

# Describing and Linking Cultural Semantic Content by Using Situations and Actions

Miikka Junnila

\*Semantic Computing Research Group  
Helsinki Institute for Information Technology (HIIT)  
University of Helsinki  
<http://www.seco.tkk.fi>  
[miikka.junnila@uiah.fi](mailto:miikka.junnila@uiah.fi)

Eero Hyvönen

†Semantic Computing Research Group  
Helsinki University of Technology (TKK)  
University of Helsinki  
<http://www.seco.tkk.fi/>  
[eero.hyvonen@tkk.fi](mailto:eero.hyvonen@tkk.fi)

Mirva Salminen

‡Semantic Computing Research Group  
Helsinki Institute for Information Technology (HIIT)  
University of Helsinki  
<http://www.seco.tkk.fi/>  
[mirva@pieni.net](mailto:mirva@pieni.net)

## Abstract

Ontologies have been used to describe cultural objects, such as artifacts, by their physical or media specific properties, or by the life cycle of the objects in collections. In contrast, this paper discusses the problem of creating ontological descriptions that allow describing different kinds of cultural content through the situations and actions that take place in the real world. This point of view is important when semantic metadata is used as a basis for creating intelligent, educational, and entertaining linking of content on the semantic web. The idea is addressed not only in theory but by presenting the first prototype implementation of a cross-domain semantic portal “CultureSampo—Finnish Culture on the Semantic Web”. This system is able to automatically link together different kind of cultural resources in meaningful ways with explanations. The content types considered include paintings, artifacts, photographs, videos, cultural processes, and stories .

## 1 Introduction

This paper investigates possibilities of exploiting semantic cultural metadata in creating intelligent portals. The research is a continuation of the work behind the semantic portal MuseumFinland<sup>1</sup> (Hyvönen et al., 2005a). This work showed that, based on ontologies and associated metadata, semantic search and browsing can be supported to enhance end-user services. The content in MuseumFinland was homogenous in the sense that only artifact metadata conforming to a shared metadata schema and ontologies was used. In this paper the main research problem is to create an ontology that can be used to describe many kinds of cultural resources, so that they can still be searched with a unified logic and be linked together semantically in insightful ways.

We chose processes and actions (events) to be the basis of our ontology. In the context of cultural re-

sources, this proved out to be a fruitful starting point. Many cultural objects of interest, such as paintings, stories, and artifacts have a connection to the processes of human life and the actions of people.

To get a concrete grip of the problems involved, we created the first prototype I of the portal “CultureSampo—Finnish Culture on the Semantic Web” system in 2005. This paper documents and summarizes experiences and lessons learned in this work documented in more detail in (Junnila, 2006; Salminen, 2006). The vision and some other results of the CultureSampo project in the larger perspective 2005-2007, including a later prototype CultureSampo II, is described in (Hyvönen et al., 2006). “Sampo” is a machine that fulfills all the needs of people in the Finnish mythology. We try to fulfill the needs of people interested in getting a good picture of Finnish culture through the semantic web.

The CultureSampo I prototype was built on top of the MuseumFinland architecture and tools (Mäkelä et al., 2004; Viljanen et al., 2006; Mäkelä et al.,

<sup>1</sup>This application is operational at <http://www.museosuomi.fi> with an English tutorial.

2006). The system is based on metadata of different kind of cultural objects, such as process descriptions, mythic poems, paintings, old photos, artifacts, and educational videos about Finnish culture. These resources have been described with matching metadata schemas and shared ontologies, which enables semantic search and browsing. We introduced a new type of metadata for describing actions and situations that relate cultural objects with each other. The main goal of this paper is to investigate, how such descriptions can be used to bring the cultural context closer to the people looking for information in cultural semantic portals.

## 2 Describing the Cultural Context of Resources

The motivation for describing cultural resources semantically is to make it easier to search for and automatically link culturally related things together. The more information there is on the semantic web, the more interesting and useful it can be to people. A prerequisite of this is that the information is easy to find, and that the cross-links from resource to resource are really semantically insightful and support the user in finding the right information and connections.

### 2.1 Towards Event-based Content Descriptions

Information that connects to other information is easier to grasp, as for example constructivist learning theories show (Holmes et al., 2001). In fact, many philosophers from Aristotle to Locke and Hume have stated that all knowledge is actually in the form of associations (Eysenc and Keane, 2002). All this leads us to observe the fact that links can be very useful for a person looking for information about a particular subject.

In our work, actions and processes in the real life and fiction were chosen as the key enabler for connecting different resources semantically. There were two major reasons for this. Firstly, actions and processes connect to many kinds of different resources. Human culture is much about action, about people doing things. People looking for information are also likely to be interested in the theme of action. Actions and processes often tell us more about the life around cultural objects than other points of view. Life, stories, and emotions are things that everyone can easily connect to and are interesting for the end-user. People with varying specific needs are surely interested

in other points of view, too, but generally speaking actions are foundational in structuring our knowledge about the world. As a result, event-based representation have been widely developed and applied in the fields of artificial intelligence and knowledge representation (Sowa, 2000). CultureSampo builds upon this research tradition and ideas developed within semantic web research.

