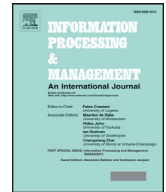


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Ontology-based affective models to organize artworks in the social semantic web

Federico Bertola, Viviana Patti*

Dipartimento di Informatica, Università degli Studi di Torino, c.so Svizzera 185, Torino I-10149, Italy

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ABSTRACT

In this paper, we focus on applying sentiment analysis to resources from online art collections, by exploiting, as information source, tags intended as textual traces that visitors leave to comment artworks on social platforms. We present a framework where methods and tools from a set of disciplines, ranging from Semantic and Social Web to Natural Language Processing, provide us the building blocks for creating a semantic social space to organize artworks according to an ontology of emotions. The ontology is inspired by the Plutchik's circumplex model, a well-founded psychological model of human emotions. Users can be involved in the creation of the emotional space, through a graphical interactive interface. The development of such semantic space enables new ways of accessing and exploring art collections.

The affective categorization model and the emotion detection output are encoded into W3C ontology languages. This gives us the twofold advantage to enable tractable reasoning on detected emotions and related artworks, and to foster the interoperability and integration of tools developed in the Semantic Web and Linked Data community. The proposal has been evaluated against a real-word case study, a dataset of tagged multimedia artworks from the ArsMeteo Italian online collection, and validated through a user study.

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1. Introduction

The development of the Web and the advent of social media has brought about new paradigms of interactions that foster first-person engagement and crowdsourcing content creation. The subjective and expressive dimensions move to the foreground, opening the way to the emergence of an affective component within a dynamic corpus of digitized contents, which advocates new techniques for automatic processing and retrieval of the available affective information. Therefore, recently a high interest raised among researchers in developing approaches and tools for sentiment analysis and emotion detection, aimed at automatically analyzing and processing of the affective information conveyed by social media (Cambria et al., 2013; Schroeder et al., 2011). In addition, the need to support users in accessing and exploring the outcomes of the emotion detection and sentiment analysis algorithms has fueled interest on research of solutions that address the sentiment summarization and visualization problem.

Organization and manipulation of social media contents, for categorization, browsing, or visualization purposes, often requires to encompass a semantic model of their affective qualities or of their reception by the users. In particular, we claim that ontologies and cognitive models of emotions can play a key role to bring advancements in this area (Cambria & Hussain, 2012). These can be defined compliant with emerging semantic web standards (which enable automated reasoning and semantic

* Corresponding author. Tel.: +39 0116706804.

E-mail addresses: bertola@celi.it (F. Bertola), patti@di.unito.it (V. Patti).

metadata processing) and integrated into traditional sentiment analysis and emotion detection techniques, with the final aim to enhance organization and access to contents.

In this paper, we address the above issues within the context of emotional aspects of Cultural Heritage. Artworks have a strong emotional impact on the visitors of an exhibition. In the last years, many cultural heritage institutions opened their collections to web access (think for instance of the Google Art project¹). User data collected by art social platforms is a precious information source about trends and emotions. However, although sentiment analysis and emotion detection of user data collected by social platforms are receiving increasing attention in many sectors, and, in spite of the fact that a high interest in monitoring the sentiment of the visitors is raised among art practitioners, curators and cultural heritage stakeholders, application of such techniques to the Cultural Heritage and Art domain is quite at its beginning (Baldoni et al., 2012; Bertola & Patti, 2013; Chae et al., 2012).

Our proposal is to elicit latent emotions behind user tags in order to recognize the emotional impact of artworks on people, relying and properly extending the ArsEmotica framework we started to develop in the very last years. The challenge is to study how to classify the sentiments of artworks in online collections by exploiting, on the one hand, tags from social media as information source, and on the other hand a structured knowledge of elicited affective information, such as affective categorization models expressed by ontologies.

The sentiment analysis of the social activity of the community (tagging the online resources) will provide an input for the “emotional engine” we are going to develop, and a basis for an emotion-driven access and browsing of the artworks. Detected emotions are meant to be the ones which better capture the affective meaning that visitors, collectively, give to the artworks.

