Folksonomies meet ontologies in ARSMETEO: from social descriptions of artifacts to emotional concepts

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Abstract. This work focusses on bridging between folksonomies, which provide social but mainly flat and unstructured metadata on web resources, and semantic web ontologies, which instead design structured, machine-processable knowledge spaces. The main purpose is to capture emerging semantics in social tagging systems and to overcome the gap between Semantic Web and Web 2.0, by preserving the complementary advantages of social and ontology-driven methods for describing, categorizing and processing web content. As a way to bridge this gap, we propose a method for linking tags from a folksonomy to concepts of an existing ontology, adopting a statistic approach. We have applied the proposed method to the data collected through the art portal Arsmeteo, relating them to the concepts of an OWL ontology of emotions. Intuitively, by our method we try to capture the *latent emotional semantics* of the tags. Some of the artworks in Arsmeteo could be visited in real exhibitions. In order to capture the emotional potential of the tagging activity during the visit, we explored the possibility to enable tagging of artifacts in real spaces, by using Semacode technology.

Keywords. Social Tagging, Ontologies, Emotions, Semantic Web

Introduction

Nowadays, we can observe many different ways to edit, categorize, search, and share Web content but while the scientific community was researching on how to design and realize the next-generation Web, based on *semantic technologies*, the way to use the Web changed in a way which is summarized by the keyword “Web 2.0". Blogs, wikis (like wikipedia[2]), and social tagging systems (like delicious, flickr, youtube[3]) attract the interest of Web users, partly surely due to the simplicity of the required interaction: plug some content, tag a resource, release a note. This user-initiated use of the Web emphasizes a collaborative perception of Web content, which, in turn, inspired researchers to look

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[2]wikipedia.org

[3]http://del.icio.us, http://www.flickr.com, http://www.youtube.com

for improved access and retrieval strategies. The collective uploading, and annotating behaviour comprises, in fact, important data for retrieving and presenting Web content.

However, despite the popularity of these technologies and its potential as an information source, the automated deduction of the semantics of annotations as well as of created content, is very limited and convincing solutions still need to be discovered. On the other hand, other (more sophisticate and powerful) systems which, by exploiting semantic web technologies, would indeed allow the generation and handling of knowledge, still lack adequate and as-easy user interfaces and are still mainly thought for a machine-to-machine use. In this context, the interest that motivated our work is to investigate possible solutions to fulfill the need of getting structured and machine-processable semantic information about online content, keeping at the same time the ease of use of Web. 2.0 applications, in the specific setting given by *social tagging* systems. In particular, we focus on the issue of integrating the complementary advantages of social (*folksonomic*) and *ontology*-driven methods for describing, categorizing and processing web content.

Folksonomies are a new user-driven approach to organizing information. They can be seen as "collaboratively generated, open-ended labeling systems that enable users of a community to categorise web content using tags" [16]; as such, they have a dynamic nature, evolving in time [12]. Usually tags are freely chosen keywords, rather than words selected from a controlled vocabulary. At the same time, they are *flat* sets and lack the structure that is required by automatic systems for supplying services to their users. Citing Berners-Lee [19]: "as soon as the user requires more complex processing from the machine, folksonomies reveal their weaknesses and semantic representations become necessary" but folksonomies neither allow the use of reasoning techniques nor they support the interoperability of data. Notice that semantic web ontologies show exactly the features that folksonomies lack: (i) they allow to categorize contents by referring to a vocabulary controlled by experts; (ii) metadata provided by using semantic web ontology are machine processable.

In this work, we propose a method for *bridging* between folksonomies (unstructured collections of metadata expressed in an uncontrolled vocabulary) and structured controlled vocabularies like semantic web ontologies, by preserving the advantages of both. We add to the *social tagging layer* a *semantic layer* that enables the automatic reuse of social content (see also Figure 1). As a result, we will gain a kind of content, that is both tagged by users and associated to an ontology; such content, originally annotated by the members of some community, is now mapped into a *machine-readable* knowledge representation format, thus enabling reasoning, and derivation of new knowledge and information. In this way we couple the naturalness of interaction with the user (due to the folksonomic approach) with the advantages of a shared and machine-understandable semantics, which enables the development of services for the users. The bridge between folksonomies and structured knowledge spaces is achieved by aid of *statistic techniques* relying on data about the natural language words corresponding to the tag and to the textual description of the chosen ontology concepts.