The second reason for using actions and processes is that the information about processes themselves is very important to preserve. For example, information about cultural processes, such as “how to farm land with the traditional slash burn method procedure”, are important to preserve. By linking other resources through action, the processes themselves are researched and the old know-how preserved in digital format for future generations (Kettula, 2005).

Let us take an example of cultural resources and their connection to each other through their cultural context and actions. Consider a painting depicting people and burning trees. We know that the picture is a part of an old cultural process, slash and burn, where trees are cut down and burned to make the soil richer for nutrition of the crop. There is also a poem in the national Kalevala epic<sup>2</sup>, where Kullervo, a tragic hero, is forced to cut down trees in the slash and burn process, but he ends up with cursing the whole forest. An axe displayed in the National Museum of Finland has been used in western Finland for slash and burn, and there may be other related tools, too. We also have some photos of people doing slash and burn, and an educational video about the subject. All these things can be linked together in insightful ways, if they have been annotated with metadata that tells about what is happening during the slash and burn procedure.

To accomplish the needed semantic annotations, we defined a set of domain and annotation ontologies. We then selected a representative set of heterogeneous cultural contents of different kinds and annotated them with metadata conforming to the designed ontologies and annotation schemas. The result was a knowledge base in RDF(S)<sup>3</sup>, that was homogenized based on the shared action-based knowledge representation scheme of the real world. After this, the view-based semantic search engine and logical recommender system of MUSEUMFINLAND was adapted and applied to the new content set, resulting in the prototype portal CultureSampo I.

<sup>2</sup><http://www.finlit.fi/kalevala/index.php?m=163&l=2>

<sup>3</sup><http://www.w3.org/2001/sw/>

## 2.2 Stories as Processes

In addition to describing general process types, we wanted to be able to describe specific process instances, i.e., situations where something actually happens. This leads us to a very classic content medium and type: stories. As processes are chains of actions, where something is done, leading to another action, and so on, stories are the same in many ways. Stories can bring separate facts into life and place in the right contexts for the end-user, and in this way give a better view to the culture that the resources are describing. Furthermore, many cultural content objects, such as historical events and biographies, are actually stories and often relate to other stories.

People want to hear stories (Kelly, 1999): they are an ancient method of spending time, educating and having fun. Stories bring new points of view to the process descriptions, which are on a general level. As Aristotle states in *Poetics* (Aristotle, 2006), drama is about action. This suggests that describing actions is a good way to describe drama. A process description just needs less information, as it is less precise. For a process description, it may be enough to tell what is done and in what order. A story needs additional information. For example, it may be important to know who does what, what are the relations between the actors, and what goes possibly wrong. Based on this, stories can be seen as a kind of subclass of processes, that need more information and give a richer and more specific description of a situation or happening.

Our main motivation to describe stories with metadata is not to represent the stories, but only to make the actual stories better accessible through better search and links from related resources. A story may be in textual form or maybe depicted in a painting, a photo or a video. The stories lose much in content when they are reduced to metadata, but since the story resources themselves can be put on the semantic web, people searching for stories will find and experience the real stories.

## 3 The Ontologies

Three ontologies were used to create the action-based metadata for the resources. First, a situation ontology was created in order to define how to describe one situation or moment, the smallest unit of a process or a story. Second, a process ontology was designed. It was used to put the moments in the right order in relation to each other: what is done first, what follows and so on. The third ontology was the content defi-

nition ontology, that included the concepts of the real world, so that reasoning could be made also based on the things that appear in the situations. For example, an axe is used in the slash and burn method, so the axe has its own place in the content definition ontology, as a subclass of tools. Also the actions, the verbs, and their relations to each other are an important part of the content definition ontology.

In the following, these three ontologies will next be discussed in some more detail. We concentrate on the situation ontology that was the main focus of the research.

### 3.1 The Situation Ontology

The situation ontology (cf. figure 1) is used to describe moments, where someone does something. It is actually not much of an ontology in the sense of a hierarchical network, but more of a metadata schema implemented with semantic web technology. The idea is to use instantiated situations for semantic browsing and search.

A *situation*, as defined in the situation ontology, is the moment starting with someone starting doing something, and it ends when the action ends, and another begins, or there is a jump in time or space. These situations can be anywhere: in a process, a story, a painting, a video or in anything else that represents a situation. There is an *actor* who does an *action*. In the same situation, the actor can have other actions going on too, and there can be other actors present, doing their actions. Apart from the actor and the action (that together form an *event*) there is also the surroundings, which consists of absolute and relative *time* and *place*, and possibly other *elements* of the situation. Also the *mood* and *theme* of the situation can be annotated.