Our approach to the sentiment analysis task is *ontology-driven*. To give a short description, given a tagged resource, the relation between tags and emotions is computed by referring to an ontology of emotions and relying on the combined use of Semantic Web technologies, NLP and lexical resources. We have developed an ontology of emotional categories based on Plutchik’s circumplex model (Plutchik, 2001), a well-founded psychological model of human emotions, which has been recently exploited also in emotion analysis from a computational linguistics perspective (Mohammad & Turney, 2013; Suttles & Ide, 2013). The ontology of emotions provides a good taxonomy for classifying artworks and it is so generic that it might also be used for analyzing emotions in running text. Moreover, it inspired an interactive user interface for visualizing and summarizing the results of our emotion detection algorithm. Detected emotional responses to artworks are represented by means of a graphical representation inspired by the Plutchik’s *emotion wheel*. Such representation allows us to convey to the user in a simple way a rich information on the underlying affective model (e.g. relationships among the emotions, such as similarities, intensities, oppositions), without referring to tree-like visualization of the ontology hierarchy. This is an original trait of our proposal. Most ontology-driven information retrieval systems cannot use ontologies this way.

Our final aim is to create a semantic social space where artworks can be dynamically organized, and then accessed according to the ontology of emotions. In this scenario, emotions can serve also as a sort of controlled vocabulary for retrieving artworks.

The proposed approach has been evaluated against a real-word case study, by relying on a dataset of tagged multimedia artworks belonging to a variety of artistic forms including poems, videos, pictures and music from the ArsMeteo Italian art portal (Acotto et al., 2009). Artworks from the ArsMeteo collection, enriched with the semantic metadata about the detected emotions, can be accessed by a SPARQL endpoint. SPARQL queries can be used to explore the collection and to extract information about relationships among emotions, artworks and their genre and author (e.g., “Give me artworks belonging to the genre *Photography* classified as joyful and created by artists living in the Salento’s Italian region”). Moreover, the connection of the ArsMeteo dataset to the linked open data cloud can foster interesting and unexpected possibilities of reusing the data.

The effectiveness of the ArsEmotica application framework for an emotional tagging task has been evaluated by means of a user study, by interviewing via survey a group of human subjects about their experience in interacting with a first release of the ArsEmotica prototype.

Contributions. First, we defined an OWL ontology, which refers to an affective model of emotions well-grounded in psychology. Second, we tuned on this ontology the ArsEmotica framework, which provides an emotional engine for detecting emotions elicited by artworks via social media analysis. Third, we explored the potential of our framework to enable ontology-based, emotion-driven access to the data of an online collection. Semantic representation of knowledge about artworks allows us to enhance access to an online collection both along the human users dimension and along the machines one, by obtaining two main results: (i) enrichment of user’s experience through the proposal of an interactive user interface for emotion-driven access to the artworks, which gives to the user a flavor about the emotional classification of the artwork, in the context of the exploited ontological knowledge model, and the possibility to personally enrich this classification; (ii) computer access to the online collection dataset enriched with emotion metadata, by means of linked open data technologies. As a proof of concept we applied the proposed framework to a real-world case study: the dataset of tagged artworks from the ArsMeteo online collection arsmeteo.org. In this context, we have developed a unified semantic data model of *artworks*, *artists* and *emotions*, and a demo SPARQL endpoint to query and access such data by combining traditional dimensions for retrieving artworks (i.e. genre, author, etc.) with the emotional axis provided by the ArsEmotica annotation. Finally, the work has been evaluated and validated through a survey with human subjects, which were asked to interact with the ArsEmotica prototype and to answer specific questions, aimed at testing the effectiveness of the application framework for an emotional tagging task from different point of views.

Organization. The paper is organized as follows. The next section contains a brief overview of the ArsEmotica framework. Section 3 focuses on the ontology-based affective model. Section 4 presents the ArsEmotica’s interactive user interface and the

¹ <http://www.googleartproject.com/>.

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