Applying Semantic Technology to Film Production

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Abstract. Film production is an information- and knowledge-intensive industrial process which is undergoing dramatic changes in response to evolving digital technology. The Deep Film Access Project (DFAP) has been researching the potential role of semantic technology in film production, focussing on how a semantic infrastructure could contribute to the integration of the data and metadata generated during the film production lifecycle. This paper reports on the preliminary development of a knowledge framework to support the automatic management of feature film digital assets, based on a workflow analysis supported by an OWL ontology. We discuss the challenges of building on previous work and present examples of ontological modelling of key film production concepts in a semantically rich hybrid ontological framework.

1 Introduction

Film production is an information- and knowledge-intensive industrial process, spanning several phases from development to archiving to re-purposing, which is undergoing dramatic changes in response to evolving digital technology. In this context the Deep Film Access Project (DFAP)[2] has been focussing on the potential role of semantic technology in film production, in particular on how a semantic infrastructure could contribute to the integration of the data and metadata generated during the film production lifecycle.

An important research objective of DFAP is the development of a knowledge framework, consisting of a workflow analysis and an ontology, to support the automatic management of feature film digital assets. To facilitiate this, the project has benefited from the consultation with the independent film production company, Adventure Pictures Ltd., who provided access to a full set of digital assets for their recent production *Ginger & Rosa* (Dir. Sally Potter, 2012), their interactive film production website SP-ARK[3], and discussions with key practioners

[3] http://www.sp-ark.org

involved in the production process. This data, metadata and expertise were analysed to develop a preliminary understanding of the knowledge underlying the film production process, which was then represented as a workflow chart and coded as an extension of pre-existing foundational and core ontologies in the Web Ontology Language (OWL)[4] using the ontology editor Protégé [5].

This process offered insights into a number of issues that need to be taken into account when automating a business process such as film production using semantic technology. It became apparent how eliciting knowledge from practioners and coding such elicited knowledge into a pre-existing ontology both raise issues of meaning negotiation. But it also has begun to reveal the benefits that more precise modelling can bring to the management, re-use and archiving of digital assets.

This paper presents results of these research activities. Section 2 describes related work for both the description of the process of producing a film and the semantic technology that may have an impact on film production. Section 3 presents a reduced version of the DFAP workflow chart that is being developed. Section 4 presents examples of modelling concepts that are relevant to film production in the DFAP ontology. Section 5 draws conclusions about the process so far and future work.

2 Related Work

In defining the area of semantic technology for film production we have elicited knowledge and researched the literature from two perspectives:

1. Process description: what happens to (digital and other) film production assets throughout the film production process?
2. Relevance of semantic technology: which results in semantic technology research offer solutions that can meet industry expectations in terms of improving the film production process?

As mentioned in section 1, in order to address question 1, above, the assessment of the state of the art in the Film Industry was based on knowledge elicitation from professional film practice. An initial description of the process of film production was provided by the taxonomy of SP-ARK. This was then enriched with categories and populated with data generated during the production of *Ginger & Rosa*. In addition, the professional film practioners were interviewed; these interviews supported the negotiation of meaning with practioners as well of the temporal and functional ordering of process components.

To address question 2, a review of projects concerned with the automation of various aspects of film production was undertaken. Some proposals concentrate on supporting workflow automation, others on supporting the automation of content analysis. Three projects were particularly relevant to the focus of

[4] http://www.w3.org/TR/owl2-overview/
[5] http://protege.stanford.edu/

this paper. The *Loculus System* [5] is "an ontology-based information management framework for the Motion Picture Industry". It takes a perspective-based approach to modelling two industry timelines: the Production Cycle Timeline and the Life Stage Timeline (which includes activities beyond production, such as re-purposing). Exploration of Loculus showed that the ontology is quite flat and the production-related branches are not very well developed. However the terminology is very extended and two additional contributions of Loculus are a rule-based relatedeness metric between the various parts of the ontology and the discussion of information extraction techniques that may apply to the production process. *OntoFilm* [4] is a core ontology for Film Production, which conceptualizes the domain and workflows of the film production process. The ontology uses Semantic Web Rule Language (SWRL) rules to express classification conditions. *COMM* [1] is a core ontology for multimedia annotation. Implemented with the purposes of explaining how a media object is composed and what its parts represent, it conveys the semantics of multimedia files (e.g. MPEG-7) by incorporating a foundational ontology (DOLCE) to support conceptual clarity, soundness and extensibility. Wrapping the multimedia ontology in a foundational ontology makes it easier to model the distinction and the relationship between what is represented and the representation. However, the philosophical and terminological overload of the chosen foundational ontology can make use by non-experts rather difficult. Also, despite providing a deeply structured hierarchy, the definitions of the foundational OWL classes are mostly quite shallow or even empty.

