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NEW Shared & Interconnected ASL Resources: SignStream® 3 Software; DAI 2 for Web Access to Linguistically Annotated Video Corpora; and a Sign Bank

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Abstract

2017 marked the release of a new version of SignStream® software, designed to facilitate linguistic analysis of ASL video. SignStream® provides an intuitive interface for labeling and time-aligning manual and non-manual components of the signing. Version 3 has many new features. For example, it enables representation of morpho-phonological information, including display of handshapes. An expanding ASL video corpus, annotated through use of SignStream®, is shared publicly on the Web. This corpus (video plus annotations) is Web-accessible—browsable, searchable, and downloadable—thanks to a new, improved version of our Data Access Interface: DAI 2. DAI 2 also offers Web access to a brand new Sign Bank, containing about 10,000 examples of about 3,000 distinct signs, as produced by up to 9 different ASL signers. This Sign Bank is also directly accessible from within SignStream®, thereby boosting the efficiency and consistency of annotation; new items can also be added to the Sign Bank. Soon to be integrated into SignStream® 3 and DAI 2 are visualizations of computer-generated analyses of the video: graphical display of eyebrow height, eye aperture, and head position. These resources are publicly available, for linguistic and computational research and for those who use or study ASL.

Keywords: American Sign Language (ASL), linguistically annotated video corpora, annotation software, sign bank

1. Introduction

We report here on several new, interconnected, publicly shared, resources for linguistic and computational analysis of video data from American Sign Language (ASL), developed in conjunction with the American Sign Language Linguistic Research Project (ASLLRP):

- We have released in 2017 a new, improved version of **SignStream®**, the Mac OS software we have been developing for linguistic annotation of ASL video data.[1]
- The annotated corpora are then made available on the Web for viewing, browsing, searching, and downloading via a Web interface that we have developed, our **Data Access Interface (DAI) 2**.[2] The datasets can be downloaded and further analyzed using the SignStream® 3 software that is shared publicly.
- Both SignStream® 3 and DAI 2 now also provide access to a new **ASLLRP Sign Bank**, which makes it possible to view multiple productions, by different ASL signers, of signs of interest. When accessed from within SignStream®, information from the Sign Bank can also be directly entered into the annotations. Furthermore, when new SignStream® datasets are uploaded to DAI 2, the new signs—and new examples of existing signs—are readily added to the Sign Bank.

See the overview in Figure 1.

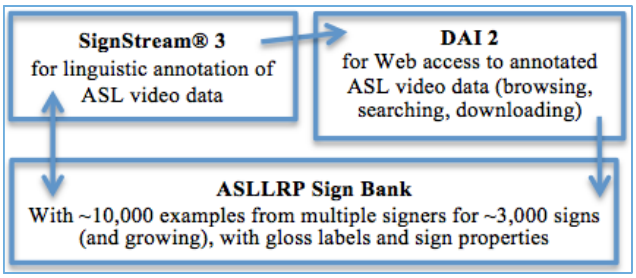


Figure 1. Publicly Shared ASL Linguistic Resources

2. Annotation Software

SignStream® 3 is a Java-based reimplementation of the original Mac Classic software (Neidle, Sclaroff, and Athitsos, 2001; Neidle, 2002), designed for linguistic annotation of video data. SignStream® provides an intuitive interface for labeling and time-aligning manual and non-manual components of the signing. SignStream® 3 has many new features. For example, version 3 enables encoding of morpho-phonological information, including sign type (lexical, fingerspelled, etc.) and number of hands. Handshape information is annotated through use of palettes (specifically for ASL handshapes), and start and end handshapes are displayed as icons left- and right-aligned with the corresponding gloss label; see Figure 2. It is also possible to scroll continuously from one utterance to the next. Version 3 also allows for multiple annotation tiers, well-suited to analysis of dialogs; see Figure 3.

This new Open Source version, released in 2017, is available from http://www.bu.edu/asllrp/SignStream/3/ and requires MacOS 10.8 or higher. For further details about functionalities, see (Neidle, 2017).

