



DATA SCIENCE
SUMMIT **ML EDITION**

Advantages and Limitations of Sign Language Corpora for Sign Language Recognition

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HearAI project



www.ml.dssconf.pl



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Warsaw + Online



Organizer:

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AGENDA

- Presenters
- Motivation
- Collected Data
- Data quality analysis
- HamNoSys annotations
- Frequency of symbols appearance
- Takeaway message
- Project & Team
- Sponsors



Presenters



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Motivation

- Deafs have limited access to information.
- Deafs cannot benefit from the services of an interpreter when contacting with doctor (also in the hospital), social worker, teacher, policeman, psychologist.
- Sign language is different compared to spoken one - Deaf learns it as a foreign language.



Scraping all data form the Internet



Phoenix

GLEX

Galex

Korpus Dict

Spread the Sign

GSL

MS-ASL

WLASL

How2Sign

Basic Lexicon

RVL-SLLL

ECHO corpus

DGS Corpus

CDPSL

Ledasila

sign2mint

Handspeak

British SL

CAVA

GSL

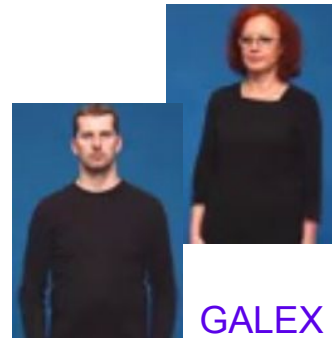
RWTH Boston

Dicto

Danish SL Dictionary

CFinSL

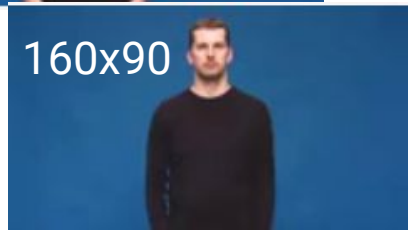
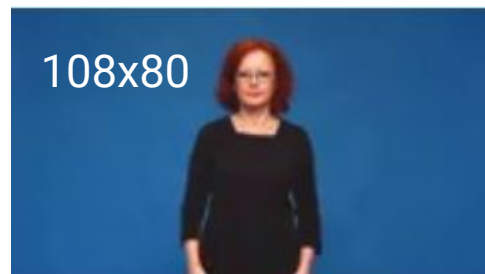
Multilingual databases



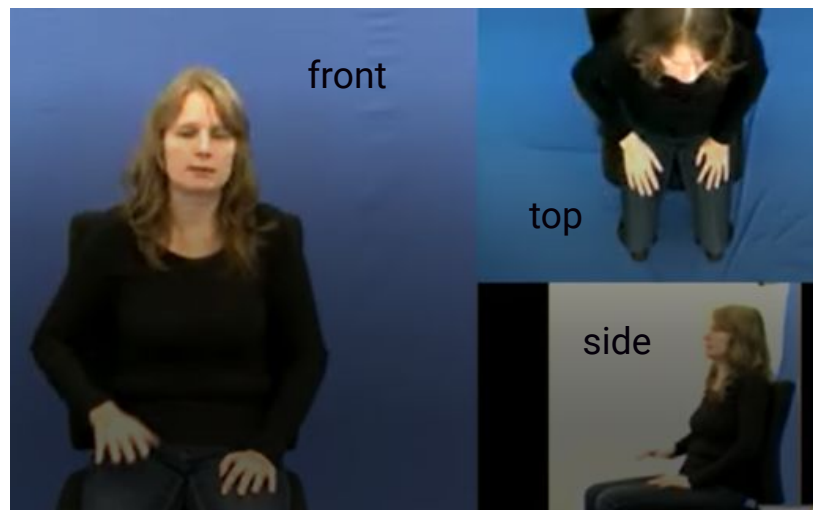
Dataset	Year	Languages	Topics	# glosses	# videos	# signers
GLEX	2004-2007	DGS	health	723	829	2
GALEX	2006-2009	DGS	landscaping	514	568	2
Basic Lexicon	2009-2012	BSL, DGS, GSL, LSF	traveling	3078	4123	6
CDPSL	2012-2014	PJM	everyday use	2480	2835	2
GSLL	2009-2021	GSL	everyday use	300	3476	2