Thanks to the bridging, new semantic relations between the tags (and between the tagged contents) can be automatically deduced. Such new relations can be inferred by reasoning on the ontology, and can be exploited for enhancing the *user's experience* in browsing the web, by creating of a (sort of) ontological order on the tag clouds which usually drives the user's navigation in systems based on social tagging.

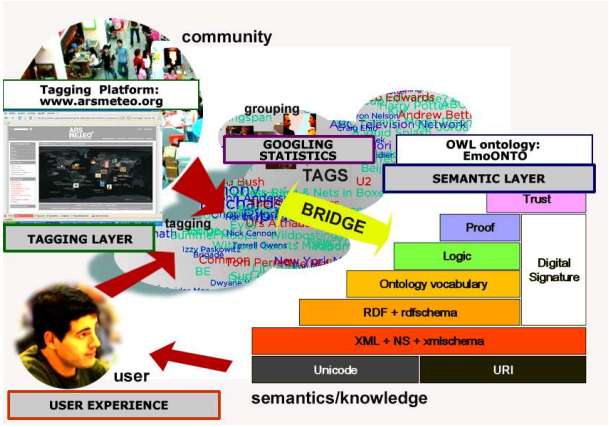

Figure 1. Vision.

Among the application areas that could benefit from this approach there are *art* and *museums*, which share a strong social characterization (people rely on other persons' experience and suggestion). Thus, in this work we applied our ideas to *Arsmeteo*[4], a web application that we have contributed to create. Arsmeteo is a portal for sharing artworks, which allows tagging and tag-based browsing. It enables the collection of digital artifacts (like texts, videos, pictures and music) or digital representations of physical artifacts that are shared by a community, as well as their tagging based on a folksonomic approach. Currently, the portal gathers a collection of about 2000 artifacts produced by over 100 artists. In this framework, the idea is to relate the tags collected by the Arsmeteo platform to concepts of an OWL *ontology* which is particularly relevant in the art domain: an ontology of *emotions*, chosen from the proposals in the literature [9] and adapted to our purpose. Italian words which describe the artifacts, uploaded in Arsmeteo, are linked to Italian emotional words referring to concepts of the ontology. The correlation between *tag-words* and *emotional words* is computed by applying a statistical approach, based on the occurrences (counted by "googling") of the corresponding words in the corpus of the italian Word Wide Web documents. Intuitively, we try to capture the *latent emotional semantics* of the tags.

Last but not least, since some of the artworks in Arsmeteo can be visited in real exhibitions, we have developed a service which allows the visitors of such exhibitions to tag the physical artefacts by exploiting the Semacode technology.

1. Emotional knowledge above the tags in the art domain

Suppose to have a user, Filippo, who is searching and tagging artworks through the Arsmeteo portal. Suppose Filippo's query is "show me pictures related to *happiness*". By linking the tags describing the artworks with concepts from an ontology of emotions, the system could not only find pictures literally tagged with *happiness* but also pictures that

[4] Arsmeteo, http://www.arsmeteo.org/, is inspired by an idea of Giorgio Vaccarino, and is promoted by the *Associatione Culturale Arsmeteo*, which leads and supports the development of the portal.

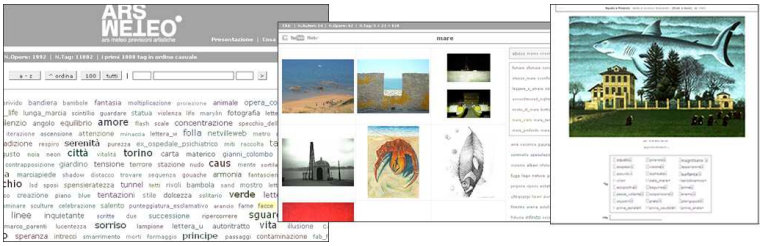

Figure 2. Arsmeteo screenshots. The tag cloud (left); individual tag page for *mare* (center); presentation of a selected resource: preview of the artifact and tagging area (right).

are annotated with other tags which have a latent emotional meaning related to *happiness*. After some ontological reasoning the system could then show further pictures, linked to emotional concepts that are subsumed by *happiness*, e.g. *jubilation* or *enthusiasm*.

