Signbank: Software to Support Web Based Dictionaries of Sign Language

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Abstract

Signbank is a web application that was originally built to support the Auslan Signbank on-line web dictionary, it was an Open Source re-implementation of an earlier version of that site. The application provides a framework for the development of a rich lexical database of sign language augmented with video samples of signs. As an Open Source project, the original Signbank has formed the basis of a number of new sign language dictionaries and corpora including those for British Sign Language, Sign Language of the Netherlands and Finnish Sign Language. Versions are under development for American Sign Language and Flemish Sign Language. This paper describes the overall architecture of the Signbank system and its representation of lexical entries and associated entities.

Keywords: sign language, lexical database, dictionary, web application

1. Introduction

Auslan Signbank [1] is an on-line dictionary for Australian Sign Language (Auslan) and is the latest in a long series of lexical resources for Auslan developed by Trevor Johnson and others. Beginning with a Filemaker Pro database (Johnston, 2001), the Auslan lexical database has been developed as a resource to inform the study of Auslan and the annotation of a corpus of Auslan video recordings (Johnston, 2008).

The original web-based version of Auslan Signbank was implemented commercially using Microsoft SQL Server which incurred a significant ongoing cost and meant that any changes to the data had to be made via contract with the developers. The current version of Auslan Signbank is an open-source re-implementation of the original website, with features added to allow updates to the database by researchers. Once this was implemented, the web based Auslan Signbank became the primary version of the dataset, removing the need to maintain the Filemaker Pro database. The various Signbank websites support a range of users interested in sign language. In some cases, a public facing dictionary of sign language is presented with a search facility allowing users to find sign videos matching keywords. Registered users can also provide feedback to the Signbank editors about missing signs or errors in the existing sign entries. In this way, Signbank acts as a resource for the deaf community to help build a shared dictionary of the language.

Another class of users are researchers who are interested in using Signbank as a lexical resource in their research or in contributing to the rich lexical models in the dictionary. These researchers are able to see a much richer set of data than the public view and can use an advanced search facility over the data. Some researchers provide detailed feedback on the signs to the editors and can help in the construction of sign entries. A further set of users are the editors of Signbank who can create new signs and upload videos associated with them. Overall, this forms a rich community of sign language users collaborating to build a resource to support their language.

Since the Signbank software is an open-source project (distributed under a 3-clause BSD licence), it can be re-purposed and extended by other projects. The software now forms the basis of three additional dictionaries with more in development. The goal of this paper is to describe the architecture of the Signbank software and the changes that have been made by the other projects. While there have been publications on the language resources themselves in the past, this is the first publication about the software system that underlies these resources.

2. The Signbank Application

The Signbank application is written in Python using the Django web application framework (Django Software Foundation, 2017). Django is a modern, widely used framework that provides a high level of support for building web applications based on complex data models. The choice of implementation environment was based on the widespread use of this environment and the consequent support for hosting these applications and the ease of finding developers with the appropriate expertise to maintain and extend the software. Django is actively maintained as an Open Source project and has frequent security updates that help to ensure that the Signbank application can be deployed safely on the web.

Django has many useful features built-in, including an object-relational mapper (ORM), extensible admin inter-

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[1]http://auslan.org.au/

Sign Number	ID Gloss	Annotation ID Gloss	Morphemic Analysis	Tags
15640	Adelaide1a	ADELAIDE		• lexis:proper name • lexis:signed english • phonology:onehand • semantic:city
19390	Adelaide1b	ADELAIDE	Adelaide1a-HND	• b92:directional • lexis:proper name • lexis:varlex • phonology:onehand • semantic:city • workflow:problematic
100025	adenoids	ADENOIDS		• semantic:health • workflow:problematic

Figure 1: A screenshot from the sign search interface in auslan.org.au showing various fields associated with the Gloss and a number of Tags.

face, static files management, and internationalisation and localisation framework allowing translation of the application into multiple different languages. There are also a wide range of third-party packages for Django that can be used to provide parts of the Signbank service - for example, user management and web page design support. The ability to combine these packages with the core Signbank dictionary applications saves a lot of effort in deploying a complete web application.

