Representation and quantification of change on spatiotemporal phenomena

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Abstract. A significant number of modern devices gather spatiotemporal data. This fact led to the need for data mining frameworks capable of processing spatiotemporal information and extracting knowledge from it. In the more specific field of change detection, this knowledge comes from the ability to automatically identify changes characterising spatiotemporal phenomena. Considering that different users have different interests while consuming the retrieved information, it is essential to provide them with the means to express the degree of interest towards change detection. However, state-of-the-art approaches have not addressed both retrieving the changes detected in the phenomena and providing the users with the ability to express their interests. Therefore, in this work, we analyse how to detect, extract and quantify user-relevant changes affecting a spatiotemporal phenomenon. To answer this question, a conceptual framework is proposed, incorporating computation methods for all of the change categories identified in the literature review. As input, and in order to retrieve pertinent information to the users, the framework accepts user-defined thresholds describing their interests. Subsequently, to validate the proposed framework, a prototype was devised and tested, in a variety of scenarios, that implements the base structure of the proposed conceptual framework and analysing a subset of the change features. To evaluate the results achieved, two novel complementary quantitative metrics were proposed. These metrics allow assessing the changes detected and their resemblance to the ground-truth. Supported by the prototype and the evaluation metrics, experiments were performed towards assessing the solution capability for detecting a singular change, sequences of changes and co-occurring changes. Additionally, tests also assessed the impact of the prototype component responsible for detecting spatial changes in the obtained performance. Results showed that the proposed solution depends significantly on the accuracy of the components responsible by detecting changes. It was verified that when the component detects changes with high-precision, the prototype can successfully retrieve the changes of interest affecting the analysed phenomenon (the worst obtained score when using high-precision components was 92.5%). Therefore, the results obtained validate the proposed solution and provide the necessary information to answer the raised research question. Moreover, the obtained results and evaluation methods can also be employed as benchmarks for future frameworks with similar objectives.

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