

Semantic media application with user created content to enhance enjoying cultural heritage

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Abstract. There are two important trends bringing changes and new opportunities into media consumption: the emergence of user-created content and Semantic Web technologies. In this paper we present an application that shows how these technologies can be combined to create an enjoyable media consumption experience. The application development work served also as a feasibility test of the maturity of Semantic Web technologies for media sector applications. The application contains material to the historical Ox road of Häme, and this way it also supports enjoying cultural heritage. The results indicated that users enjoyed using the application. Several ontologies were utilised, most of which were based on existing ontologies or taxonomies. With their help, it was possible to offer multiple views and exploratory routes into the available content. Further development can, among other things, be made in improving search strategies and in utilising user-created metadata for both for enriching ontologies and as an indication of user interests.

Keywords: Media consumption, User-generated content, Semantic Web, Ontologies, Metadata, User experience.

1 Introduction

Media sector is undergoing huge changes as the continuously evolving electronic media gets a stronger role in consumers' daily lives. Another important change is the more active role of media consumers. The active role does not only mean commenting and discussing the content that media companies publish but actively interacting with the content - publishing one's own content and combining self-created content with content from other sources. Neither are users satisfied only with good usability but they expect enjoyable experiences with a considerable element of play and fun.

Semantic Web is an important trend changing the Web. The vision of the Semantic Web is to make the web more intelligent. Semantic Web technologies such as

standards and tools relating to ontologies are currently being developed to reach this goal.

The work that we describe here was made in a project that wanted to research what kind of new opportunities these two trends bring to commercial media companies. In our view these trends connect to each other. Semantic Web technologies make it possible to make more enjoyable media content experiences because applications can be made more intelligent, and this way they require less effort from the users. The research approach of the project was prototyping, and a prototype application called StorySlotMachine was developed. The application helps people in choosing a travel destination by letting them explore background information relating to sights. They can also combine different media objects - both their own and others' - into presentations. The assembled material can be taken along to enrich the actual visit. The aim was to make an application that offers interactivity opportunities for the active users, but also gives an enjoyable user experience for the less active ones. All this should be built utilising rich metadata and Semantic Web technologies to test their applicability.

2 User scenario

Our initial use scenario was inspired by a slot machine analogy: users are presented with some content in the topic of their interest, and if they are not happy with the results, they can try their luck again. An underlying assumption was that if a person does not know so much about a topic, exploring and browsing a media object collection is more pleasant than making explicit searches. Also, the results should not be shown as a typical list of items as usual in search engines, but as a page or collection where different elements like images, videos and texts may be seen.

The presented material may then be taken as a starting point to explore the topic more, a bit like with a slot machine, where some of the items may be locked and some redrawn to improve the result. The most active users may explore the topic from many different points of view whereas the less active ones are satisfied with what is initially shown them. This way both the more and less active users are taken into consideration.

Our scenario also includes the opportunity to store the presentation and show it to other people, because an important feature that many people appreciate is the opportunity to get feedback from other users. Other opportunities for utilising presentations are either exporting it into a personal device or printing the content. Different templates may be offered to take into consideration, which media elements are emphasised and for which device the presentation is generated for. If allowed by the original creator, other users may utilise these presentations and their components in their own ones.

We chose location related content for our pilot application with the emphasis on travelling. When preparing for a trip, people often are interested in exploring content to find out about their destination. During a trip, people take photos and videos, which can be used together with content from other sources.

The use scenario can be divided into three separate cases: before, during and after the trip. Before the trip the user can familiarise with potential destinations and their sights to find out more about them. The material can be browsed theme wise, and the user can select and combine the most relevant items into a collection that can be viewed either on the web or printed to be taken along for the trip. After the trip, the user makes his own travel story either utilising his or her own material or by combining it with the material of fellow users or the content that the media company provides. Also after the trip, the user may make theme stories like before the trip as well as also normal word based searches. The users are encouraged to add metadata in the form of keywords or tags, which are utilised to propose additional material. The users may choose any words to describe their content or choose from the ones that the system offers based on relevant ontologies.