2.1. Lexical Model

At the core of the Signbank dictionary is a lexical model that supports various levels of description of the signs in the language.

In the earlier FileMaker version of the dictionary, each sign was stored as an entry in a single table with a very large number of properties. This structure had been developed from the earlier CDROM dictionary and was added to as new descriptive properties were developed for the dictionary. The current model was developed as a normalised version of this table to allow, for example, an arbitrary number of keywords and definitions to be associated with a sign.
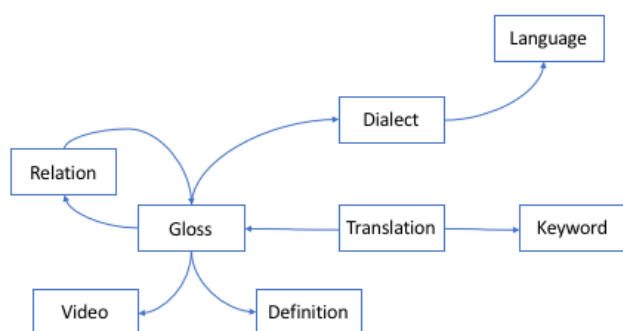

Figure 2: The entities in the Signbank data model.

The central entity in the data model is the sign, represented by the *Gloss* model; the model name reflects the central use of the dictionary to inform the annotation of sign language corpora, each lexical entry is associated with a textual gloss that is used in annotation. Each lexical entry has a unique identifier, the *IDGloss* which can be used to refer to this entry. A second *Annotation IDGloss* is the gloss used in

annotation and may be shared by one or more lexical entries that differ in form in only minor or insignificant ways.

A Gloss has a number of descriptive properties that are used to describe the sign from a morphological and phonological perspective (Johnston, 2001).

Each Gloss can have an associated *Sign Number* that is optionally used to define the ordering of the entries in the dictionary. If the sign number is assigned to every sign, then the user can traverse the dictionary in sign number order to find signs that are near each other in the dictionary.

Relationships between signs can be represented using the *Relation* model to represent a named link between two gloss entries. New relation names can be defined as part of the dictionary. Common relations are *synonym*, *homophone* and *variant*.

As an example, in Fig. 1 two signs are shown with the Annotation IDGloss *ADELAIDE*, each with a different ID-Gloss identifier. In this case these are *variants* of a single sign (and will be linked with the variant relation).

A Gloss represents a single entry in the dictionary but may correspond to one of a number of alternate *senses* of a sign. In this case the same surface form (sign) has a number of meanings (homophony) and each is recorded as a separate Gloss entry. Each sense has a different sense number and senses are related to each other via the *homophone* relation. To provide a search facility for the online dictionary based on words, each gloss can have one or more *Keywords* associated with it via the *Translation* model, in English or any other spoken language with an orthography. These keywords are intended to be the most common English translations for each sign. Each sign can also have one or more *Definitions* associated with it. Again, these definitions are written language definitions of the meaning of the sign for presentation in the dictionary view. Definitions can be recorded with different roles, for example *as a noun*, *as a verb or adjective* or *as a question*. In general, the definition can hold any text that should be associated with the sign, so it has also been used for lexicographic notes which would not be shown on the public view.

Each Gloss can have an associated *Video* instance that contains a video showing the sign. The Video model is a simple wrapper around a stored video file, but supports versioning of videos uploaded to the dictionary; new versions of videos can be uploaded but the old versions are maintained

for reference.

To allow further descriptive properties to the dictionary, Signbank supports adding *Tags* to Gloss entries (see examples in Fig. 1). Tags can be arbitrary text strings but in the application, a pre-defined set of tags is defined to give a controlled vocabulary that can be used in a particular instance of Signbank. Tags can be used for different purposes, for example, Auslan Signbank uses tags to define semantic categories such as health, education and sports related signs, but also some phonological and morphological properties. Tags can also be used for dictionary workflow purposes (as in NGT and FinSL Signbank), for example tagging signs that need to have videos recorded or reviewed, or whose phonological description needs double-checking.