Data quality assessment

Different resolutions

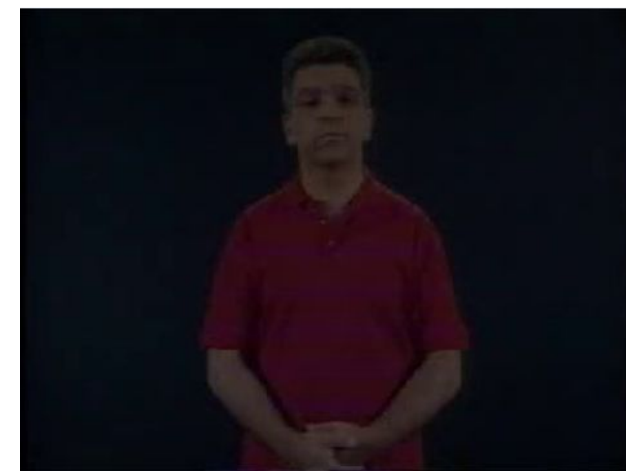


3 perspectives:
frontal, side
and bird view

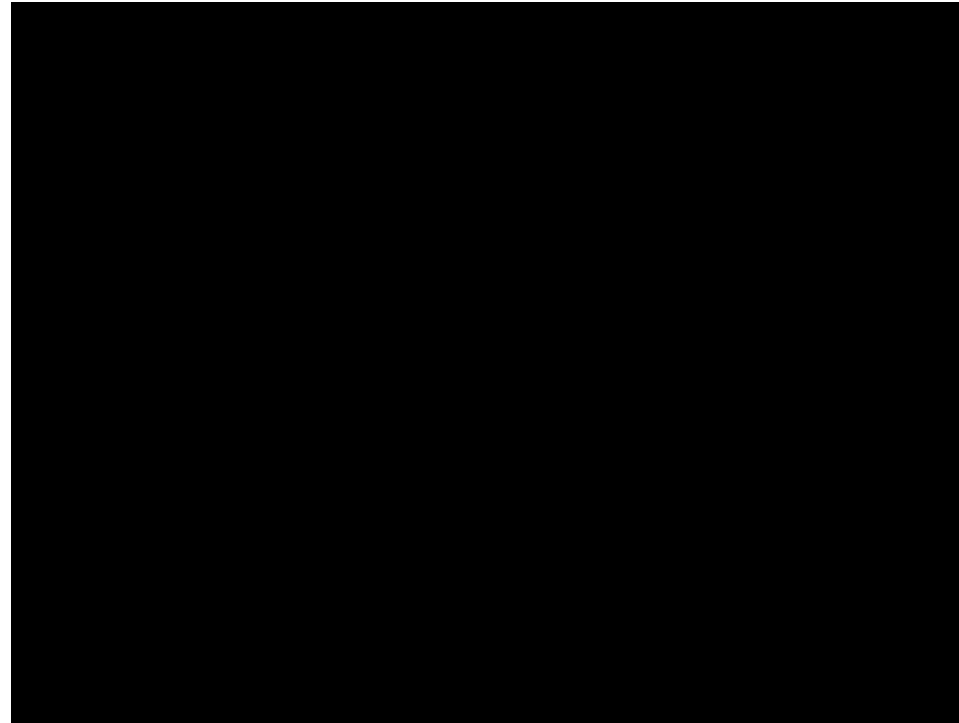


blurred,
overexposed

fade
in/out



HamNoSys



HamNoSys

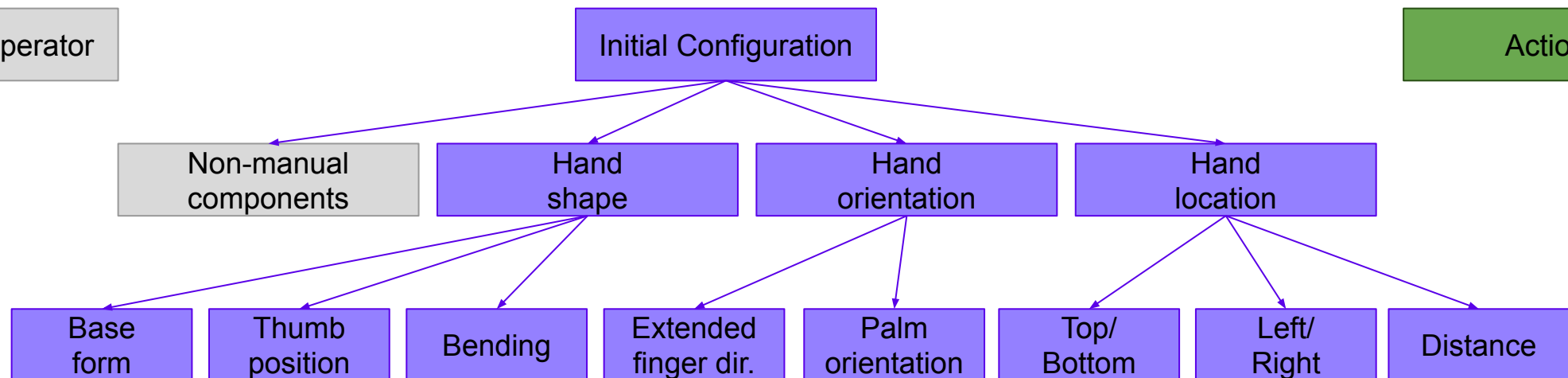


Initial Configuration



Actions

Symmetry operator



Actions

video source: <https://www.slownikpjm.uw.edu.pl/>

Base Form:

- Fist
- Flat
