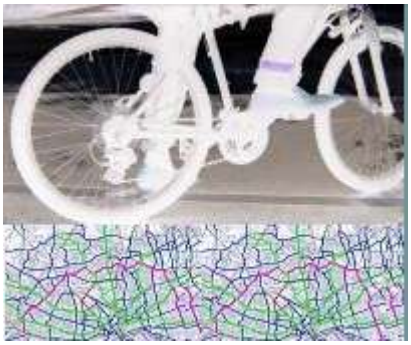
EXPLORING AGENT-BASED MODELLING TECHNIQUE FOR CYCLE TRACK MODELLING



11/18/2012

Reconstructing cyclists' travel behaviours

This STSM report, as part of the work in progress, contributes to the use of ABM in reconstructing cyclists' travel behaviour inferred from collected and cleaned GPS data with associate travel diaries and questionnaire forms. In doing so, technically, a particular ABM platform called NETLogo is explored in terms of how: 1) Polylines from collected GPS data could be used to model movement; 2) Logged points from collected GPS data could be used to model movement; 3) Network from real data for network analysis in NETLogo could be generated. The brief work in this report is an outcome of a Short Term Scientific Mission (STSM) sponsored by EU MOVE-COST. The discussion in this report assumes that the reader has gone through the three NETLogo tutorials in NETLogo help documentation.

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INTRODUCTION

Interest in technical solutions towards transport planning and demand modelling, in developed countries, became more prevalent towards the end of the 1980s (Dios Ortúzar and Willumsen, 1990, p. 1); with continued interest in the 1990s and beginning of 2000 using both Global Positioning Systems (GPS) vis-à-vis Personal Digital Assistance (PDA) devices with other methods in Geographical Information Systems (GIS) for the collection of disaggregate data on movement behaviour and further travel demand estimation using intelligent agents often following simple behavioural rules (Miller and Shaw, 2001, p. 270-271).

However, despite these developments, there are still challenges in the use of intelligent agents in modelling and simulation movement behaviour at various levels of complexity using both geographical concepts and agent based modelling or Model(s) (ABM) and simulation (ABMS) techniques (Batty et al., 2012, p. 3; Couclelis, 2006; Crooks et al., 2008). Furthermore, there is increasing popularity in the combined use of both ABMS and GIS in towards understanding the built as well as natural environments (Batty et al., 2012). Perhaps, it is appropriate to indicate that the use of ABMS with GIS methods is work in progress (Batty et al., 2012, p. 13,739-746); suggesting the need for further research.

This report, as part of the work in progress, contributes to the use of ABM in reconstructing cyclists' travel behaviour inferred from collected and cleaned GPS data with associate travel diaries and questionnaire forms. In doing so, practically, a particular ABM platform called NETLogo is explored in terms of how: 1) Polylines from collected GPS data could be used to model movement; 2) Logged points from collected GPS data could be used to model movement; 3) Network from real data for network analysis in NETLogo could be generated. The brief work in this report is an outcome of a Short Term Scientific Mission (STSM) sponsored by EU MOVE-COST. The discussion in this report assumes that the reader has gone through the three NETLogo tutorials in NETLogo help documentation; to avoid repetition and unnecessarily many pages.

RELATED WORK IN NETLOGO

Possibilities for modelling movement behaviour of moving entities such as boat, taxi cabs, and pedestrians exist in NETLogo. NETLogo as an ABM platform has been used to study: boat traffic (Guerin et al., 2009); human movements constrained by underlying street topological (but not geometrical) structure and comparing with GPS data collected from taxi cabs and pedestrians (Jiang and Jia, 2011).

However, ABM approaches of how cycling data, derived from portable GPS devices, are used to model movement of cyclists are not clear amidst available sources of literature. The subsequent sections discuss how both point and polyline datasets from such portable GPS devices can be used in NETLogo such that the movement behaviour as captured can be visualized. The focus is more technical in nature rather than theoretical; the emphasis is on technical possibilities of modelling movements using spatial-temporal data.

DESCRIPTION OF THE WORK CARRIED OUT DURING THE STSM

In addition to the literature review which was undertaken as part of the STSM, this section discusses the work carried out during the STSM.

Modelling movement from polylines from GPS data

In order to incorporate GPS data in NETLogo, the *GIS extension* must be declared in the procedure section: "*extensions [gis]*". Such a declaration allows for GPS data in ESRI Shape files to be loaded and be drawn in the 2D View. Unfortunately in NETLogo, such an effort is not enough; the loaded data is still more or less as an image. In order to have a sense of structure, the loaded data has to be re-structured in terms of NETLogo turtles and links where turtles serve as nodes/points and links serve as lines in-between points or nodes. Appendix A shows the interface and the codes used to generate the nodes and links as well as creating an cyclists as a node per each cycle trip. The cyclist is placed at the start of the generated trip ready to move when movement is initialized. A simple step-wise operational flow for the developed NETLogo application can be seen in Figure 1.