3 User interfaces

This chapter presents screen shots of the user interfaces and describes their functionality. More detailed descriptions of the implementation and utilisation of underlying ontologies are described in chapter “Ontologies”.

The first step is to select the places of interest from the map or list. The demonstration target area is the Ox road of Häme, a historical route between Hämeenlinna and Turku (<http://www.harkatie.net/english/index.html>) in the South of Finland. After selecting a place, the user is shown a list of the sights located there.

The user can sort the sights by history, nature and culture, read short descriptions of them, view both commercial and user imported pictures and add the sights he or she finds most interesting into a personal item list (See Fig 1).

The user can search background information of the selected sights as theme stories. A theme story is a collection of media content from some point of view. Our theme stories are “Life now and then”, “Life stories”, “Nature and animals”, “Historical events”, “Fairytale and stories”, “Wars”, and “Art and culture”. Some of the themes are divided into sub themes. For example, historical events are divided according to historical periods. Only those categories that have some content are shown to the user. The user can play with the content: View commercial and user-created pictures and videos, and view and build theme stories. The user may include theme stories into the travel plan to be created for the trip, as well as photos and descriptions of the chosen sights. The travel plan is available as a slide show and as a web page suitable for printing. (See Fig 2 and 3)

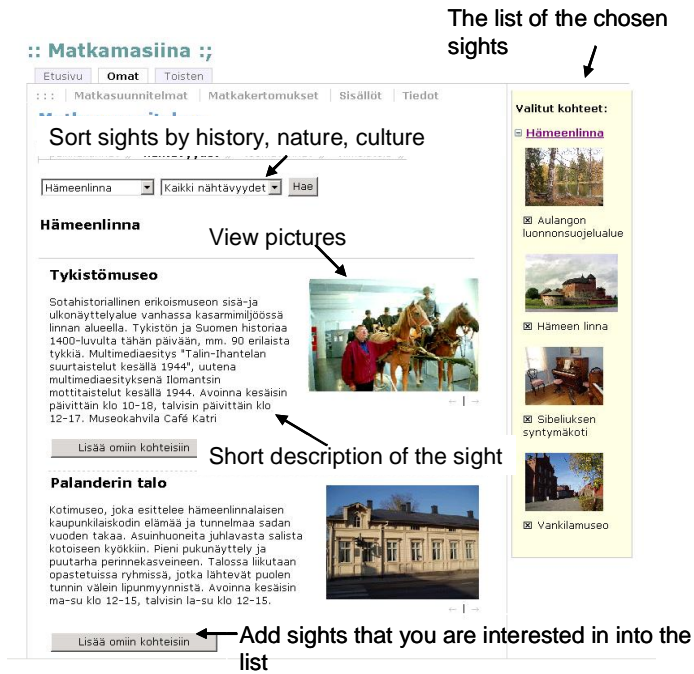


Figure 1. Choosing sights to visit.



Figure 2. Making theme stories to get background information relating to the selected sight.