2.2. Public and Researcher Views

Figure 3: The Auslan Signbank public view for a sign.

The application provides two views of the dictionary; a detailed view for sign language researchers and a more restricted view for the general public.

The public view provides a keyword search facility that allows users to find signs based on their written translations. Each sign is presented as a single page with the sign video featured prominently (Fig. 3). Sign definitions and dialect information is presented on these pages. If sign numbers are used in the dictionary, users can navigate backwards and forwards in the dictionary. If more than one sign matches a keyword, the user can navigate between these matches.

Logged in users can also provide various kinds of feedback on the entries in the dictionary. Feedback can be from the general public, reporting errors or omissions from the dictionary, or from interpreters or researchers providing feedback as part of a review process. Feedback is visible to the editors and publishers of the dictionary.

The researcher view (Fig. 4) is available only to certain users assigned to different user groups (e.g. editors, researchers, interpreters) with various levels of access to browse and update the dictionary. The researcher can view

displays the full set of data associated with each sign, including phonological and morphological descriptors, definitions and relations to other signs. If users have permission, they can edit the entry for a sign and upload new video clips.

Researchers also have access to a rich search facility where signs can be located via any aspect of their description. This includes search by keyword, IDGloss, tags and textual search within definitions and notes.
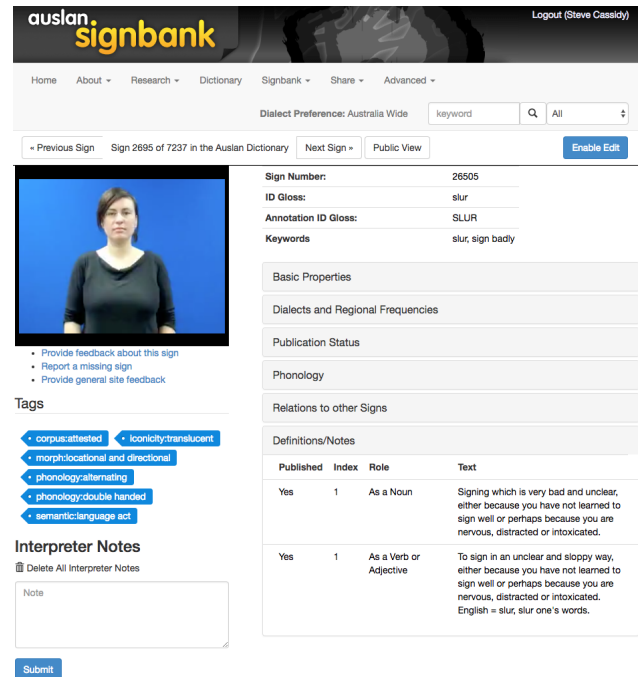

Figure 4: The Auslan Signbank detail (researcher) view for a sign.

3. Open Source Development

As previously mentioned, the release of the Signbank software as open source has allowed other research groups to implement Signbank systems for other languages. These projects have run independently following their own research goals and so have diverged somewhat in the features that each has implemented. Unfortunately, this has meant that there are now three distinct versions of the software with different feature sets; however, the three groups are now planning to collaborate where possible and have established a shared organisation on Github[2] to facilitate this. This section gives an overview of the major new features that have been implemented by the two new projects.

3.1. Datasets

FinSL Signbank introduced and and NGT sigbank later adopted the concept of a *Dataset* as a container for a collection of *Gloss*es Fig. 5. This among other things allows a single Signbank instance to be used to store lexicons for multiple languages at once. Now several research groups can work under the same Signbank seamlessly, permissions are controlled per Dataset in order to allow user access to

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[2] https://github.com/signbank

the glosses of each corpus lexicon. Datasets are also used to control the publicity of the data, Datasets can be set to be public or private, and the glosses can be marked published in order to show them in the public version of the site.