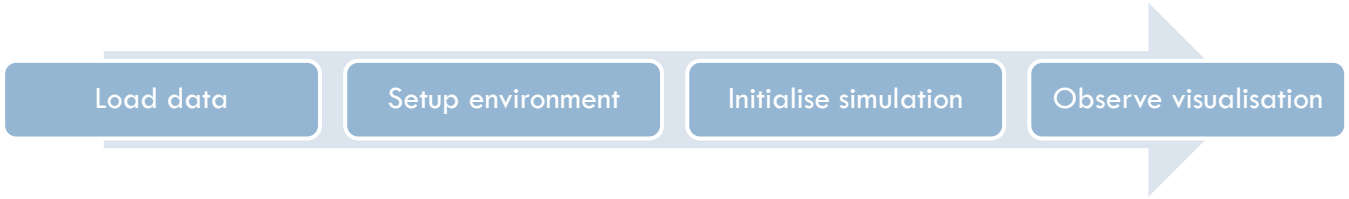

FIGURE 1: SIMPLE OPERATIONAL FLOW FOR DEVELOPED NETLOGO APPLICATION

Modelling movement from GPS LOGGED POINTS

Using GPS logged point datasets in NETLogo is little different from GPS tracks/polylines for several reasons; point data sets need some form of categorization to group which sub-pointsets conform to particular tracks/trip as well as an index numbering for each sequential points per trip to enable proper definition of a track/trip when generating NETLogo nodes and links. Same operational flow exists in this case (see Figure 1) but, with different algorithms in coding (see Appendix B).

Generating Network from Real Data for Network Analysis in NETlogo

Generating road network in NETLogo, using real road network data, for network analysis appears not to be quite straight forwards. The recent network extension in NETLogo, which can be used by first declaring the extension as "extension [network]", can only compute shortest path based on minimum counts of the number

of links from define origin to destination but do not consider distance computation. To this end, it is not likely that shortest path result will always be the shortest distance. More work is therefore needed to enable proper computation of shortest path.

Foreseen publications / articles resulting or to result from the STSM

Outcome of fruitful discussions with one (i.e., Bernhard Snizek) of the researchers I met during the STSM suggests a verbal agreement to draft an article about modelling bicyclists' behaviour using ABM technique which may result in publication late next year 2013. Also, given already submitted paper in GIS Research UK (GISRUK2013) which suggests possible use of ABM for modelling bicyclists' behaviour, there is potential outcome of submission to Journal of Transport Geography (JTG).

ACKNOWLEDGEMENT

Funding for attending PhD course / workshop (5th – 9th Nov. 2012) which was part of 2-week (5th – 18th Nov. 2012) short term scientific mission (STSM) in University of Copenhagen is acknowledged from COST Action IC0903 MOVE. Also, finances for the NETLogo PHD course/workshop is acknowledged from: the Research School for Forest, Landscape and Planning (REFOLANA); the Bikeability project: www.bikeability.dk; and Department of Geosciences and Natural Resource Management, University of Copenhagen.

