ISOGA: A System for Geographical Reachability Analysis

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Abstract. In this paper, we present a web-based system, termed ISOGA, that uses isochrones to perform geographical reachability analysis. An isochrone in a spatial network covers all space points from where a query point is reachable within given time constraints. The core of the system builds an efficient algorithm for the computation of isochrones in multimodal spatial networks. By joining isochrones with other databases, various kinds of geospatial reachability analysis can be performed, such as how well is a city covered by public services or where to look for an apartment at moderate prices that is close to the working place. ISOGA adopts a service-oriented three-tier architecture and uses technologies that are compliant with OGC standards. We describe several application scenarios in urban and extra-urban areas, which show the applicability of the tool.

Keywords: Spatial networks, isochrones, geospatial reachability analysis, WebGIS.

1 Introduction

Geospatial analysis covers various approaches to perform analysis on data with a geographical dimension and provides an important tool in many application areas, including environmental sciences, social sciences, emergency management, or city planning.

In this paper, we describe ISOGA, a system for geographical reachability analysis using isochrones in multimodal spatial networks. An isochrone in a spatial network is a possibly disconnected subgraph that covers all space points from where a query point $q$ is reachable within a given time span and by a given arrival time at $q$. As an example, consider a person looking for an apartment in a specific price range, from where his/her working place is reachable in less than 15 minutes using the public transportation system. Figure 1 illustrates this query for Bozen-Bolzano. The '*' indicates the working place (query point), the gray area represents the isochrone, and white circles represent buildings that satisfy the search criteria. The popup shows additional information about one of the qualifying apartments, such as the actual distance and details on how (bus numbers and departure times) to reach the working place.

In ISOGA, the user inputs first the parameters for an isochrone, i.e., one or more query points, walking speed, arrival time, and a maximal timespan. At the core of the system is an efficient algorithm for the computation of isochrones in multimodal spatial...
networks together with the possibility to join an isochrone with an arbitrary relation of geo-referenced objects, e.g., people, houses, or hotels. First, the disk-based algorithm MINEX computes an isochrone as a subgraph of the multimodal network. Second, the surface of the isochrone subgraph is determined. Third, the isochrone surface is joined with a relation of geo-referenced objects, which can be specified by the user as an arbitrary SQL expression. As the result of a query, a simple summary statistics is shown together with a list of all objects that are located within the isochrone. The objects can be visualized on the interactive map as well, and by clicking on an object a popup shows additional information. ISOGA adopts a service-oriented three-tier architecture and uses standardized OGC services for exchanging spatial data. The system can be accessed at www.isochrones.inf.unibz.it/isoga. To summarize, the main contributions of this paper are as follows:

– We present the ISOGA system for geographical reachability analysis in multimodal networks, which uses isochrones to efficiently determine geo-referenced objects that are reachable within given time constraints.
– We describe the three-tier architecture of the system with an interactive WebGIS client that uses OGC standards for the communication between client and server.
– We discuss three application scenarios using real-world data that illustrate the applicability of ISOGA for various kinds of geographical reachability analysis.

The rest of the paper is structured as follows. Section 2 discusses related work. In Section 3 we describe the scientific background of the system. The system architecture is presented in Section 4. Section 5 describes three application scenarios.

2 Related Work

Previous work on isochrones, upon which this paper is based, has been presented in [1, 4, 5, 7]. Bauer et al. [1] introduce a main memory algorithm that suffers from a high initial loading cost and is limited by the available memory. To overcome these limitations, Gamper et al. [4] propose a disk-based algorithm that loads the network