https://doi.org/10.2352/issn.2168-3204.2018.1.0.28

Bring All Together – An Approach of a Multimedia Keep-Alive Archive

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Abstract

Research on moving images usually presents difficulties because the dynamic medium is not so easy to grasp. Existing software solutions facilitate the task, but are often limited to the medium of audio or video. But in our field — the humanities — we have a lot of various disciplines, each with its specific resource objects like photograph, text, video and audio, but also geographic information data, 3-d models or reflectance transformation imaging (RTI).

At our lab, we are developing one virtual research environment with the approach to bring all these different fields and their multimedia content together. The development includes a web-based user interface, a media (stream) server and a database architecture with a long-term perspective.

The Desire of Moving Images Annotation

In film and media studies, there has always been a desire to annotate and analyze movies as easily as still images. Video is an interesting research object in historical and ethnographic research. The recordings then need to be transcribed. This could be a simple interview transcription, but in disciplines like sociology, or film and media studies, it can be more complicated. In this case, the scholar would also like to annotate the source, to describe the composition of the image, the soundtrack, or the movement of the camera. The question was always: how can we watch and describe a movie / video at the same time?

The moving images has a continuous linearity and makes only sense in a dynamic state. So, this medium is difficult to grab and the researcher is not able to write notes and commentaries direct to it. Because, in contrast to an image, the moving images is always bound to technical devices. [1] This fact does not make it easier to annotate them. In the digital world today, moving images research is better to do as before, because we can work with only one technical device now — namely the computer. This step is comfortable, but without a corresponding software awkward to do. If the researcher works with moving images, he needs software for the video file and software for the text processing. Especially when he wants to create table based sequence protocols. He has to switch at least between two (proprietary) programs. To avoid these issues, we decided to implement a special module for moving images, into our own software.

One platform for everything

At our lab, we are developing a purely web-based virtual research environment (VRE) — a system for annotation and linkage of sources in arts and humanities (Salsah). The project originated from an art historical research project about early prints in Basel (Incunabula Basiliensis). It allows for the collaborative annotation and linking of digitised sources or to define special regions inside the source (e.g. region of interest on a picture) and to link them again. [2]

Figure 1. "2001: A Space Odyssey" — Connect the movie with film posters, making of... scenes, screenplay and film stills.

In the recent years the interest into our platform grew enormously. More than 20 projects from art history, from history, from media and cultural studies are using the Salsah platform. They're all working with different kind of sources and meta data information. But it doesn't matter with which kind of data a researcher wants to work with, because we have implemented a semantic graph database in the back-end: a triple store service based on the semantic web idea, called RDF (resource description framework). But as the platform grows, we had to manage thousand of datasets. In addition, the user interface (salsah.org) wasn't very user-friendly and we decided to split Salsah into three different layers and tools. So our VRE platform needs at least three tools.

One tool should handle the data; it means it communicates with the triple-store database in the back-end and provides the data via a RESTful application programming interface (API). This service is our main tool and is called Knora, which stands for Knowledge Organization, Representation, and Annotation (knora.org). Knora is managin all the metadata. But what's about the media files? They should be stored somewhere and they should managed by a separate media service. We developed an own media file server for these data: The Simple Image Presentation Interface (sipi.io). At the moment Sipi is developed for still images only, but we will expand it into a multimedia service, which will be able to handle still, but also moving images as well audio and text (Word, PDF a.s.o.) files.

The back-end Knora has a properly RESTful API, which allows the usage of different kind of front-ends to work with the data or to present the results at the end of a project. One of these front-ends is the already mentioned Salsah. It's the generic user interface with all the specific tools like annotation and linkage of any kind of media. This includes a module for moving images to transcribe them, to link them with subtitles, with images or geographic information. When the development of the software is done, it should be possible, to bring images, text and audiovisual sources together and to work with them.

Main tool: Knora framework

Knora is based on the idea that the continuous availability and reusability of digital qualitative research data in the humanities requires a common, flexible data representation and storage technology capable of performing queries across large quantities of heterogeneous data, organised according to project-specific data structures that cannot be known in advance. It also requires a convenient, storage-independent way for Virtual Research Environments (VREs) and automated data-processing software to access, query, and add to this data.

