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An Ontology-based Visual Analytics for Apple Variety Testing

Ekaterina Chuprikova, Abraham Mejia Aguilar, and Roberto Monsorno
EURAC research, Center for Sensing Solutions, Bolzano, Italy (ekaterina.chuprikova@eurac.edu)

Increasing agricultural production challenges, such as climate change, environmental concerns, energy demands, and growing expectations from consumers triggered the necessity for innovation using data-driven approaches such as visual analytics. Although the visual analytics concept was introduced more than a decade ago, the latest developments in the data mining capacities made it possible to fully exploit the potential of this approach and gain insights into high complexity datasets (multi-source, multi-scale, and different stages). The current study focuses on developing prototypical visual analytics for an apple variety testing program in South Tyrol, Italy. Thus, the work aims (1) to establish a visual analytics interface enabled to integrate and harmonize information about apple variety testing and its interaction with climate by designing a semantic model; and (2) to create a single visual analytics user interface that can turn the data into knowledge for domain experts.

This study extends the visual analytics approach with a structural way of data organization (ontologies), data mining, and visualization techniques to retrieve knowledge from an extensive collection of apple variety testing program and environmental data. The prototype stands on three main components: ontology, data analysis, and data visualization. Ontologies provide a representation of expert knowledge and create standard concepts for data integration, opening the possibility to share the knowledge using a unified terminology and allowing for inference. Building upon relevant semantic models (e.g., agri-food experiment ontology, plant trait ontology, GeoSPARQL), we propose to extend them based on the apple variety testing and climate data. Data integration and harmonization through developing an ontology-based model provides a framework for integrating relevant concepts and relationships between them, data sources from different repositories, and defining a precise specification for the knowledge retrieval. Besides, as the variety testing is performed on different locations, the geospatial component can enrich the analysis with spatial properties. Furthermore, the visual narratives designed within this study will give a better-integrated view of data entities' relations and the meaningful patterns and clustering based on semantic concepts.

Therefore, the proposed approach is designed to improve decision-making about variety management through an interactive visual analytics system that can answer "what" and "why" about fruit-growing activities. Thus, the prototype has the potential to go beyond the traditional ways of organizing data by creating an advanced information system enabled to manage heterogeneous data sources and to provide a framework for more collaborative scientific data analysis. This study unites various interdisciplinary aspects and, in particular: Big Data analytics in

the agricultural sector and visual methods; thus, the findings will contribute to the EU priority program in digital transformation in the European agricultural sector.

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