- ∩ Finger 2
- ∩ Finger 23
- ∩ Finger 23 spread
- ∩ Finger 2345
- ∩ Pinch 12
- ∩ Pinch all
- ∩ Pinch 12 open
- ∩ Cee 12
- ∩ Cee all
- ∩ Cee open

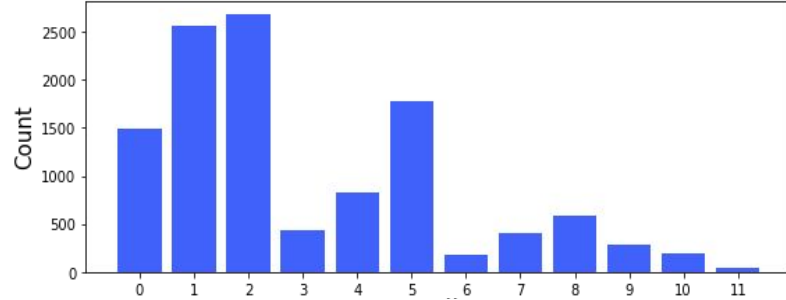
Thumb position:

- Not defined
- ∩ Thumb out
- ∩ Thumb cross
- ∩ Thumb open

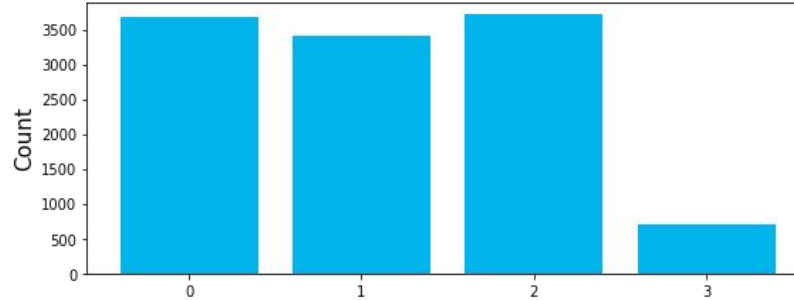
Bending

- Not defined
- ∩ Double bent
- ∩ Fingers straight
- ∩ Finger bend
- ∩ Finger hook
- ∩ Double hooked

