Dynamic space-time visualisation: an introduction to i2maps

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The objective of this workshop is to provide an overview of i2maps, an open-source geocomputing environment. i2maps provides a flexible programming framework for knowledge discovery from spatio-temporal data and web-oriented visualisation, providing a means to «enable your data to speak for themselves». It consists of two libraries, one written in Javascript, and one written in Python. The Javascript library is used for building the interactive user-interface. The Python library consists of a server-based API for linking data sources and spatio-temporal analysis modules to the Javascript library.

Exploratory visual analysis can be an efficient way of preliminary investigation and hypothesis elaboration. Combining modern visual analysis with state-of-the-art Web technologies and real-time data streams increases the accessibility to rich datasets and allows domain experts to explore complex relationships in an easy visual way. However, extracting patterns, meaning and knowledge from large, spatio-temporal datasets is a challenging task. Consequently, such datasets are typically underused in many applications [1]. i2maps tries to solve the problem of bringing rich spatio-temporal data sets into the Web browser, by offering a flexible and easy-to-use structure and algorithms to handle both databases and data streams. i2maps tries also to tackle the problem of integrating spatial analysis tools for big data sets and data stream into the visualisation tools by offering powerful incremental algorithms.

The architecture of i2maps is designed to allow for dynamic interactive visualisation of spatio-temporal data. The Javascript front-end handles the interactivity and requests the data from the server. The Javascript library allows visualisation of dynamic raster and vector layers, and offers an interactive timeline. The map framework is built on top of OpenLayers. The Python back-end connects to various data sources and sends the data in JSON format to the Web browser. The i2maps Python library builds on top of other state-of-the-art libraries such as Numpy for matrix operations and numerical computations, or GEOS for various GIS operations. The Pico framework allows calling Python functions directly from Javascript making the development of complex Web applications easier. The Python library also handles transparent connections to PostGIS or SQLite databases and handles the data transforms between the data source and the Javascript front-end. It is also possible to integrate various other data sources, such as file-based storage, or data streams. i2maps also provides a raster cube offering flexible storage of temporal and potentially high-dimensional raster data in an efficient way. The Javascript front-end supports visualisation and exploration of these spatio-temporal surfaces through interactive user queries.

i2maps also provides powerful incremental algorithms based on machine learning methods. These algorithms are designed to be trained from both static data sources and data streams, and can also be updated in near real-time. Kernel Recursive Least Squares Regression (KRLS) offers a flexible framework for kernel regression and spatial interpolation [2, 3]. Scalable Local Regression (SLR) is a spatial regression algorithm similar to Geographically Weighted Regression (GWR) [4], but suitable for big data sets [5]. It can typically be used to discover and visualise spatial heterogeneity. i2maps has also an implementation of Projectron++ [6], a powerful classification algorithm similar to a Support Vector Machine (SVM) [7], but also working as an incremental algorithm and suitable for big data sets.

This workshop gives first an overview of the architecture of i2maps, and then works through the process of setting-up a complete i2maps project, involving setting up the data sources, linking the input data to a customised

spatial analysis method, and providing the results as an interactive map/timeline in a Web browser. The process of building an interactive i2maps application will be illustrated using the example of an interactive weather app. This example requires storage of spatio-temporal sensor measurements such as temperature or rain, display of the sensor data on a map and in a timeline, and computing a KRLS spatial interpolation surface based on the sensor data. Other examples will be discussed in order to illustrate the different features of i2maps. Among these examples, an application for visualising real-time Twitter messages will be shown. An example of a thematic map featuring temporal data will also be demonstrated.

After the workshop, each participant should have the necessary knowledge to start a simple project on their own, by using the appropriate documentation and code examples. A pre-configured Ubuntu-based virtual image will be provided with i2maps and discussed example applications already installed. This image should enable the participants to get started with i2maps without working through the steps of installing the required components. Installation instructions will still be provided for users deciding to develop applications with i2maps. Options for deploying i2maps applications are also shown during the workshop. Workshop documentation will also be available for download.

i2maps is an initiative of the National Centre for Geocomputation of the National University of Ireland Maynooth. It is currently actively developed by a community of international developers. More information on i2maps is available at http://ncg.nuim.ie/i2maps and https://github.com/christiankaiser/i2maps.

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