When using the situation ontology, the philosophy is to leave the properties open if they don't exist or one doesn't know them. The ontology is meant mostly to be used for creating links and for helping in search.

Culture, for example art, is often much about interpretations (Holly, 1984). This means that when bringing culture resources available to people on the semantic web, interpretations cannot be left out of the system. For example, consider the painting "Kullervo departs for the war" in figure 2 depicting an event in Kalevala. In this case the interpretation that the painting is in particular about Kullervo (and not about some unknown man) departing for the war in Kalevala in order to take revenge on his enemies is of importance. Therefore we have made it possible to dis-

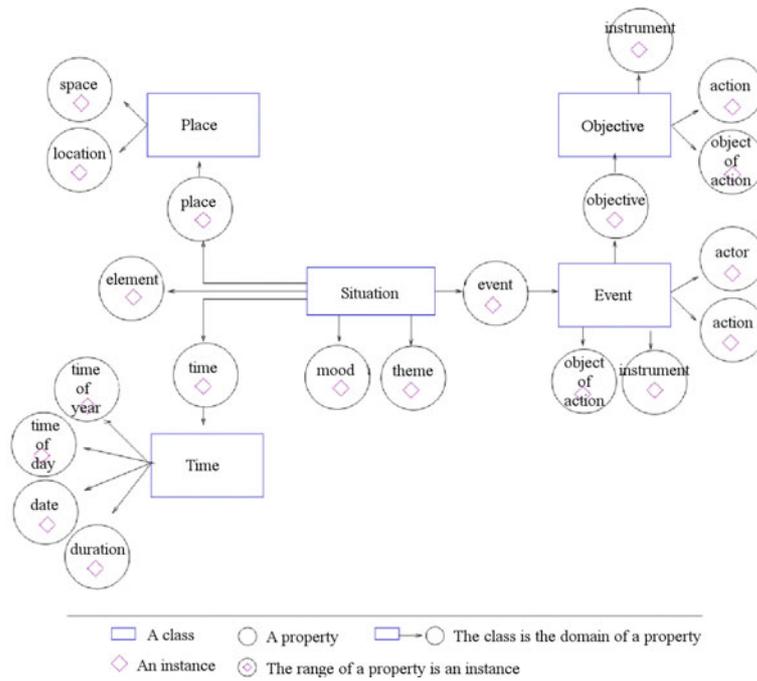


Figure 1: The situation ontology



Figure 2: Kullervo departs for the war. A painting at the Finnish National Gallery. On the right, the original keywords describing the content are given as the value of the CIDOC CRM (Doerr, 2003) property P129F is about: Kalevala, event, Kullervo, birch bark horn, sword, ornament, animal, horse, dog, landscape, winter, sky, stars, snow.

tinguish between factual information and interpretations in the annotations. Interpretations can be shown in a different way in the user interface or even left out, if the person looking for information wants to avoid interpretations.

### 3.1.1 Describing Action

In one *situation*, there can be many *events*. An event refers to one whole, that consists of an *actor*, an *action*, an *object of action* and an *instrument*. The actor, action and instrument are quite straightforward in their semantics, but the object of action can vary depending on the situation. The object can vary from being an object (e.g., hitting a ball), or a predicate (e.g., try to get up) to being an adverbial (e.g., sit on a couch). Because of this, the object of action is somewhat semantically ambiguous and cannot be used so easily for machine reasoning. However, when people use the system, the natural meaning of the relations can usually be understood easily by the user.

The action can also have an *objective*. The objective is an important part of the event, as what a person does may tell much less about what he is actually doing than knowing the objective. In a generic process description, the objective isn't used, as there it is taken for granted that doing one part of the process always has the objective of getting to the next part of the process. But when we look at stories, the objective becomes important. If we have a painting where a man is riding a horse, it is important to know that he is not only riding, but actually his objective is to depart for the war. We may know this objective from the name of the painting, like in the case of the painting "Kullervo departs for the war". When the objective has been annotated, this painting is found also when looking for information about war, not only about horses and riding.

The question about interpretation is quite apparent in the case of the objective. If the painter of "Kullervo departs for the war" would have given the name as an ironic joke for example, it would already require some knowledge about this to not make the wrong annotation. The same is true if the painting would not have a name at all, but still the objective is obvious by looking at the picture: there is a man with a sword on his side, he's blowing a big horn, etc. Especially when describing pictures much of metadata is based on the interpretations of the annotator. In textual stories, the objectives can actually be explained in the text.

Objectives can also exist on many levels. When we read the story about Kullervo in Kalevala we can see that the objective of him to go to the war is actually to

take revenge on the people who killed his family. So he is riding to get to war to get revenge. That's three levels already, and more can sometimes be found.

