C H O R O L O G O S
N e w s l e t t e r

Semantic Spatio-textual Data Analysis and Processing

The CHOROLOGOS project is a research project that is funded by the Hellenic Foundation for Research and Innovation (HFRI) and the General Secretariat for Research and Innovation (GSRI), under grant agreement No [HFRI-FM17-81]. The instrument aims to support research of Academic Staff and Researchers, and the principal investigator of CHOROLOGOS is Christos Doulkeridis. The project is hosted at the Department of Digital Systems in the University of Piraeus.

Objectives and Challenges (Space + Time + Text)

With the widespread adoption of web-based services, mobile smartphones equipped with GPS capabilities, the Internet of Things (IoT), and social networks, an ever-increasing wealth of geotagged data is available for use daily. Interestingly, geotagged data originating from mobile users is not only **multidimensional** but also **unstructured**; apart from its spatial and temporal dimension, or numerical information (ratings, likes, retweets, etc.), textual descriptions are also available.

The combination of spatio-textual data with spatio-temporal data arises several challenges which are related to their collection, representation, processing, analysis, mining, and interpretation. This opens up new research directions, while at the same time challenges existing data processing solutions.

The research objective of CHOROLOGOS include:

- Formulation of expressive query types that enable selection of underlying spatio-temporal-textual data based on diverse information needs.
- Theoretical contributions in terms of properties and search bounds for the proposed query types, thus laying the foundations for efficient processing and search.

PROJECT'S MAIN GOAL

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CHOROLOGOS aims at advancing the state-of-the-art in spatio-temporal-textual query processing, by introducing a novel framework that tightly combines spatio-textual and spatio-temporal querying with semantic retrieval, focusing on expressive query formulation beyond syntactical matching, efficient indexing and query processing, and scalable analysis of massive spatio-textual data.
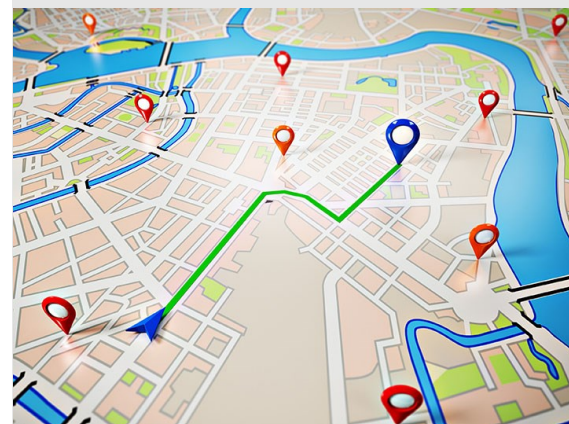
- Design of appropriate access methods that jointly index space, time, and text, in an appropriate way to support filtering of data that is irrelevant to the query at hand.
- Efficient query processing algorithms following well-established methodologies, including filter-and refine and branch-and-bound, aiming at fast delivery of accurate query results.
- Parallel processing of the proposed query types, towards scalable algorithms that make the analysis of vast-sized data sets feasible in practice.

Impact

By exploiting CHOROLOGOS, the analysis of massive spatio-textual datasets (especially in social networks), is going to be facilitated significantly. In consequence, applications will be able to query and analyze larger quantities of spatio-textual data in more expressive ways exploiting semantic retrieval, thus speeding up the analysis and interpretation of heterogeneous data (spatial or multidimensional data and unstructured textual data).

The expected impact of CHOROLOGOS to economy is non-negligible, as it relates to one of the main pillars of Greek economy, namely tourism. CHOROLOGOS promises to deliver innovative location-based services and applications, which would benefit the local tourism business considerably. The research results will be directly applicable as web/mobile search application for tourist-related information, using advanced and more expressive querying, which can be extremely useful to a tourist visiting an unknown city.

A Novel Indexing Method for Spatial-Keyword Range Queries

Mapping Spatio-textual Data to 2D

- ❖ We propose a novel method that transforms spatio-textual object to points in a 2D space, which can be effectively indexed using traditional spatial access methods

- ❖ We provide appropriate search bounds for spatial-keyword range queries in the transformed space, in order to prune the search space and avoid processing unnecessary data objects

- ❖ We develop algorithms for query processing of spatial-keyword range queries in the transformed space

- ❖ We demonstrate the efficiency of our algorithms by implementing them in PostgreSQL

Spatial-keyword range queries

Given a query $q(r, \tau)$ that consists of:

- a location $(q.x, q.y)$ and
- a set of keywords Q,

the objective is to retrieve all spatio-textual objects within distance r from q and having keyword set similarity above a user-specified threshold τ.