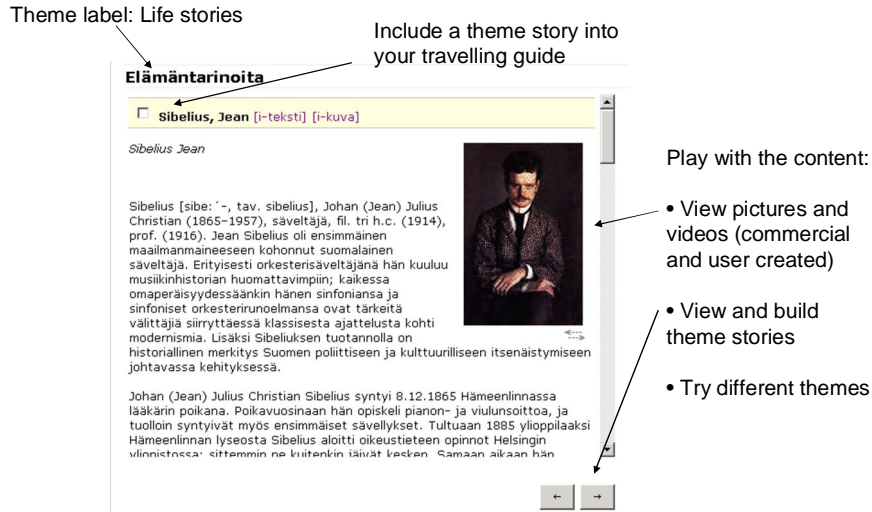


Figure 3. An example of a theme story.

After the trip, the user may create his or her own travel story by utilising his/her own material and the materials in the system. Photos can be uploaded after selecting the visited sights. As part of the uploading process, the user determines whether the photos can be viewed by other users, and accepts the licensing terms.

After uploading the content, the user is asked to add some metadata. As the first step, the photos are connected to the sights by dragging and dropping them to the correct sight. After that, additional metadata can be given in the form of keywords or tags and by indicating the genre of the photo (See Fig. 4). The keywords can be written freely or the user may utilise those that are suggested by the system based on relevant ontologies. The user may also add free text to their photos and change the visibility of the photos to other users.

Users are offered commercial and other users' content, which they can combine with their own (See Fig. 5). There are several ways to search for additional content. The user can browse through the available photos, videos and texts. Content can also be searched with the help of tags, both user's own tags and those suggested by the application based on ontologies, or by making a traditional free text search. The travel story is created automatically out of the content selected by the user. It can be viewed as a slide show or as a web page suitable for printing.

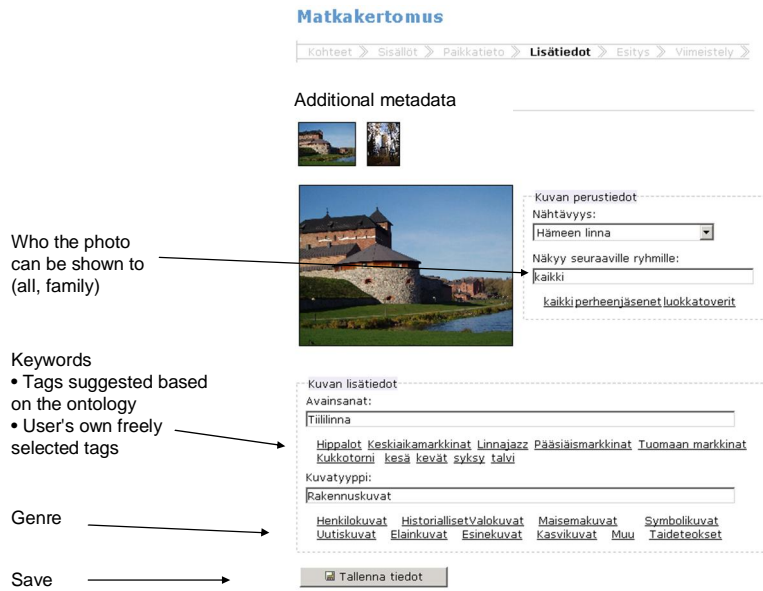


Figure 4. Adding metadata.