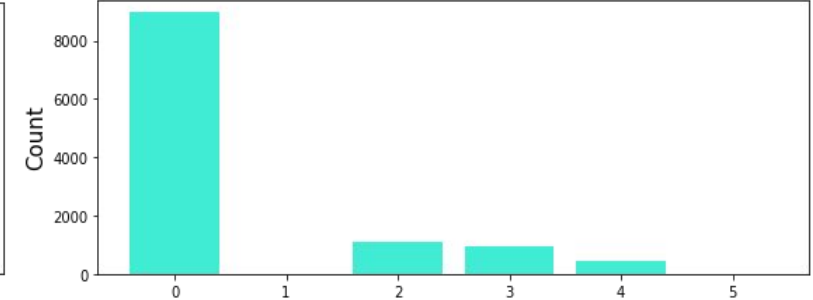
Base form



Thumb position



Bending



Signer's view:

- ^ Up
- ↗ Up right
- > Right
- ↘ Down right
- ∨ Down
- ↙ Down Left
- < Left
- ↖ Up left

Bird's view:

- △ O
- ↖ OR
- ⊥ IR
- ∨ RI
- ⊥ IL
- ↙ OL

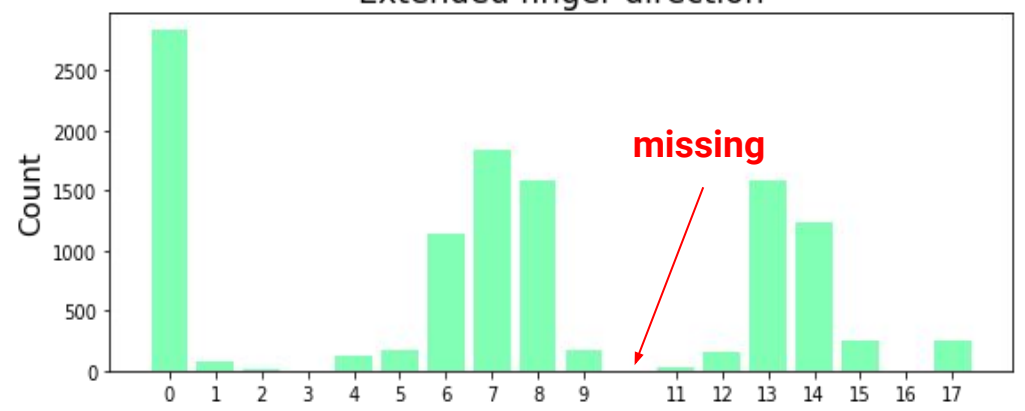
From-the-right view:

- ⊥ IL
- ⊥ OL
- ↖ UO
- ↙ DO

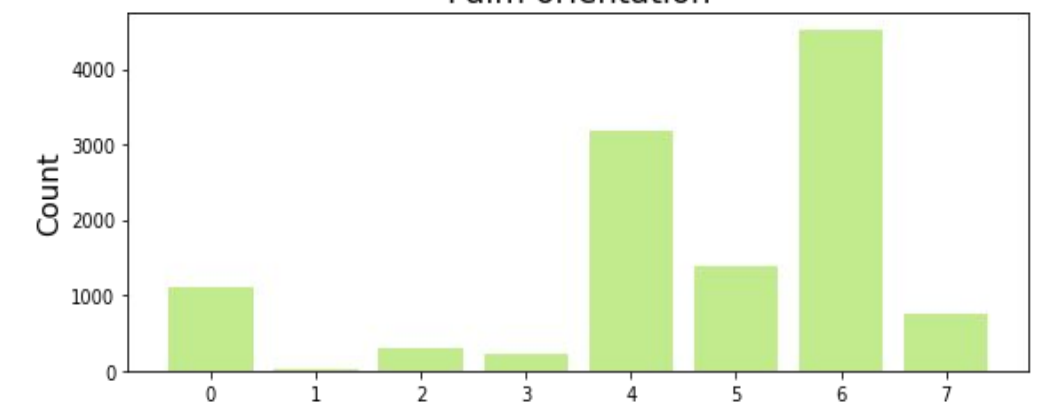
Palm orientation:

