Sign Language Production using Deep Learning

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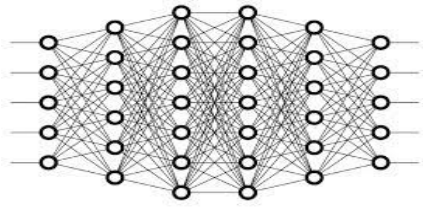

Outline

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6. Keypoints generation
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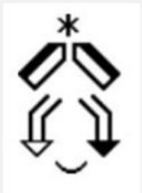
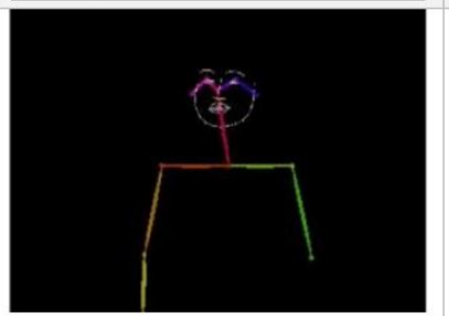
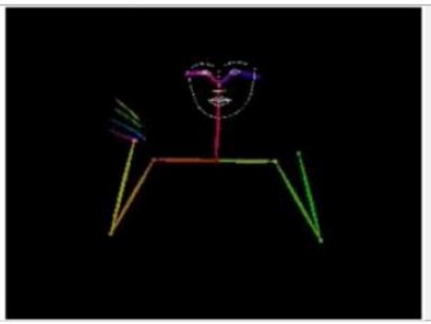
Motivation

The Sign language is a language, that is visually performed with hand gestures, body postures and face expressions, so the meaning of signs depends on the combination of all of them.

1. There are up-to 300 different signed languages (United Nations 2022) and up-to 70 million deaf people exist in our world (World Federation of the Deaf 2022).
2. There are two main tasks can be implemented for Translation:
   - 2.1 from sign language (Sign Language Recognition)
   - 2.2 into sign language **(Sign Language Production)**

Motivation

Every sign has an unique identifier, which is called as **Gloss**. There is no direct alignment between sign sequences and spoken language sentences.

English Translation	Gloss	Notation	Pose	Video/Avatar
House	HOUSE			
What's the matter? What's wrong?	Wrong-What			
Different But	DIFFERENT BUT			

https://research.sign.mt

Tasks

Tasks:

- Methods overview
  - end-to-end system (text2sign architecture)
  - with the intermediate results production (text2gloss architecture)
- Implementation and evaluation of Gloss production
  - seq2seq from scratch
  - seq2seq with pre-trained model
- Implementation of mapping from Gloss to Sign Keypoints

Goal:

Tasks

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- Methods overview
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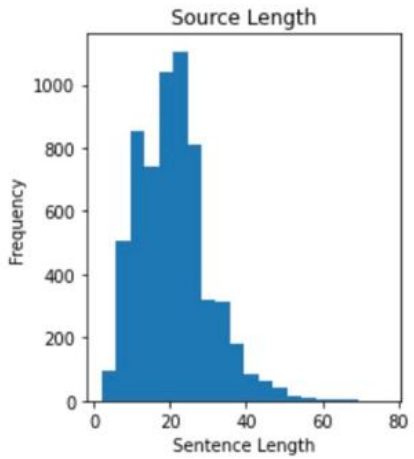
Goal:

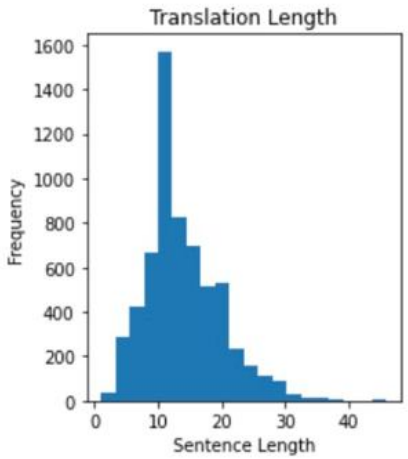
- Implementation and evaluation of possible improvements of seq2seq models for text2gloss translation for Sign Language Production.