Consider now a group of further art associations (museums, art galleries, etc.) which also offer, each through its own web site, the possibility of sharing, searching and tagging artifacts. By relying on the shared knowledge supplied by the emotional ontology, it would be possible to show Filippo also artworks annotated by different communities and belonging to different museums, composing on the fly a personalized exhibition that includes artefacts "lent" by other art portals.

The vision depicted above calls for the definition of three different layers which can be arranged in a circular flow: the social *tagging layer*, the *semantic web layer* and the *user experience layer*, Fig. 1. The contribution of this paper is a method, described in Section 2, for linking the tagging layer to the semantic layer. In the remainder of this section we will describe *Arsmeteo*, the kinds of interaction that it supports, and *OntoEmotions*, an ontology that particularly fits our application purposes, showing how we adapted it to the particular application context. We will, then, briefly introduce the advantages for the system users brought along by the bridging. Such advantages affect content browsing, search and visualization. The actual implementation of these services is the next step to be executed within this project.

1.1. The tagging layer. Arsmeteo: a folksonomic approach to art sharing and tagging

Arsmeteo, on-line since June 2007, enables the collection of digital artifacts (like texts, videos, pictures and music) or digital representations of physical artifacts, that are shared by a community, as well as their tagging based on a folksonomic approach. So far, the community produced a folksonomy of over 10000 tags.

In its core, ARSMETEO is similar to other social resource sharing systems. Registered users can upload multimedia resources and assign arbitrary tags, to them. Once uploaded, artifacts can be browsed and tagged by any visitor of the community. The user can have a preview of the uploaded resources, together with the tags currently assigned to them (see screenshot in Fig. 2(right)). One interesting feature is that a user can also vote the *relevance* of a previously stated tag-artifact relation, by clicking on the plus and minus symbols next to the tag. Such kind of "voting" activity allows the system to associate a *weight* to the tags related to a given artifacts, which will affect the ranking of search results. The tagging activity of the community suggests relations of *similarity* between artifacts, which result somehow categorized based on tags. The set of tags is a

flat namespace: tags are not extracted from predefined sets but they form a folksonomy. With the term *Arsmeteo folksonomy* we refer to the set of terms by which the community of users (artists and visitors) has tagged artifacts.

Artifact search can be performed in a tag-driven way by accessing the search page in Fig. 2(left)), where a tag cloud is used for visualizing the 1000 (or 100) most used tags of our folksonomy. By default the tags appear in random order, their size reflects frequency of use (popularity). Then, it is possible to order the tag cloud both by tag popularity or by alphabetical order. Moreover, searching filters can be applied to select all the tags containing a given string specified as a query in the search input box. When clicking on a tag T of the tag cloud, the user accesses a page (see Fig. 2(center)), whose left side contains previews of the artifacts tagged by T. Such results can be browsed page by page and are ranked, taking into account the relevance voting. On the right side, the user finds a new tag cloud, made of all the other tags related to the retrieved artifacts and tagged by T. Since these new tags describe the same resources tagged by T, they are considered *related* to T. This interface opens the navigation to new unexpected connections with other artifacts, described by the new related tags, but not literally by T (*serendipity*). Moreover, the interface also reports two lists of tags that can be used for refining the search: (1) a list of synonyms for T, and (2) a list of tags with a lexical relation with T (e.g. tags having T as a prefix/postfix, or complex tags containing T).