- Up
- ↘ Up right
- Right
- ↙ Down right
- Down
- ↖ Down left
- Left
- ↗ Up left

Extended finger direction



Palm orientation



Frontal plane (top/down):

- Head top
- Head
- ∩ Forehead
- ⊥ Nose
- ⊥ Nostrils
- Lips
- ⊖ Tongue
- ⊖ Teeth
- ∪ Chin
- ∪ Underchin
- ∪ Neck
- ∪ Shoulder top
- ∪ Shoulders
- ∪ Chest
- ∪ Stomach
- ∪ Below stomach
- ∞ Eyebrows
- ∞ Eyes
- ∞ Ear
- ∞ Earlobe
- ∞ Cheek

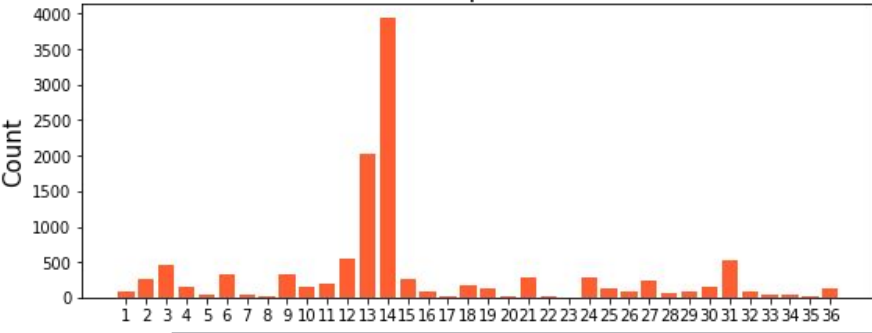
Frontal plane (top/down):

- ◌○ Left to
- ◌○ Left side of
- Center
- ◌ Right side of
- ◌ Right to

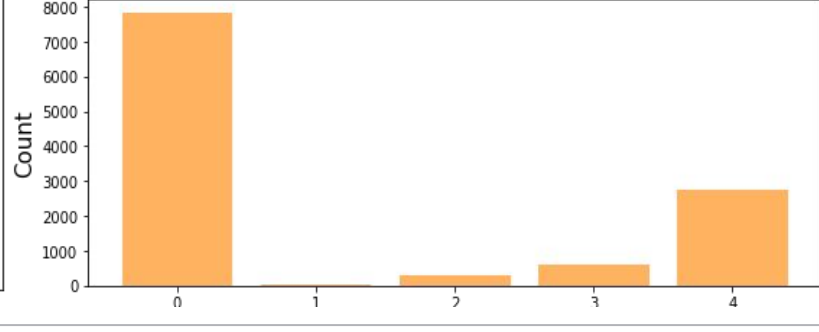
Distance from the body:

- ⌞ Behind the body
- ⌞ Contact with body part
- ⌞ Close to body part
- Standard
- ↪ Max (extended arm)