Phoenix Dataset for SLP

	src	trg
0	tiefer luftdruck bestimmt in den nächsten tage...	DRUCK TIEF KOMMEN
1	das bedeutet viele wolken und immer wieder zum...	ES-BEDEUTET VIEL WOLKE UND KOENNEN REGEN GEWIT...
2	meist weht nur ein schwacher wind aus untersch...	WIND MAESSIG SCHWACH REGION WENN GEWITTER WIND...

```
Length distribution in Train data
Average length of source sentences: 20.69
Average length of target sentences: 13.71
```



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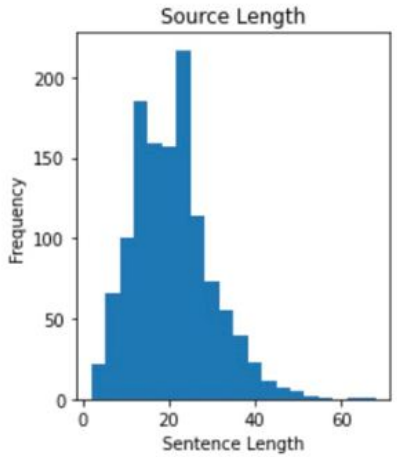
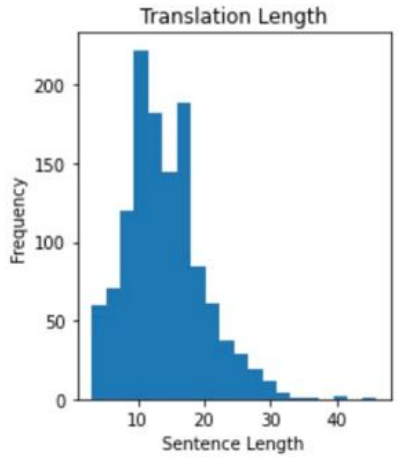
Length distribution in Test data
Average length of source sentences: 20.81
Average length of target sentences: 14.02
```





8257 videos of 9 different signers are provided, with a vocabulary of 2887 German words and 1066 different sign glosses.

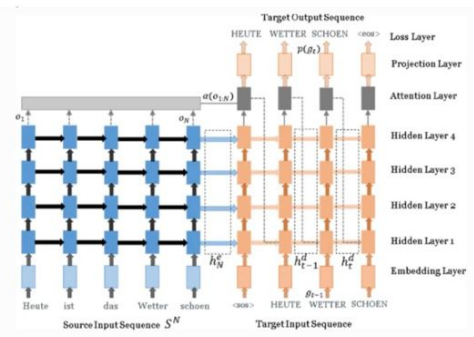
Methods overview

In general, text to sign language process can be divided into three modules:

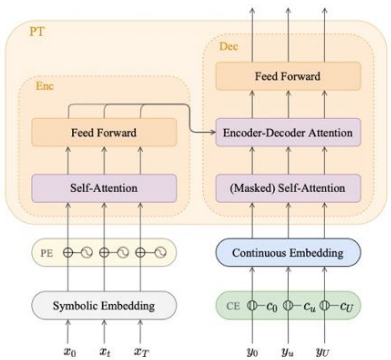
- pre-processing the input text
- convert into sign sequences using MT
- generate videos or animated avatars

Methods examples overview:

- Production of concatenated isolated signs (Stephanie Stoll).
- Automatically Mapping between the text and the pose sequences, without need of Gloss production. Glosses are produced only for comparison (Ben Saunders).



