SketchMapia: a Framework for Qualitative Alignment of Sketch Maps and Metric Maps

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Abstract

The SketchMapia aims at relaxing technical constraints on Geographic Information Systems (GISs) by developing a framework taking freehand drawn sketch maps as input. This paper describes the framework that is designed to provide non-expert users of geospatial information with alternative methods for contributing data to and querying geographic information systems. The architecture of the framework consists of three components: (a) object recognizer, (b) qualitative qualifier, and (c) qualitative matcher. The web-interface of the project integrates these components and synchronizes the processes involve in the qualitative alignment of spatial objects.

Keywords: qualitative representation, sketch map, geographic information system, qualitative matching

1. Introduction

Sketch maps are externalization of the individuals' mental image of the environment. Being aware of the typical cognitive impact in cognitive maps, we developed a qualitative alignment framework called *SketchMapia*, which establishes an alignment between a sketched configuration and the corresponding configuration in the real world represented on a metric map. As typically only qualitative relations are persevered in sketch maps, *SketchMapia* processes spatial information on a qualitative level [1–3].

The project aims at relaxing technical constraints to create, assemble, and disseminated spatial information from freehand sketches provided by layperson. The system interprets input sketches, computes qualitative descriptions in the form of Qualitative Constraints Networks (QCNs), and determines potential alignments between sketch and corresponding metric maps based on the consistent qualitative descriptions. The successful alignment of spatial objects helps to integrate information from sketch and metric maps into one data repository. An intuitive web-interface makes the system accessible also for laypersons.

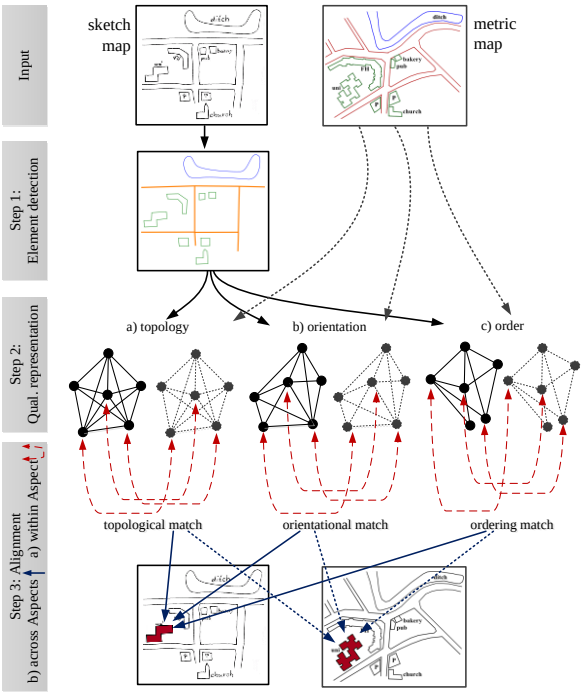
2. Project Components

The overall architecture (Figure 1) of the *SketchMapia* consists of three major components: the object recognizer, the qualifier, and the qualitative matching.

2.1 Object Recognizer

The object recognizer is a system for recognition and interpretation of sketch maps. It transfers the user input into a digital format. The system identifies the freehand sketch elements using shape, features, and contextual information [4, 5]. It analyzes nearby objects to create contextual information.

Figure 1: Architecture and workflow of the framework: (1), object recognition, (2) computing QCNs, (3) qualitative alignment.



2.2 Qualifer

The Java-based qualitative qualifier is a plugin [6] which computes the QCNs from a vector representation of either a sketch map or a metric map . In previous studies [7–9], we determine a set of qualitative representations to formalize the sketch aspects qualitatively [10, 11]. These representations successfully deal with cognitive effects such as distortion and

typical schematization. The qualifier computes QCNs for each representation, which serves as inputs for the matching algorithm.

2.3 Qualiative Matching

The qualitative matcher performs the actual alignment of the input maps. The qualitative matching of spatial scenes is a task that involves finding correspondences between the spatial objects in the first scene ($\mathcal{M}$) and those in the second scene ($\mathcal{M}^-$). The matching algorithm uses *Tabu search meta-heuristic* [12] to explore the search space for potential matching objects. The performance of the Tabu algorithm was successfully tested against sample sketch maps [13].

