# Signing for the Deaf using Virtual Humans

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# SignAnim

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Televirtual, Norwich

Subtitles to Signing Conversion

Funded by

Independent Television Commission (UK)

# Tessa

**School of Information Systems, UEA**

**Televirtual, Norwich**

**Speech to Signing of Counter Clerk Turns in PO Transactions**

funded by Post Office

# ViSiCAST

**School of Information Systems, UEA**

**Televirtual, Norwich**

**Independent Television Commission (UK)**

**Post Office (UK)** **RNID (UK)**

**IvD (Holland)** **University of Hamburg (Germany)**

**IST (Germany)** **INT (France)**

**EU funded 5th Framework Project**

# Background – Deaf Community

| | | |
|---|---|---|
| **Deaf** | **v** | **Hard of Hearing** |
| **Signing** | **v.** | **Subtitles** |
| **60,000** | **v.** | **1 in 8 of population** |

**300 Level 3 signers**

# Background – Sign Language

| Signed English (SE) | Sign Supported English (SSE) | British Sign Language (BSL) |
|---|---|---|
| educated deaf community | | preferred first language |

## SignAnim – Aims and Aspirations

**Exploration of (semi-)automatic conversion of subtitles to sign language …**

**… to increase access for the Deaf ...**

**… with a potential of providing access to up to 50/80% of TV broadcasts.**

# SignAnim – Natural Language Processing

**Subtitle stream up to 180 words min $^{-1}$**

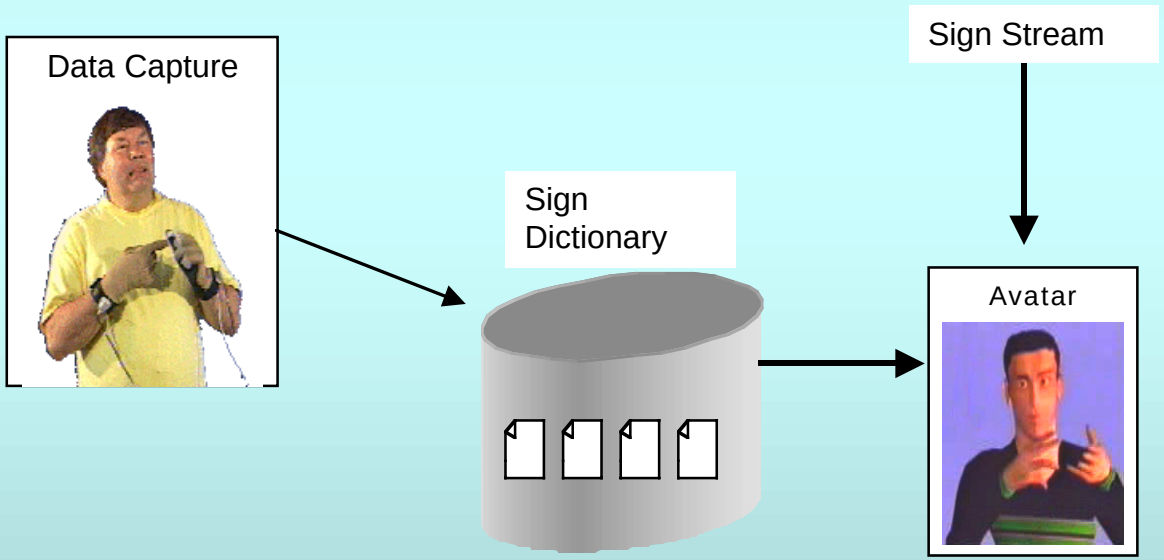
Sign rates typically 50% of speech rate (100 signs min$^{-1}$)