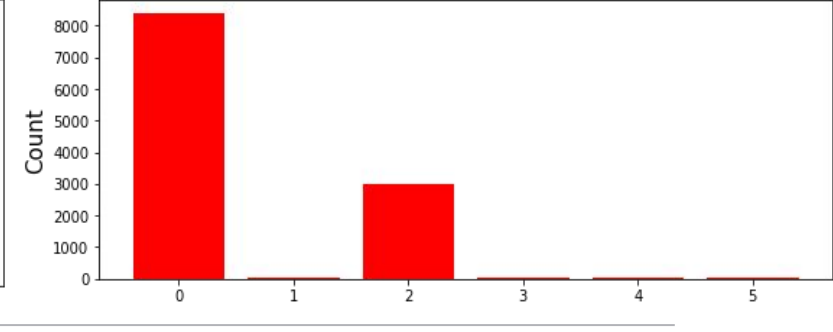
Frontal plane t/b



Frontal plane l/r



Distance

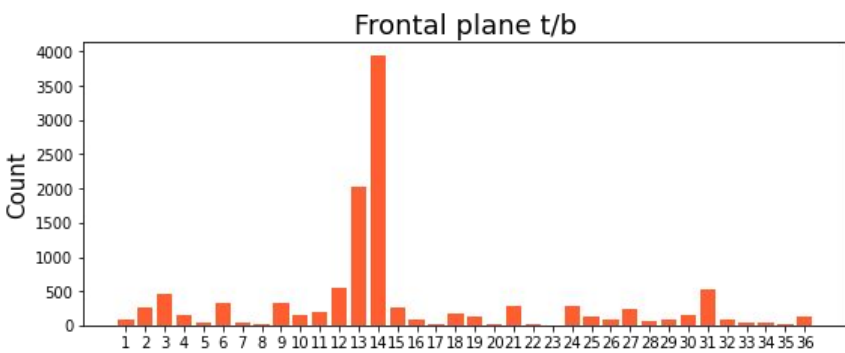


Frontal plane (top/down):

- Head top
- Head
- ∩ Forehead
- ⋈ Nose
- ⊥ Nostrils
- Lips
- ⊖ Tongue
- ⊖ Teeth
- ∪ Chin
- ∪ Underchin
- ∩ Neck
- ⊖ Shoulder top
- ⊖ Shoulders
- ⊖ Chest
- ⊖ Stomach
- ⊖ Below stomach
- ∩ Eyebrows
- ∞ Eyes
- ∩ Ear
- ∩ Earlobe
- ∩ Cheek

		Front side	Back side	Right side	Left side
∩	Upper arm	∩	∩ ↶	∩ □	□ ∩
∩	Elbow	∩	∩ ↶	∩ □	□ ∩

		Right and left hand		Right hand		Left hand	
		Hand back side	Palm side	Ulnar side	Radial side	Ulnar side	Radial side
∩	Finger tip	∩					
∩	Fingernail, Finger pad	∩ ~	∩ ~	∩ □	□ ∩	□ ∩	∩ □
∩	Middle joint of finger	∩ ~	∩ ~	∩ □	□ ∩	□ ∩	∩ □
∩	Base joint of finger	∩ ~	∩ ~	∩ □	□ ∩	□ ∩	∩ □
	Hand	∩	∩	5	1	5	1
∩	Ball of thumb	∩ ~	∩ ~	∩ □	□ ∩	□ ∩	∩ □
∩	Wrist joint	∩ ~	∩ ~	∩ □	□ ∩	□ ∩	∩ □
∩	Forearm	∩ ~	∩ ~	∩ □	□ ∩	□ ∩	∩ □