By clicking on an artifact preview, the user accesses the presentation page for the selected resource A (see Fig. 2(right)), which mainly consists of three parts: the preview of the artifact, the tagging area showing the tags currently describing A, and an area containing a selection of the resources *related to* A. As already mentioned, users can add new tags or they can vote the relevance of the tags already associated to A. Below the tagging area, a list of artifacts *related to* A is presented as a list of thumbnails. Intuitively, such resources were selected the measure of their *connection* to A. The selection is based on tag-similarity, and the related artifacts are ranked, taking into account the relevance voting associated to the describing tags by the community. Thus, the order of the related artifacts in the thumbnail list reflects the degree of connection/similarity calculated by the ranking algorithm. Connections between artifacts are dynamic and change over the time, because of the uploading of new artifacts from the artists and of the tagging and voting activity from the community.

When an artifact is uploaded, besides the tags, the system collects also standard information about the resource like author, genre, year of publication, format. Genres can be described according to a given list of categories. Such information is used by the system to classify contents in standard way and for offering the user access to the repository also by a more traditional kind of search by author, genre and date. Tags can also be added to resources, that are physically shown as part of real exhibitions (e.g. at some art gallery), by means of an application for mobile phones that we have developed and that is described in Section 3.

1.2. The semantic layer: OntoEmotions

One of the most important characteristics of art is that it expresses or stirs emotions. Art can be a record of what the artist is feeling and, at the same time, it can bring about emotional reactions in the viewer. Starting from this consideration, we have chosen to instantiate the methodology sketched in the introduction by linking the Arsmeteo tags

describing artifacts to an ontology of emotions. Even though affective computing has been gaining importance in the last years, there is still no agreement on a standard emotion markup language, complemented by the representation of an ontological structure of emotions. The work of the W3C Emotion Incubator group, that was chartered for defining a general-purpose emotion annotation and representation language, is still at the beginning [14]. We have adopted an emotional ontology, taken from the literature, that met our requirement to have a taxonomic structure mirroring well-founded psychological models of emotions, and that was already implemented by using semantic web technologies: *OntoEmotions* [10,9]. OntoEmotions is based on description logics and has been implemented in the semantic web language OWL. It has successfully been used within a project for developing an emotional voice synthesizer, as an interface between an application for the emotional mark up of text and a voice synthesizer.

OntoEmotions is an ontology of emotional categories, which are structured in a taxonomy covering basic emotions as well as the most specific emotional categories; it includes 85 *concepts*. The basic emotions are: *Sadness*, *Happiness*, *Surprise*, *Fear* and *Anger*. As discussed in [10], the taxonomic structure basically refers to the psychological model by Parrot [17], adapted to these five basic emotions, and integrated with all the emotions which appear in other well-established models. OntoEmotions has been conceived for categorizing emotion-denoting words. So classes corresponding to the emotional concepts have been populated by instances, consisting in emotion-denoting words of two languages: English and Spanish. The ontology has two root concepts: *Emotion* and *Word*. *Emotion* is the root for all the emotional concepts. *Word* is the root for the emotion-denoting words, i.e. the words which each language provides for denoting emotions. In order to allow the classification of words into their corresponding language, the root concept *Word* has two subclasses: *EnglishWord* and *SpanishWord*. Each instance of these two concepts has two parents: one is a concept from the *Emotion* hierarchy (the type of emotion denoted by the word), while the other is a concept from the *Word* hierarchy (e.g. the language of the word). For instance, the word *unhappiness* is both an instance of the concept *Sadness*, and an instance of the concept *EnglishWord*, which means that *unhappiness* is an English word for denoting sadness. Notice that, the class *Emotion* of OntoEmotion has also a special subclass which is called *Neutral*, that in our application can be used for categorizing tags that, according to our measures, do not result to have an emotional potential.

Adapting OntoEmotions to our purposes has been simple. Since the tags used by the Arsmeteo community are mainly Italian words, we have added a new subclass *ItalianWord* to the root concept *Word*, having as instances Italian emotion-denoting words. Our bridging method (between tags and emotional concepts) uses statistic techniques that rely on data, collected by counting the co-occurencies of tag-words and emotion-denoting words in the corpus of Italian Word Wide Web documents. Thus, we needed to add one Italian emotion-denoting word for each emotional concept in the taxonomy. This has been done by using the open source ontology editor Protégé [15]. The list of the Italian emotion-denoting words is the input of the bridging algorithm (Sec.2). The complete list can be found in [5].