NMT-based encoder-decoder architecture with Luong attention (Stoll)



Progressive Transformer (Saunders)

Evaluation of Gloss production

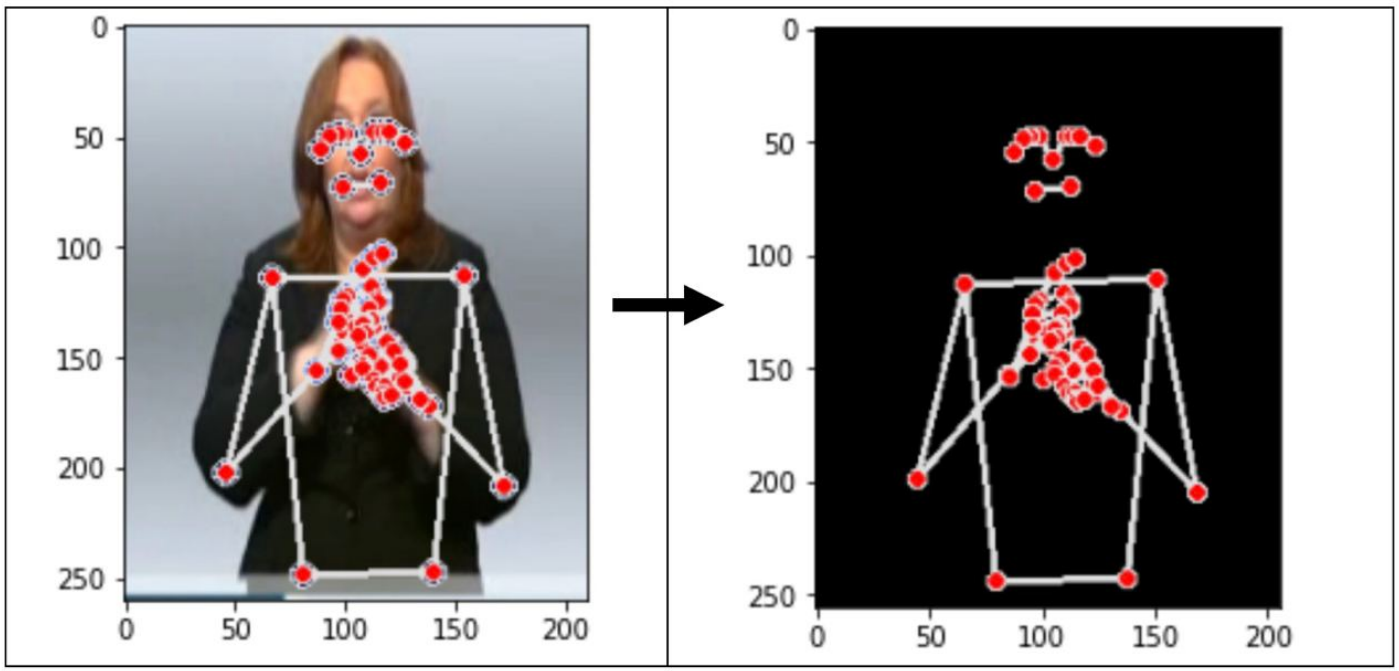
Text to Gloss production results:

- with small dataset (ca. 8000 pairs) and relatively simple model a good BLEU 23.72 for generating the Gloss is achieved, which further could be used for avatar generation.
  Methods results comparison table:

Method	Number of parameters	Bleu-4	Rouge-1
Stoll: Enc-Dec with attention	Not available	19.10	54.55
Saunder: Progressive transformer case, text2gloss part	Not available	15.26	48.10
Our: Enc-Dec without attention and with LSTM	2,452,438	7.35	29.15
Our: Encoder-Decoder model with attention and with bidirectional GRU	4,937,430	19	49.69
Our: pre-trained Huggingface transformer	73, 886, 208	23.72	64.92

Keypoints generation

- 2D upper body joint and facial landmark positions are first extracted using MediaPipe library:
  - 21 keypoints for each hand
  - 33 keypoints for pose
- Lookup table is created for each gloss.
- The glosses are mapped to the sequence of prepared frames (video).



Outlook

- Further fine-tune the Huggingface transformer
- Generate more natural movements of avatars (out of the scope of this work)