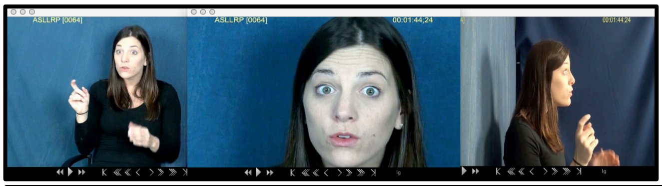
3. Interfaces for Web Access to Corpora

We previously developed a Web-based **Data Access Interface (DAI)**[3] for sharing our ASL video corpora created with SignStream® 2. The DAI facilitates browsing, search, and download of the data (Neidle and Vogler, 2012). The DAI was extended to provide access as well to the **American Sign Language Lexicon Video Dataset (ASLLVD)**, with ~10,000 citation-form examples (of ~3,000 signs) (Neidle, Thangali, and Sclaroff, 2012).

We have recently created a new **Data Access Interface, DAI 2**,[4] because the new version of SignStream® incorporates significant enhancements to the annotations (now including handshape information, e.g.). Thus, the DAI needed to be extended for display of the richer repre-

[1] Gregory Dimitriadis is the principal developer for version 3.
[2] Augustine Opoku is the principal developer for DAI 2.
[3] http://secrets.rutgers.edu/dai/queryPages/
[4] http://dai.cs.rutgers.edu

sentations in our new **ASLLRP SignStream® 3 Corpus**. We have taken the opportunity to provide more powerful search functionalities, as well. It is now possible to search for characters in the gloss string (on the dominant and/or non-dominant hands), and type of sign (e.g., lexical, fingerspelled, classifiers, or specific types of classifier, and to restrict the search to 1- or 2-handed signs and/or signs containing a particular start and/or end handshape on either or both hands. Searches can also be restricted to particular data sources or signers. It is also possible to search for utterances that contain specific types of non-manual events (e.g., raised eyebrows) or grammatical markings (e.g., wh-question). The user can select the view (front, side, close-up of the face) and play the video of the sign or the utterance containing the sign. This is shown in Figure 4.