To solve the data representation and storage problem, Knora represents humanities data as RDF graphs, using OWL ontologies that express abstract, cross-disciplinary commonalities in the structure and semantics of research data. Each project using Knora extends these abstractions by providing its own project-specific ontology, which more specifically describes the structure and semantics of its data. Existing non-RDF repositories can readily be converted to an RDF format based on the proposed abstractions. This design makes it possible to preserve the semantics of data imported from relational databases, XML-based markup systems, and other types of storage, as well as to query, annotate, and link together heterogeneous data in a unified way.

By offering a shared, standards-based, extensible infrastructure for diverse humanities projects, Knora also deals with the issue of conversion and migration caused by the obsolescence of file and data formats in an efficient and feasible manner. To solve the access problem, Knora offers a generic HTTP-based API. In the Knora framework, the standard implementation of this API is a server program called the Knora API Server. This API allows applications to query and work with data in terms of the concepts expressed by the Knora ontologies, without dealing with the complexities of the underlying storage system and its query language (e.g. SPARQL). It also provides features that are not part of SPARQL, such as access control and automatic versioning of data. While the Knora API is best suited to interacting with RDF repositories based on the Knora ontologies, it can also be implemented as a gateway to other sorts of repositories, including non-RDF repositories.

Knora is thus a set of standard components that can be used separately or together, or extended to meet a project's specific needs. You can learn more about each component:

- **The Knora Ontologies**, a set of OWL ontologies describing a common structure for describing humanities data in RDF.
- **The Knora API Server**, a server program written in Scala that implements an HTTP-based API for accessing and working with data stored in an RDF triple-store according to the structures defined in the Knora ontologies.

It uses a hierarchy of ontologies based on the Resource Description Framework (RDF), RDF Schema (RDFS), and the Web Ontology Language (OWL). Both RDFS and OWL are expressed in RDF, which expresses information as a set of statements (called triples). A triple consists of a subject, a predicate, and an object:

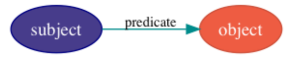

Figure 2. *RDF triple: subject, predicate, object.*

The object may be either a literal value (such as a name or number) or another subject. Thus it is possible to create complex graphs that connect many subjects, like this:

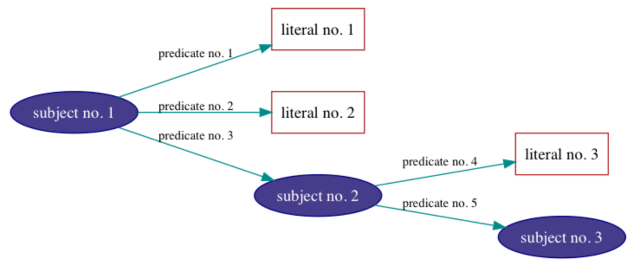

Figure 3. *RDF graph connection.*

In RDF, each subject and predicate has a unique, URL-like identifier called an Internationalised Resource Identifier (IRI). Within a given project, IRIs typically differ only in their last component (the "local part"), which is often the fragment following a # character. Such IRIs share a long "prefix". In Turtle and similar formats for writing RDF, a short prefix label can be defined to represent the long prefix. Then an IRI can be written as a prefix label and a local part, separated by a colon (:). For example, if the "example" project's long prefix is http://www.example.org/rdf#, and it contains subjects with IRIs like http://www.example.org/rdf#book, we can define the prefix label ex to represent the prefix label, and write prefixed names for IRIs:

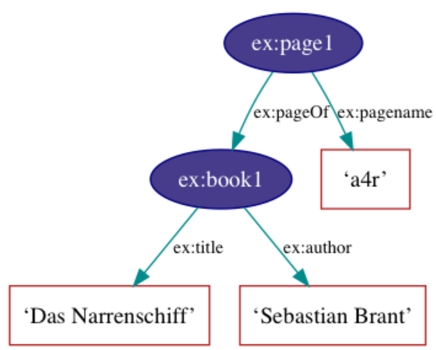

Figure 4. *RDF IRI example.*

To ensure the interoperability of data produced by different projects, each project must describe its data model by creating ontologies that extend Knora's built-in ontologies. The main built-in ontology in Knora is the Knora Base ontology.