1.3. The user experience layer: Tag-based navigation in an emotional space

The link between the tags of the Arsmeteo folksonomy and the concepts of OntoEmotions creates relations and connections among tags (and then among artifacts), opening

the way for the user to experiment tag-based navigation in an *emotional space*. Tags that were unrelated, e.g. *silence* and *donkey*, will be recognized as having a connection to the same emotion, e.g. *sadness* (see table 1). This creates new connections between artifacts tagged with tags which are literally different but are related to the same emotion. New relations can also be created by reasoning on the taxonomic structure of the ontology of the emotions. Notice that, as we will discuss in the next section, a given tag can result as being related in a significant way to more than one emotion, thus providing access to the artifacts, driven by different emotional concepts. Artifacts are usually tagged with many words, that express a variety of meanings and thus support the emergence of different emotional potentials. This is consistent with the idea that art can emotionally affect people in different ways. However, by analyzing the results of the bridging algorithm, we could discover that most of the tags associated to a given artifacts are linked to one particular emotional concept, or to concepts that in the ontology taxonomy are related to one of the basic emotions. For instance, given an Arsmeteo picture tagged only with *ties* and *blood*, by using the results in table 1, that stress a large correlation of both the tags with *fear*, it would be possible to relate the artifact to the *fear* basic emotion.

There are two fundamental challenges at this level: (i) the definition of new methods for sharing retrieving, accessing, and *browsing* content, that take into account the new relations and the semantic emotional structure; (ii) the study of a proper way to visualize to the user the presence of an ontology layer on the tagging layer, with final aim of arriving to a user interface where tags are settled in an emotional space.

(i) **Browsing emotional content**. There are two possible solutions that we would like to explore. *One possibility* is to simply extend the actual Arsmeteo tag-driven search mechanism by offering the possibility to the user to start the search by selecting an emotional category. For example, Filippo could start the search by querying for artifacts related to the emotional concept *sadness*. As result he could get a tag cloud consisting of all the tags of the folksonomy resulting to have an high correlation with *tristezza* (the italian sadness-denoting word). Then, as in normal tag-based navigation, Filippo can choose a tag and access the artifacts described by that tag. Intuitively, the idea is that tags in the tag cloud links Filippo to artifacts that has some tag-driven relation with *sadness*. Moreover, it will be possible to *reason* on the taxonomic structure of emotion ontology in order to offer to Filippo new connections with tags (and then with artifacts). For example, we could show to Filippo tags that can have a high correlation with concepts subsumed by *sadness*, as *nostalgia* and *desolation*. The *second possibility* is to allow the user to search for artifacts that are related to a set of emotions. For instance we could let Filippo search for artifacts that stir contradictory emotions, e.g. *hate*, *fascination* and *rejection*. In this case the system could present to Filippo, rather than a tag cloud, those artifacts which have been described by a list of tags presenting a high correlation with all the three emotions. Again reasoning on the ontology could be used for proposing connections to other artifacts, described by tags with a high correlation to more specialized terns, e.g. *hate-fascination-disgust*, where *disgust* is a concept subsumed by *rejection*.

(ii) **Visualization of the folksonomy in an emotional space**. One interesting issue to study in this context is to find a proper graphic visualization for giving the user the impression to move in an emotional space with an ontological structure when browsing the tags. In this direction it could be interesting to see how to integrate technologies for 3D visualization of ontologies (see for instance the tool OntoSphere [6]) with a 3D version the most popular graphical solution for browsing folksonomies: the tag cloud.

2. Bridging between the Arsmeteo tags and OntoEmotions concepts

Our aim is to determine if there is a relationship between an Arsmeteo tag and an OntoEmotions concept. The first idea that comes into mind is to count the documents in which both the tag and the concept are present. For two reasons, however, this idea is not suitable. First, we look for a method whose result *does not* depend on the frequency of a tag. Second, co-occurrences captures only the very direct relationship when the tag and the concept appear in the same document, while we aim at capturing *latent*, more indirect relationships as well. Hence, instead of counting co-occurrences, we use of a tool of statistics, the *correlation coefficient*.