### 3.1.2 Describing the Surroundings

Even though our main focus in this research is on the action and the processes, sometimes the surroundings of the situation are also interesting. They should not be left out of the metadata description of the situation. In the situation ontology, the surroundings of the situation are described by the *time* and the *place* of the situation (cf. figure 1). It may be important to know, where and when something happens. This can be relevant to generic process descriptions as well as to story situations.

Time and place can be modeled both on the level of absolute facts and from the relative point of view. For example, a situation described in a news article may have the absolute time (*date*) September 11th 2001, and the absolute place (*location*) New York. However, in many kinds of resources the absolute time and place are not known. For example, generic process descriptions have no absolute time or place, and many stories lack these facts, too. Thus the relative time and space are important. Relative time describes the *time of year* and *time of day* of the situation, and relative place (*space*) describes the surroundings on a more general level. The relative time and space of the example above could be "in autumn", "in daytime", and "in a city". When describing the slash and burn procedure, one could say that the "cutting down the trees" -situation happens in spring time in a forest. The *duration* of the situation can also be modeled by creating an instance of the class *Time*.

## 3.2 More Features

Apart from modeling events in time and space, the situation ontology allows the annotation of a *theme*, a *mood* and other *elements*. The theme and the mood are properties that have to do with all the non-generic situations, like parts of a story or a painting. The theme reflects the meaning of the situation from an intellectual point of view, whereas the mood reflects the emotional mood of the situation. The elements mean any objects or things of interest in the situation, that are not directly involved in the events, but are still somehow important to mention. These properties add to the flexibility of the model, even though they don't have to be used, and especially the two former need lots of interpretation from the annotator.

To further deepen the model, we have included some more features in a wrapper class called *Situa-*

*tionElement*. All the instances of the properties mentioned in the ontology are wrapped inside this class. In addition to the link to the content definition ontology, this class has the possibility to mark the information inside as an *interpretation*. With this information explicitly shown, the part of the information that is most subjective can be shown to the user in a different way in the user interface, or it can be left out if someone chooses to only be interested in definite facts.

There is also a property called *attribute* in the *SituationElement*-class. The annotator can add attributes to any elements of a situation. This may bring interesting additional information about some elements and can be used for answering questions such as "How?" or "What kind of...?". Still another property is *symbolizes* that makes it possible to express the fact that something symbolizes something else. As a last addition, we have added the property *freeText*, so that everything annotated can also be given a literal value that can be used in the user interface.

### 3.3 The Process Ontology

The situation ontology can be used to describe the parts of a process or a story, but there has to be a logic for binding situations together in order to form large processes or stories. The process ontology was created for this. The process ontology was strongly influenced by the OWL Services (Coalition, 2003) processes part. The atomic processes of OWL-S could be seen as a close relative to the situations in our terminology, as these are the units used to build up bigger wholes. It was needed for easy specification of the ordering of the situations. The class *ControlConstruct* with its subclasses made this possible.

Some problems arose when annotating the order of the situations with Protege-2000<sup>4</sup> because this editor did not support the use of ordered lists, even though they are a part of the RDF specification. Some hard-coding was needed to get around this problem, taking away the possibility to reuse subprocesses as a part of other processes, but this can probably be solved in later versions of the ontology.

### 3.4 The Content Definition Ontology

The content definition ontology is the ontology that defines how things in the world relate to each other. The actions, the objects, the places, indeed everything that is present in situations that are being annotated,

<sup>4</sup><http://protege.stanford.edu>

should be defined in a this large ontology that tells what are the semantic connections between the concepts.

As the processes are made up of situations, the situations are made up of different properties of the situation. All these properties have a value, that is a reference to a resource of the content definition ontology. For example, consider the situation where the trees are cut down in the slash and burn method. In the action-property of the situation, there will be a reference to the concept of cutting down, and the object of action is a reference to the concept of tree. With all the concepts and there relations defined, we can later create links between different processes that have to do with trees, even though in another process or situation, the annotation would have been oaks. The ontology tells the computer that oaks are a subclass of trees.

### 3.5 Semantic Difficulties Encountered

Some theoretical problems of using these ontologies were discovered during the ontology design process. One was that of interpretation. Even the same situation can be seen in many ways, depending on the point of view of the annotator. Things get even more subjective when properties such as mood are used. Still, we wanted to include these possibilities, as this metadata is meant primarily for people and not for machines, that can't as easily cope with the fact that all facts are not really facts. We envision that interpretations of cultural resources can be very interesting to many end-users. It would be too a high price to pay for making the data totally fact-based.

Another interesting dilemma encountered was the relation between the thing being modeled and reality. What is the relation between a story character and a real historical character? There may be almost no differences, but the fact that the other one is only fictional. There is a relation between Alexander the Great and Aragorn of the "Lord of the rings", but should the difference of the fictional world and the real world be emphasized or not?