A Dataset can be associated with a *SignLangauge*, and with multiple written *Language*s in order to select the translation equivalent languages of the glosses of a Dataset.
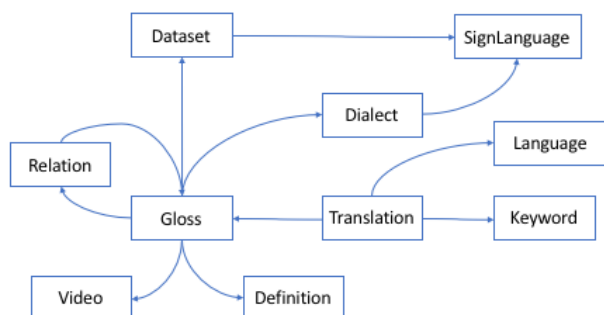

Figure 5: Signbank lexical model extended with Datasets.

This is an important step towards the production of a *Global Signbank* that would be capable of handling a wide range of sign languages in a single lexical database.

3.2. ELAN Export

NGT Signbank implemented and FinSL Signbank later adopted facilities for exporting of lexical information from Signbank to the ELAN annotation tool (Max Planck Institute for Psycholinguistics, 2017) as an external controlled vocabulary (ECV). This can make annotating corpus videos faster and more reliable as annotators are able to easily refer directly to lexical entries from Signbank as they work in the ELAN environment.

On top of that, NGT Signbank has implemented an application programming interface (API) for accessing additional gloss data and gloss media. This API can now be used as a so-called 'lexicon service' in ELAN (from version 5.0.0b on). It lets the user view gloss videos from Signbank in the ELAN annotation panel and display a subset of the fields from Signbank in the Lexicon tab in ELAN. The functionality is explained in more detail in a screen-cast (Crasborn, 2017) and in the ELAN manual.

3.3. Morphology in NGT and ASL Signbank

A number of additional functionalities have been created for NGT Signbank, most of which are also made available in ASL Signbank. These have led to an enriched model of morphology that is represented in Figure 6.

In addition to accounting for sequential compounding by referring to sequences of other glosses, the model accounts for 'simultaneous morphology': bound morphemes like handshapes or locations that have their own form-meaning pairing and that recur in various signs. The phonology section has been extended not just with a number of additional fields at the gloss level (see section 4.), but also with a separate specification of handshapes into their constituent features in terms of the phonological model for NGT (**?**).

Some further linguistic issues related to NGT Signbank are discussed elsewhere (Crasborn et al., 2016).
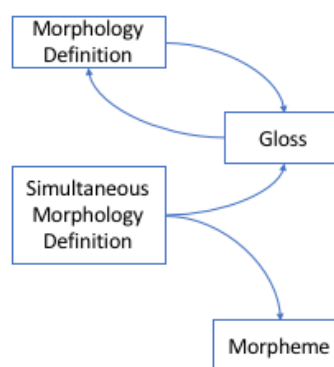

Figure 6: The NGT Signbank model of Morphology.

3.4. Interface changes in NGT

At the level of the user interface, a Variant View has been added, which is a detail view for a sign that lists any relations to other signs: signs with the same Annotation ID Gloss before the suffix (e.g. DOG-A, DOG-B, and DOG-C), which are usually regional variants, and as such, synonyms across regions; signs with a semantic relation (e.g. synonym, homonym, hypernym) specified as a relation to another Annotation ID Gloss; and finally, minimal pairs (which are based on a single field difference within a subset of all the phonology fields). This Variant View facilitates navigation between signs in the database, and helps improve the quality of the phonological description. To further promote the latter, a special warning in the Detail View of a sign highlights forms that have the same phonological description but are not explicitly marked as homophones, and vice versa, signs listed as homophones but which do not have the same phonological description.

3.5. Extensions for FinSL

Development of FinSL Signbank started in May 2015 based on the NGT Signbank. The aim was to make it possible to translate the interface into multiple languages, allow hosting of several corpus lexicons in the same Signbank, and make it possible to export Glosses from Signbank into ELAN (Salonen et al., 2016).