The study of correlation is performed on the corpus of the Italian Web documents because it is an immense set of everchanging documents reflecting the actual society and its use of language in various ways. The calculation is based on *frequency of appearance* of words which we obtain by Google, a powerful search engine whose advanced interface allows us to perform the necessary queries in automatic manner as described in [5]. In this section we first give some background on "correlation coefficients", then, we show how to apply this concept to look for relationships between Arsmeteo tags and emotions present in OntoEmotions. Finally the application to Arsmeteo is presented.

2.1. Correlation coefficient

Correlation coefficients measure the strength of relationship between random phenomena. Formally, the correlation coefficient of two random variables X and Y is given by:

$$\rho_{X,Y} = \frac{E((X-\mu_X)(Y-\mu_Y))}{\sigma_X \sigma_Y} \tag{1}$$

where E denotes the expected value operator (i.e., it gives the "average" of the random variable given as operand), $\mu_X = E(X)$ is the expected value of X, $\sigma_X = \sqrt{E((X-\mu_X)^2)}$ is the standard deviation of X, while μ_Y and σ_Y are likewise for Y. It is easy to see that $-1 \leq \rho_{X,Y} \leq 1$. To get the intuition behind Def. (1), let us consider an example. If $X = cY$, i.e. Y determines exactly Y, then $\mu_Y = c\mu_X$ and we have:

$$\rho_{X,Y} = \frac{E((X-\mu_X)(cX-c\mu_X))}{\sqrt{E((X-\mu_X)^2)}\sqrt{E((cX-c\mu_X)^2)}} = \frac{E((X-\mu_X)c(X-\mu_X))}{\sqrt{E((X-\mu_X)^2)}\sqrt{E(c^2(X-\mu_X)^2)}} =$$

$$\frac{E(c(X-\mu_X)^2)}{\sqrt{E((X-\mu_X)^2)}\sqrt{c^2E((X-\mu_X)^2))}} = \frac{cE((X-\mu_X)^2)}{cE((X-\mu_X)^2)} = 1$$

If $\mu_Y = -c\mu_X$ then $\rho_{X,Y} = -1$. If X and Y are instead completely independent simple calculations $\rho_{X,Y} = 0$. In a more general setting, if X is large when Y is large and X is small if Y is small then in the numerator of (1) we have a positive value which is as close to the denominator of (1) as strong the relationship is between X and Y. On the contrary, if X is large when Y is small and X is small if Y is large then in the numerator of (1) we have a negative value whose absolute value is as close to the denominator of (1) as strong the relationship is between X and Y.

Several guidelines exist for the interpretation of the correlation coefficient. For the purpose of this work we have found suitable and hence adopted the one proposed in [8]. Accordingly we judge the correlation coefficient as "small" if it is between 0.1 and 0.3, "medium" if it is between 0.3 and 0.5, and "large" if it is between 0.5 and 1.0.

2.2. Correlation between Arsmeteo tags and OntoEmotions concepts

Assume that we are given an Arsmeteo tag and an OntoEmotions concept. To evaluate their relationship we calculate the correlation coefficient of two random variables, X and Y. Given a set of documents, X is the percentage of documents in which the *Arsmeteo tag* is present. Likewise, Y is the percentage of documents in which the *OntoEmotions concept* can be found. In practice, we evaluate the correlation coefficient of X and Y as follows: we identify N disjoint sets of documents of the world wide web by choosing domains; then by simple google queries we determine X and Y for every domain. Let us denote the resulting values of X and Y by $x_i, y_i, 1 \leq i \leq N$. The estimate for the correlation coefficient of X and Y based on $x_i, y_i, 1 \leq i \leq N$ is given by:

$$\frac{N\sum_{i=1}^{N} x_i y_i - \sum_{i=1}^{N} x_i \sum_{i=1}^{N} y_i}{\sqrt{n\sum_{i=1}^{N} x_i^2 - \left(\sum_{i=1}^{N} x_i\right)^2}\sqrt{n\sum_{i=1}^{N} y_i^2 - \left(\sum_{i=1}^{N} y_i\right)^2}}\,.$$