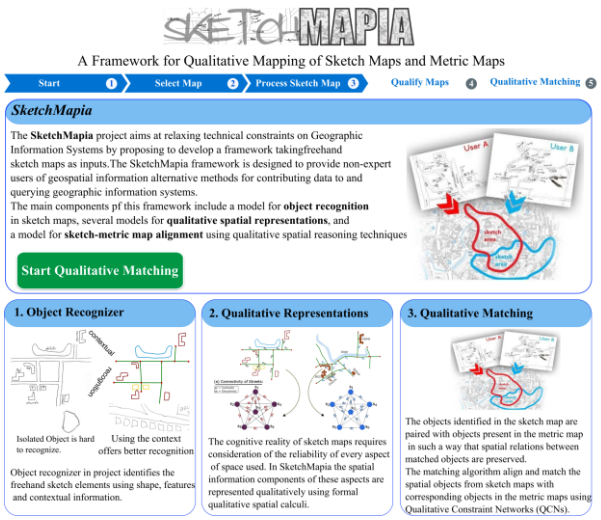
3. Web-Interface

The system is accessible via a web-based user interface which integrates all abovementioned components and synchronizes the processes involved in the alignment of spatial objects[1] (Figure 2). It helps non-experts to align the spatial information from freehand sketches with the information in corresponding metric maps. Users integrate spatial information from sketch maps into geographic information systems (GISs) as volunteered geographic information (VGI) without taking into account the technical barriers imposed by traditional GIS as noted in [14] .

Step 1: Select Map

The user selects sketch maps from a sketch map database. Each sketch map has a corresponding metric map (currently pre-processed, but in a later version automatically selected based on geo-reference information from the sketch map).

Figure 2: Web-interface of the project.



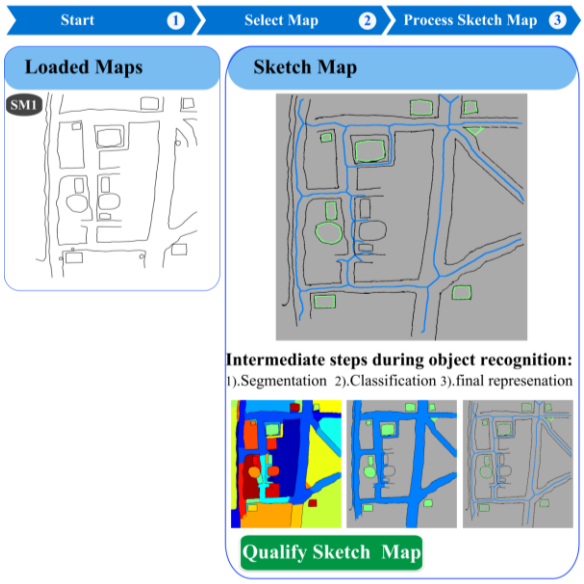
Step 2: Process Sketch Map

The processing step calls the object recognizer to transforms the selected sketch map into black & white image with homogeneous illumination. It identifies individual elements such as street segments, junctions, and landmarks and creates a shape file of each entity type (Figure 3).

Step 3: Qualify Map

This step calls the qualifier which computes QCNs form geometric representations (shape files) of the maps. The constraints are shown as text with the structure: element – relation – element (see Figure 4).

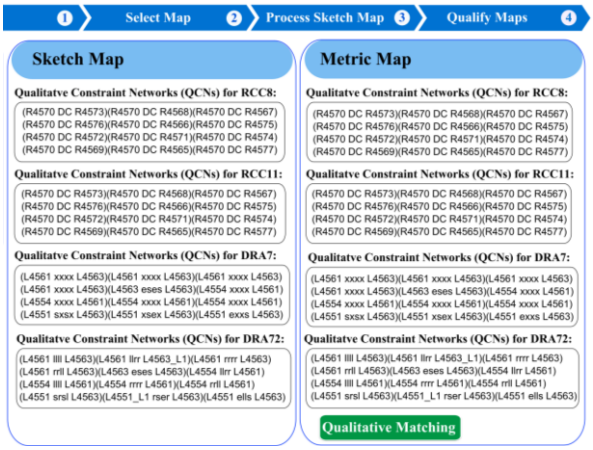
Figure 3: Recognition of the freehand sketch elements.



Step 3: Qualiative Matching

The step calls the qualitative matcher, which takes the QCNs as inputs and computes possible alignments. The result indicates the possible matches of spatial objects for each sketch aspect. The process stores matching results as simple text files.

Figure 4: QCNs of the sketch and metric maps.



[1] http://giv-sketchmapia.uni-muenster.de:8080/sketchMapiaInterface/index.php

4. Conclusion

In many geo-spatial applications, sketch maps are considered an intuitive user interaction modality. We developed a qualitative alignment framework—*SketchMapia*, which aligns sketched configurations with corresponding configurations in metric maps and integrates information into a single data source. We developed a web interface for this framework which allows easy interaction for laymen. Future work will address the visualization of the alignments.

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