From User-Generated Tagging to User-Agreed Knowledge: An Argumentation-Based Approach

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Abstract

Ontologies and folksonomies represent two alternative approaches for creating and managing knowledge on the web. Ontologies are produced by some experts in charge of formally defining terms and relationships among them in a given domain. Folksonomies emerge from a free tagging activity performed by direct participation of end users, but lack a controlled vocabulary and a formal content organisation, thus making difficult their management. To overcome the limits of folksonomies while keeping their advantages, we propose a novel approach allowing users both to relate their tags to a reference ontology and to discuss about inserted tags and relationships to reach a collective interpretation. To this aim, argumentation theory is used as the underlying model to manage persuasive dialogues among users. The proposal is substantiated by an example referred to an application for collaborative web mapping in the domain of natural heritage interpretation, called TheSilence.org.

Introduction

The knowledge available on the web constitutes today an important source of information for most people all over the world. This is also favoured by the so-called Web 2.0, where knowledge exchange among users through the web is becoming predominant. Actually, this exchange leads to obtain a great amount of non-structured knowledge, which is very hard to manage due to the intrinsic nature of the hypertext paradigm underlying web content organisation. In fact, this knowledge can be redundant and, at the same time, insufficient to support information retrieval or even simple reasoning.

A well-known approach to this problem is represented by the semantic web, whose goal is to "allow data to be shared effectively by wider communities, and to be processed automatically by tools as well as manually" (W3C 2009). In particular, the semantic web promotes the use of *ontologies*, for which several definitions exist. The most accepted one describes an ontology as an explicit and shared representation of a conceptualisation (Gruber 1995). In short, an ontology is a controlled vocabulary resulting from discussions among domain experts and a balanced synthesis of their positions. However, there are domains that cannot be modelled through an ontology because they are too huge and heterogeneous to be captured by a unique and crisp model, or simply because no expert exists who can provide an ontology for that domain. In these situations, a great amount of resources (people, time, money) are required for creating a comprehensive ontology.

On an opposite side, *folksonomies* (Wal 2007) are highly promoted by Web 2.0 applications (mainly social networks). A folksonomy is freely created by end users through annotation tools that allow users to associate web resources with meta-data, called *tags*. However, folksonomies lead users to create knowledge that may result very difficult to manage and use, since tags are generally affected by ambiguity, imprecision and inaccuracy, and are not related one another by formal relationships.

In this paper we aim at providing more structure to the knowledge exchanged by users through the web by overcoming the limitations of folksonomies and by turning their strong points to advantage. To reach this goal, we provide users with an arena supporting opinion exchange and a shared unambiguous dictionary, as usually happens when domain experts have to build an ontology. The result of this approach is a structured representation of knowledge, that we call *demonomy*. This term derives from Ancient Greek 'démos' (people) and 'nomos' (rules). The suffix 'nomos' refers to the unambiguous dictionary, while the prefix 'démos' represents the democratic characterisation of the approach, which is aimed to encourage and support the debate among participants.

Two kinds of knowledge are managed in a demonomy: the dictionary, which is not questionable, and a defeasible knowledge base, where the dictionary concepts are either referred to or enriched with additional information provided by users. Ideally, defeasible information should be shared by the whole community. Therefore, we should allow every member of the community both to state a new position and to disagree with another one's. To this aim, we adopt an argumentative approach based on Walton's *argumentation schemes* (Walton 1996) and a formal dialogue protocol.

A related issue of the approach is concerned with its Human-Computer Interaction (HCI) perspective. Indeed, typical web users, representing the knowledge sources in a specific domain of interest, are not computer scientists. Therefore, no training should be required to the users for

Appears in the Proceedings of the 13th International Workshop on Non-Monotonic Reasoning (NMR 2010).

exchanging knowledge that needs to be formally managed through the dialogue. To face this problem, our approach is based on the idea that the inner structure of arguments and the dialogue protocol should be determined on the basis of the specific domain at hand. This allows one to represent, as close as possible, the mental model of the users interested in the domain itself. To this aim, we hypothesise the presence of a domain expert identifying a *user-oriented argumentation model*, based on a set of argumentation schemes, a dialogue protocol and a formal way to determine the outcome of the dialogue. Due to the great generality of existing theoretical approaches to argumentation models, they cannot be applied as such to the specific context of real-world user interaction. Therefore, one of the aims of the paper is also to define an approach to manage user-oriented argumentation models.

