Mind the Gap - Requirements for the Combination of Content and Knowledge

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Abstract— **In this short paper we report on a semantic model for content and knowledge which distinguishes between three descriptive levels: information relating directly to the resource, to the meta data of the resource, and to the subject matter addressed by the content. This model addresses five fundamental requirements for automation: formality, interoperability, multiple interpretations, contextualisation, and independence of knowledge items from the resource's content.**

Index Terms— **knowledge content objects, intelligent content models, rich media content.**

I. Introduction

Semantics – i.e. the interpretation of the content – is important to make content machine-processable and to enable the definition of tasks in workflow-environments for knowledge workers in the content industries. Some of the recent research projects in the area of semantic (or symbolic) video annotation try to derive the semantics from the videos' low level features or from other available basic metadata. Most of these approaches are – as also pointed out in [1] – not capable of fully exploiting the semantics of multimedia content because the meaning of the content is not localized just in the media that is being analysed. The construction of meaning is – for humans – an act of interpretation that has much more to do with pre-existing knowledge and the context of the user and/or the media than with recognition of the contents' low-level-features. This is known as the semantic gap [2]. Popular examples on the Web show that there are currently many service-based platforms (like Flickr[1] or LastFM[2]) that make use of their users' knowledge to understand the meaning of multimedia content.

We suggest that representing richer semantics for multimedia content requires more expressive and more sophisticated knowledge content models than those currently used. We therefore introduce a model for representing knowledge and content alongside each other, with clear separation of the content and the knowledge items, so as to obtain optimal conditions for content and knowledge reuse, and for subsequent re-contextualization of content.

II. Related Work

For a long time, combining knowledge and content did not play a great role in the research communities: On the one hand there were metadata models for content like MPEG-7 [3], and on the other hand there were domain ontologies developed by the Semantic Web community. However, in the past few years much work has been done on the specification of ontologies that aim to combine traditional multimedia description models [4], [1]. Related approaches include work from two different research communities: First there are traditional content models like MPEG-7 or MPEG-21 [5] which are coming from the multimedia community. Besides these traditional approaches some efforts in modeling of intelligent content objects exist: More recent efforts include amongst others the ACEMEDIA[3] ACE-objects [6] or the knowledge content objects (KCOs) of the METOKIS project[4].

III. Requirements for Knowledge Content

Possible relations between knowledge and content are manifold. Based on observed applications and requirements of current projects (see [7] for details) we have derived the following **requirements for knowledge content**:

1) Knowledge must be encoded using a formal language
2) Interoperability especially for cross domain aspects
3) Different interpretations of content objects
4) Link content with knowledge that cannot be directly derived from the content
5) Make knowledge independent of content

IV. KCO – a Model for Knowledge Content

KCOs are based on the DOLCE foundational ontology[5] and have so-called semantic facets that form modular entities to describe the properties of KCOs, including the raw content object or media file, metadata and knowledge specific to the content object and knowledge about the topics of the content (its meaning).

Knowledge is represented by the structure of the KCO in three different levels:

1) **Resource Level**: This level refers to the actual content object (File, stream, image, etc).
2) **Meta Level**: This level refers to knowledge describing features of the content object, eg. frame rate, compression type or colour coding scheme.
3) **Subject Matter Level**: This level comprises knowledge about the topic (subject) of the content as interpreted by an actor. The content object realizes this interpretation.

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[1] http://www.flickr.com

[2] http://www.last.fm

[3] http://www.acemedia.org

[4] http://metokis.salzburgresearch.at

[5] http://www.loa-cnr.it/DOLCE.html

In addition to this knowledge structure the KCO also defines a structure based on the different domains of the knowledge objects. This structure is divided into six so-called *facets*, each of them optimized for a specific usage. Facets include for example a content- or community description facet [8].

Relating the above description to the requirements from section III on knowledge content, we suggest that KCOs provide a good foundation for modeling combinations of content and knowledge.

1) **Knowledge must be encoded using a formal language**: KCOs are based on the information objects design pattern, which is an extension of the DOLCE foundational ontology. The main concepts and relations used in the description of the KCO are well grounded on this foundational framework. The current definition of KCOs is based on OWL-DL[6].
2) **Interoperability especially for cross domain aspects**: The facet based structure of the KCO serves as a good starting point for the alignment of standards to the KCO structure. Some of the facets and elements there use parts of different standards like NewsML[7] or MPEG-7.
3) **Different interpretations of content objects**: The possibility of different interpretations of content objects is the main reason for distinguishing between the mesta level and the subject matter level. Thus the KCO model support multiple interpretations of one content object.
4) **Clear definition of possible relations between content and knowledge**: The KCO defines two different interrelations between content and knowledge: First, knowledge objects can be about a content object, meaning that the subject matter of the knowledge object is the content object itself. Second, knowledge objects can be realized by content objects. This relation is used for all knowledge objects which are about the subject matter of the content object.
5) **Make knowledge independent of content**: This requirement is modeled by the fact that knowledge objects which belong to the subject matter level are about an arbitrary topic and only realized by the actual content.

V. Bridging the Gap

In this section we will shortly sketch how the ideas of KCOs can be applied to address the various conceptual relationships between content and knowledge in media-rich systems.

a) Search based on meta data: KCOs can be used to model complex queries: In mental models that are representing users intentions, subject matter level information about the topic of the content is often mixed up with meta level information about the content objects: By posing queries to the system, users create descriptions about topics or subjects that they are interested in.

b) Collaborative filtering: A query in that setting specifies the actual context of the actor by considering some of the concepts and relations within the knowledge space of the actor, which are typically stored in the form of user profiles containing additional knowledge about preferences of the users. This information can be used to further contextualize queries by combining the context specified by the query, with the characteristics of the user profile. Based on the active concepts and relations of the contextualized query, the system can find similar interpretations. Such a system is sensitive to different interpretations of one and the same content object, because it handles different interpretations of different users separately.

c) Context-based content classification to minimise the semantic gap: This scenario refers to the problem of how to overcome the gap between low level features and higher level semantics. It assumes that new content objects typically have to be analysed at the expense of some time and effort. The complextity of this operation can be reduced based on background information about the content or some predefined knowledge of parts of the content as knowledge about one part can help to understand other parts of the content.

VI. Conclusions and Future Work

More details about the reported work can be found in [7]. We are currently trying to apply KCOs in several national and international projects. Amongst them is the recently started IST project LIVE[8], in which we are responsible for the definition of an intelligent media framework to support broadcasters in the live staging of media events.

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