The same problem exist with for example toys. A toy aeroplane has lots of semantic connections to real aeroplanes, but still it's a totally different thing. And if there is an old tractor somewhere, that children use as a playing ground, should it be annotated as a tractor, a playing ground, or a space ship, as the children always think of it as one?

The impact of changes in time and space in the metadata and ontologies is also an interesting question. For example, an old axe may have been used in a

medieval war, but in modern wars axes are rarely used as weapons. Thus the war related properties are only relevant to axes during a certain time in history. Axes are an easy example because axes have been fairly similar objects all through the history. In contrast, some concepts may mean a totally different thing in different eras. For example, the process of healing a wound with modern technology and knowhow is very different from what it was a thousand years ago. Also a change in place or culture can twist the meanings of some concepts very much. Depending on the viewpoint, these differences can be seen either as a problem or as a source of most interesting and complicated semantic connections.

## 4 CultureSampo I Prototype

In order to test whether the actions and processes indeed provide a useful basis for linking different cultural resources, the theory has to be tested. The CultureSampo I prototype was built on top of the MuseumFinland architecture to test the new point of view, and especially to see how different kinds of resources could be linked together.

The content of MuseumFinland was semantically homogenous, conforming to a shared metadata schema, consisting of mainly artifact metadata originating from heterogenous and distributed museum collections. In contrast, CultureSampo aims at publishing Finnish culture content of many kinds, conforming to different metadata schemas, on the semantic web. The idea is to allow the search of the resources through the actions they are involved in or involve, and provide the end-user with automatic semantic linking of the resources based on the content (Hyvönen et al., 2006).

### 4.1 Goals

CultureSampo shares the main goals of MuseumFinland:

1. Global view to distributed collections. It is possible to use the heterogeneous distributed collections of the museums participating in the system as if the collections were in a single uniform repository.
2. Content-based information retrieval. The system supports intelligent information retrieval based on ontological concepts, not only simple keyword matching as is customary with current search engines.

3. Semantically linked contents. A most interesting aspect of the collection items to the end-user are the implicit semantic relations that relate collection data with each other. In MuseumFinland, such associations are exposed to the end-user by defining them in terms of logical predicate rules that make use of the underlying ontologies and collection metadata.
4. Easy local content publication. The portal should provide the museums with a cost-effective publication channel.

CultureSampo I prototype was designed especially to deepen the third goal of the system, by bringing in the possibility to relate different kinds of cultural resources through semantically richer annotations, based on actions and processes. The need for this became evident when making MuseumFinland and was actually also echoed in the end-user feedback of MuseumFinland. One of the feedback e-mails brought us this wish:

*“Are there any plans to give more detailed information about the objects? Now the items are laid on display: here they are, look at them. But it’s not told to what, how and why the artifacts have been used....This kind of extra information would serve me at least. Some of the objects and their use is familiar to me, but not all.”*

Also the professionals in the museum field are pondering these questions. Trilce Navarrete writes the following (Navarrete, 2002):

*“As museums expand the definition of ‘education’ there is a need to consider alternative models of explanation, such as oral history, mythology, family folklore and other ways to create the context in which stories are told — the story of each museum. How do museums go about fostering their community’s narrative construction? The question in museums is not only how to better explain the story of the given object, but also how can museums better create and inspire the context for the public to construct an interest to relate to these stories?”*

These two quotes outline nicely the field of problems that we tried to approach with the help of CultureSampo I, using the ideas described earlier in this paper.

### 4.2 A Use Case

To illustrate the intended usage of CultureSampo, consider the following use case. John is a 12-year-old pupil of a school in Helsinki. The teacher has given him and his friend Michael the task of doing an

exercise together. John and Michael should do their work about agriculture in Finland in the nineteenth century. The work should be broad in content, and contain pictures and other materials, too.

The objective of John is to get information about agriculture in the nineteenth century. Michael wants to write about the farm animals, so John has to consider the part about agriculture and people's lives in general. The teacher gives John a link to CultureSampo to find some information. John goes to the site, looks at the search window, ends up with choosing the search categories "Agriculture" and "The nineteenth century", and he gets a link to a scathe that has been used in Helsinki in the nineteenth century. He copies the picture, it's good material. Then he finds a link to the slash and burn process, which is a process where a scathe has been used. He gets information about this kind of farming, and decides to write about that. He also finds a link to a painting where a mythic figure from the Finnish epic Kalevala is using the slash and burn method, and from that he finds a link to the right point in the poem itself, and gets excited about the dramatic twists. The poem also gives him some insight to the life in ancient Finland, and he writes about the jobs he finds people were doing in the poem, like shepherding and fishing. On the basis of the information of CultureSampo, John and Michael manage to make a good school essay about agriculture.