In this paper we propose a preliminary approach able to satisfy the needs mentioned above by proceeding in two steps. First, we consider a shared structured controlled vocabulary such as WordNet (Miller 2009), as a reference ontology for the language. Then, we focus on a conceptual framework to collect defeasible knowledge based on user-oriented argumentation. A running example, in the context of an application for collaborative web mapping, is used throughout the paper to illustrate the approach. In particular, we describe an interaction scenario that should be supported in the considered web application.

Running example: Thesilence.org

To illustrate the ideas proposed in this paper we refer to the application for collaborative web mapping called TheSilence.org, which is part of the project *The Silence of the Lands* (Giaccardi 2007). This project promotes the use of environmental sounds to empower the active and constructive role of local communities in natural heritage interpretation, conservation, and renewal. This goal is undertaken by enabling people to record environmental sounds through a mobile system equipped with a GPS (Global Positioning System), and then upload the sounds on the web application TheSilence.org (Fogli and Giaccardi 2008; Giaccardi and Fogli 2008). TheSilence.org represents the sounds on a satellite map as geo-localized dots. Registered users can then describe the sounds they have recorded by annotating them with different meta-data: a title, some tags, a textual description, and a colour that expresses how much the user likes or dislikes a given sound. Registered users have also the possibility to leave comments about the sounds uploaded by other participants.

In this way, TheSilence.org supports a participatory activity for creating and sharing knowledge about the environment. In particular, the tagging activity supported by the annotation tool provides a simple and free manner for creating knowledge, thus enabling the generation of a folksonomy.

The aim of the application is also to create the basis for social debates on natural heritage. Using TheSilence.org, participants can exchange opinions with other participants and possibly revise their initial judgements on their own uploaded sounds. However, richer tools are needed to support end users to create structured knowledge, regulate debates within communities, and facilitate mediation between different perspectives.

Let us illustrate an example of debate that should be supported by a web application like TheSilence.org. This example is derived from a real situation involving some members of the Colorado Field Ornithologists. They discussed since November 2008 until August 2009 about the supposed sighting of a particular species of gull in the Six-Mile Reservoir of Boulder, Colorado.

John, Mary and Carl participate in this scenario. John studies natural science and is keen on bird-watching. He uploads on TheSilence.org a sound of a gull recorded near the Six-Mile Reservoir, and titles it "seagull in Boulder". While observing the gull during sound registration, John recognised it as belonging to the slaty-backed gull species. Therefore, he associates the sound with the tags "gull" and "slaty-backed gull". Mary is a John's course-mate. Although she was not present during the sound registration, she considers the tag "slaty-backed gull" a mistake, since she knows that these kinds of gull are common in Japan but very rare in North America. Through the system, she comments that the tag is not adequate for that sound and motivates her position by saying that "the slaty-backed gull is indigenous to East Asia". John does not agree with Mary's critique on his tag. He claims that the critique is not correct and justifies his reply by referring to an on-line video, titled "Potential Slaty-backed Gull, 6-Mile Reservoir, Boulder County, Colorado, 11/27/08". The video shows a recent sighting of a slaty-backed gull in a neighbouring area. John's reply persuades Mary of the reasons underlying his tagging. Therefore Mary decides not to keep on with this discussion. Carl is an ornithologist living in Denver, and often collaborates with the City of Boulder Open Space and Mountain Parks Department on studies about birds that are present in the Boulder area. Carl listens to the new sounds registered by John; he reads the tag "slaty-backed gull" associated with a sound and observes that a discussion about this tag is already under development. Carl agrees with Mary's critique and he does not recognise with certainty in the video referred to by John that the gull is a slaty-backed gull. Therefore, Carl criticises John's source of information by providing as a proof another information source: a paper, entitled "Bird's Boulder appearance still a mystery", recently appeared on the local press. When John reads Carl's critique, he accepts it and abandons the discussion. As a consequence, the tag "slaty-backed gull" is removed from the system.

This scenario will be used in the rest of the paper to illustrate the ideas herewith proposed.

The linguistic ontology

As already mentioned, usually the terms appearing in a folksonomy are not precise enough to be used for content classification: different terms are used to denote similar concepts, or the same term is used with different meanings, or some users adopt more general (or more specific) terms with respect to other users. Moreover, a folksonomy does not represent semantic relationships among terms, and this affects content findability. We propose to solve these problems by adopting WordNet (Miller 2009) as a tool for term disambiguation. WordNet is a lexical ontology defined for the English language. It includes the word meanings and defines the concept of *synset* as a set of synonyms in a given context. Moreover, WordNet organizes the synsets in a hierarchical structure by introducing different kinds of relationships among synsets: antinomy, iperonimy, iponimy, meronimy, olonimy and troponomy.

