Smart Cities and the New Urban Analytics: Opportunities and Challenges in Urban Transport

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Abstract. This paper considers the development of urban modelling and analysis techniques over the past two decades in the context of smart cities. It identifies a number of generations of thinking and highlights the nature of the broad opportunities and challenges present in the field. It illustrates the arguments with examples drawn from the domain of urban transport planning and operations, focusing on a number of areas including the development of vehicle automation, the growth of servicized mobility, the integration between transport and other business sectors, the hyper-personalization of mobility products and the virtualization of user experience. The paper concludes by identifying the some wider implications of these developments for the governance of data and analytics.

Keywords: Smart cities · Big data · Analytics · Transport

1 Introduction

Over the past two decades the concept of a "smart city" has grown spectacularly in global prominence, and is now the focus of substantial interest from the business, government and the academic communities. Although there is no commonly agreed definition of what constitutes a smart city and many different visions have been promulgated, a common feature of almost all manifestations of the concept is an emphasis on the role of new ICT-enabled data resources as a means to achieving improvements in a range of aspects of the performance of urban systems including economic, social, environmental and health outcomes. As a result of this, in many cities, considerable effort is being devoted to creating repositories and platforms for a wide range of existing and emerging urban data resources. However, the mere accumulation of data, in and of itself, clearly achieves nothing. Data can only become the source of new value when they are linked to decision making. And this requires analysis. Moreover, if improvements are to be made in the performance of specific urban systems and functions, this analysis must be domain and context specific. It is therefore surprising that in the smart cities literature, relatively little discussion has been devoted to what forms of analysis could or should be undertaken with the data that are now increasingly populating these new repositories and platforms.

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2 Generations of Urban Analytics

It is possible to identify at least four overlapping generations of urban analytics that have emerged in the wake of the growth of the concept of smart cities. The first generation, still current today, is concerned with the descriptive presentation and visualization of granular and often highly dynamic spatial and temporal data relating to various aspects of urban systems and their operations, such as mobility patterns, energy consumption, air quality etc. Such analytics typically have little or no connection to actuation and little by way of actionable consequence; their role is largely as a means of communication with various stakeholders. This style of analytics is typified by the increasingly ubiquitous, *urban dashboards*.

The second generation of urban analytics consists of marginal adaptations of existing modelling and analysis tools that are designed to take advantage of specific features of newly available data sources, such as their lower cost or improved spatial and temporal granularity. In the domain of transport for example, longstanding models for strategic and tactical infrastructure planning and for real time operational control are increasingly being adapted to operate with probe vehicle or mobile network data instead of conventional survey or infrastructure based sensing data sources. The key characteristic of this style of analytics is that little or nothing is changed either in the underlying conceptualization of the problems being addressed or the modelling methods used.

A third generation of urban analytics exists that shares with the second generation a clear focus on traditional problem conceptualizations but is distinguished by the fact that it addresses these traditional problems using new modelling methods, often drawn from the burgeoning field of machine learning and data science. Again taking the domain of transport as an example, we are seeing the increasing use of machine learning based classifiers in applications such as incident detection or behavioral modelling, augmenting or supplanting more traditional physical or statistical based approaches to classification.

The fourth generation of urban analytics is distinguished by a concentration on problem definitions and solution methods that go beyond traditional frameworks and are focused on the specific opportunities and challenges that are created by the development of smart cities.

3 Opportunities and Challenges for New Urban Transport Analytics

In recent years, the domain of transport has been subject to enormous disruptions as a result of rapid change in technologies, business models, regulation and market behavior. These changes have created a new a slew of new practical and corresponding analytical challenges. We will explore examples of these opportunities and challenges as they are manifest in a number of areas including the development of vehicle automation, the growth of servicized mobility, the integration between transport and other business sectors, the hyper-personalization of mobility products and the virtualization of user experience.