CityScope Andorra: A Multi-level Interactive and Tangible Agent-based Visualization

Extended Abstract

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ABSTRACT

This study proposes a novel information visualization approach developed and deployed in the state of Andorra. We present a framework to analyze and represent the flow of people through a multi-level interactive and tangible agent-based visualization. The presented framework, developed to understand Andorra visitor behavior, is embedded in the MIT CityScope framework used for civic engagement, urban development, and decision making.

KEYWORDS

Agent-based Modelling; Tangible User Interface; Civic Engagement

ACM Reference Format:
Arnaud Grignard, Núria Macià, Luis Alonso Pastor, Ariel Noyman, Yan Zhang, and Kent Larson. 2018. CityScope Andorra: A Multi-level Interactive and Tangible Agent-based Visualization. In *Proc. of the 17th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2018), Stockholm, Sweden, July 10–15, 2018,* IFAAMAS, 3 pages.

1 INTRODUCTION

Contemporary paradigms in urban planning and architecture aim to converge temporal and spatial data to enhance the well-being of urban dwellers and visitors. Traditional approaches usually consist of collecting a limited amount of data from surveys and statistically generalizing their results. However, these methods have shown limitations due to the exponential growth and incurred complexity of urban centers [2]. One alternative is to combine telecommunication data with geospatial information to improve the comprehension of human behavior [1]. By coupling telecommunication data with a spatially explicit agent-based model [3], our approach allows for better insights into local interactions, variability among entities, adaptive behaviors, and environmental states. This work has been implemented in an open and generic platform called CityScope and in the following, we describe the deployment of the Andorra case study.

2 CITYSCOPE PLATFORM

Andorra has a population of nearly eighty thousand people and hosts more than eight million visitors a year. As part of a research collaboration between MIT and Andorra, the CityScope platform was suggested as a tool for both analyzing visitors' behavioral patterns and displaying them to the relevant stakeholders. The CityScope (CS) is an ongoing research theme at the MIT Media Lab City Science group. CS projects are either demos (experiments and research done at MIT Media Lab, usually in the form of generic and scalable tools [5]) or deployments, as active tools in local planning processes [6]. CityScope platform helps non-experts engage in conversations through visualizations that synthesize data analyses in a coherent manner in the context of their cities. The platform can (i) visualize and understand the meaning of complex urban data and its inter-relationships, (ii) simulate the impact of multiple, real-time interventions, and (iii) support decision making through a dynamic, iterative, and evidence-based process. A common CityScope platform is described in figure 1. On top of running a real time simulation, the computational analysis unit has sensors or cameras and computers for real-time scanning of the scene. User feedback is made through display screens, projectors and other AR representation tools.

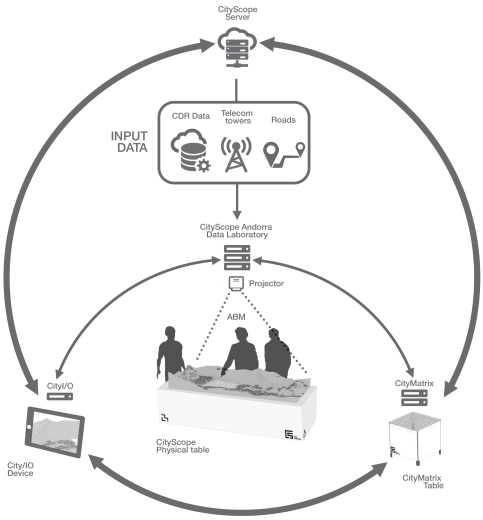

Figure 1: CityScope platform framework.

Proc. of the 17th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2018), M. Dastani, G. Sukthankar, E. André, S. Koenig (eds.), July 10–15, 2018, Stockholm, Sweden.

2.1 Computational Layer

The computational layer includes the abstract elements of the platform: data and computational models to perform data analyses and visualizations. The computational layer is projected onto the CityScope table and uses different data sources as a baseline for simulation. It has been implemented using the GAMA platform [4] and Processing [8] [1]. GAMA is a modeling and simulation-development environment for building spatially explicit agent-based simulations.

2.2 Tangible Layer

The tangible layer has three components which enable the user to interact with the platform in different ways: the physical table, a tangible interface and an augmented reality module.

Physical Table. CityScope Andorra table is a 3D topographical model of the two main cities of Andorra—Andorra la Vella and Escaldes-Engordany and the rest of the territory is conceptually represented by visual clusters, giving an abstract country-level view.

Tangible Interface. CityMatrix [9] is a TUI that allows the user to modify the city's structure by manipulating predefined physical pieces . It gives real-time feedback to users for facilitating rapid, collaborative, informative decision-making. Users can reshape the design of the urban area under study and the ABM then takes into account (via CityI/O server) this modification and updates the agent behavior accordingly.

Augmented Reality. CityI/O [7] extends the physical confines of CityScope providing an AR tool for remote participation, data sharing, and high-end realistic visualization. In this case, CityI/O provides the following data layer: (1) telecom data origins, (2) existing built environment, (3) real-time 3D representation of design iterations, and (4) mobility analysis.

3 ANDORRA CASE STUDY

3.1 Model Description

CityScope Andorra ABM provides a dynamic simulation in which users can instantly identify three main elements: (i) clear representation of the cityscape defined by geography, buildings, amenities, cell towers, and roads, (ii) people's movement defined by dynamic agents, and (iii) amenities' popularity and density.

Agents. *State.* The set of variables is composed of (1) agent's country of residence, (2) origin location—defined using telecom data—, (3) preferred destination—generated by a decision making submodule—, (4) distance traveled, (5) speed of movement, and (6) passable streets. *Behavior.* The agent's trajectory is determined by the Origin-Destination matrix computed from the CDR[2] data and constrained to the local weighted road network. Agent behavior will slightly evolved according to traffic congestion (recomputing path in case of high congestion) and amenities occupancy (choosing another amenity if the current amenity is full).

[1] A release of the ABM model can be downloaded here github.com/CityScope.

[2] Call Detail Records (CDR) are digital records gathered by the mobile network operator containing spatial-temporal information. Andorra Telecom privately (anonymized using SHA-512 Algorithm) released three years of CDR data sets (2014-2016).

3.2 Results

Results focus on two major aspects: visitors' attendance at certain events held annually in the country and traffic congestion levels caused by these events. The two events analyzed—(i) *Cirque du Soleil: VISION* and (ii) *Le Tour de France*—occurred in 2016.

Visitors' Flow and Impact. People are represented by solid circles and vehicles by stroke circles. Their colors vary according to the country of residence. The number of people present in the city's amenities evolves during the simulation. The amenity size increases (or decreases) according to the number of agents currently in the location.

Heatmaps. Aggregated data can be visualized onto the CityScope platform, resulting in graphic heatmaps that summarize global activity in the city and provide geo-located attendance estimates.

Online Media.

- ABM visualization: youtu.be/fLikAuFvVyg.
- Smart City Expo World Congress 2016: youtu.be/hdL0aundHL4
- Andorra Deployment youtu.be/42hfpzJXhhU

4 CONCLUSION

In this article we presented a version of the CityScope Andorra that, after being developed and tested at the MIT Media Lab City Science group and Barcelona Smart City Expo World Congress (2016 - 2017) was finally deployed in Andorra in Aug. 2017. During this period, dozen of workshops, classes, and more than a hundred public-private demonstrations have been successfully conducted, supporting the performance of the CityScope Andorra as an efficient civic engagement tool. Finally, we hope to have contribute to the spreading of ABM by democratizing the usage of ABM into new fields, using new methods and to the broad non-expert community.

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