Therefore in our approach, after the user has inserted a tag, s/he should be asked to select the answer provided by WordNet that better matches with the meaning s/he intends for that tag. Whenever the tag inserted by the user is too specific and thus not present in WordNet, the user should be able to insert the new term as a new synset, by providing a brief description of its meaning and/or by indicating a relationship with an existing synset.

For instance, in the scenario described in the previous section, when John inserts the tag "gull", the system should propose possible meanings in terms of sets of synsets and a brief description for each set. In the case at hand the user would select the synset "gull, seagull, sea gull" having this associated description: "mostly white aquatic bird having long pointed wings and short legs". Moreover, when John inserts "slaty-backed gull" as a further tag, the system will not provide any suggestion and the user could manually specify that it is a kind of gull by selecting the "hyponomy" relation with respect to the term "gull". We assume that users cannot modify terms and relationships already present in WordNet, but that they can debate on the correctness and adequacy of new terms.

The user-oriented argumentation model

Since users are allowed to insert tags and relations among tags in an uncontrolled way, it would be unrealistic assuming that this activity is always accurate and yields results on which all users agree. In the absence of a mediator (e.g. a domain expert) in charge of verifying and possibly revising user-generated data, it is necessary to let users themselves discuss about data correctness and/or appropriateness with respect to the web resource. This way, a previously accepted tag (or relation) can be revised in case there is a good reason to do it (e.g. the evidence that a tag is mistaken).

In order to let untrained users participate in the discussion, we have to design an interactive mechanism which allows to capture the users' opinion through common used interaction design patterns, while hiding the underlying computational model. Moreover, to avoid problems like off-topic discussions or dialogue fallacies (like *ad hominem*, *ad verecundiam*. . .), the dialogue should be appropriately constrained. For instance, let us consider again the running example and the disagreement between John and Mary. To collect it, we could adopt a set of step-by-step questions. Such questions will depend on the disagreement topic, and will be driven by user's answers, in order to capture the motivation underlying the disagreement. Indeed, if a user disagrees with a previously stated position, then s/he is bound to supply a motivation. Since it would be practically unfeasible to automatically check whether a motivation provided by a user is actually a good reason to enforce a revision, also the burden of this verification is left to the users' community as an outcome of their discussion. In other words, it may be the case that a user critiques the motivation provided by another user, and the critique becomes in turn an object of debate within the community. Moreover we want to make it possible for the users to effectively contribute to the debate so as to reach a shared conclusion about the appropriateness of a given tag or relation. Therefore at any time the result of the dialogue (in particular, whether a given tag or relation is accepted or not) should be determined and should be visible to the community, as well as all the opinions that supported it. Furthermore, any user disagreeing with the current outcome can revise it by questioning the opinions of other users. A user can also change her/his idea when convinced by the motivations provided in the dialogue by other users.

For such an approach to be effective, three main requirements should be fulfilled:

1. the opinions of the users should be formalised in such a way that it is possible to systematically collect and expose them to criticisms by the users' community;
2. a restrictive protocol to govern the dialogue between the users, including their possible moves, should be provided;
3. a computational method to determine the outcome of the dialogue should be identified.

In the next subsections we show how to fulfil these requirements by adopting argumentation theory as an adequate conceptual basis. Arguments are entities including a supported conclusion and a set of premises that represent not necessarily deductive reasons to believe the conclusion itself (Prakken and Vreeswijk 2001). In general, different arguments may be in conflict, and the theory explicitly manages these contradictions modelling them through a binary relation. For each argument there may be one or more arguments representing its counterarguments. In this way, a set of arguments can be represented by a directed graph on which formal methods to determine the set of acceptable arguments can be applied (Baroni and Giacomin 2007).

Argumentation schemes to formalise users' opinions

To represent the opinions expressed by end users, our approach exploits the concept of *argumentation scheme* (Walton 1996), namely a reasoning pattern consisting in the statement of a presumption in favour of a given conclusion. Whether this presumption stands or falls depends on the positive or negative answers to a set of *critical questions* associated with the scheme, which identify the possible reasons or conditions that make the reasoning pattern not applicable or invalid. An example of argumentation scheme with the relevant critical questions is given below.