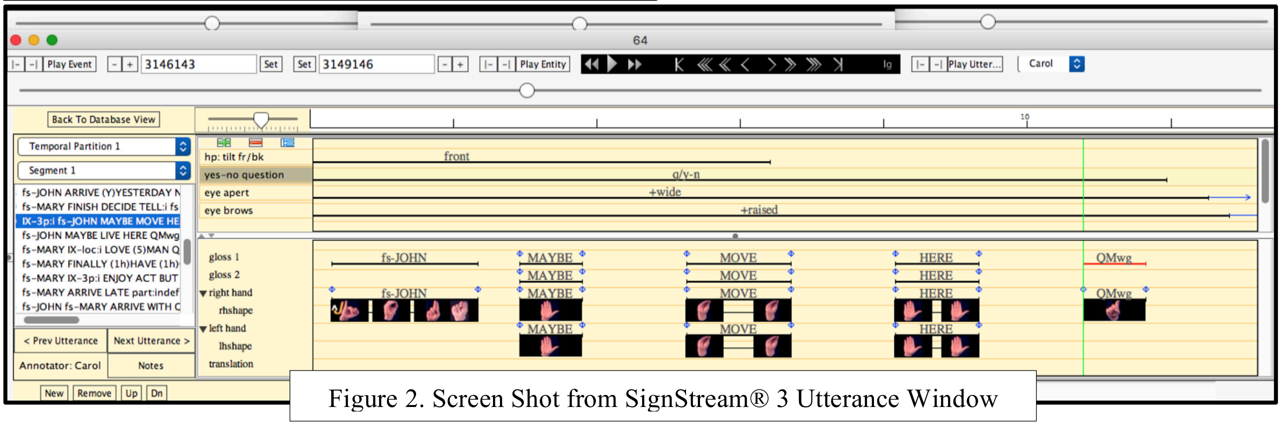


Figure 2. Screen Shot from SignStream® 3 Utterance Window

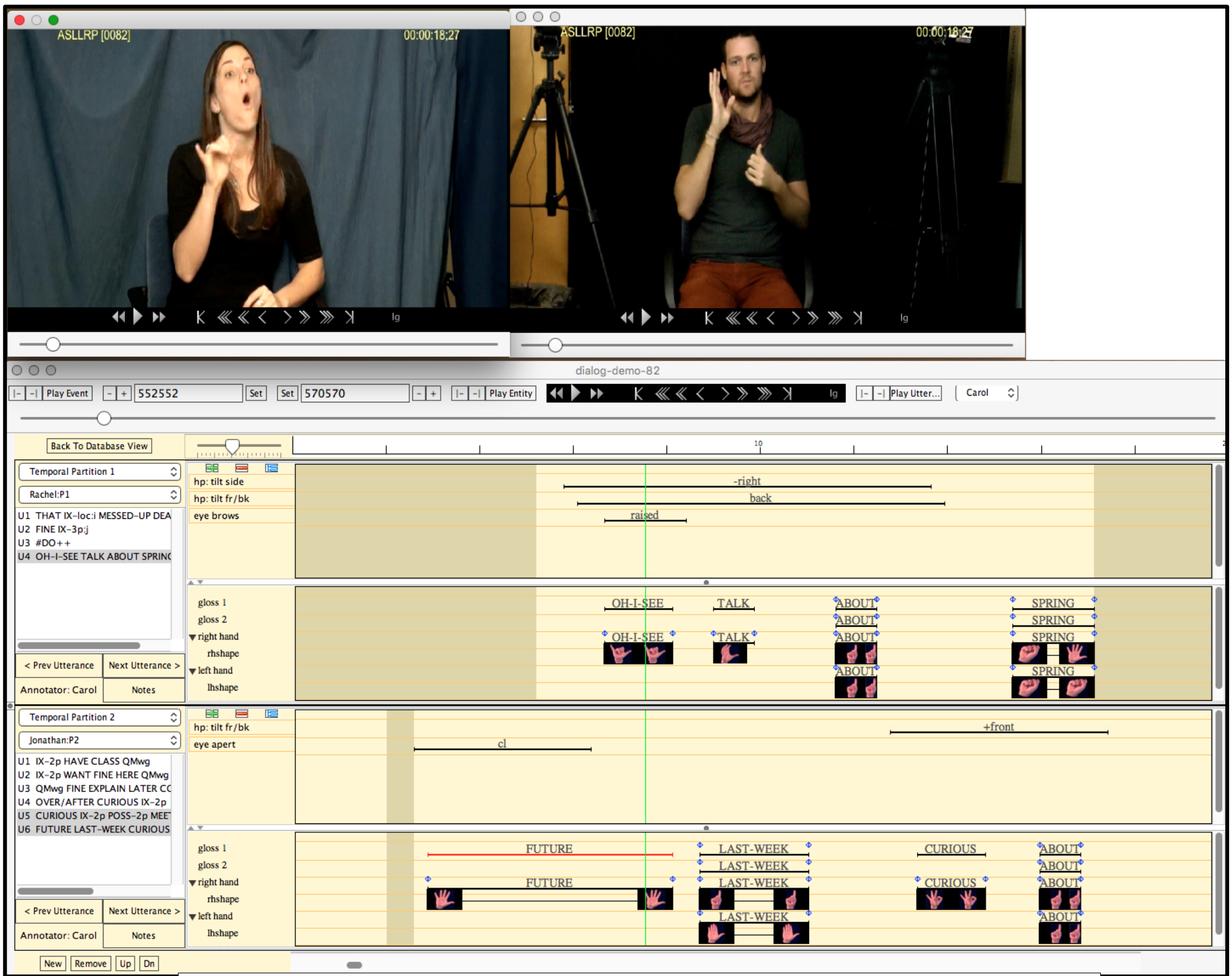


Figure 3. Multiple Tiers – Facilitating Annotation of Dialogs within SignStream®

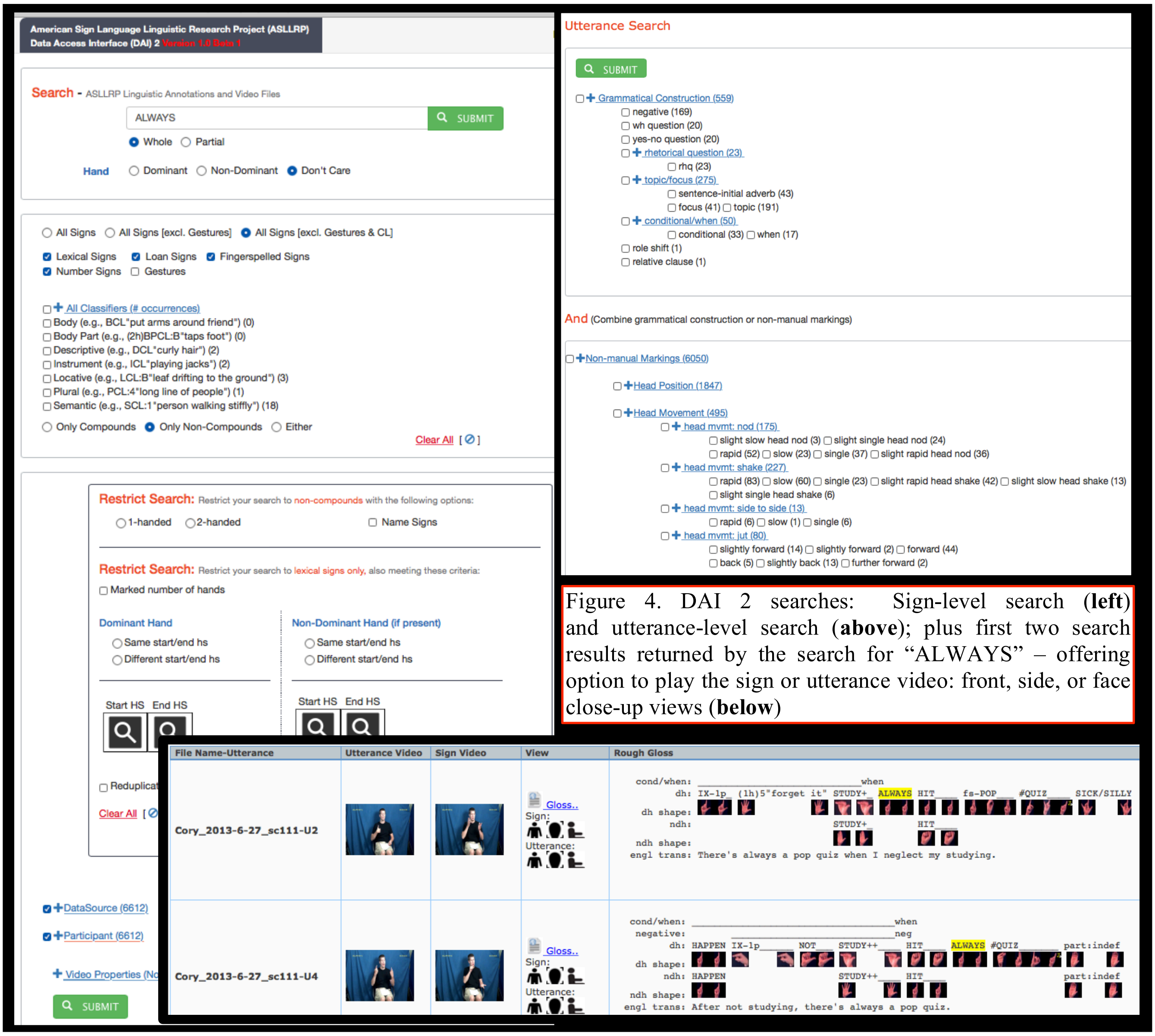


Figure 4. DAI 2 searches: Sign-level search (**left**) and utterance-level search (**above**); plus first two search results returned by the search for "ALWAYS" – offering option to play the sign or utterance video: front, side, or face close-up views (**below**)

Material of interest can be designated for download according to user preferences. The download feature gives the user the ability to add utterances or entire SignStream® files to the download cart while browsing the various search results. The user can then initiate the download of the marked items from the download page (after selecting options, such as choice(s) of video views (Front, Face, Side)). The associated components (including video files and annotation, in XML format) will then be packaged and returned to the user in a compressed format (zip). The user can save the packages and return to them at a later date. This allows users to browse and add items to the cart on a low bandwidth connection and return to download the packaged items when they are on a faster Internet connection. The user can also create a download package and share the link to it with other users who can subsequently view and download the items in that package. After SignStream® files have been downloaded, they can also be opened using the SignStream® software to allow for further exploration by the user.