The current version of FinSL Signbank, as of February 2018, has many differences to Auslan Signbank. For instance, the user interface has been made translatable using Django's internalisation and localisation features, currently the interface is translated in Finnish and English. Due to the need for having translation equivalents in several written languages, the translation model holds information about the language. This addition makes it possible to have *Translation* equivalents in multiple *Language*s for one sign, not just in English. The way translations are represented can also be modified, translation equivalents can be grouped according to a set of rules in order to make it possible to have more dictionary like way of representation of translation equivalents.

The public version of the Signbank has been completely remade for FinSL Signbank, with focus on allowing users to access the videos with less effort. The search results list

shows the videos and the videos can be directly viewed on the search page, while the search hits are highlighted on the page.

It is possible to have multiple videos per Gloss, so the users are free to determine their conventions and are not limited to only one video per Gloss. To speed up the annotation process, a feature was added to allow capturing videos directly in the browser via webcam. With this feature annotators can quickly record a video for a new gloss, making it possible for other annotators to recognize the form of the sign from the video.

Other features currently only present in FinSL Signbank include a commenting feature and notifications. Since the introduction of commenting, the users have started organizing the workflow of annotation via Signbank. The commenting is strictly for users using the detailed view. The Auslan Signbank Feedback application also provides the ability to comment, in a slightly different manner. Notifications were added to make it possible to mention other users in comments so that they will surely see them. A separate view for searching *Relation*s has been implemented, and relations and reverse relations are also shown on gloss pages. To help with tracking changes to Glosses it is possible to view the changes in an easy to read format directly on the *Gloss* page. Tags are utilized in many places, to make it easier to add the relevant tags to each object, a feature was added to control which tags can be used for which types of objects.
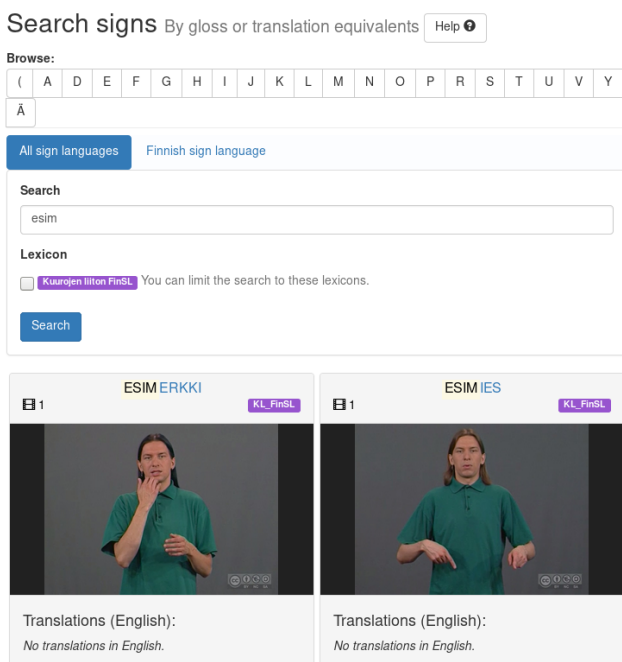

Figure 7: Public search of FinSL Signbank.