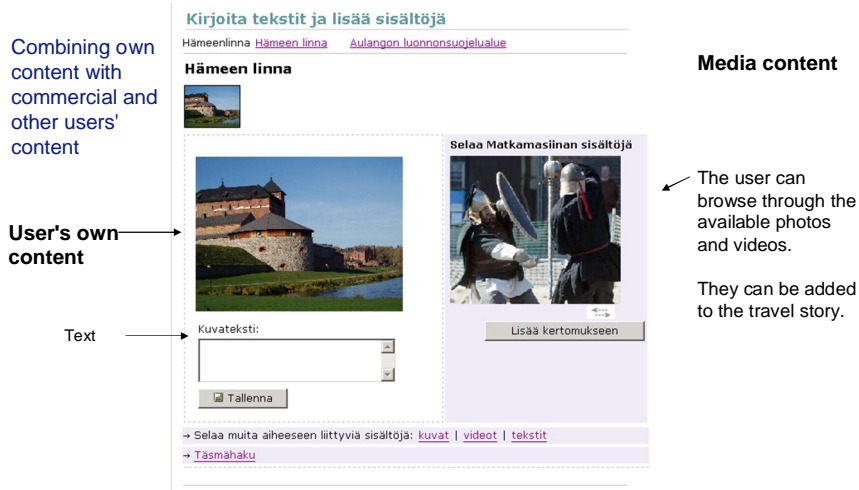


Figure 5. Combining user-created content with commercial and other users' content. Additional content can be searched by browsing available photos and videos and by media types or tags.

4 Content

Different types of media content, such as facts, stories, and news, are needed in order to be able to create versatile travel plans, theme stories and travel stories. Media content that is directly related to the target area is preferred, but also more general information is usable. A mixture of videos, photos, sounds and texts makes the presentations more appealing and interesting.

The commercial media content of the pilot application consists of newspaper and encyclopaedia articles with images, articles from the Häme Ox road magazines, stories out of a book called "Hämeen Härkätiellä", and photos from the Häme Ox road website. In addition to the commercial content, the application has user-created photos. The content is mostly general background information and not specific travel information like opening hours or prices.

This mixture of content and media formats meant that it was necessary to work with several metadata vocabularies. Different vocabularies are used to describe newspaper, magazine and encyclopaedia articles as well as short stories and users' own content. Also different media formats (text, photos, and videos) have different needs and vocabularies for metadata.

5 Ontologies

5.1 The role of ontologies

The prototype utilises a number of ontologies, each of which captures knowledge of some area that is necessary to fulfil the required functionality. Ontologies are utilised when selecting content and also to produce some basic information to show to the users. The ontologies are also utilised when users add metadata to their own content as suggestions to keywords.

The *Target ontology* describes the knowledge related to places, routes and sights and contains information that has relevance to them such as persons, events, objects and nature.

The *Media ontology* describes the media content. Relevant elements were selected out of the Dublin Core (DC) and IPTC Newscode vocabularies. The Media ontology includes the typical metadata fields, such as title, creator, publisher, date, media type, genre, scene, but also relations to the Time and Target ontologies, for example relations to persons, sights, places, routes, events, objects, animals or plants. The subject of media content is described with the YSA-ontology (a general-purpose thesaurus in Finnish) whenever possible, but some content also with IPTC (news articles) and Facta - ontologies (encyclopaedia articles).

The *Presentation ontology* contains the information on themes and their subcategories and what kind of content (subject, genre, scene, time) that is related to the selected sight is searched for presentations. There are themes like "Life now and then", "Life stories", "Nature and animals", "Historical events", "Fairytales and stories", "Wars", and "Art and culture".

An ontology based on YSA (a general-purpose thesaurus in Finnish), is utilised as a kind of *upper ontology* for classifying the knowledge. Target, Media and Presentation ontologies are connected to each other via the concepts of the upper YSA-ontology. The YSA-ontology was created only to a limited extent because the idea is to replace it with YSO (Finnish General Ontology), which was under development and not yet available during the time when the application was made.

The *Time ontology* defines a taxonomy of time eras and periods by time intervals, and it is based on the ontology developed in the MuseumFinland project (<http://museosuomi.cs.helsinki.fi/>). We added some time periods relating to the Finnish history as well as the seasons.