IIIF media server: Sipi

Knora uses a high-performance media server, called Sipi, for serving and converting binary media files such as images and video. It's written in C++, developed by ourselves and implements the International Image Interoperability Framework (IIIF). IIIF is an emerging standard in accessing media files using standard URI's. It implements an authentication standard for access control and offers many extensions. New extensions can be written in Lua. This enables to expand the Sipi service in a fast and easy way.

Sipi already converts efficiently between image formats, preserves metadata (such as EXIF, IPTC and XMP) contained in original image files or transforms ICC colour profiles. In particular, if images are stored in JPEG 2000 format, Sipi can convert them on the fly to formats that are commonly used on the internet. It offers a flexible framework for specifying authentication and authorization logic in Lua scripts, and supports restricted access to images, either by reducing image dimensions or by adding watermarks. This allows to store only one working image copy on the server. So, no additional thumbnails or images with watermarks are needed.

We're planning to use Sipi as well for moving images together with the IIIF definition. At the moment isn't clear yet how to implement it. Especially when the IIIF standard for moving images isn't ready. But this will be the next important step.

A generic front-end: Salsah

Using the RESTful API of Knora, it is possible to create a variety of front ends. These can be web-based or native one. There is no limit to the implementation. We provide several levels to facilitate access:

- **Scripting**
  The RESTful API of Knora allows mass uploads and automated data analysis using scripting tools. As long as submitting HTTP-requests are supported, any scripting platform can be used. We are currently using Python, PHP, Tcl / Tk and bash.
- **Native Applications**
  Relying on the RESTful API, it is straightforward to create native applications using JAVA, C++ / Qt, Python / Tk, Swift etc. which are able to offer more elaborate possibilities because native applications are not limited by the meager user interface capabilities of HTML 5.
- **Generic Web-Application (Salsah)** and **Component Library**
  We are currently investing the largest effort in the development of the generic web application. This interface allows manipulation and addition of data and resources provided by Knora. It should deal with all types of media including moving images and offers annotation, transcription and linking between all different kind of media types. A visualisation tool shows the connection between the resources and gives a new way to discover the data and enables new access to knowledge. Salsah consists of modules that can be extended and reused in other applications. Using the module library and creating special purpose web-applications is straightforward. (For examples see http://www.salsah.org/dokubib or http://www.salsah.org/kuhaba).

We started developing the VRE Salsah in 2008. Salsah in the first version is still running on salsah.org. It's build with HTML 5 and a lot of jQuery (JavaScript) functionality. As already mentioned the user interface isn't very user-friendly but it works and is in use since 10 years. A year ago we started with re-creation of Salsah as version 2. This version is based on Google's Angular (today in version 5) and styled with Angular Material. The modularity of the framework, written in TypeScript, is really good and it allows us to create own angular modules for Salsah. And they can be reused by other projects with own user interfaces.

The whole Salsah app code – as well the Knora and Sipi code – is open source and is available on GitHub [3]. In January 2018 we decided to create standalone Salsah modules, which will be published and accessible on NPM [4]. The idea is now to extract existing services and components from the Salsah App, which is currently in beta status, and to develop individual modules from there. One of the modules will be the already described film transcription tool.

Implementation of new Salsah modules: e.g. the Salsah Movie Player (SMP)

For a deep, moving images analysis, we want to have the possibility to connect a movie or just a sequence of it with related objects like screenplay, film stills or making-of...-descriptions as shown in figure 1. The connection of the movie with these additional objects and their own metadata information, enables a powerful (re-)search possibility. The new module in Salsah is not a standalone solution like other video analysis tools. The network behind every movie / video would be visible and another difference with conventional video transcription tools is the representation of the transcription. Especially in film and media studies the researcher has to describe different aspects in the movie: camera position, sound, actors, text etc.[5, 6]. The result is a table based sequence protocol, as shown on the right-hand side in figure 5.

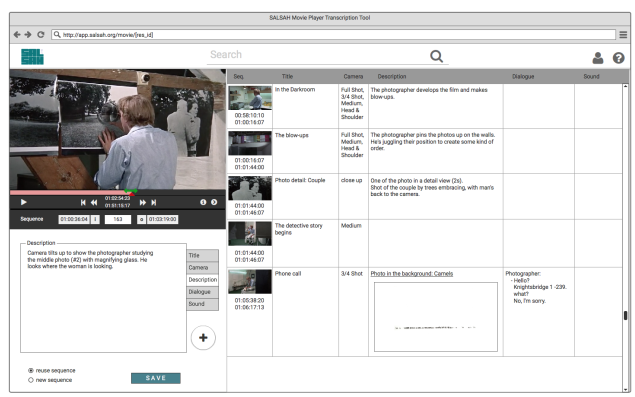

Figure 5. Example of the Salsah movie player (top left) with the transcription tool (bottom left) and the sequence protocol (right).