3.6. Video Definitions in Auslan

A recent addition to the Auslan Signbank is the ability to associate videos with the definitions of signs. This relatively minor change allows for the first time a sign language native dictionary to be produced in Signbank. Sign definitions can be created and published in the native language of the
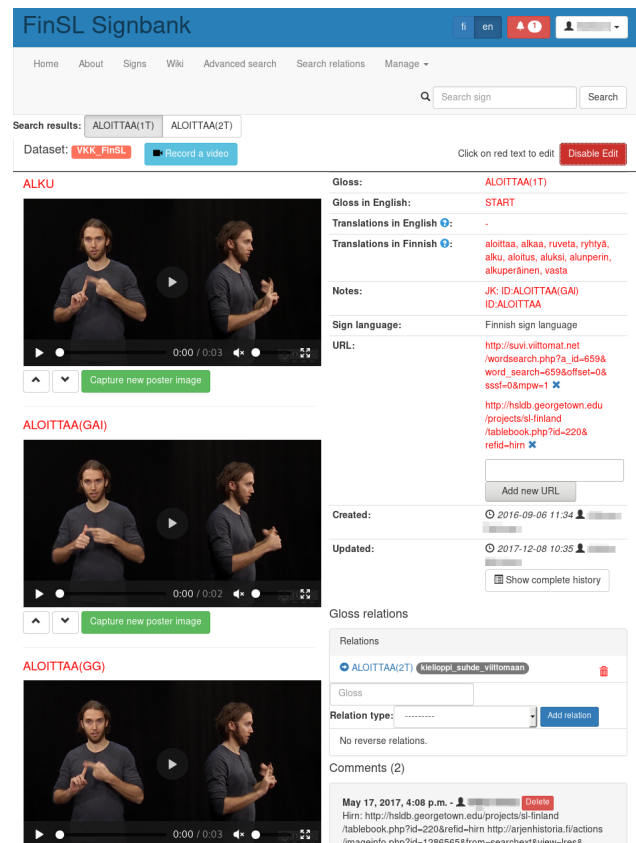

Figure 8: Detailed view of FinSL Signbank with edit mode on.

dictionary, rather than in a written language. Work is now underway to create video definitions for Auslan signs.

4. Areas of divergence in linguistic descriptions

The differing goals of the various research groups that have given rise to the different Signbanks have resulted in some differences in the linguistic description of signs, in particular in relation to the phonological form of a sign. In addition, there are multiple phonological models in the linguistic literature that have resulted in differences in how the phonological form of signs is described (see e.g. (Corina and Sandler, 1993). Where, for the NGT Signbank, one of the aims is to enable research on the phonological system of sign languages, for the Auslan, FinSL, and ASL Signbanks, the central goal is to provide a short phonological characterisation of a sign that enables dictionary users to search for signs by major parameters like handshape and location. These differences inevitably lead to big differences in how many fields are needed to specify the phonological form. In order to make data sets compatible, ongoing work is trying to identify exactly what the overlap between the different ways of describing the form a sign is, and where perspectives differ.

5. Collective Development

Development of the Signbank software has been divergent so far because of the requirements of funding to produce

specific features in different versions of Signbank. This has resulted in three incompatible code-bases with significant overlap and the need to 'port' features already in place in one of the other projects. Over the past year, we have been discussing how the projects might collaborate more closely to ensure that effort can be shared between them rather than duplicated. This has led in the first instance to the establishment of a shared Github organisation[3] that hosts all of the project's source code.

One step towards a more collaborative development model has been the work done on the Auslan Signbank project to modularise the Signbank application. While the original version was a Django project consisting of a number of sub-modules, these were closely linked and inter-connected such that all were needed to build the application. The most recent version of the Auslan Signbank consists of separate applications for the dictionary, video handling and user feedback. Each of these is independent and can be developed and tested on their own. One early goal is to have the three Signbank project share at least the video handling module so that they can take advantage of each other's work in this area - for example the work done by FinSL on in-browser video recording.

One of the biggest areas of difference, as described above, is the representation of linguistic descriptions in each system due to the divergent goals and theoretical positions of the linguists driving these projects. From a software perspective, the challenge is to develop models that would allow any of these forms of description within the same framework. This is challenging in particular because all of the funding for development of this software comes from one or other group. However, the developers are now engaging in discussions about how the projects might collaborate more closely and the increased level of communication can only help this effort.

6.   Conclusion

This paper has presented the Signbank software that manages online dictionaries of sign language. Starting from a single system for Auslan, the software now supports a range of languages and has three active development groups. The three groups have diverged somewhat partly based on the linguistic drivers behind their different projects. Future collaboration will hopefully see more shared components being developed to enhance this significant software project.

7.   Acknowledgements

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ASL Signbank, `https://aslsignbank.haskins.yale.edu`
FinSL Signbank, `https://signbank.csc.fi`

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[3]`https://github.com/signbank/`