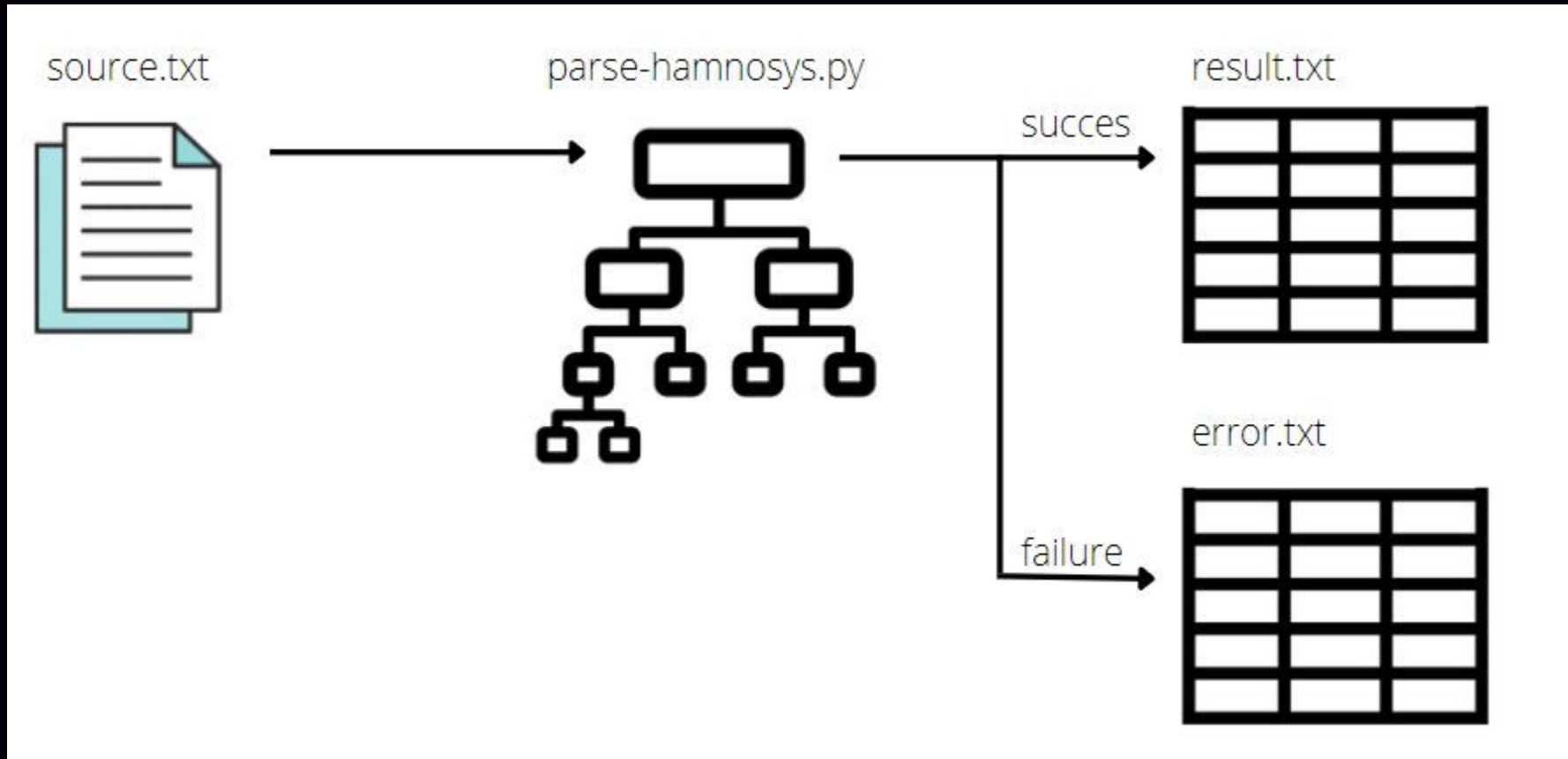


Two-handed signs

symbol flips the marked directions:	left/right	up/down	away from / towards body
⋮			
⋯	✓		
⋮ •		✓	
⋮ • •	✓	✓	
⋮ —			✓
⋮ — •	✓		✓
⋮ — • •		✓	✓
⋮ — • • •	✓	✓	✓



Encoding HamNoSys into numbers



Unanalyzed features

- **Actions:** Path movement buildings can be straight lines, curved and zigzag lines, circles and similar forms. For every movement, the hand being the default articulator can be substituted by other body parts, as the symbols appear very rare we discarded them.

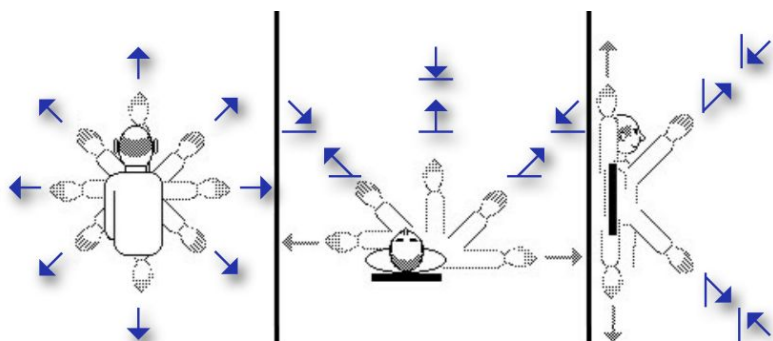
- **Non-manual components:** HamNoSys codes schemes defined for eye gaze, facial expression or mouth gestures and mouth pictures, but they were not analysed.