4. Sign Bank

DAI 2 also provides access to a new ASLLRP Sign Bank. The Sign Bank was initially comprised of the data from the ASLLVD, the American Sign Language Lexicon Video Dataset (Sclaroff et al., 2010; Thangali et al., 2011; Neidle, Thangali, and Sclaroff, 2012), consisting of almost 10,000 examples of almost 3,000 distinct signs, in citation form. However, DAI 2 provides a simple mechanism for adding new signs to the Sign Bank as new data get added to our continuous signing corpora. Since these signs are clipped from continuous video, however, they are different in appearance from recordings of signs produced in citation form. In the future, we plan to video-record citation-form examples of the newer. Nonetheless, for the time being, this allows us to expand the collection of signs and signers in the Sign Bank and also to offer users examples of sentences containing particular signs.

Figure 5 shows a Sign Bank search via DAI 2. The user can search for a text string, and for properties of the sign, including start and end handshapes. The search results are displayed; it is possible to view any or all of the examples of a given sign, as well as the containing utterances.[5]

5. Access to the Sign Bank from within SignStream®

SignStream® users can search the Sign Bank for the sign they wish to annotate. See Figure 6 below. Thus users can ensure that the gloss label chosen is consistent with the glossing of previous examples of the same sign. Furthermore, if the desired sign is found in the Sign Bank, then it can be entered directly into the annotation with its associated properties and handshapes. The user can further edit if modifications are necessary. If the sign in question is not already in the Sign Bank, the user can add the sign to their local Sign Bank so the information will be available for subsequent annotations.

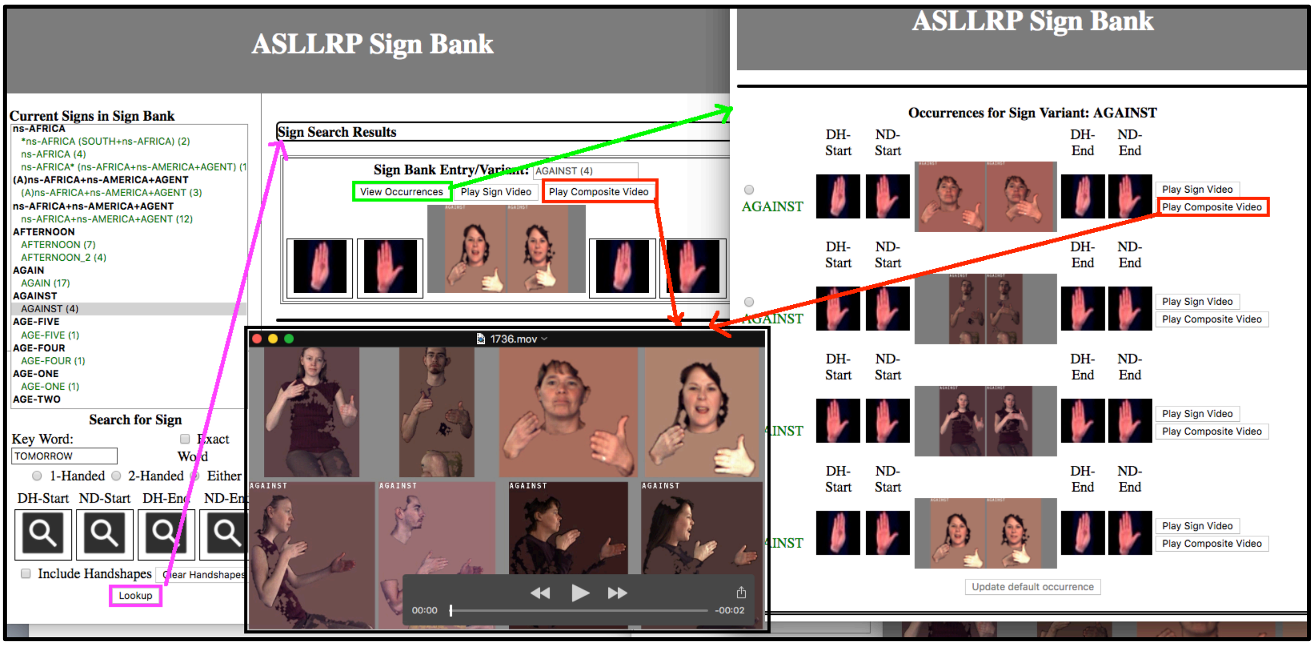


Figure 5. Sign Bank–Access from DAI 2: Sample Search for Text String AGAINST in Gloss. User can display all occurrences and play sign videos or composite video of all productions together.