### 4.3 Illustration of Semantic Linking

Figure 3 illustrates semantic linking in CultureSampo I by a screenshot. The page shows metadata about the painting "Kullervo curses" by Akseli Gallen-Kallela depicting a famous event in Kalevala. The painting itself is shown on the left and its metadata in the middle. The semantic links appear on the right. They include different kinds of links, depending on the logical rules that have created them. The labels of the links and headlines explain why following this link should be of interest of the user. Three semantic recommendation links created by the system are visualized on top of the screenshot. One link points to an artifact in the collections of the National Museum, one to bibliographic information of the artist, and one to the actual point in Kalevala where the event takes place. Different kinds of content items have pages of their own similar to this painting page. They look different because of the differences in content types and content on them, but in all cases the content item itself is shown on the left, the metadata in the middle, and the semantic links on the right.

In addition to semantic browsing, the system also supports faceted semantic search in the same way as MuseumFinland.

### 4.4 Cultural Content

In the prototype seven kinds of content resources were used. We selected resources that were somehow important for the Finnish culture, and that related to each other, so that links could emerge between them if described correctly with the annotation ontologies. We also wanted to have examples of different mediums present in the resources.

1. *Processes* were one of the core things we wanted to have in the system, as they have a lot to do with action and with culture. Preserving information about cultural processes is also important in itself. We had the slash and burn procedure and seine fishing as examples of old Finnish processes that are not any more very well known to modern Finns. These two processes were built up from about ten situations each.
2. *Stories* were the other resource type that had been much thought of when designing the CultureSampo ontologies, and is an inspiring way to describe the context of old Finnish culture. Kalevala was a natural choice when choosing what stories to include in the prototype. As the Kalevala stories are old, the world they describe is close to the context of life in the past agrarian Finland. Two quite separate entities were chosen from the whole epic: the sad story of Kullervo whose family was killed, and another where the most famous hero of Kalevala, Väinämöinen, learns how to farm land by the slash and burn method. These stories had a start and an end of their own, and they had good references to the other resources we had.
3. *Paintings* were the first resource where no text was included, but the information was in picture form. It was good to add paintings not only because of getting to test describing this medium, but also as visual resources give another kind of life to the context of old Finnish culture. We selected some paintings about Kalevala to fit the stories we had, and also some other paintings describing the old days.
4. *Photographs* are quite similar to paintings w.r.t. their content annotation. Still, the documentary aspect of photographs is much stronger than in

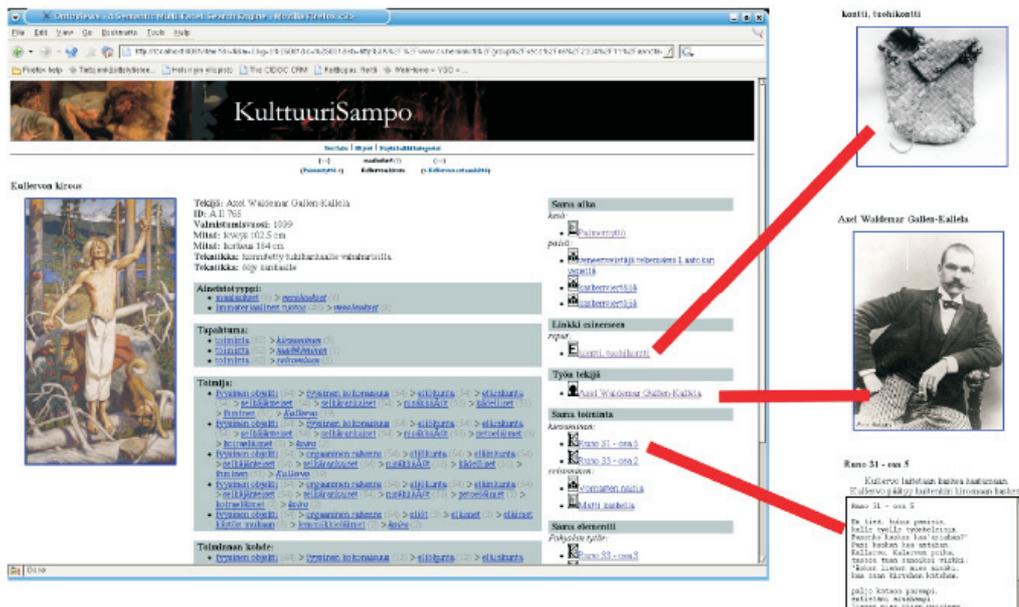


Figure 3: An example of the interface of CultureSampo I illustrating a painting at the Finnish National Gallery about an event in the epic Kalevala. Three semantic recommendation links created by the system are visualized on top of the screenshot.

paintings, so we believe they bring a good authentic point of view to old processes.

