UNIVERSITY OF PIRAEUS

SCHOOL OF INFORMATION AND COMMUNICATION TECHNOLOGIES

DEPARTMENT OF INFORMATICS

ST-Visions+: Extending the ST-Visions Library for Real Time Visual Analytics

2nd Progress Report

BACHELOR THESIS

of

PARASCHOS MORAITIS

Chapter 1

Introduction

The advent of IoT devices, such as sensors, smartwatches, smartphones, and GPS trackers, has led to the production of a huge volume of data, including mobility data, on a daily basis, a quantity that will continue to grow over time. These data sets, after appropriate processing, are critical for understanding mobility patterns [1, 2], which allow conclusions to be drawn, but also predictions of significant importance for multiple sectors [3], such as ship/fleet tracking [4], route risk assessment [5], traffic flow prediction [6], ride-sharing applications, etc.

This volume of information makes it necessary to create a workflow that will be able to bridge the gap between "pure" geographic information and human understanding of the results that an analysis of this information can offer. This need is addressed by the research field of Visual Analytics (VA), which creates a framework in which methods and software exploit human "vision" and decision-making to extract knowledge from spatiotemporal data [7], both of movement (Mobility Data) [8, 9], as well as other types (Social Networks, Economy, Climate Science) [10, 11, 12].

Therefore, there is a need for easy support for Visual Analytics applications on data, so that the respective domain experts can have an overview of the data they are working on. For these purposes, the Data Science Laboratory of the University of Piraeus [1] created the ST-Visions [13] library for visualizing spatiotemporal data. The purpose of this bachelor's thesis is to enhance the capabilities of the library by adding live data streaming visualization support. This has the aim of enabling the visualization and analysis of spatiotemporal data in real time (Real-Time Domain Visual Analytics).

1.1 Problem Statement

Along with the sheer quantity of available static mobility data, technological advancements in navigation satellite systems has brought about an exponential increase in mobility data streams that are produced continuously in real time[14]

1.2 Structure of the 2nd Progress Report

---

[1] https://www.datastories.org

Bibliography

[1] Andreas Tritsarolis, Eva Chondrodima, Panagiotis Tampakis και Aggelos Pikrakis. *Online Co-movement Pattern Prediction in Mobility Data*. *Proceedings of the Workshops of the EDBT/ICDT 2021 Joint Conference*, τόμος 2841 στο *CEUR Workshop Proceedings*. CEUR-WS.org, 2021.

[2] Andreas Tritsarolis, Eva Chondrodima, Panagiotis Tampakis, Aggelos Pikrakis και Yannis Theodoridis. *Predicting Co-movement Patterns in Mobility Data*. *GeoInformatica*, 28(2):221–243, 2024.

[3] G. A. Vouros και others. *Big Data Analytics for Time-Critical Mobility Forecasting*. Springer, 2020.

[4] Andreas Tritsarolis, Nikos Pelekis, Konstantina Bereta, Dimitris Zissis και Yannis Theodoridis. *On Vessel Location Forecasting and the Effect of Federated Learning*. *MDM 2024*, σελίδες 83–92. IEEE, 2024.

[5] Patrik Thomas Michalski, Niko Preuss, Matthias Renz, Andreas Tritsarolis, Yannis Theodoridis και Nikos Pelekis. *Collision-Risk-Aware Ship Routing*. *SIGSPATIAL 2024*, σελίδες 545–548. ACM, 2024.

[6] Petros Mandalis, Eva Chondrodima, Yannis Kontoulis, Nikos Pelekis και Yannis Theodoridis. *Towards a Unified Vessel Traffic Flow Forecasting Framework*. *EDBT/ICDT Workshops*, τόμος 3379. CEUR-WS.org, 2023.

[7] N. V. Andrienko και G. L. Andrienko. *Spatio-temporal Visual Analytics: A Vision for 2020s*. *Journal of Spatial Information Science*, 20:87–95, 2020.

[8] Andreas Tritsarolis, Yannis Kontoulis, Nikos Pelekis και Yannis Theodoridis. *MaSEC: Discovering Anchorages and Co-movement Patterns on Streaming Vessel Trajectories*. *Proceedings of the 17th International Symposium on Spatial and Temporal Databases*, σελίδες 170–173, 2021.

[9] Andreas Tritsarolis, Nikos Pelekis και Yannis Theodoridis. *VesselVision: Fleet Safety Awareness over Streaming Vessel Trajectories*. *SIGSPATIAL 2023*, σελίδες 20:1–20:4. ACM, 2023.

[10] S. Pezanowski και others. *SensePlace3: A Geovisual Framework to Analyze Place-Time-Attribute Information in Social Media*. *Cartography and Geographic Information Science*, 45, 2017.

[11] Roger A. Leite και others. *Hermes: Guidance-enriched Visual Analytics for Economic Network Exploration*. *Visual Informatics*, 4(4):11–22, 2020.

[12] Abdullah Al Raihan Nayeem και others. *A Survey on Exploratory Spatiotemporal Visual Analytics Approaches for Climate Science*, 2024.

[13] Andreas Tritsarolis, Christos Doulkeridis, Nikos Pelekis και Yannis Theodoridis. *ST VISIONS: A Python Library for Interactive Visualization of Spatio-temporal Data*. *MDM 2021*, σελίδες 244–247, 2021.

[14] Zdravko Galić, Emir Mešković και Dario Osmanović. *Distributed processing of big mobility data as spatio-temporal data streams*. *Geoinformatica*, 21(2):263–291, 2017.