**SE – too verbose to be signed in full**

**SSE – elision of low information words**

**BSL – translation to multi-modal signs**

# SignAnim Components – Simon the Avatar



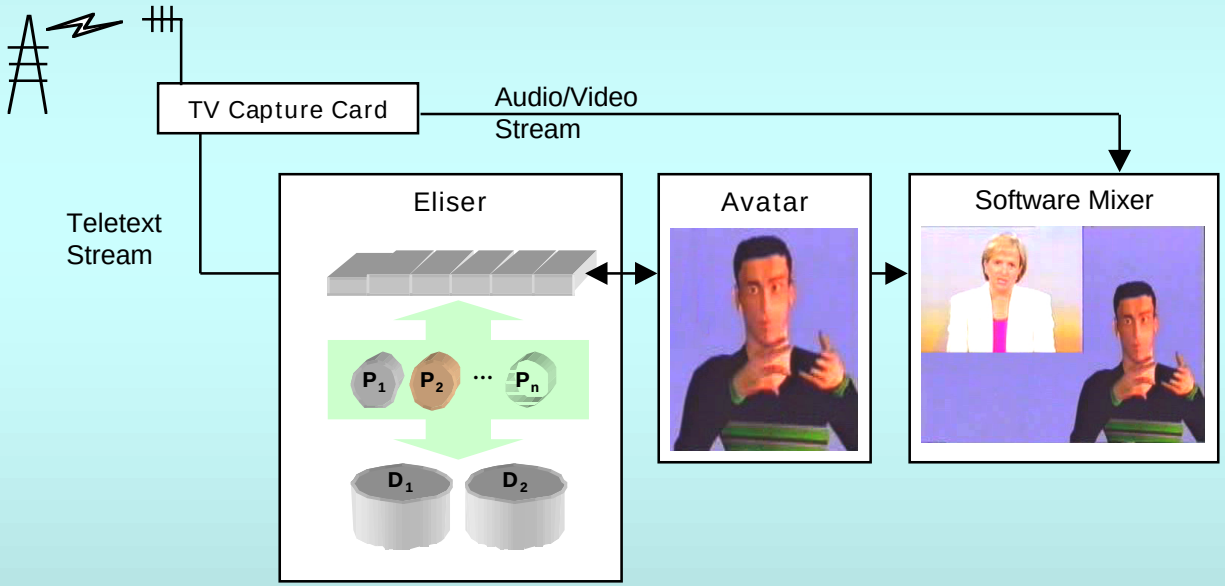
# Motion Capture

**Cybergloves**

**Magnetic Sensors**

**Video face tracker**

# Schematic of SignAnim system



# SignAnim Components – Eliser

**Requirements**

**Resolution of Lexical Ambiguity**

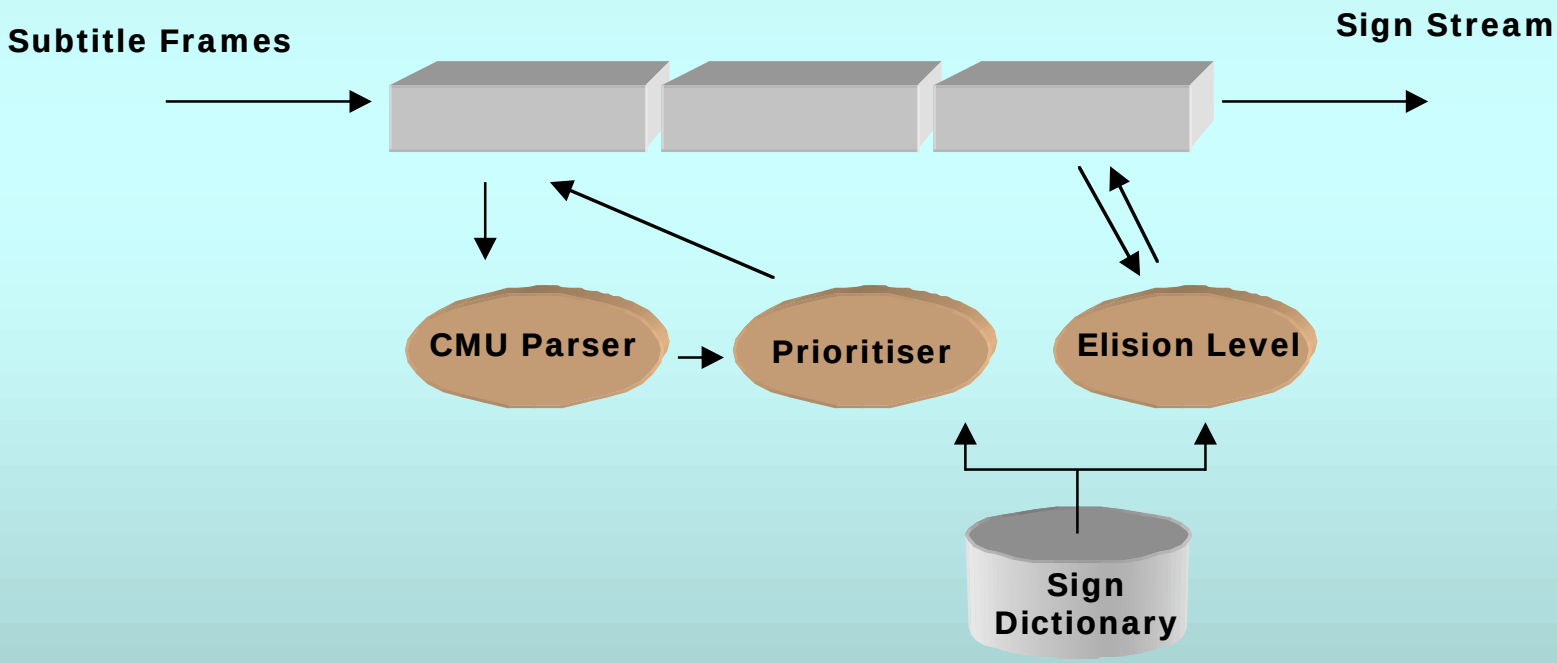
**Elision**

**If @ receiver Timeliness of signing**

**v**

**If @ transmitter prioritising of parts of sign sequence**

# Eliser - Summary



# SignAnim – Natural Language Processing

**‘Last night we brought you the tale of the duck that could not swim and had to learn while a guest of the RAF in Norfolk.’**

| | |
|---|---|
| **26 words** | |
| **in 2 subtitle frames** | |
| **time to speak / time subtitles on screen** | **7 secs** |
| **time to sign in full** | **18 / 14 / 9 secs** |
| **finger spelling significant overhead** | |