The subject of the media content is determined differently for different content types: IPTC ontology is used to determine the subject of newspaper articles. The ontology is based on IPTC ontology (<http://nets.i.uam.es/neptuno/iptc/>) that was developed in the Neptuno-project. The content of encyclopaedia uses its own taxonomy (Facta ontology). YSA-ontology is usable as a general subject ontology.

5.2 Searching content for theme stories

Theme stories consist of elements like a title, text, image and fact box, and they are selected on the fly based on the knowledge in the ontologies. The fact box shows information retrieved out of the ontology. It may contain knowledge about how events, like a war, are related to the sight or basic information about a person who has a connection to the sight. Sometimes the user may wonder why a certain article was shown, and the role of the fact box is to give some indication about the connection.

Media content is not linked directly to the various themes. The knowledge in the Target ontology and the search rules are utilised in searching and offering relevant media content. The search rules are determined with the Presentation ontology, Java application and SPARQL queries. The criteria for how the media content is connected to a theme, such as the subject, genre or time, are determined in the Presentation ontology. The advantage is that the search criteria are not hidden inside the Java code, but that they can be changed by modifying the instances of the ontology. Also, themes may be created, changed or deleted by modifying the ontology classes or their instances.

The Java application creates SPARQL queries for searching relevant media content based on the knowledge in the Presentation ontology. Searches utilise the knowledge in the Target ontology (e.g. Life stories -> persons related to the sight) and/or subjects related to themes (e.g. Every day life now and before -> food, professions, clothing etc. or Wars ->Great Northern War, World War I &II etc.). In addition to that, some restrictions may be used, like time (e.g. Historical events), genre (e.g. Stories and fairy tails), place or sight.

The subjects of the different themes are determined as relations to the YSA ontology. Also the subjects of the IPTC and Facta ontologies are connected to themes. Media content that is related to same subjects is searched for. If content that is described with some other ontology were brought into the system, the subjects of this new ontology would need to be connected to the existing themes.

5.3 Adding metadata to user generated content

Users can add metadata to their own content. Users are free to use any words they want to describe their content, but by utilising the available contextual information and the Target ontology, keywords are suggested. These suggestions relate to yearly events, objects, terms, other related sights and seasons. Using these terms has been made easy - it is enough to click a word, and no writing is needed. This way users are encouraged to utilise these words, which can then be used to suggest additional relevant content from the system.

In similar manner, users are encouraged to add keywords relating to the genre based on the knowledge in the Media ontology. Genres have been defined for all media types but only image genres are currently utilised. The genre information is useful when the user generated media objects are utilised by future users.

5.4 Searching commercial content to complement user's own content

Offering media content to complement user's own content is based on the metadata given by the user at importing and the knowledge of the Target ontology. First, the media content that is related directly to the sight is searched. After that, more general media content relating to events, persons and places is searched for. The relevance of the media content is determined with the help of the search order starting with from exact searches and then proceeding to more general searches.

Additional content can be searched with the help of tags. The tags suggested by the ontology may also be related persons or events in addition to tags relating to yearly events, objects, terms, other sights relating to sight and seasons. Already existing theme stories made by earlier users might be an additional way to search information also when creating one's own travel story. Theme stories give ready-made text and image/video combinations that can easily be added to a new travel story.

6. Results

6.1 User tests

The application was tested with users in two phases. In the first test, user needs and expectations were studied using artefact interviews, observation, collages and prototype tests. The test group consisted of 33 schoolchildren (12-18 years old) and 4 teachers. The user research was carried out in the context of real school excursions. The second test was made with the same group but with a smaller number of participants at the end of the project when the application was functional, and after they had made a trip to the Häme Ox road.

Following requirements for the system were found as the result of the first user test. The application should:

§ arouse interest and offer necessary facts before the trip,

- § enable experiencing the stories during the trip,
- § give additional information about the themes studied on the trip, as well as the themes about which no information was available on the trip,
- § support creating a personalised travel story and
- § enable rich metadata about pictures, such as memories and feelings, as well as comments and hints for other travellers.