5. *Videos* were an interesting and complicated case of resources. At this stage of the process, we didn't yet implement very complicated metadata descriptions of the videos we had, even though using the situation ontology with moving image and sound could be used in a more sophisticated way. At this time it was enough to get some links to the other resources through a simple metadata description, and the logics can later be improved.
6. *People* were added as one kind of "resources", as information about people who lived in the old days can be relevant, when forming the context of cultural resources. Since the core of our metadata schema is action, and the actor's are usually people, it was natural to use people as content items. Most of the persons in the system were artists who had created the artworks included. However, there were also a couple of fictitious people from the Kalevala epic.
7. *Artifacts* were a natural kind of resource we

needed to have, because artifacts are important in actions (e.g., as instruments), and we also had lots of metadata about them in the MuseumFinland knowledge base.

The CultureSampo I prototype uses ontologies designed for action-based description of cultural resources. The resources we used in the prototype were 2 processes, which were built from 21 situations, 2 stories of Kalevala in 32 situations, 8 paintings, 4 photographs, 2 educational videos and 14 museum objects. The annotation of the situations was quite slow, as there were no existing action-based metadata available, and no special tools designed to help in the process. Most situations could be described in the way we wanted, so the expressive power of the situation ontology proved out to be satisfactory.

A couple of problems arose in describing the situations of stories. One was a situation where a woman reads a spell to protect the cows when sending them to the forest. This was a long monologue, and the contents of the monologue could not be made into situations, but we could only say the woman is reading a spell. This shows a problem of describing speech in stories and in general: the things that people talk about are not necessarily true or real actions. In our

scheme there is no notion of reification, although this is in principle supported by the RDF recommendation. As a result, dialogues or monologues are difficult to describe with our action-based annotations as it is. When describing some parts of the story, we needed to limit the level of detail. All the actions were not described in situations, but only the ones that were interesting and mattered in the whole plot.

In describing processes, there were some problems with representing time. As different situations of a process take different amounts of time, choosing what is important in the process sometimes ended up with situations that are very uneven in their lengths. For example, cutting the trees down is fast but waiting for a year or letting the forest grow back take longer times.

These problems were not critical to the functionality of the system. Most of the situations in different resources were straightforward to annotate with the ontologies. When using the prototype, it could be seen that actions really do link different cultural resources together. Lots of links were created with the logical rules we defined, and the links really had meaning for the end-user. When looking at an axe in a museum, you get a link to the process of slash and burn where axes were used, to a painting where someone is using an axe, and to a poem of Kalevala where Kullervo is sharpening his axe.

The situation ontology was the main object of our interest, but also the other ontologies worked well enough. The process ontology was expressive enough to describe the order of the situations we had. As the content defining ontology we used a preliminary version of the General Finnish Upper Ontology YSO (Hyvönen et al., 2005b), that was being designed at the same time. As it wasn't totally ready, we made a version of it that had the concepts we needed, and it worked at this stage of the process.

## 5 Related Work

Process models have been researched a lot in computer science, though usually from the point of view of machine-executable processes or business processes. As examples of these include the Process Specification Language (Schlenoff et al., 2000), Business Process Execution Language for Web Services (Andrews et al., 2003) and OWL Services (Coalition, 2003), that we used as a starting point when designing our process ontology. However, these approaches to process modeling were not designed for describing cultural processes, so the end results are quite different, even though some similarities exist. Questions

about actions happening in time are always somehow involved in processes.

There are ontologies that have been designed for describing cultural resources. The CIDOC CRM (Doerr, 2003) is an upper level ontology that has been designed for making different metadata schemas and content interoperable. The ABC Harmony (Lagoze and Hunter, 2001) is a related effort intended to provide a common conceptual model to facilitate interoperability among application metadata vocabularies. Our approach is different from these ontologies and other metadata systems that concentrate on describing the cultural resources in collections. Our focus is on describing the actions and processes that relate the resources in the real world (or in fiction), with goal of providing the user with insightful semantic recommendations and enhancing search.

## 6 Conclusions

This paper is about describing the cultural context of resources. As the common denominator of different cultural resources, a situation including some actions was chosen. Situations describe what happens in a painting, in a story, or in a cultural process. Such descriptions provide a semantic network linking related cultural content items together. This point of view complements the more traditional idea of using classifications and ontologies for defining cultural concepts and metadata schemas.

An experimental situation ontology was created to provide the common annotation scheme to describe situations and their main properties, whatever the medium in which the situations appear is. Also a process ontology and a content defining ontology were taken as a part of model, in order to link different situations together into larger wholes, and in order to define the concepts appearing in the situations unambiguously.

It was clear from the beginning that describing cultural content in terms of real world actions and processes is more complicated than describing cultural objects in collections. The prototype CultureSampo I was designed and implemented in order to find out both the practical and theoretical problems of the approach, and also to see if the benefits of this kind of metadata in use could be as useful as we hoped. The first results seem promising. However, the content set used in this experiment was very small and it was pre-selected according to our goals. Experiments with larger content sets and annotations are definitely needed.