Argument from Position to Know

`Premise 1:` Source S is in a position to know things in a certain subject domain D containing proposition a

`Premise 2:` S asserts that a (in domain D) is true (false)

`Conclusion:` a is true (false)

Critical questions:

`CQ1` Is S in a position to know whether a is true (false)?
`CQ2` Is S an honest (trustworthy, reliable) source?
`CQ3` Did S assert that a is true (false)?

While argumentation schemes have been mainly introduced to identify and validate existing arguments, we intend them as a means to synthesise new arguments from the opinions expressed by users. Furthermore, we consider the critical questions as a way to identify possible counterarguments. More specifically, we model here an argumentation scheme as an entity including: the *name* of the argumentation scheme; a set of *parameters*; a *formulation* of the argumentation scheme (depending on the parameters) in natural language; a set of *invalidity conditions* (depending on the parameters) that, if verified, undermine the reasoning represented by the argumentation scheme. An argumentation scheme can be instantiated with respect to an individual case by assigning a value to each parameter: the instantiation of an argumentation scheme gives rise to an argument. For the sake of conciseness, in the following we introduce only four argumentation schemes and a restricted set of invalidity conditions, nevertheless sufficient to manage the running example.

The first argumentation schemes (AUT and AUDR) are automatically instantiated whenever a user inserts a tag or a relation respectively.

Argument from user tagging (AUT)

`Parameters:` u, T, S
`Formulation:` User u says that the tag T is related to the content of the sound S, so, the tag T has been added to S sound
`Invalidity conditions:`
`IC1` T tag is not related to S sound

Argument from user defined relation (AUDR)

`Parameters:` u, W, S, R
`Formulation:` User u says that the word W is related to the synset S according to the R relation, so, the relation R has been added beween W and S
`Invalidity conditions:`
`IC1` W is not in relation R with the synset S

The following argumentation schemes (APK and ASK) recall the "Argument from position to know" and the "Argument from expert opinion" respectively (Walton 1996). However, ASK is pretty different from Walton's original scheme, since it can encompass not only an expert opinion, but also a source of knowledge (an article, a book, a YouTube video, etc...).

Argument from personal knowledge (APK)

`Parameters:` u, a, C
`Formulation:` The user u knows that C holds, and, from C, u derives that a holds. So, it should be the case that a.
`Invalidity conditions:`
`IC1` from the fact C we cannot know a

Argument from source of knowledge (ASK)

`Parameters:` u, a, S
`Formulation:` The user u says that, according to the source of knowledge S, it holds that a. So, it should be the case that a.
`Invalidity conditions:`
`IC1` S is not credible as a source of knowledge
`IC2` S is not relevant wrt the dialogue
`IC3` S is incoherent wrt other sources of knowledge

A dialogue protocol

In order to specify in abstract terms the possible interactions among users, we refer to the concept of *dialogue* as an ordered sequence $\langle m_1, \ldots, m_n \rangle$ where m_i is the i-th *move* in the dialogue. Each move is a triple $\langle u, a, \phi \rangle$ where: u is the user performing the move; $a \in \{claim, attack\}$ is the corresponding action, which consists either in the generation of a new argument (claim) or in the attack of an existing argument (attack); and ϕ is the argument (an instance of an argumentation scheme) the move refers to.

The dialogue protocol should enforce the requirement that users are committed to provide a justification of their positions. Therefore, from a more abstract point of view, the dialogue can be seen as a sequence of two kinds of *commitment* (Walton and Krabbe 1995): *propositional commitment* and *critique commitment*. Every propositional commitment is a move of the form $\langle u, claim, \phi \rangle$, where ϕ is an instance of AUT or AUDR. On the contrary, a *critique commitment* consists of two moves of the form $\langle v, attack, \psi \rangle$ and $\langle v, claim, \xi \rangle$ respectively. The first move represents an attack to ψ and requires that there is a previous move of the form $\langle z, claim, \psi \rangle$. The second move claims an argument ξ, which provides the justification for the attack move. A dialogue can be seen as a sequence of commitments constrained by the *dialogue protocol*, which identifies the sequence of moves that are actually allowed. More formally, we define a given dialogue $\langle m_1, \ldots, m_n \rangle$ as *correct* (i.e. allowed by the system) if $\forall i \in \{1, \ldots, n\}$ the following conditions are satisfied:

- $m_i = \langle u_i, claim, \phi_i \rangle$, where ϕ_i is an instance of AUT or AUDR; or
- $m_i = \langle u_i, claim, \phi_i \rangle$, where ϕ_i is neither an instance of AUT nor of AUDR, $m_{i-1} = \langle u_i, attack, \phi_{i-1} \rangle$ and $\phi_{i-1} \in \{\phi_j \mid 1 \leq j \leq i-2, m_j = \langle u_j, a_j, \phi_j \rangle\}$. In this case, ϕ_i is called a *counterargument* of ϕ_{i-1}.