After the first user tests the prototype was developed further and tested with users again. Using the StorySlotMachine was found to be more pleasant than traditional search machines, because the relevant content could be found easily as stories. Adding metadata into own pictures was intuitive and did not burden the users.

In the first tests the users found the user interface somewhat confusing, because the prototype did not yet have all of its functionality. The idea of mixing own and media content did not become clear to everyone. In addition, media contents were not presented attractively enough to rouse the interest of users.

In the second tests user attitudes towards the functional StorySlotMachine were very positive. The system was found useful, quick and easy to use. Images were the most interesting part of the content and the users were eager to write short descriptions to their own photos. Other users' pictures were found interesting, as well.

Some users wanted to create their travel story quickly, whereas others were ready to use a lot of time to finish their stories. Interestingly, StorySlotMachine was found to be suitable for both these user groups. All of participants of the last test said that they would like to use the system again. Summary of user experiences can be seen in Figure 6, and the complete report of the first user tests in [1].

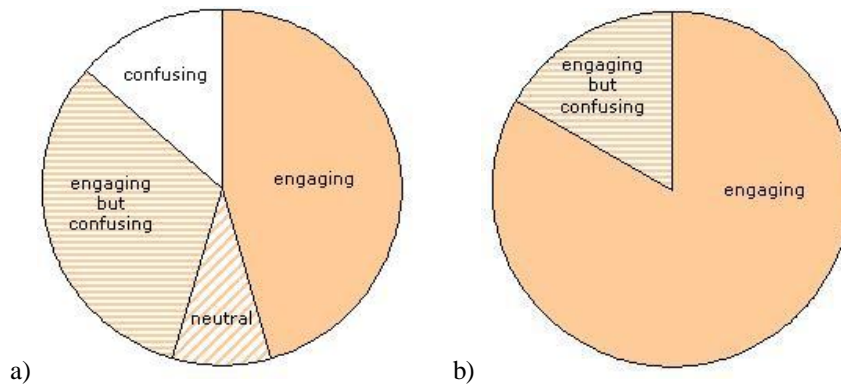


Figure 6. User experiences of the system. a) after the first user test (N=22), b) after the second user test (N=6)

6.2 Ontologies and implementation

Creating, updating and managing ontologies are not easy tasks, but there are clear benefits in this type of an application:

- Ontologies make it possible to search content from multiple directions (sights, events, persons etc.).
- Also general media content can be utilised.
- It is possible to make different thematic presentations or views for people with different interests
 - For example, one user might be interested in the historical places and events of the Ox road during the 19th century and another is only in churches during the trip. They can easily be served with this kind of an application.
 - Ontologies contain knowledge that makes it possible to create visualisations such as timelines, cause-effect diagrams, dialogues, trees, and maps of related resources.
- Ontologies support generating aggregations automatically.
- The benefits of being able to link the content automatically into different themes become significant as the number of content items increases and grows continuously.

There already are usable tools for developing semantic web applications, but currently many tools only have a partial support for the specifications. There is room and need for further development to make the implementation and management of Semantic Web applications easier.

Theme stories were the most central part of the application for ontology deployment. Theme stories could be easily generated for sights with a long history, but not so smaller sights. Theme stories should rather be offered at higher level like for a town or a village or as in our case, for the whole historical route, than for a single sight.

There were challenges in creating general search rules for the themes. Every theme had unique requirements and complicated the Presentation ontology. Some examples are listed below:

- "Every day life now and before" has subcategories weekday, celebration and society. Subjects like food, professions, clothing, inhabitation, celebrations, laws, and source of livelihood relate to this theme. These determines the main framework for searching, but to get more relevant content also the time periods and the type of the sight should be determined to find relevant content for a particular sight.
- "Arts and culture" is divided into the following subcategories: persons, art and buildings, and environment. When searching for content for the subcategory 'Persons' it is required to find persons who have a connection to the sight and have or had a profession relating to art and culture, such as composer, writer, painter, or architect.
- "Historical events" are divided into historical periods, and time restrictions are needed in searches. There are several ways to do this: search the media

content that relates to the time and the sight/place, utilise terms that describe the time period or events that happened during that time.