A novel 2D mapping

We propose a carefully-designed mapping of spatio-textual data to a two-dimensional (2D) space, where:
- one dimension is used to represent spatial distance
- the other dimension represents textual similarity

Example

On the left figure, the top-right image shows the transformed 2D data space, where the spatio-textual objects are mapped to regions of the 2D space

More details

P.Tampakis, D.Spyrellis, C.Doulkeridis, N.Pelekis, C.Kalyvas, A.Vlachou: A Novel Indexing Method for Spatial-Keyword Range Queries. SSTD 2021: 54-63 (**best paper award**)
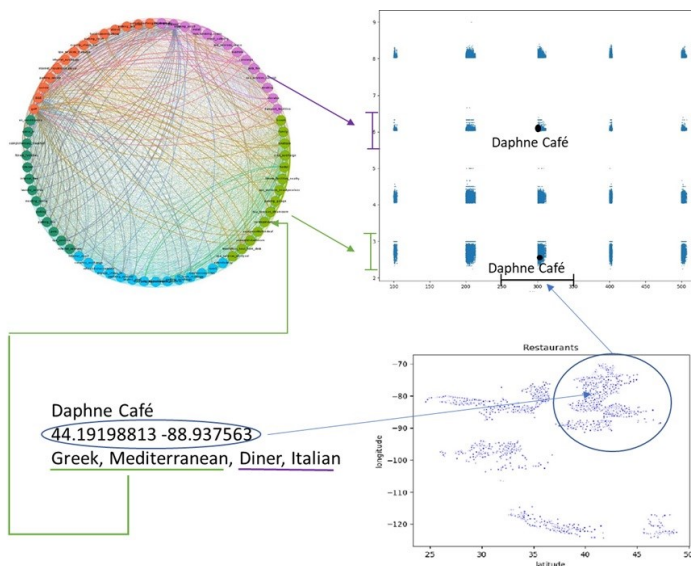
Publications

Book Chapters

1. Georgios Santipantakis, Christos Doulkeridis, Akrivi Vlachou, George Vouros, Integrating Data by Discovering Topological and Proximity Relations Among Spatiotemporal Entities, Big Data Analytics for Time-Critical Mobility Forecasting: From Raw Data to Trajectory-Oriented Mobility Analytics in the Aviation and Maritime Domains, "Springer International Publishing", (pp. 155-179), 2020.

2. Georgios Santipantakis, Christos Doulkeridis, George Vouros, Link Discovery for Maritime Monitoring, Guide to Maritime Informatics, Springer, (pp. 201-227), 2021.

Conferences

1. Georgios Santipantakis, George Vouros, Christos Doulkeridis, Coronis: Towards Integrated and Open COVID-19 Data, EDBT'21 demo track, 2021.

2. Nikolaos Koutroumanis, Christos Doulkeridis, Scalable Spatio-temporal Indexing and Querying over a Document-oriented NoSQL Store, EDBT'21, 2021.

3. Nikolaos Koutroumanis, Nikolaos Kousathanas, Christos Doulkeridis, Akrivi Vlachou, A Demonstration of NoDA: Unified Access to NoSQL Stores, VLDB'21 demo track, 2021.

4. Nikolaos Koutroumanis, Christos Doulkeridis, Akrivi Vlachou, Tearing Down the Tower of Babel: Unified and Efficient Spatio-temporal Queries for NoSQL Stores, MDM'22, 2022.

5. Fragkiskos Gryllakis, Nikos Pelekis, Christos Doulkeridis, Iraklis Varlamis, Yannis Theodoridis, Social Spatio-temporal Keyword Pattern (S²KP) Queries in Multiple Aspect Trajectories Databases, SSDBM'22, 2022.

Journals

1. Georgios Santipantakis, Konstantinos Kotis, Apostolos Glenis, George Vouros, Christos Doulkeridis, Akrivi Vlachou, RDF-Gen: Generating RDF Triples from Big Data Sources, In Knowledge and Information Systems (KAIS) Journal, Springer, 2022

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