2.3. Experiments

The procedure proposed was applied to look for relationships between tags picked up *randomly* from Arsmeteo and the *five principal emotions* present in OntoEmotions which are sadness, fear, anger, happiness and surprise. Since most tags are in Italian, we used the corresponding Italian words which are *tristezza*, *paura*, *rabbia*, *felicità* and *sorpresa*. The disjoint sets of Italian documents were formed by choosing domains corresponding to daily or weekly newspapers (e.g., `repubblica.it`), websites of towns or regions (`intoscana.it`) and webportals providing information on culture or politics (`exibart.it`). Our aim was to look for rather large sets (all the sites contain a few hundred thousand documents) and identify sets which are not limited for what concerns the typology of its documents.

We have performed numerous experiments of which Table 1 reports the correlation coefficient for a few tags that illustrate the insight that one can gain by the proposed procedure. The chosen tags in Italian are *asino*, *uomo*, *centro*, *grattacielo*, *infinito*, *legami*, *sangue* and *silenzio*. Bold numbers indicate large correlation. Let us discuss briefly Table

	donkey	man	centre	skyscraper	infinite	ties	blood	silence
sadness	**0.90**	**0.83**	0.09	0.22	0.20	**0.60**	**0.83**	**0.94**
fear	**0.68**	**0.92**	0.00	0.25	0.11	**0.89**	**0.99**	**0.82**
anger	**0.53**	0.47	0.38	0.29	0.21	0.28	0.42	**0.64**
happiness	0.20	**0.58**	-0.14	0.07	**0.65**	**0.72**	**0.67**	0.34
surprise	0.13	0.16	-0.05	0.29	-0.07	0.09	0.22	0.21

Table 1. Correlation between Arsmeteo tags and emotions.

1. "Donkey" and "man" are living creatures and hence have a lot to do with emotions. The tag "donkey" is associated with four artworks in ARSMETEO and all these works have something disquieting that provoke negative sentiments. The tag "centre" has no large correlation with the five concepts of emotions. It has medium correlation with "anger" which can be caused by its second meaning in politics. This example reveals a general weakness of the method: results for words with *double meaning* are hard to interpret. "Skyscraper" has only small correlation with emotions provoking negative emotions and surprise. The abstract concept "infinite" has large correlation only with "happiness" and

it is interesting to note that many of the works tagged “infinite” in Arsmeteo provoke positive feelings. The Italian word corresponding to “ties” is used primarily to describe emotional ties and hence it makes sense that it has large correlation both with negative emotions and “happiness”. As expected, “blood” has several high correlation values and a very high one for fear. “Silence” is mostly associated with negative emotions while has medium with happiness. Note that significant negative correlation cannot be found in Table 1. This is explained by the fact that the sets of documents are large and contain a high variety of documents and hence it is not probable that the presence of a word implies the absence of another. Negative correlation can be found if we perform the study on smaller set of documents which concentrate on a given subject.

3. Tagging art in real spaces by Semacode technology

Many museums and art galleries have a web site that shows digital reproductions of the artworks that are exposed. The same artists who contribute to Arsmeteo expose their works not only in digital format but also in real exhibitions. Seeing artworks in the setting of an exhibition has a strong emotional impact on the visitors of the museum/gallery, impact that it would be interesting to collect as the result of a tagging activity. Nevertheless, it is quite unlikely that visitors will access the artist’s (or the museum’s) web site, once returned at home, to tag the reproductions of those artworks that impressed them the most, as it is not easy to scatter internet terminals in the exhibition rooms to allow those visitors, who are willing to express their emotions, to tag the reproductions of their preferred artworks. To overcome these limits we have developed a simple application [11], that runs on mobile phones which exploits the 2D-code (more specifically, the *Semacode* libraries for 2D-code generation [4] and the Kaiwa reader [3]) technology to allow the direct tagging of the artworks. Semacodes are two-dimensional barcodes, created on the DataMatrix standard. They are used to encode web page URLs. One of their chief characteristics is that they are easy to read even using cheap optical devices (like mobile phone cameras). Each painting (sculpture, installation) has a 2D-code, which represents a query to a web site, whose execution loads a wap-page which, in turn, allows to tag the artwork, showing at the same time the current tag list for the same object. This application is related to applications like geoblog [2], developed by the “Museo Diffuso della Resistanza" in Torino, that uses 2D-codes to encode information about historical places, that can be read by using a 2D-code reader when visiting such places.

