

Truthfulness and Reliability in Collaborative Image Annotation

[Extended Abstract]

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1. INTRODUCTION

Interdisciplinary collaboration between computer scientists and scholars in the humanities is enabling the development of innovative digital technologies in a variety of areas. Tracing Networks is a Leverhulme-funded research project that brings together archaeologists and computer scientists to investigate networks of crafts-people and craft traditions across and beyond the Mediterranean region, between the late Bronze Age and the late classical period. In this project, we are developing new digital data management technology to help solving questions of connectivity and relatedness.

In this extended abstract, we introduce a novel collaborative framework for image annotation, which allows users to create tags that are based on a concept repository that provides a hierarchical context for them as well as extend tagging to relationships among concepts. Our framework also provides a systematic way to represent uncertainty, establish credibility as well as compute the truthfulness or reliability of statements, which are used for ranking search results.

Keywords

Image tagging, annotation, ontology, uncertainty, credibility

2. TRADITIONAL TAGGING SYSTEMS

In recent years, teams of archaeologists have gathered a massive amount of image resources. Cross-team knowledge sharing and analysis are vital for their research and being able to retrieve the right images, in the right context, and with the right level of confidence is essential.

Keyword-based tagging is the traditional way of adding searchable information to images, but there have also been some efforts centred around ontologies. In spite of their popularity, these techniques suffer from several shortcomings [2]: *Ambiguous semantics* – Different pictures may be tagged in the same way but the same tag might have different interpretations. *Describing relationships* – Tagging systems

focus mostly on objects and overlook relationships. *Automated reasoning* – Unstructured plain text tags do not support automated reasoning. *Truthfulness and reliability of statements* – Most semantic tagging applications lack the ability to describe how truthful a statement is.

The collaborative annotation framework that we are developing addresses the shortcomings highlighted above. In this extended abstract, we focus mainly on the ability to capture truthfulness and reliability of statements.

3. COLLABORATIVE IMAGE ANNOTATION AND SEARCH FRAMEWORK

Our framework is built over an *Image Annotation Ontology* [Fig.1], which functions as an abstract data model for storing tagging information. A user can link a tag to a group of predefined synonyms organised into hierarchies by hypernym in a conceptual-semantic lexical database such as WordNet. A reasoner can be used over this database to exploit implicit knowledge (for example, to understand the fact that a rider is a person).

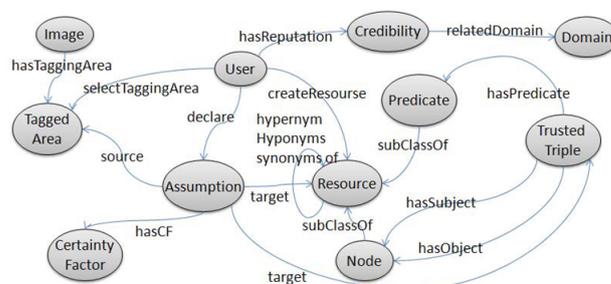


Figure 1: Image annotation ontology overview

3.1 Trusted triple graph and composite user-certainty/credibility factor

The truthfulness and reliability of a statement is determined by two factors [5]: (1) Uncertainty of the assumption given by the annotator and (2) Reputation of the annotator in a specific domain.

Triple graphs, which consists a number of subject-predicate-object triples, offer the basic data structure for storage and retrieval of ontological data. In our framework, we extend triple graphs to include a certainty factor (CF) [4] and a

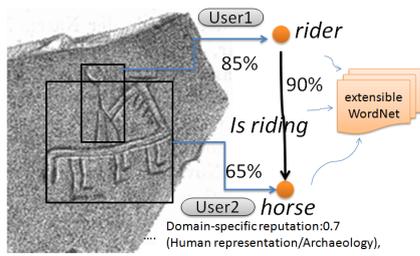


Figure 2: Fragment of an ancient ceramic vessel showing a man riding a horse.

credibility factor [1]. As in conventional image-tagging systems, the Image Annotation Ontology allows users to store information regarding a specific tagging area but, in addition, assumptions concerning a triple statement or the links between tagged areas and predefined resources can also be stored. Each assumption is associated with a certainty factor given by the annotator. Every individual user is also assigned a set of credibility values for the different domains in which they annotate images according to their expertise and reputation in that domain. We also provide a mathematical model to combine these two factors into a composite user certainty-credibility factor.

3.1.1 Uncertainty of a statement

A certainty factor (CF) [4] is a number ranging from -1.0 to 1.0 indicating how confident annotators believe a statement they make is correct. It is their own judgment of how good the evidence is. Positive certainty means that the user basically believes the assumption to be a true statement, but possibly not 100% certain. Negative certainty means a disagreement with a given assumption, though the possibility might not be ruled out. For example, in [Fig.2], if a user is not sure about what is in the picture, they can state that there is a 65% chance that the animal is a horse. If more than a user makes a judgment over the same statement, our system uses a parallel function to combine their opinions [4].

3.1.2 User credibility extraction

Secondly, our system takes into account the reputation [3] of a user in a particular domain. The expertise factor [1] defines the degree of a user's competency to provide an accurate prediction in a particular field. The reputation of an annotator is determined by several aspects. For example, we can extract the reputation of a user by looking into the statements previously made by that user. In general, (a) the more statements in the same category a user commented on, the more likely they are to have specific expertise in the field and this will increase their reputation in this category, but only if (b) the opinions the user provided reflect the truthfulness of the actual statement as measured by the similarity between their judgment and judgments made by other users. For example, in the case of Fig.2, a statement made by an archaeologist specialised in ancient human representation is more trustworthy than others in that particular domain.

3.2 Ranking

Once the search results are obtained they are ranked by the degree of truthfulness. This is calculated for every sub graph

in the result set that matched the pattern. The degree of truthfulness will then be used in the ORDER BY clause of the concrete query implementation providing a results-set with the most trusted results at the top.

4. CONCLUSION

In this abstract, we identified problems and limitations of available tagging systems and proposed a framework for image annotation and search in a collaborative environment. We developed an ontology-based data model for identifying concepts, relationships and storing context regarding users. We also briefly introduced a systematic way to represent uncertainty of a statement and user-credibility measurement; these two factors can be combined into a composite uncertainty-credibility factor, which is used for ranking the search results. A web-based prototype application has been implemented which is being used for evaluating our approach within the archaeology community. Our ultimate goal is to enhance collaboration between teams and enable future research by others. We are currently looking into several areas such as evaluating the approach with a variety of users and investigating a more complex user context to provide better context-aware search.

5. ACKNOWLEDGEMENT

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6. REFERENCES

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