# SignAnim – Natural Language Processing

**‘Last night we brought you the tale of the duck that could not swim and had to learn while a guest of the RAF in Norfolk.’**

**Resolution of some lexical ambiguity by p.o.s. tagging**

| | |
|---|---|
| **- duck** | **noun/ verb** |
| **- had** | **auxiliary/ verb** |
| **- swim** | **noun/ verb** |
| **- in** | **participle/ preposition** |

**to facilitate correct sign selection**

# SignAnim – Natural Language Processing

**‘Last night we brought you the tale of the duck that could not swim and had to learn while a guest of the RAF in Norfolk.’**

**Potential elision**

- **determiners**
- **auxiliary verbs**
- **modifying phrases**
- **adjectives and adverbs**

**in extreme cases jettison entire sentences**

# SignAnim – Natural Language Processing

**‘Last night we brought you the tale of the duck that could not swim and had to learn while a guest of the RAF in Norfolk.’**

**Additional problems**

**structural ambiguity**

**appropriate sign**

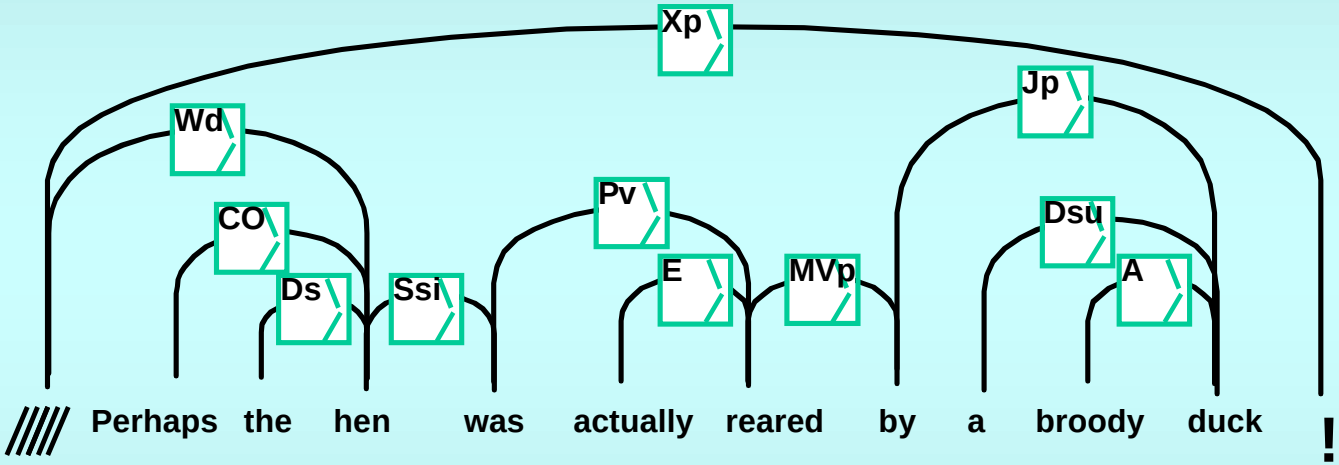
**no sign for guest, default finger spell**