4. Final remarks

In this paper we have proposed a methodology for linking Arsmeteo tags with emotional concepts of the OntoEmotion ontology. Statistical techniques are applied for calculating the correlation between *tag-words* and *emotional words*. The correlation tag-emotion is calculated relying on the occurrences of the corresponding words in the corpus of the Italian Word Wide Web documents. Occurrences are counted by “googling”. Our methodology works properly under the assumption that a precise meaning has been associated to the tag words. Results of correlation with emotional concepts for ambiguous words would be hard to interpret, especially in case of homographs (e.g. *pésca* ’fishing’

and *pèsca* 'fruit'). In order to cope with this problem, we are studying how to enforce our methodology by applying existing NLP techniques for performing homography-level sense-discrimination of tags-words [13] before proceeding to googling. A promising direction to explore is to adopt some WordNet-based query expansion techniques [22]. In particular, we plan to explore the use of the Italian component of the multilingual computational lexicon MultiWordNet [5]. The lexical information stored in MultiWordNet can have a twofold use in our application context. On the one hand, we plan to use it as a pre-defined sense inventory in order to select the most important multiple senses of the Arsmeteo tags and to implement query expansion strategies for capturing the different sense frequencies. On the other hand, we will explore how to use the lexical semantic relations of MultiWordNet for facing the semantic disambiguation problem, e.g. for choosing the sense of a given tag in the context of an Arsmeteo's resource description. Notice that, in our application domain, we cannot count on the traditional notion of context: the only kind of context we can consider is given by the tagged resource and by the other tags used for describing the resource. Moreover, we plan to clean up and optimize the whole process by performing, along the line of [20], a shallow pre-processing on the set of the Arsmeteo tags, aimed at grouping *morphologically similar* tags (e.g. *cane* and *cani*). Once selected a representative for each group of similar tags, we can evaluate the correlation coefficient with emotions only for such tag-representatives.

Folksonomies are *flat* sets and lack the structure that is required by automatic systems for supplying services to their users. Folksonomies do not allow the use of reasoning techniques nor the interoperability of data: as soon as the user requires complex machine processing, folksonomies reveal their weaknesses and semantic representations become necessary. There are on-going researches aimed at giving a structure to a folksonomy by inducing an ontology out of it, e.g. [18]. Other researches aim at understanding how the activity and interactions of many uncoordinated users produces patterns of classification, by exploiting the tools supplied by the study of complex systems [1].

Many other interesting directions could be explored, especially if we consider *specific characteristics* of a certain *application domain*. Museums are a typical example. Organizations like museums have a different role to play in the online world than Flickr, YouTube and the like [7]. Such institutions, by making their collections accessible, aim at providing *knowledge*, rather than *information*. Interpreting artifacts to the general public requires bridging the semantic gap between the professional language of art history and the public perceptions of its visual evidence. The words that a curator uses, in fact, may not be familiar to the average museum visitor. Some important museums (amongst them *Guggenheim*, *Metropolitan Museum of Art*, and *San Francisco Museum of Modern Art*) have been studying for over one year the potential of social tagging in the development of better interfaces, and aim to break the semantic barrier with their visitors, by supporting the project STEVE[6] [21]. Tagging, due to its highly subjective nature, is perceived as a valuable *feedback* that reveals the way in which the public perceives collections, exhibitions, and artifacts. However, this technology is not sufficient: on the one hand, the feedback returned by the visitors in terms of tags cannot be automatically integrated in the museum knowledge base; on the other hand, mere tagging helps in no way the translation of the message/knowledge, that the museum would like to communicate, into

[5] Available at http://multiwordnet.itc.it

[6] http://www.steve.museum/

terms that are more familiar to the public. The integration of semantic technologies is needed.

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