The moving image is the main object in the new module. The film analyst can describe and annotate every scene with a simple transcription tool at the bottom of the Salsah movie player (SMP). On the right-hand side, we can see the result of the transcription: the sequence protocol. The figure is showing just a simple example. The researcher can define the columns of the protocol by himself. Through the RDF triple store in Knora it is possible to have the metadata depending on the research question. At the end, it should be possible to export this table based sequence protocol as shown or like a subtitle file to reuse it with other media players.

At the moment, more than twenty projects are using Salsah / Knora and two projects are working already with the old Salsah movie player:

One partner is the swiss society for folklore and their collection about 10,000 pictures and one hundred documentary movies. There are many movies and pictures with the same topic. For example old crafts. Here we're bringing the different media – pictures and movies – together and connect them with a short description, to find them better and quickly.

The second project is an ethnographic one, with a lot of pictures, movies, interviews and a dozen diaries from Bruno Manser – an ethnologist and environmental activist. Bruno Manser is missing and presumed dead. He was last seen in May 2000 in the isolated village of Bario in the Malaysian state of Sarawak. His very interesting recordings are managed by the Bruno Manser Fund in Basel. They are all digitised and will now been organised by Salsah / Knora.

With the creation of the new Salsah Movie Player in summer 2018, a third project will start using Salsah / Knora. It would be collaboration with the Metamedia center at the EPFL in Lausanne. We will connect Knora with their petabyte storage system from the Montreux Jazz Digital Project: 5,000 hours of video, also 5,000 hours of audio recordings and 4,000 documented concerts, which provide the A/V media as a kind of metadata.

Conclusions

Ten years ago we started the development of a virtual research environment (VRE) for an art history project. This VRE (called Salsah) had an open concept from the beginning, which allowed us to expand the platform for other disciplines than the art history. Salsah – the system for annotation and linkage of sources in the humanities – is grow enormously and is used today by more than twenty projects from different disciplines in the humanities.

Thanks to the high acceptance and the possibility of long-term availability of data and media files, the platform has been used for the newly established Data and Service Center for the Humanities (DaSCH) since January 1st 2017. The DaSCH is a member of the Swiss Academy of Humanities and Social Sciences and is payed by the Swiss government. We are a small team of about six person in Basel and two person in Lausanne and we are developing the three described main tools: Knora API framework, Sipi media server and the generic user interface Salsah.

With these tools it should be possible to fulfil the goals of the DaSCH, which are "long-term curation of research data", "permanent access and reuse" and "services for researchers to support data life-cycle management". And "the main task of the institution is to operate a platform for humanities research data that ensures access to this data. In addition, the networking of data with other databases is to be promoted (linked open data), thus creating added value for research and the interested public." [7, 8]

Thanks to Knora and the integration of resource description framework (RDF), it is possible to easily incorporate the different data from the various disciplines in the humanities. The connection to the RESTful application programming interface (API) of Knora makes the data accessible from everywhere, when the user has the permission to access them. A modular user interface, such as Salsah, makes it facile to expand the functionality and to share those modules for other web based presentation interfaces. We're looking forward to the further development of the various tools and the inclusion of new data sets that contribute to the preservation of digital research data.

References

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Author Biography

André Kilchenmann studied cultural anthropology, media studies and computer science at the university Basel. During this time, he worked at the museum of cultures in Basel and at the data center of the university. His interests are photography, design and digital work in general. 2016 he completed the PhD studies and is working now for the Data and Service Center for the Humanities DaSCH.

Lukas Rosenthaler studied physics and astronomy in Basel and received his PhD also there. He worked as a Postdoc at ETH Zürich. He wrote his habilitation in the humanities department of the university of Basel about long-term archiving of digital data. Since 2012, he's the head of the Digital Humanities Lab and since 2017 he's the director of the Data and Service Center for the Humanities DaSCH.