# SignAnim – CMU link grammar

**Positive features**

- **Lexically driven sentence parser**
- **Robust**
- **Prioritorises multiple analyses**
- **On failure returns partially parsed word sequence**
- **Modifiability**

# SignAnim – CMU link grammar example

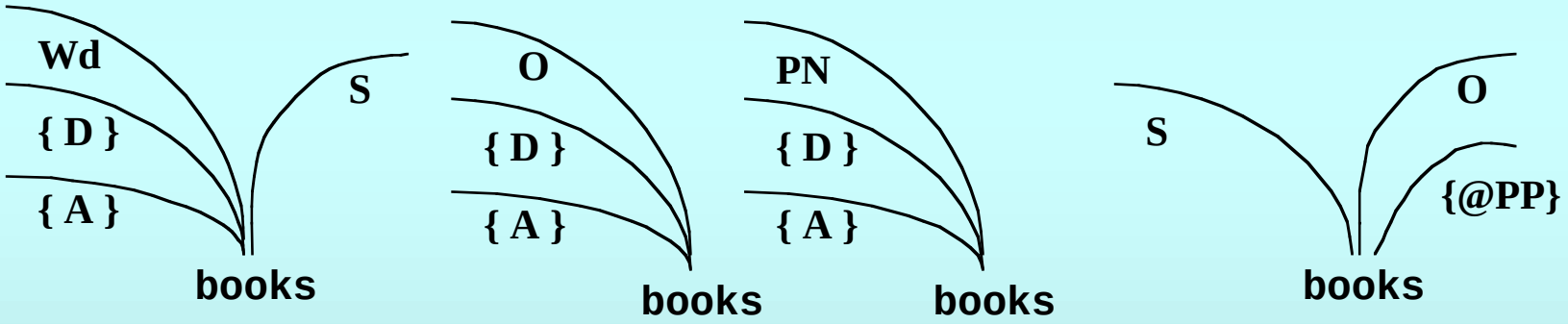


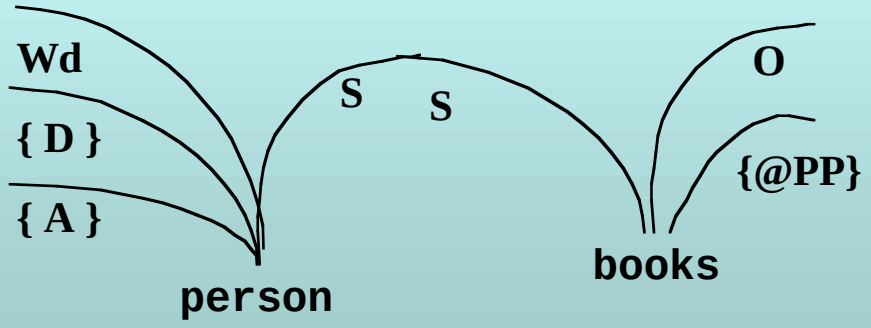
# CMU link grammar parser - a shell

```
<noun>   :        ( {A-} & {D-} & Wd-  & S+ ) or
                  ( {A-}  & {D-} & O- ) or
                  ( {A-}  & {D-} & PN- );
<adj>    :  A+ ;
<det>    :  D+ ;
<verb>   :  S- & O+ & {@PP+};
<prep>   :  PP- & PN+;

book.n books.n report.n reports.n room person       : <noun> ;
yellow green                                        : <adj> ;
the a                                               : <det> ;
book.v books.v report.v reports.v brings            : <verb> ;
on in                                               : <prep> ;

CAPITALIZED-WORDS                  : <noun> or <adj> or <det> ;

"."                                                 : FS- ;
LEFT-WALL                                           : (Wd+ & FS+) ;
```

# CMU link Grammar Parser - link construction

```
books    .n :    ( {A-} & {D-} & Wd-  & S+ ) or
                 ( {A-}  & {D-} & O- ) or
                 ( {A-}  & {D-} & PN- ) or
         .v :    (S- & O+ & {@PP+});
```