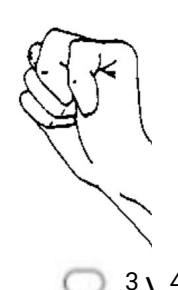
cheeks puffed



tongue pushed into cheek



- **Finger details:** In HamNoSys non default fingers are encoded by number. We skipped that part.



Backward encoding into gloss

Proposed computer-friendly numeric multilabels greatly simplify the structure of the language-agnostic HamNoSys without significant loss of gloss meaning!

Dataset	Languages	Topics	#glosses	#singly decoded	#decoding efficiency
GLEX	DGS	health	723	684	94.61%
GALEX	DGS	landscaping	514	484	94.16%
Basic Lexicon	BSL, DGS, GSL, LSF	traveling	3078	2580	83.82%
CDPSL	PJM	everyday use	2480	2259	91.09%
GSL	GSL	everyday use	300	283	94.33%

Detected incompatibility

- Initial configuration - Hand location - top/bottom



Chin



Below chin



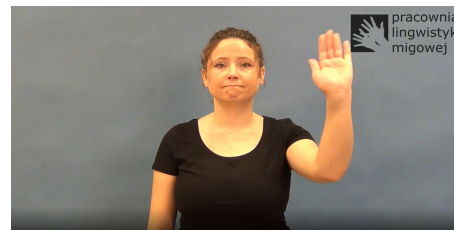
Head



Above the head



Eyes



“Wolać” (*call*)



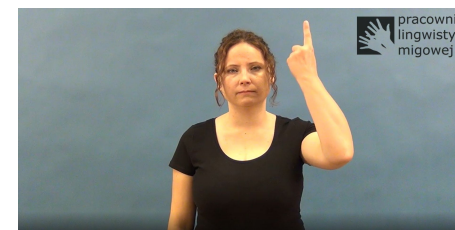
“Borsuk” (*badger*)



“Czarny” (*black*)



“Zerwać” (*break*)



“Najwyższy” (*the highest*)



“Życzenie” (*wish*)



“Mówić” (*speak*)



“Czytać” (*read*)



“Płakać” (*cry*)

Takeaway message

- A major limitation in the development of a sign language recognition system is limited access to data.
- Accessible data is mainly online dictionaries which contain one example per gloss (word).
- The videos quality and angle of camera differs amongst different datasets.
- There is no universal sign language, but there are language-agnostic notations, such as HamNoSys.
- Non-uniform way of HamNoSys labeling make this notation hard to utilise for automatic sign language recognition.

HAI Team

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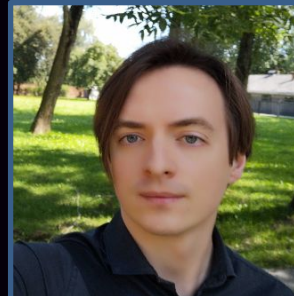
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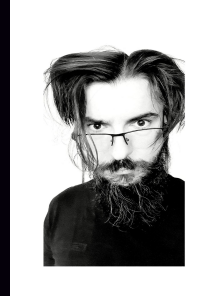
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Jacek
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Digital Innovation Hub
Gdańsk



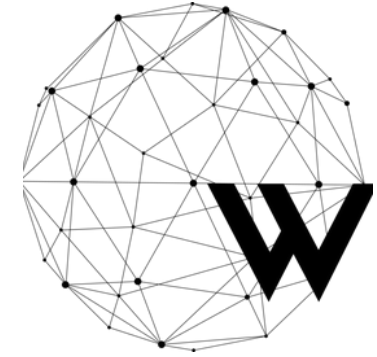
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Neptune.ai
Experiment management tool



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