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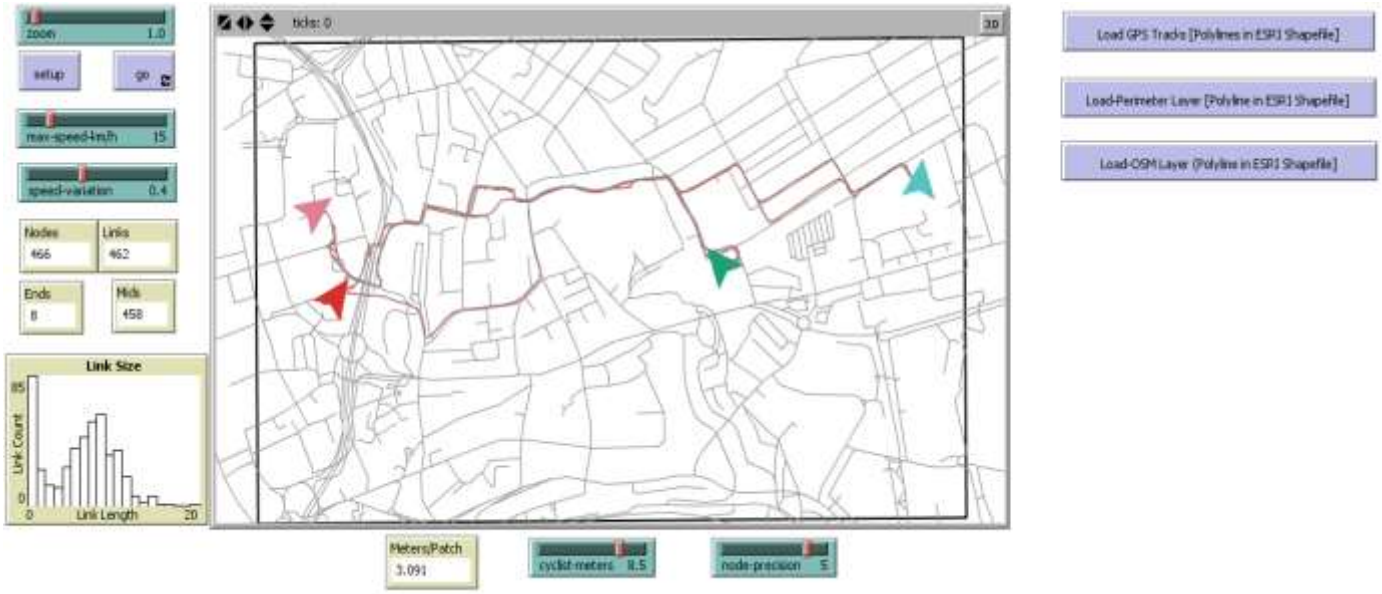
APPENDICES

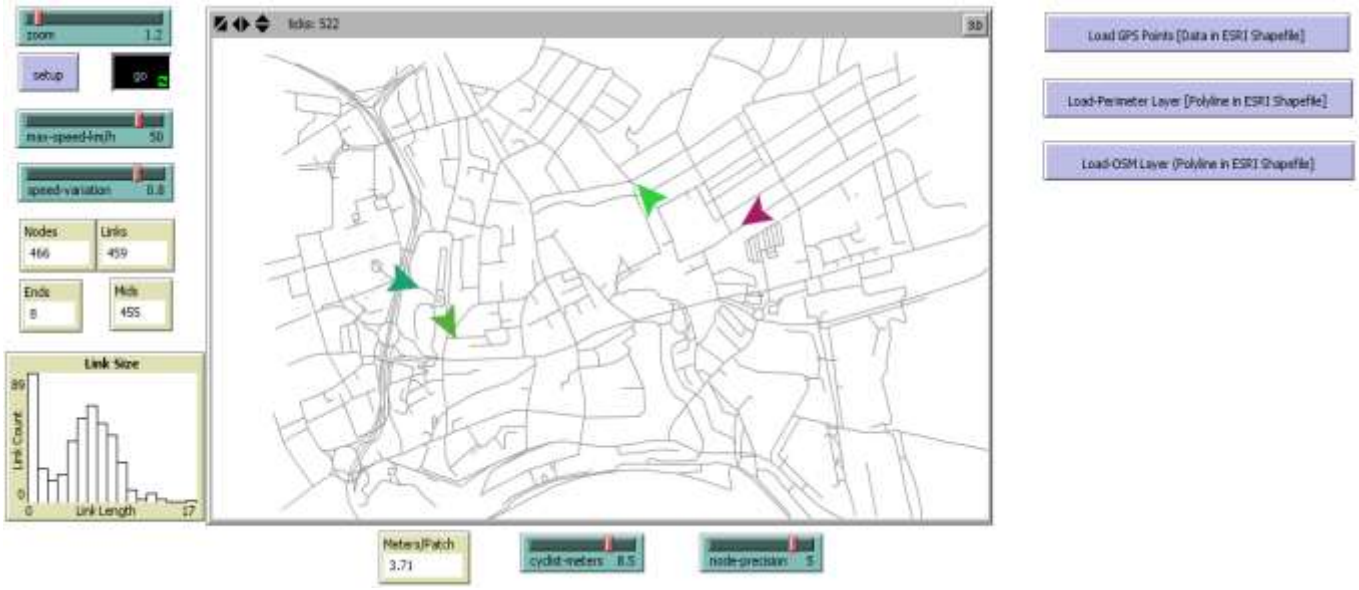
Appendix A



NETLogo codes for loading and modelling GPS tracks/polyline datasets accessible here (as phase 1):

https://www.dropbox.com/sh/ok6ll1nyuk3l2py/J-GOhwgt2s

Appendix B



NETLogo codes for loading and modelling GPS points datasets accessible here (as phase 2):

https://www.dropbox.com/sh/ok6ll1nyuk3l2py/J-GOhwgt2s