**linkparser> A person reports the book.**

Found 1 linkage (1 had no P.P. violations)
Unique linkage, cost vector = (UNUSED=0 DIS=0 AND=0 LEN=7)


| | | | | | |
|---|---|---|---|---|---|
| | ///// | FS | <---FS----> | FS | . |
| (m) | ///// | Wd | <---Wd----> | Wd | person |
| (m) | a | D | <---D-----> | D | person |
| (m) | person | S | <---S-----> | S | reports.v |
| (m) | reports.v | O | <---O-----> | O | book.n |
| (m) | the | D | <---D-----> | D | book.n |

# Eliser - elision stategy

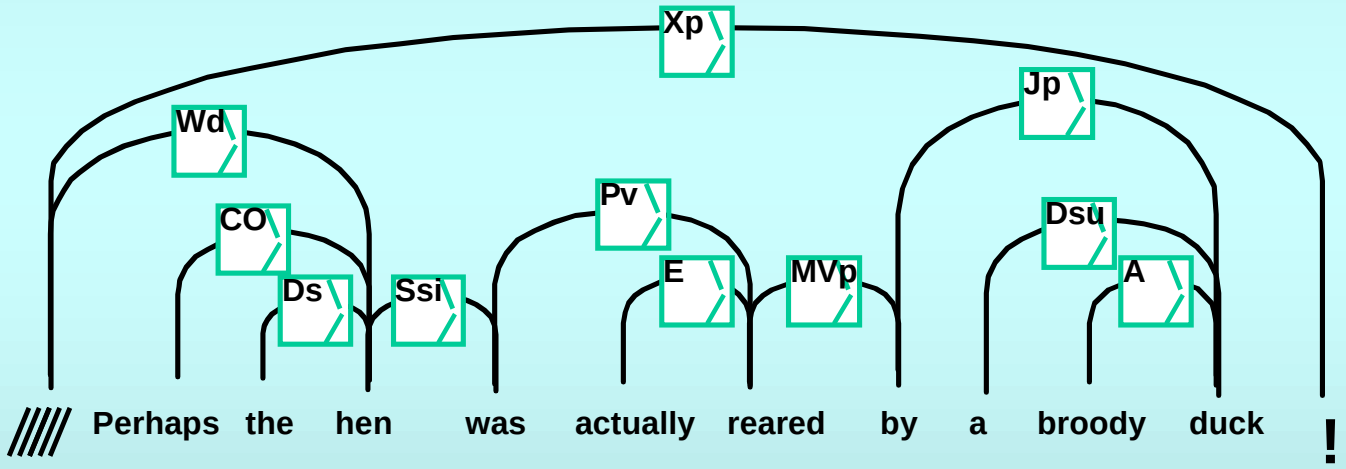
**Augment CMU dictionary with further p.o.s. information**