Based on the overall results of the literature review, the project decided to adopt an integration and extension approach of existing proposals. In particular the initial DFAP ontology imported both Loculus (for film production terminology) and COMM (for multimedia and foundational terminology). But, as this first version of the DFAP Ontology grew, with more classes using parent classes and properties defined in Loculus and COMM, the imported ontologies became more entangled, which seemed to cause ever growing efficiency problems in reasoning. Loculus was therefore dropped and part of it remodelled directly in the next version of the DFAP ontology. Besides COMM the DFAP Ontology also imports an implementation of Allen's Interval Algebra as SWRL rules created as part of the scene interpretation system SCENIOR [3] which enhances the expressivity of COMM and supports the representation of non-reified temporal and identity constraints within and across classes.

3 The DFAP Workflow

Figure 1 shows part of the current state of the (ongoing) activity of charting the Film Production process as a workflow, using five main categories (i.e., Process, Phase, Operation, Agent or Agent Role, Product). These categories are akin to classes commonly used in Business Process Modelling or Planning (e.g. Process, Activity, Task etc..).

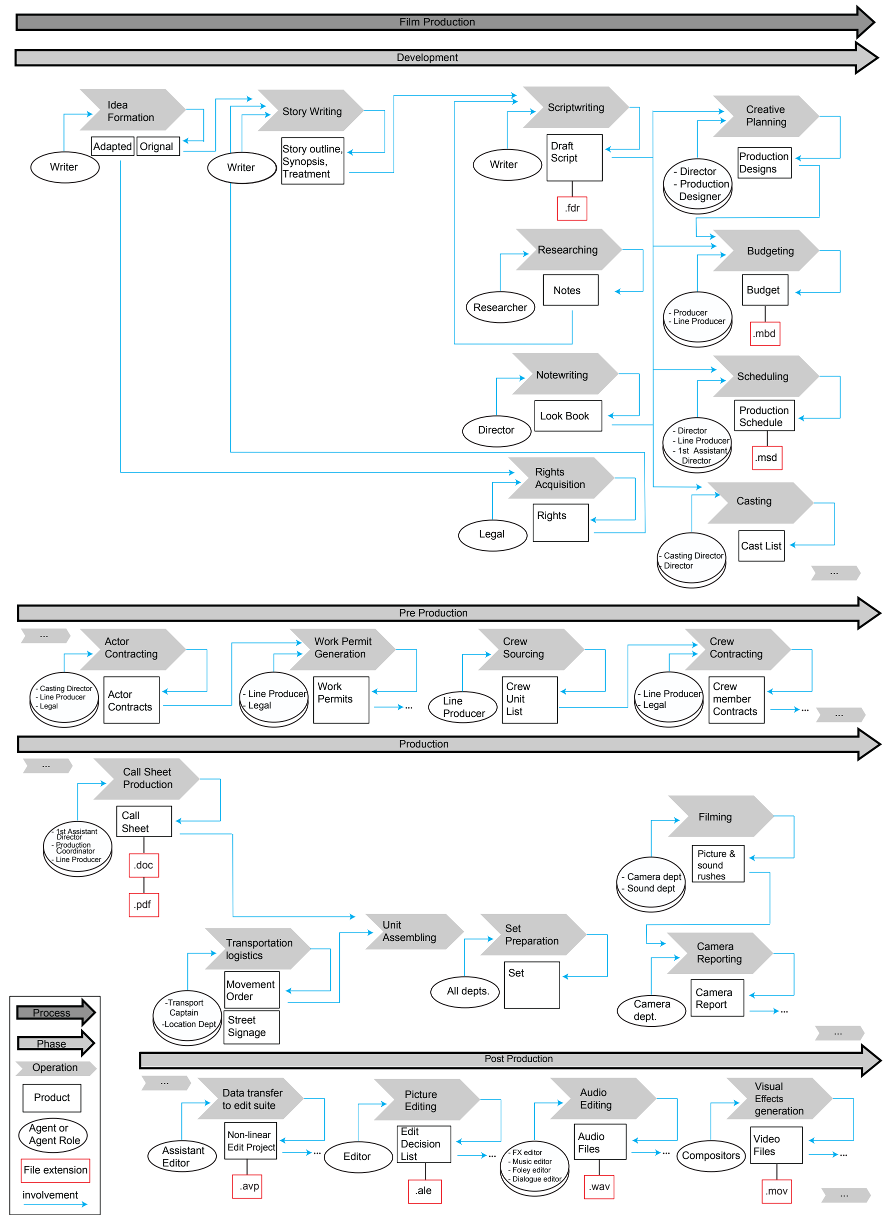

Fig. 1. Fragment of the preliminary DFAP Workflow.

In very general terms, the relations between these categories should be understood as temporal part-of relations: a process comprises phases, which in turn comprise operations, which involve agents, often indicated by the role they have, and products. More accurate definitions of these relations depend on the adopted foundational ontology, which is discussed in section 4.