- In the theme "Stories and fairy tails" the genre is used to restrict the content selection.

When making ontology-based searches, several search criteria can be used and their priority order must be determined. Here, it is important to find the correct balance between the number of different search criteria to use and the speed of the application. First, the most relevant content is searched and after that, the search can be expanded to more general material. The challenge is to know how deep the searches should navigate into the net of relations of the ontology and still find content that is relevant to the user. We encountered this problem both when making theme stories and searching for additional content to complement users' own content.

When the application has more content, this will probably be less of a problem, and the challenge is the ordering or grouping of the relevant media objects in an interesting way. One of the challenges is to inform user of why certain content is offered to her/him in this context. For example, pictures of historical persons might be confusing, if user does not know who the person is and how he/she is relating to the sight. In connection to the theme stories, a fact box was used to give some indication about the connection by utilising the knowledge in the ontology, and a similar approach should be used elsewhere in the application.

The implementation uses an upper ontology that can be replaced with another one, if needed. This gives flexibility to the application development. We turned selected parts of YSA (a general-purpose thesaurus in Finnish) into an ontology, and used it as our upper ontology. There is currently a project in Finland making a comprehensive ontology out of the YSA, and it should be used also here when it becomes available.

7 Related work

The key idea in the StorySlotMachine is to aggregate content in a way that let users explore the content in an enjoyable manner. Related work is being done in the various areas. The first distinction can be made between the aggregation level: is the aim a single story to be created of out the available content, or a collection of independent resources. Geurts et al. [2] and the Artequakt [3] project work at the first area. Our work is more related to creating a collection out of independent resources and turning them into presentations. However, we let users combine images and texts in new ways and we do not aim at producing one collection for the user to view but a starting point for further exploration with the content. Geurst et al. [2] describe the system where the knowledge of ontologies is used to create multimedia presentations like artists bibliographies. Presentations vary based on the genre (e.g. Biography and CV) and output format that can be selected by the user. The basic idea of their discourse ontology is same than our presentation ontology. The ontologies define rules for searching content. They have different genres, whereas we have themes. Our themes use more versatile data than what is needed for artists' bibliographies and we also

have more general content which complicated the ontologies and rules. One difference is that they focus more on ready-made multimedia presentations, which contain parts (e.g. address, private life, career) that are determined in the discourse ontology.

Our work is more related to creating a collection out of independent resources and turning them into presentations. However, we let users combine images and texts in new ways and we do not aim at producing one collection for the user to view but a starting point for further exploration with the content.

Mc Schraefel et al [4] have developed an open source framework called mSpace, which is available at mspace.sourceforge.net. The starting point for the mSpace development as well as for our StorySlotMachine is same: to offer an exploratory access to content. The user should be able to browse content according to their interests and associations, to leave tracks on the way by storing the most interesting items, and to get multimedia as a result rather than links to resources.

mSpace is based on the idea of associative exploration of the content and user-defined and manipulated hierarchies. mSpace let the user explore the material with the help of hierarchical columns and the selection in the first column constrains the selections of the following column. Users can arrange columns according to their preferences and also add or remove dimensions.

mSpace provides preview cues (for example audio clips) of some representative example in the various dimensions help exploring and deciding whether an area is interesting. This way users may find new interesting areas without prior know of them. mSpace also has info views to show related information like for example a description of a composer. Interesting items may be stored in favourites for future reference.

The preview cues in mSpace have the same aim as the themes in the StorySlotMachine: to give users ideas and hints as to what kind of content is available relating to a topic.