**e.g. has.aux v. has.v**

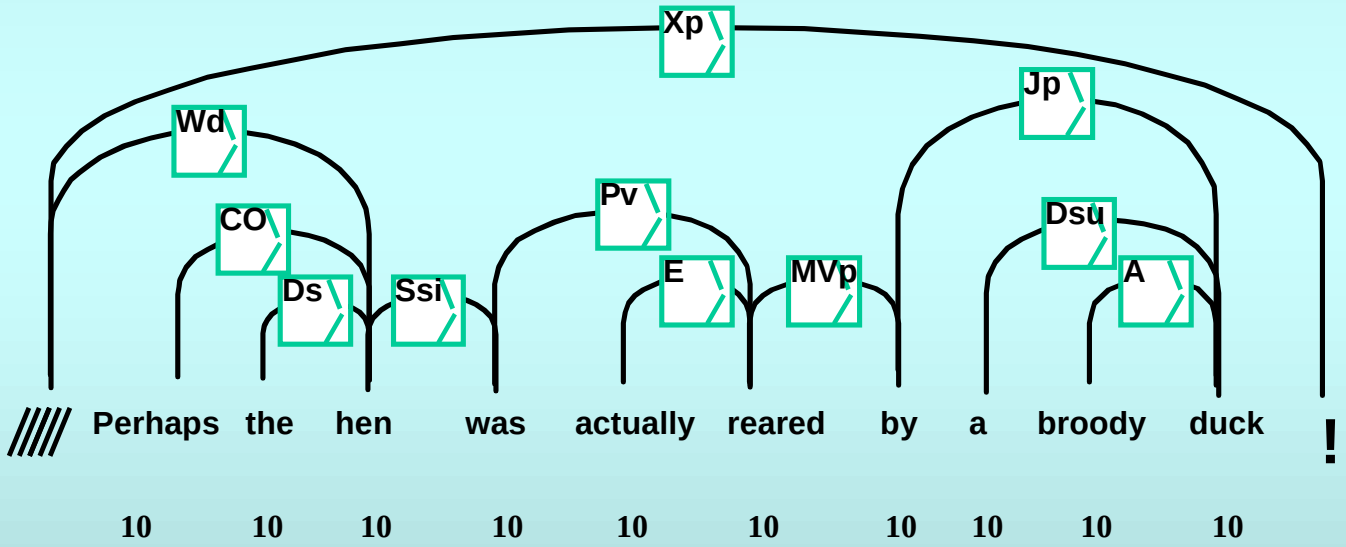
**Rules for word and path priorities**

| #Link | Weight | Left Path | Left Word | Right Path | Right Word | |
|---|---|---|---|---|---|---|
| CO | 3 | X | X | - | | - |
| D | 1 | - | X | - | | - |
| Ds | 1 | - | X | - | | - |
| G | 4 | X | X | - | | - |
| AN | 4 | - | X | - | | - |
| A | 4 | - | X | - | | - |
| RS | 4 | - | X | X | | X |

# Eliser - Prioritorising



# Eliser - Prioritorising



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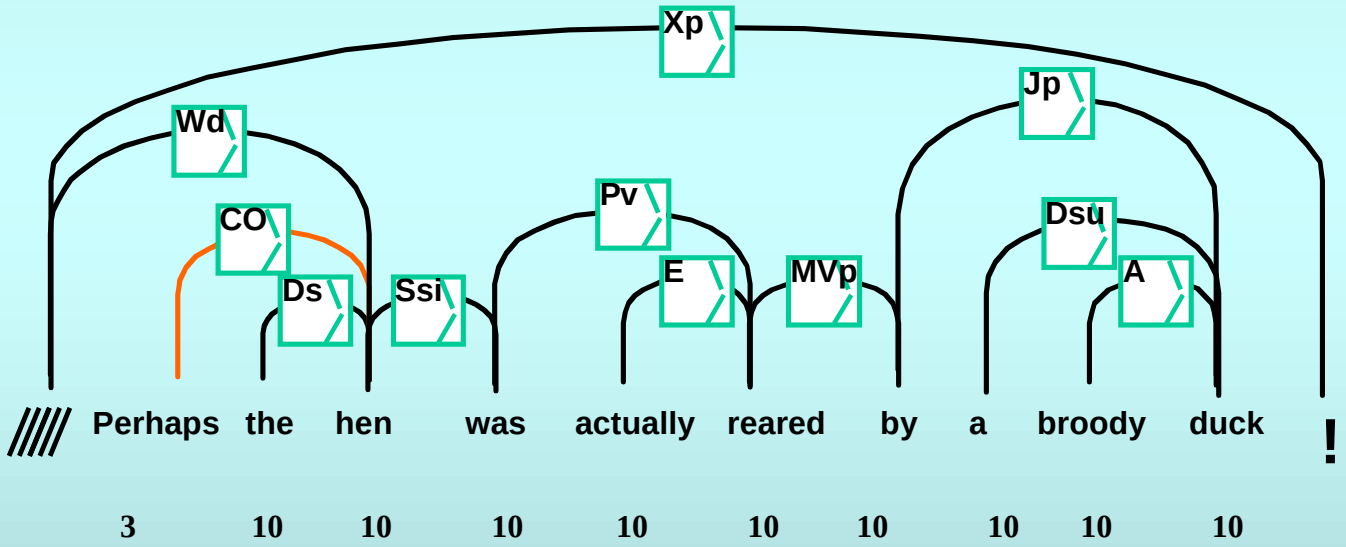
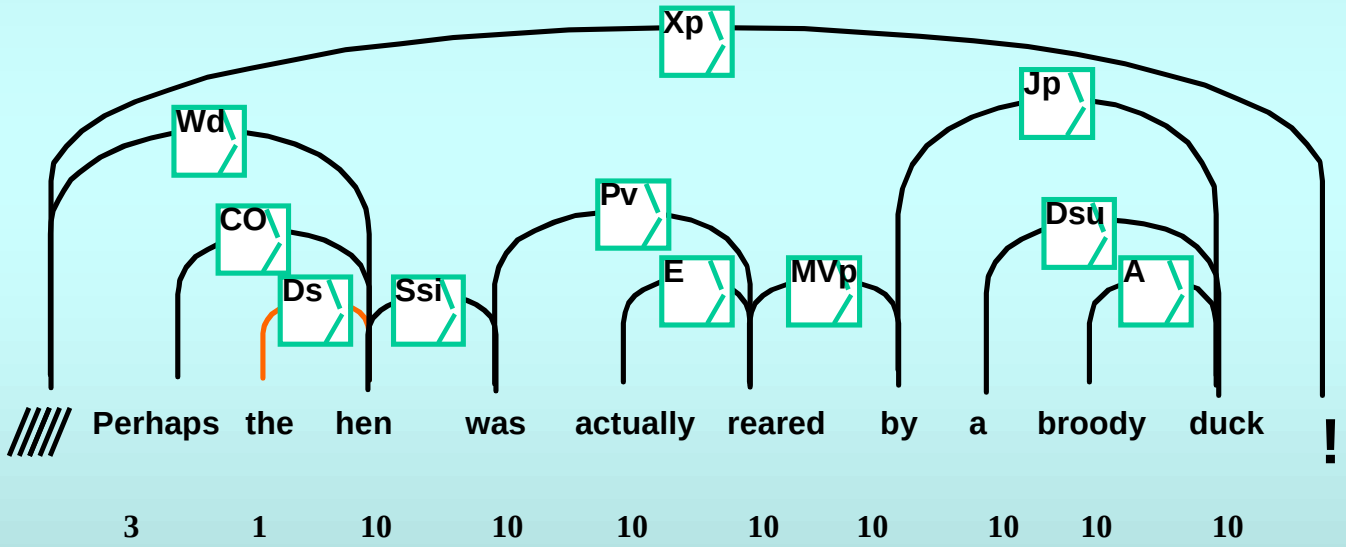