In defining the workflow, the transition from the source material (e.g. existing taxonomies, data, specialist knowledge etc.) had several aims: avoiding ambiguity (when for instance the name of a product was used for the operation that produces that product); finding the right temporal order; finding the right functional order (i.e. the output of which operation is the input of which later operation). The entire workflow consists of seven main phases (Development, Pre-production, Production, Post-production, Delivery, Marketing Distribution & Reception, Archiving).

4 The DFAP Ontology

As mentioned, the DFAP Ontology[6] is based on an integration and extension approach of existing proposals. The present import structure of the DFAP ontology is shown in Figure 2: on the right side the COMM multimedia ontology and its imports[7], the names of which mostly convey the type of knowledge coded

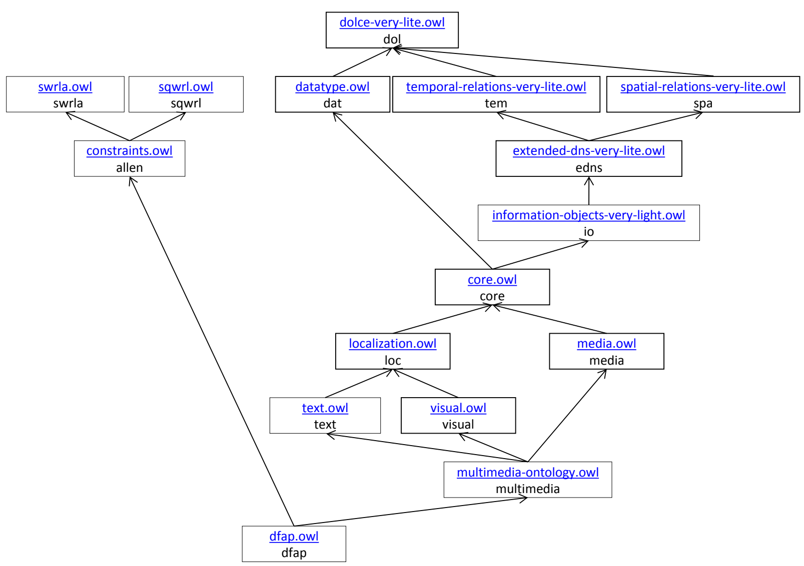

Fig. 2. DFAP Ontology import structure.

[6] http://dfap.dame.org.uk/dfap-ontology/dfap.owl
[7] http://www.uni-koblenz.de/FB4/Institutes/IFI/AGStaab/Research/comm/Ontology/

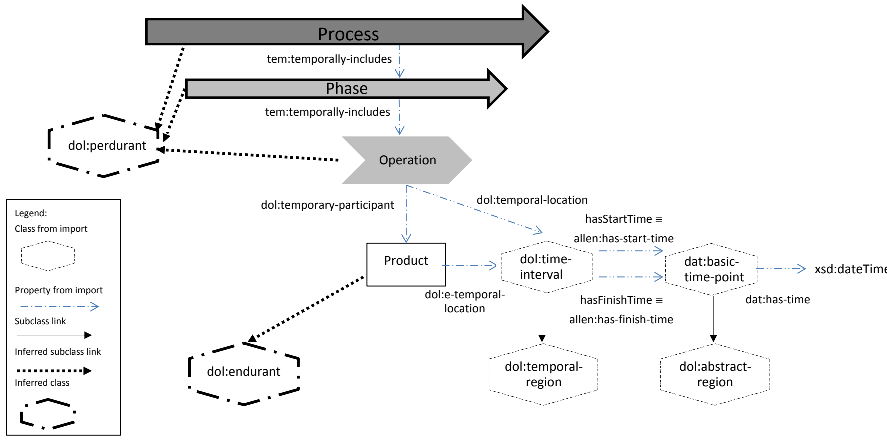

Fig. 3. Pattern for temporal relations

in the .owl file (e.g. *spatial-relations*-very-lite.owl); on the left hand side, the SWRL-rule representation of Allen's Interval Algebra.

Figures 3, 4 and 5 provide examples of how to give a semantics to the notions employed in the Workflow chart show in Figure 1. Figure 3 models the temporal parthood relations between Process, Phase, Operation and Product in terms of temporal inclusion, temporal participation and temporal location. This further allows the adopted temporal relations to be grounded in the xsd:dateTime data present in the digital assets of the Film Production process. Moreover, the classifier returns the correct classification for the classes Process, Phase and Operation with respect to DOLCE, as subtypes of dol:perdurant, i.e., as entities that take place in their entirety only through time, while Product is classified as a subtype of dol:endurant, i.e., as an entity that entirely takes place at a unit (i.e. interval or instant) of time. Although not surprising, such results of classification are an important factor in guiding the modelling process, as they confirm whether the modeller is using the appropriate relations with respect to the imported ontology to express the ontological structure underlying his or her domain of reference.

