents some interesting patterns with respect to the structure of the functional regions formed. A number of the regions correspond to some of the core routes (known as ‘corridors’) flowing into Central London, indicative that these routes are used together entirely. Conversely, however, Figure 1 also demonstrates how the M25 motorway – the ring road around London – and the North Circular – another ring road in North London – while usually considered as single entities, are segmentalized into modules defined by their usage.

Additional, more spatially granular, patterns of regionalization are found in Central London. In this region, a number of routes are established as independent regions. There are, furthermore, a number of regions identified that may be informally deemed homogeneous entities – specifically Knightsbridge, Soho, Shoreditch, the City and Hyde Park. The specification of these regions reflects a shared interdependency between nodes, indicative of a shared functional status.

The generation of these regions helps identify areas of the road network that are used together. This representation can both help improve our understanding of the

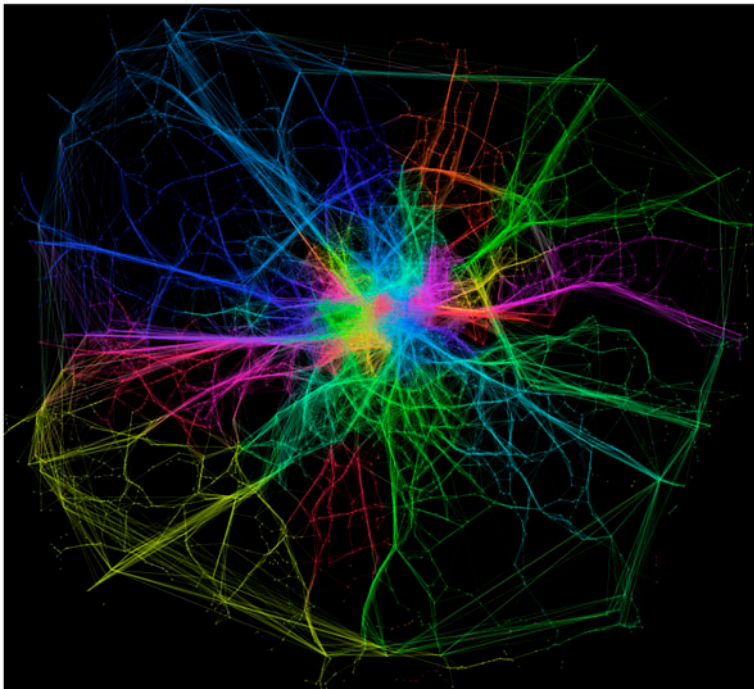


Figure 1. Functional regions identified on the London road network, each community is indicated using a distinct colour.

functional structure of the city in addition to potentially assisting in the management of road network engineering and connectivity.

Acknowledgement

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