An interesting feature of mSpace is to let users sort and swap dimensions according to their interests. In the current StorySlotMachine version, the users are tied to pre-made themes, but one idea for future development is to let users create new themes with the help of the tags they have used.

One difference between the StorySlotMachine and mSpace is that the StorySlotMachine offer users the possibility to make exportable packages out of the content and also utilise their own content. The mSpace user interface is more formal in style than in the StorySlotMachine, where emphasis has been put to offering a user interface with the element of play.

The Bletchly Park Text application developed for the Bletchly Park Museum by Knowledge Media Institute [5] concentrates on post-visitors of museum. During their visit, people may express their interest by sending text (SMS) messages containing suggested keywords relating to displayed objects. After the visit, they can get a collection of content relating to the selected keywords as a personalised web site. The content can be explored and a number of different views on the collection are provided.

Bletchly Park Text application is made for a specific museum and its specific content. In the StorySlotMachine application, we have several places and sights, and the material is general by nature, since one of the major goals of our project was to

study how the general media content can be utilised in new ways with the help of semantic metadata. Both Blentchly Park Text application and the StorySlotMachine share the similar ideas of using the application for learning, but the Blentchly Park Text does not include utilising users' own material like we do.

8 Future work

There are several opportunities for utilising and developing the StorySlotMachine application further. The StorySlotMachine application can be used as a platform to test user expectations and experiences of mixing and playing with media content, and sharing one's own content with other users' content more extensively. For additional testing more content should be added, and the conversion of metadata into RDF format should be made automatically.

The application could be developed into a commercial travel application or a learning application, e.g. for teaching history. For the travel application, some additional features are needed, like exact travel information (opening hours, prices), maps and mobile user interface, and collecting feedback and recommendations from users. Also new features like collaborative storytelling e.g. creating one travel story from the contents of all group members, and real time travel story that is continuously updated with topical information, could be added.

Similar applications could be built relating to other topics such as hobbies or collecting gathering personal memories from past. A new Target ontology may be needed for a new application, if it does not make sense to expand the existing one. The search criteria are not hidden inside the Java code, but they can be changed by changing the instances of the ontology, which makes it easy to develop the current application and to adapt it to new areas. Also, themes may be created, changed or deleted by changing the classes of ontology or its instances.

There is always room for improving the search criteria with help of the Presentation ontology, or even a general tool for automatic generation of theme stories could be created. In the future, SWRL (Semantic Web Rule Language) may be the solution to use.

Creation of different theme stories in StorySlotMachine is based on associations that are inferred automatically by utilising the knowledge in the ontologies. For example, a theme story may tell about a war that relates to a sight and story may include important historical persons. New theme stories are offered based on these relations and other theme story may tell more about the person. Now this is made by the system, as our guiding idea was to give the users the opportunity to try their luck and get surprised, but as an alternative, users could be given the opportunity to guide the process based on their own associations.

Automatic methods for creating metadata and converting it into RDF format were not addressed in this project, but they are important when existing media archives are utilised in semantic applications. Additionally, users should be utilised as metadata creators, where possible.

There are many opportunities to develop the searches and the ways that search results are ordered for presentation. Scene and genre information could be used for

ordering images. Images from outside and inside a building, and general images and detailed close-ups could be alternated. New ways grouping media objects could be developed in addition to the current location-based presentation.

User generated metadata could be utilised more extensively. The words that people use to describe their content could be stored in case they are not found in the ontologies, and they could be offered to future users visiting the same sight. In the current system, users can add tags only to describe their content, but tags could be utilised more widely, for example, to describe media content, travel plans, and sights. If we had mechanisms to combine tags with more formal semantics and to analyse the reliability of user generated knowledge, this could be one way of adding knowledge into the ontologies.

To summarise, we can conclude that the application lets users explore and combine various types of media content, as well as virtual and real life experiences. Utilising ontologies helps in making the application more intelligent and gives opportunities to offering enjoyable user experiences.

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