Figure 4 exemplifies even better the process of meaning negotiation taking place between the modeller and the DFAP ontology and its imports. The pattern shows a model of the relation between the class IndividualAgent (which includes all types of individual agents, no matter whether physical or fictional) and its subclass FictionalCharacter. The latter is related by means of the relation edns:interpreted-by to the former. The classifier, on the one hand, returns the intuitively correct classification of the class IndividualAgent as subtype of dol:endurant by virtue of temporal participation in an operation and similarly to Product in Figure 3. On the other hand, FictionalCharacter is also classified as an edns:information-object, i.e., as something like the content of a document, which is an interesting option for the modeller – indeed a fictional character should at least implicitly have some of the properties of a agent, even of a physical agent (e.g. weight), as well as the properties of a non physical information

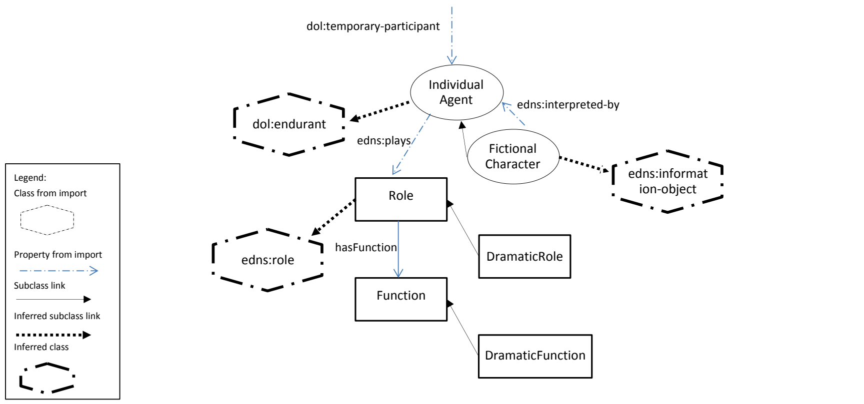

Fig. 4. Pattern for fictional characters

object (e.g. the contents of a book) as it inherently needs to be interpreted by an individual agent. This type of consequences force the modeller to think through his or her modelling choices, as well as about how much the imported ontologies she or he is using are sufficiently developed.

Figure 5 illustrates an initial model for the class Scene, its relation to the classes Text, Video and Sound, entities which during most phases of the Film Production process are stored in different types of files that need to be synchronized to achieve semantic integration. Similarly to the previous example for the class FictionalCharacter, Scene is correctly classified as a dol:non-physical-endurant with respect to the imports.

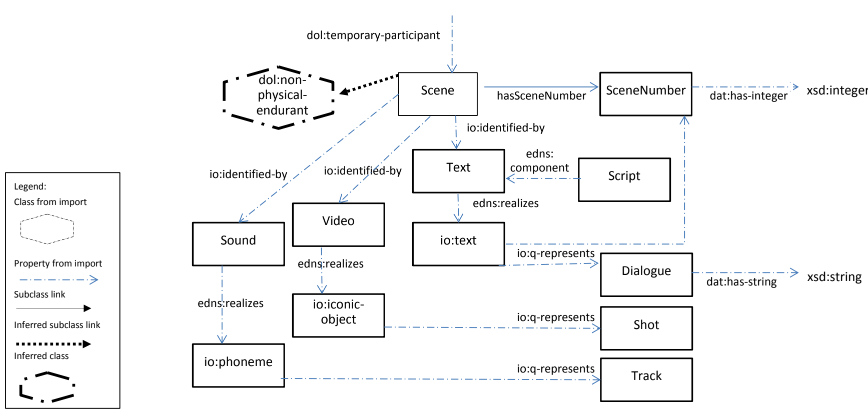

Fig. 5. Pattern for scenes

5 Conclusion

The DFAP workflow and ontology presented here are still preliminary, but their development has already offered insights into a number of issues for automating the process of film production using semantic technology. While working on the workflow and the ontology, it has become apparent how the activity of eliciting knowledge from film production specialists and the activity of coding such elicited knowledge into a pre-existing ontology pose similar issues of meaning negotiation. On the one hand, when practioners are interviewed about their activities, they need to be guided through an analytical process of simplification of what they know about their field. On the other hand, when the elicited knowledge is coded into a pre-exiting foundational or core ontology, the knowledge modeller needs to keep testing whether the consequences drawn by the reasoner about the newly inserted knowledge are compatible with the elicited domain knowledge. Once this is established, the full power of the reasoner will be available to support advanced semantic inference over film assets. Our long term aim is to show what impact semantic technology could have on the film industry, for example by improving ease of access to film assets, increasing the depth and value of access, providing new methods of processing data sets for digital film production, and extending metadata protocols within film archival practices.

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