The last condition implies that the first argument of the dialogue is either an AUT or an AUDR. However, a dialogue built from this protocol does not consider the exchange of opinions related to a single topic only (e.g. an AUT or an AUDR), rather it encompasses all the information exchanged within a community, i.e. it is a multi-topic dialogue where each topic is an AUT or an AUDR. Notice that this design choice allows reusing arguments in more than one topic.

Determining the dialogue outcome

Every time a user makes a move, the current dialogue is updated and a new argument arises. It is then necessary to determine for any inserted tag and relation whether it can be considered justified given the set of arguments constructed during the dialogue. A natural way to model a set of arguments is based on the notion of *argumentation framework* introduced in (Dung 1995), i.e. a pair $\mathrm{AF} = \langle \mathcal{A}, \rightarrow \rangle$ where $\mathcal{A}$ is a set of arguments and $\rightarrow \subseteq (\mathcal{A} \times \mathcal{A})$ is a binary *attack relation* between them. Given a correct dialogue $\langle m_1, \ldots, m_n \rangle$, we define its *associated argumentation framework* as $\langle \mathcal{A}, \rightarrow \rangle$ where $\mathcal{A} = \{\phi \mid \exists i : m_i = \langle u_i, a_i, \phi \rangle\}$ and, for any $\phi_1, \phi_2 \in \mathcal{A}$, $\phi_1 \rightarrow \phi_2$ holds if and only if ϕ_1 is a counterargument of ϕ_2.

Several *argumentation semantics* have been proposed in the literature to determine, given an argumentation framework, the set of arguments that can be considered as justified, i.e. those that are able to survive the attacks they receive (Baroni and Giacomin 2007). The most satisfactory semantics from the computational point of view is the well-known *grounded semantics*, which identifies the set of justified arguments as the least fixed point of the function $F_{\mathrm{AF}} : 2^{\mathcal{A}} \rightarrow 2^{\mathcal{A}}$ where $F_{\mathrm{AF}}(S) = \{\alpha \mid \text{if } \exists \beta \text{ such that } \beta \rightarrow \alpha \text{ then } \exists \gamma \in S \text{ such that } \gamma \rightarrow \beta\}$.

The example revisited

Referring to the running example, the first argumentation scheme is instantiated twice when John associates the sound "Seagull in Boulder" with the tags "gull" and "slaty-backed gull", giving rise to the arguments A_1=AUT(<John> <seagull> <seagull in Boulder>)[1] and A_2=AUT(<John> <slaty-backed gull> <seagull in Boulder>). The second argumentation scheme is instantiated when John selects the hyponomy relation for the tag "slaty-backed gull" giving rise to the argument A_3=AUDR(<John> <slaty-backed gull> <gull, seagull, sea gull> <hyponomy>).

Moreover, an APK argumentation scheme is instantiated when Mary expresses her disagreement, giving rise to the argument A_4=APK(<Mary> <"slaty-backed gull" tag is not related to "seagull" sound> <the slaty-backed gull is indigenous to East Asia>). Since the conclusion of this argument coincides with the invalidity condition of A_2, A_4 is a counterargument of A_2.

When John claims that Mary's critique is not correct, the system constructs the argument A_5=ASK(<John> <from the fact that the slaty-backed gull is indigenous to East Asia we cannot know that "slaty-backed gull" tag is not related to "seagull" sound> <Potential Slaty-backed Gull, 6-Mile Reservoir, Boulder County, Colorado, 11/27/08>), which represents a counterargument of A_4. Finally, the critique by Carl against John's source of information corresponds to the argument A_6=ASK(<Carl> <"Potential Slaty-backed Gull, 6-Mile Reservoir, Boulder County, Colorado, 11/27/08" is not credible as a source of knowledge> <Bird's Boulder appearance still a mystery>), which represents a counterargument of A_5.

[1]This notation considers only the parameters of the related argument scheme. For instance, A_1 should be read as: User John says that the tag "seagull" is related to the content of the sound "seagull in Boulder", so, the tag "seagull" has been added to "seagull in Boulder" sound.

