Chapter 8

Developing a Method for Visualizing Population Movements

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ABSTRACT

This chapter describes a technique for visualizing the movements of a population in a region at a point in time. It is suitable for cases where a large population is spread throughout the region and can move in all directions, for example the population of a large city. By repeatedly clustering movement vector arrows it can visually summarize the movements of millions of individuals, and do so with moderate computing resources. The technique is designed to work with data captured from mobile phone networks, but other sources of data can also be used.

INTRODUCTION

Due to the widespread use of mobile phones, data is becoming available about the location of people as they move around their environment. Whenever a mobile phone communicates with a network, it reveals its current *cell*, the area covered by a base station antenna, and the details of many of these transmissions are recorded.

According to the latest figures from the Australian Communications and Media Authority (ACMA), the rate of mobile phone ownership among working-age Australians is over ninety percent (ACMA, 2014). This ubiquity means that the location of Australia's handsets is a good proxy for the location of its adult population at any point in time. And, unlike other movement tracking techniques, such as road sensors, public transport ticket tracking, and the filling out of surveys, the collection of mobile phone location data provides widespread coverage of the population, in real-time, using existing infrastructure.

The positional accuracy of cells varies from a few hundred meters in a city to a few kilometers in a suburb, and up to 100 kilometers in rural areas (Trevisani & Vitaletti, 2004). When combined with time information and a unique handset identifier, this data can be used to track population movements.

In terms of population coverage, mobile phones are carried by most people in the developed world (CIA, 2011). For example, in June 2008, 72 per cent of the Australian population carried a mobile phone (Australian Communications and Media Authority, 2008), with a total penetration rate of 102 percent (due to some people owning more than one). If people under 15 and over 50 are excluded, over 90 percent of the Australian population carried a mobile phone in 2008 and would have been generating location data.

With all this data available, methods are needed to provide a visual representation of the useful information it contains. While there has been much work done on visualizing population densities, for example using colors or 3D effects, little has been done to visually represent the *movement* of populations, especially when they are spread throughout a region and can move in all directions.

This chapter first describes the type of location data that is available from mobile phone networks, and briefly explores its usefulness and accuracy for tracking populations. It then describes some existing techniques for visualizing movement, and their limitations when dealing with large, dispersed populations. Finally, it describes a new method for visualizing population movements, and the algorithms needed to generate the graphics.

BACKGROUND

Whenever a mobile phone communicates with a cell tower as part of a *billable* event, a record is created by the carrier. Billable events include making a call, sending an SMS, and accessing the Internet, and records of these events are used to calculate the customer's bill at a later date. The records also contain a cell ID, which identifies the cell tower the phone was communicating with.

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