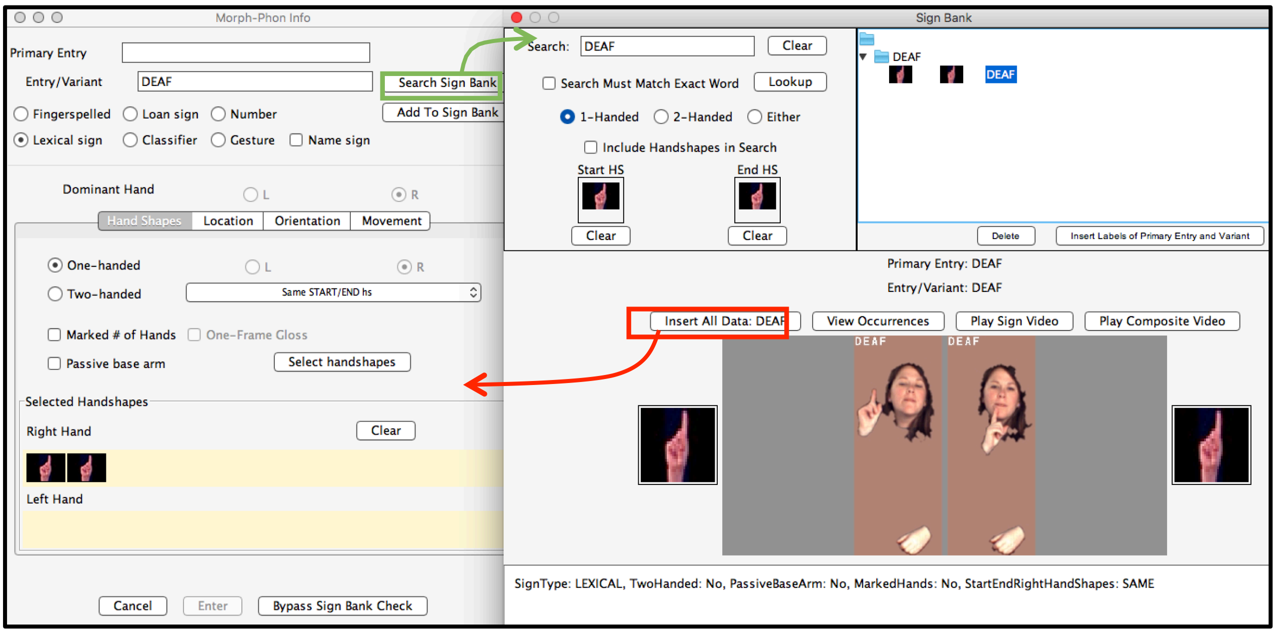


Figure 6. Sign Bank–Access from within SignStream®: Sign labels & properties can be copied directly into annotations

[5] There is another "sign bank" project under development for ASL (Hochgesang, Crasborn, and Lillo-Martin, 2017), but this is not yet shared publicly, so it is difficult to compare with ours. "Sign bank" projects for other signed languages (e.g., Auslan, BSL, NGT, FinSL, and Swiss German Sign Language (DSGS)) are somewhat different in nature from ours; they tend to be more dictionary-like (see, e.g., https://github.com/signbank/).

6. Available New Data

The **ASLLRP SignStream® 3 Corpus** is shared through the DAI 2 interface. It is an expanding collection; files are added as verifications of the annotations are completed. The corpus includes 3 different ASL signers, and the shared data (as of February 2018) include over 6,000 sign tokens, in just over 300 total utterances, from 2 signers.

The data were elicited in an open-ended way. We explained to our ASL consultants that we were interested in a wide range of different types of constructions (e.g., questions, negations, conditional sentences, etc.) and they were asked to come up with a set of sentences that were natural for them to produce. They were given no specific directions about content or structure. Subsequent signers were shown the examples produced by the earlier signers and asked to produce, in general, similar types of sentences.