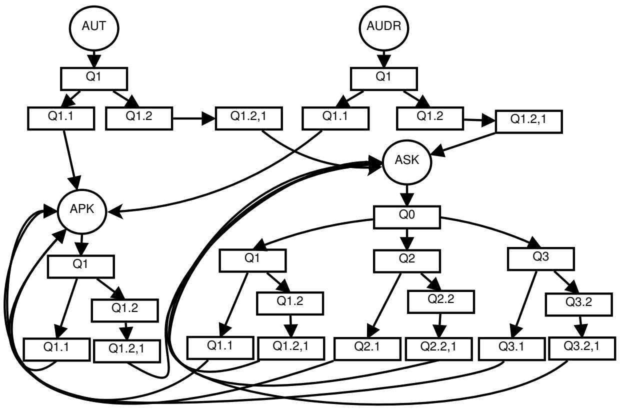

Figure 1: Question-driven interaction graph.

The running example is a dialogue that can be formalised as follows: $\langle m_1, m_2, \ldots m_9 \rangle$, where $m_1 = \langle John, claim, A_1 \rangle$, $m_2 = \langle John, claim, A_2 \rangle$, $m_3 = \langle John, claim, A_3 \rangle$, $m_4 = \langle Mary, attack, A_2 \rangle$, $m_5 = \langle Mary, claim, A_4 \rangle$, $m_6 = \langle John, attack, A_4 \rangle$, $m_7 = \langle John, claim, A_5 \rangle$, $m_8 = \langle Carl, attack, A_5 \rangle$, $m_9 = \langle Carl, claim, A_6 \rangle$.

After the first three moves by John the resulting argumentation framework is made up of the three unattacked arguments A_1, A_2, A_3, which are clearly justified. After the moves by Mary, the new argument A_4 arises, which attacks A_2. According to the grounded semantics, A_4 is justified while A_2 (as well as the supported tag "slaty-backed gull") turns out to be unjustified. The subsequent two moves by John generate a new unattacked argument A_5, which in turn attacks A_4: now the latter is not justified, therefore A_2 is reinstated. The final argumentation framework after Carl's intervention (apart from A_1 and A_3, which remain justified after all moves) is $A_6 \rightarrow A_5 \rightarrow A_4 \rightarrow A_2$, therefore A_2 and the "slaty-backed gull" tag is not accepted by the system.

From an HCI point of view, Figure 1 shows a graph that organises all the questions related with the four argumentation schemes reported in the previous section. These questions, organised in a step-by-step interaction sequence, allow investigating the reason underlying the disagreement. Circular nodes represent arguments that can be attacked; each argument can be identified by the corresponding scheme. Rectangular nodes represent the questions that are presented to the user step-by-step. From this graph it is possible to build all the possible interaction histories constituting multi-user debates in TheSilence.org based on the argumentation schemes defined until now.

A dialogue always starts when a user associates a sound with a tag or adds a relation to the controlled vocabulary. Therefore, as a consequence of these activities, the system will generate an argument corresponding either to a node AUT or AUDR in Figure 1.

When a user selects an argument to be attacked, the system presents a question to her/him, automatically obtained from the scheme of the argument itself. Given an argument with an associated invalidity condition ICi, the system will ask: “Why do you say ICi?”. For example, in our interaction scenario, when Mary selects tag “Slaty-backed gull” for inserting her critique, the system asks Mary: “Why do you say “Slaty-backed gull” tag is not related to “Seagull in Boulder” sound?”. This question corresponds to a Walton’s critical question and is referred to in the graph as the rectangular node Q1 linked to the node AUT. To provide her motivation, Mary must answer affirmatively one of the two mutually exclusive questions: “Your own justification?” (Q1.1 in the graph) or “Have you got some sort of proof?” (Q1.2 in the graph). In fact, the dialogue protocol defined in previous section prescribes that the user, while inserting her/his critique to an argument, must also state the reason for the critique. In the case at hand, Mary selects the first question; as a consequence, the system replies by showing a new screen where Mary can provide her justification: “Slaty-backed gull is indigenous to East Asia”. This justification is used to instantiate the parameter C of the argumentation scheme APK. This way, the system is able to synthesise the counterargument A_4 for the argument A_2.

In general, critiquing an argument previously claimed in the dialogue (circular node in the graph) means, for the user, to answer a sequence of questions corresponding to the rectangular nodes linked to the argument under attack. The process stops when the system reaches a circular node, namely a new argument. This new argument is in turn an instantiation of an argumentation scheme and it can be considered as a counterargument for the argument under attack.