The final goal of the CultureSampo project

(Hyvönen et al., 2006) is to become a demonstration of a nation-wide cross-domain cultural publication for the semantic web. As a first step towards this ambitious goal, the work of this paper shows that a situation ontology and action-based metadata descriptions can bind together different kind of cultural resources in meaningful ways, from paintings and objects to processes and stories.

## References

- T. Andrews, F. Curbera, H. Dholakia, Y. Golland, J. Klein, F. Leymann, K. Liu, D. Roller, D. Smith, S. Thatte, I. Tricovic, and S. Weerawarana. Business process execution language for web services - version 1.1, 2003.
- Aristotle. *Poetics*. Focus Philosophical Library, Pullins Press, 2006.
- The OWL Services Coalition. *OWL-S: Semantic Markup for Web Services*, November 2003. <http://www.daml.org/services/owl-s/1.0/owl-s.pdf>.
- M. Doerr. The CIDOC CRM - an ontological approach to semantic interoperability of metadata. *AI Magazine*, 24(3):75–92, 2003.
- M. Eysenc and M. Keane. *Cognitive Psychology A Students Handbook*. Psychology Press, Exeter, UK, 2002.
- M. Holly. *Panofsky and the foundations of art history*. Cornell University Press, Ithaca, 1984.
- B. Holmes, B. Tangney, A. FitzGibbon, T. Savage, and S. Meehan. Communal constructivism: Students constructing learning for as well as with others. In *Proceedings of SITE 2001, Florida*, 2001.
- E. Hyvönen, E. Mäkelä, M. Salminen, A. Valo, K. Viljanen, S. Saarela, M. Junnila, and S. Kettula. MuseumFinland – Finnish museums on the semantic web. *Journal of Web Semantics*, 3(2):224–241, 2005a.
- E. Hyvönen, T. Ruotsalo, T. Häggström, M. Salminen, M. Junnila, M. Virkkilä, M. Haaramo, T. Kauppinen, E. Mäkelä, and K. Viljanen. CultureSampo — Finnish culture on the semantic web. The vision and first results. In *Semantic Web at Work - Proceedings of the 12th Finnish Artificial Intelligence Conference STeP 2006, Volume 1.*, Nov 2006.
- E. Hyvönen, A. Valo, V. Komulainen, K. Seppälä, T. Kauppinen, T. Ruotsalo, M. Salminen, and A. Ylisalmi. Finnish national ontologies for the semantic web - towards a content and service infrastructure. In *Proceedings of International Conference on Dublin Core and Metadata Applications (DC 2005)*, Nov 2005b.
- M. Junnila. Tietosisältöjen semanttinen yhdistäminen toimintakuvausten avulla (Event-based approach to semantic linking of data content). Master's thesis, University of Helsinki, March 6 2006.
- L. Kelly. Developing access to collections through assessing user needs, May 1999. Museums Australia Conference, Albury.
- S. Kettula. Käsityöprosessit museossa semanttisen tiedonhaun lähteenä ja kohteena. (Handicraft processes in museum as a source of object for semantic content and search). In L. Kaukinen and M. Collanus, editors, *Tekstejä ja kangastuksia. Puheenvuoroja käsityöstä ja sen tulavaisuudesta. (Views of handicraft and its future)*. Artefakta 17, Juvenes Print, 2005.
- C. Lagoze and J. Hunter. The ABC Ontology and Model. *Journal of Digital Information*, 2(2), 2001.
- E. Mäkelä, E. Hyvönen, and S. Saarela. Ontogator — a semantic view-based search engine service for web applications. In *Proceedings of the 5th International Semantic Web Conference (ISWC 2006)*, Nov 2006.
- E. Mäkelä, E. Hyvönen, S. Saarela, and K. Viljanen. Ontoviews – a tool for creating semantic web portals. In *Proceedings of 3rd International Semantic Web Conference (ISWC 2004), Hiroshima, Japan*, November 2004.
- T. Navarrette. Museums in the street: Cultural creation in the community, October 2002. INTERCOM Conference Leadership in Museums: Are our core values shifting?, Dublin, Ireland.
- M. Salminen. Kuvien ja videoiden semanttinen sisällönkuvailu (Semantic content description of images and videos). Master's thesis, University of Helsinki, May 2006.
- C. Schlenoff, M. Gruninger, F. Tissot, J. Valois, J. Lubell, and J. Lee. The process specification language(psl): Overview and version 1.0 specification, 2000. NISTIR 6459, National Institute of Standards and Technology, Gaithersburg, MD.

- J. Sowa. *Knowledge Representation. Logical, Philosophical, and Computational Foundations*. Brooks/Cole, 2000.
- K. Viljanen, T. Känsälä, E. Hyvönen, and E. Mäkelä. Ontodella - a projection and linking service for semantic web applications. In *Proceedings of the 17th International Conference on Database and Expert Systems Applications (DEXA 2006)*, Krakow, Poland. IEEE, September 4-8 2006.