7. Value for Research, Education, and Potential Future Applications

The video data and annotations have been used by our extended research team and by others for linguistic and computational research on ASL. Linguistic and computer science research by others (including students) that has made use of our data and software over the years includes, e.g., among many others: (Goldenstein, Vogler, and Velho, 2005; Vogler and Goldenstein, 2005; Zahedi et al., 2005; Zahedi, Keysers, and Ney, 2005a; b; Goldenstein and Vogler, 2006; Grossman and Kegl, 2006; Rybach, 2006; Zahedi et al., 2006a; Zahedi et al., 2006b; Ciaramello and Hemami, 2007; Davidson, Caponigro, and Mayberry, 2008; Forster, 2008; Hendriks, 2008; Roh and Lee, 2008; Vogler and Goldenstein, 2008b; a; Weast, 2008; Williford, 2008; Yang, Sclaroff, and Lee, 2009; Yang and Lee, 2010; Caponigro and Davidson, 2011; Kammann, 2012; Nguyen and Ranganath, 2012; Greene, 2013; Yang and Lee, 2013; Wolfe et al., 2014; Roush, 2015; Toman and Kuefler, 2015; Boulares and Jemni, 2016; Costello, 2016; Kim et al., 2016; Lim, Tan, and Tan, 2016b; a; Raud, 2016; Roush, 2016; Elakkiya and Selvamani, 2017; Kumar, 2017).

Our own research on computer-based recognition of manual signs and of non-manual grammatical information has also greatly benefited from use of these data, e.g.: (Athitsos, 2006; Duffy, 2007; Thangali et al., 2011; Liu et al., 2012; Metaxas et al., 2012 ; Liu et al., 2013; Thangali, 2013; Dilsizian et al., 2014; B. Liu et al., 2014; J. Liu et al., 2014; Neidle et al., 2014; Mark Dilsizian et al., 2016; M. Dilsizian et al., 2016; Yanovich, Neidle, and Metaxas, 2016; Metaxas, Dilsizian, and Neidle, 2018). Most recently, we have shown high accuracy and scalability in recognition of signs from our Sign Bank, using model-based machine learning, with incorporation of linguistically relevant features and constraints (Metaxas, Dilsizian, and Neidle, 2018). For a vocabulary of 350 signs from our Sign Bank, we achieve recognition accuracy of 93.3%. In 97.9% of the cases, the correct sign is within the top 5 results.

What this means is that we can envision development of a user interface that would allow a user to search for a sign in our Sign Bank in one of two ways: either by producing the sign in front of a webcam, or by selecting a sign by identifying its start and end points from a continuous video. The user could then be offered 5 (e.g.) likely options, in order of decreasing likelihood, with the option to play any of those signs to confirm or disconfirm the correctness of the sign identification. This is illustrated in Figure 7. The user could then be taken to the relevant information in our Sign Bank. This could also be used from within SignStream® to facilitate the annotation process, especially for signs that the user may not know how to gloss. This interface could also be used as an entryway to other ASL resources, e.g., to enable sign lookup in an ASL dictionary. We intend to pursue research to make such a lookup interface a reality.

Figure 7. Example of Choices to be Offered to a User before Confirmation of a Lookup Selection – Based on the Interface for our Current ASLLRP Sign Bank

These tools also have obvious applications to education, for those teaching/learning ASL.

8. Planned Enhancements

In addition to developing lookup capabilities just described for navigation through our own resources, we are also currently working to expand the functionalities of both SignStream® and DAI 2 to allow display of computer-generated analyses of the relevant video. In particular, we now have the ability to produce graphs from the close-up face view to illustrate changes, over time, in eyebrow height, eye aperture, and head rotation along the 3 axes. See Figure 8 and our website with examples (ASLLRP, 2016). This will provide valuable information for linguis-

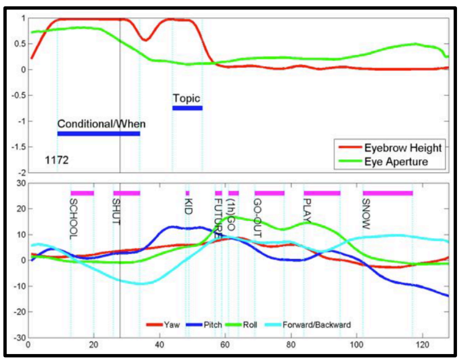


Figure 8. Computer-generated Graphical Information about Facial Expressions

tic and computational research on ASL of a kind that has not been available to date over large datasets Ultimately such technology will also enable semi-automatic transcription of sign language data.

9. Acknowledgements

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