If we keep on examining our interaction scenario, we can observe that a new counterargument A_5, attacking A_4, is generated by the system as a consequence of John answering the question “Why from the fact that Slaty-backed gull is indigenous to East Asia we cannot know that “Slaty-backed gull” tag is not related to “Seagull in Boulder” sound?”. This question (node Q1 associated with APK in the graph) is built automatically when John attacks Mary’s argument. Two further questions (Q1.1 and Q1.2) permit to investigate John’s reason for critiquing Mary’s argument. Q1.1 asks the user: “Have you got a personal motivation for thinking it?”, while Q1.2 asks: “Have you got some sort of proof?”. John answers by selecting Q1.2 (“Have you got some sort of proof?”). As a consequence, the system presents another question (Q1.2.1): “Do you know an external information source that contradicts user’s claim?”. Then John provides his proof, namely the link to an on-line video. According to the graph and to the definition of argumentation scheme ASK, this answer instantiates the parameter S of the argumentation scheme itself, thus generating the (counter)argument A_5. Finally, Carl intervenes in the debate by attacking John’s argument A_5 with A_6 that encompasses Carl’s point of view, which is supported by a source of knowledge. Since John at the end decides not to answer Carl’s counterargument, then the tag “Slaty-backed gull” is removed.

Related work

The approaches to the construction of structured knowledge from existing folksonomies or from other user-generated data are usually based on data mining techniques. For example in (San Pedro and Siersdorfer 2009), a novel methodology is proposed for automatically ranking and classifying photos according to their attractiveness for users. A training set of photos available in Flickr, which are considered more or less attractive by a community of users, is built on the basis of social feedback. This set permits to define classification and regression models based on the combination of visual features and tags, which can be used for photo search and to complement retrieval methods based on text or other (meta-)data. The approach cited above and many others (e.g. (Schmitz 2006), (Zhou et al. 2007)) use statistics of cooccurrence of tags created by distinct users. However, this makes it difficult to distinguish between popularity and generality of concepts. To cope with this drawback, Plangprasopchok and Lerman (Plangprasopchok and Lerman 2009) propose to use user-specified relations between resources for the automatic construction of folksonomies.

With respect to the literature work discussed above, our approach is more strongly based on user participation to derive structured knowledge from users’ views. To this end, beyond formalising the dialogues between users through argumentation, suitable interaction techniques have been designed to elicit and represent the arguments of a debate.

Argumentation is a natural approach to drive discussions in forums, blogs, and other Web 2.0 applications. Therefore, many proposals are emerging for enabling users to create arguments consisting of premises and conclusions and to focus on the debate visualisation problem (see for instance, (Buckingham Shum 2008)). With respect to these works, our approach does not require users to know the formal structure of arguments or to have some specific debating skills. From a more theoretical point of view, the use of argument schemes in a dialogue protocol is widely investigated in the context of legal argumentation. Indeed, (Verheij 2003) proposed a methodology for investigating argumentation schemes that have to be effectively used in a formal dialogue. This methodology is similar to ours, but we do not constrain the language in the dialogue, as required by Verheij’s approach, in order to favour acceptance by an heterogeneous wide community like the web one.

The use of argumentation theory has also been proposed for solving the problem of reconciling heterogeneous ontologies (e.g. (Laera et al. 2007)). However, in this case the argumentation activity is carried out by autonomous agents (and not by humans), which aim at finding an agreement on the semantics of the terms used during their interoperation. This approach can be adopted for example in web service retrieval, whenever an agent should find a match between the service it is looking for and the services offered by other agents. Even though the problem here addressed is slightly different from ours, the ideas presented in (Laera et al. 2007) could be integrated with our approach to better assist users during debates through automatically-generated arguments.

Finally, PARMENIDES (Atkinson, Bench-Capon, and McBurney 2006) has many similarities with our proposal.

PARMENIDES is a web application for e-democracy. It supports a democratic debate driving the users in the formulation of a critique to some starting position. The interaction is modelled according to a unique argumentation scheme and always foresees an interaction within one party (usually the Government) and one user. The dialogue always starts by a proposal of action by the Government and is carried out through a sequence of questions admitting only closed answers, from which, at the end of the interaction, the user's position can be determined. In this paper, we have extended these ideas to a Web 2.0 context, where many users may participate in a debate, and we have proposed a more articulated way to conduct the dialogues by exploiting a variety of argumentation schemes.

