Accepted Manuscript

A network centrality measure framework for analyzing urban traffic flow: A case study of Wuhan, China

Shuangming Zhao, Pengxiang Zhao, Yunfan Cui

PII: S0378-4371(17)30171-1
DOI: http://dx.doi.org/10.1016/j.physa.2017.02.069
Reference: PHYSA 18049

To appear in: *Physica A*

Received date: 9 September 2016
Revised date: 1 February 2017

Please cite this article as: S. Zhao, P. Zhao, Y. Cui, A network centrality measure framework for analyzing urban traffic flow: A case study of Wuhan, China, *Physica A* (2017), http://dx.doi.org/10.1016/j.physa.2017.02.069

A network centrality measure framework for analyzing urban traffic flow: A case study of Wuhan, China

Shuangming Zhao [a], Pengxiang Zhao [b,] *, Yunfan Cui [a]

[a] School of Remote Sensing and Information Engineering, Wuhan University, Wuhan, China

[b] Department of Land Surveying and Geo-Informatics, Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, PR China

Abstract: In this paper, we propose an improved network centrality measure framework that takes into account both the topological characteristics and the geometric properties of a road network in order to analyze urban traffic flow in relation to different modes: intersection, road, and community, which correspond to point mode, line mode, and area mode respectively. Degree, betweenness, and PageRank centralities are selected as the analysis measures, and GPS-enabled taxi trajectory data is used to evaluate urban traffic flow. The results show that the mean value of the correlation coefficients between the modified degree, the betweenness, and the PageRank centralities and the traffic flow in all periods are higher than the mean value of the correlation coefficients between the conventional degree, the betweenness, the PageRank centralities and the traffic flow at different modes; this indicates that the modified measurements, for analyzing traffic flow, are superior to conventional centrality measurements. This study helps to shed light into the understanding of urban traffic flow in relation to different modes from the perspective of complex networks.

Key words: taxi trajectory data; network centrality; urban traffic flow; multi-mode; correlation analysis

1 Introduction

An axiom of network science is that structure affects function and vice versa [1]. The various elements of a system are abstracted as nodes, and connections between elements are considered as edges; thus the entire system can be represented as a network with complex connection relations. Examples of networks include the Internet, social networks, neural networks, metabolic networks, and many others [2]. Like other complex networks, urban road network can be viewed as a complex system composed of intersections with segments between them. Traffic flow reflects the motion of vehicles along the roads, and this is a traffic phenomenon attached to the road network. Many previous studies have indicated that the structure and morphology of road networks has a significant influence on shaping dynamic urban traffic flow [3-6]. In cognizance of the increasingly severe traffic conditions which exist widely, identifying locations which facilitate more traffic flow, measuring this, and predicting future traffic flow are all important for transportation planning and design. The analysis of road network geometries and topologies provides a new approach to the quantitative analysis and model traffic flow analysis. Thus, the analysis of urban traffic flows from the perspective of road networks is significant in terms of the alleviation of urban traffic congestion, and also in terms of urban transportation planning and management.

Traffic flow refers to the number of vehicles that pass through a road unit per unit time, and

∗ Corresponding author.
E-mail addresses: peng.x.zhao@polyu.edu.hk (P. X. Zhao)