Conclusion

In this paper we have presented a novel approach to defeasible knowledge creation and sharing on the web. To denote a system developed according to this approach we have coined the term *demonomy*. More specifically we analysed user-oriented argumentation, which requires (i) context-dependent argument schemes, (ii) a proper dialogue protocol and (iii) formal ways to determine the outcome of the dialogue.

Demonomies evolve the idea of folksonomies, in that a folksonomy can be considered, in simple terms, as a set of *user-generated tags*, while a demonomy is actually a set of *user-agreed tags and relations*. Like folksonomies, demonomies are built bottom-up by the activities performed by users. However, the hierarchical representation structure obtained through the controlled vocabulary and the collaborative approach supported by the argumentation framework permit to create a commonly agreed knowledge reference, which can also be used in search activities.

Many future directions of this work can be envisaged. Among them, it would be useful both to implement further argumentation schemes, and to complete the existing ones with further critical questions, in order to enrich the debate possibilities. Moreover, voting mechanisms could be introduced for aggregating users' opinions, in order to assign a strength to arguments to be used in evaluating their acceptance. From an implementation point of view, this work is a preliminary survey of the necessary concepts and methodology that we will finalise in a running prototype, which will be useful to investigate the application of argumentation theory in real-world contexts and collect proper feedback about user experience.

References

Atkinson, K.; Bench-Capon, T.; and McBurney, P. 2006. Parmenides: Facilitating deliberation in democracies. *Artif. Intell. Law* 14(4):261–275.

Baroni, P., and Giacomin, M. 2007. On principle-based evaluation of extension-based argumentation semantics. *Artif. Intell.* 171(10/15):675–700.

Buckingham Shum, S. 2008. Cohere: Towards web 2.0 argumentation. In *Proc. of COMMA'08*, 97–108.

Dung, P. M. 1995. On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming, and n-person games. *Artif. Intell.* 77(2):321–357.

Fogli, D., and Giaccardi, E. 2008. Capturing and sharing sonic experiences through web-based acoustic maps. In *Proc. of DMS 2008*, 202–207.

Giaccardi, E., and Fogli, D. 2008. Affective geographies: Toward richer cartographic semantics for the geospatial web. In *Proc. of ACM AVI 2008*, 173–180.

Giaccardi, E. 2007. Cross-media interaction for the virtual museum: Reconnecting to natural heritage in boulder, colorado. In Kalay, Y.; Kvan, T.; and J., A., eds., *New Heritage: New Media and Cultural Heritage*. London, UK: Routledge. 112–131.

Gruber, T. 1995. Towards principles for the design of ontologies used for knowledge sharing. *Int. Journal of Human-Computer Studies* 43(5-6):907–928.

Laera, L.; Blacoe, I.; Tamma, V.; Payne, T.; Euzenat, J.; and Bench-Capon, T. 2007. Argumentation over ontology correspondences in mas. In *Proc. of AAMAS'07*, 1293–1300.

Miller, G. A. 2009. Wordnet - about worknet. `http://wordnet.princeton.edu/`.

Plangprasopchok, A., and Lerman, K. 2009. Constructing folksonomies from user-specified relations on flickr. In *Proc. of WWW 2009*, 781–790.

Prakken, H., and Vreeswijk, G. A. W. 2001. Logics for defeasible argumentation. In Gabbay, D. M., and Guenthner, F., eds., *Handbook of Philosophical Logic, Second Edition*. Dordrecht: Kluwer Academic Publishers.

San Pedro, J. S., and Siersdorfer, H. 2009. Ranking and classifying attractiveness of photos in folksonomies. In *Proc. of WWW 2009*, 771–780.

Schmitz, P. 2006. Inducing ontology from flickr tags. In *Proc. of the Collaborative Tagging Workshop (WWW 2006)*.

Verheij, B. 2003. Dialectical argumentation with argumentation schemes: an approach to legal logic. *Artif. Intell. Law* 11:167–195.

W3C. 2009. What is the semantic web? `http://www.w3.org/RDF/FAQ`.

Wal, T. V. 2007. Folksonomy. `http://vanderwal.net/folksonomy.html`.

Walton, D., and Krabbe, E. 1995. *Commitment in Dialogue: Basic concept of interpersonal reasoning*. Albany NY: State University of New York Press.

Walton, D. N. 1996. *Argumentation Schemes for Presumptive Reasoning*. Lawrence Erlbaum Associates.

Zhou, M.; Bao, S.; Wu, X.; and Yu, Y. 2007. An unsupervised model for exploring hierarchical semantics from social annotations. In *Proc. of ISWC/ASWC 2007*, 680–693.