# Eliser - Prioritorising



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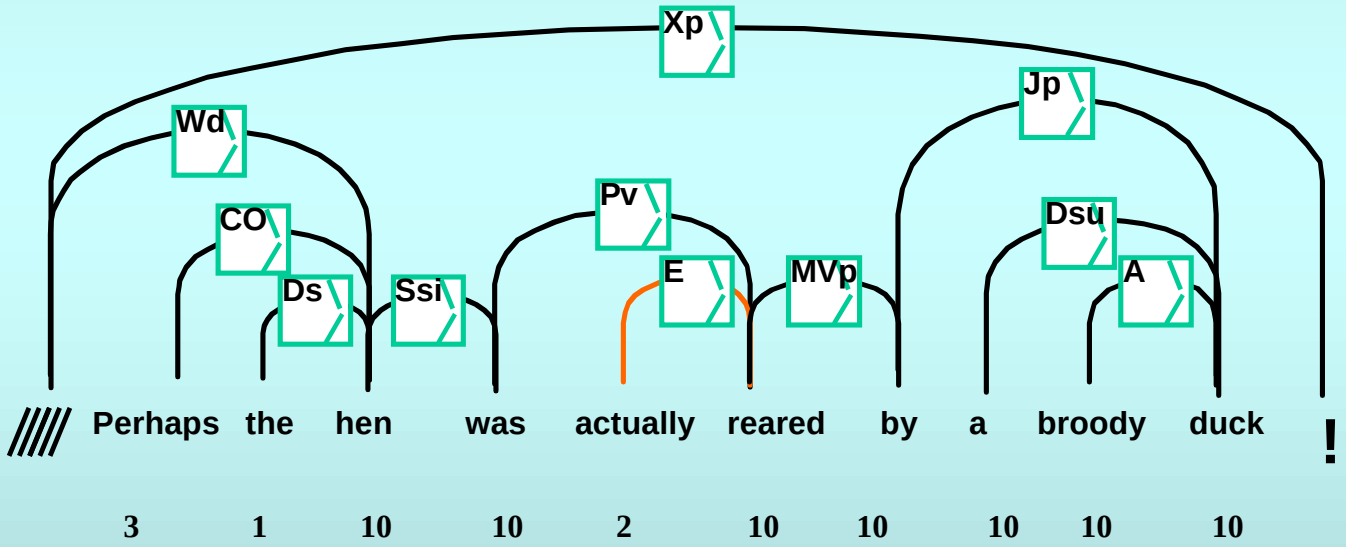
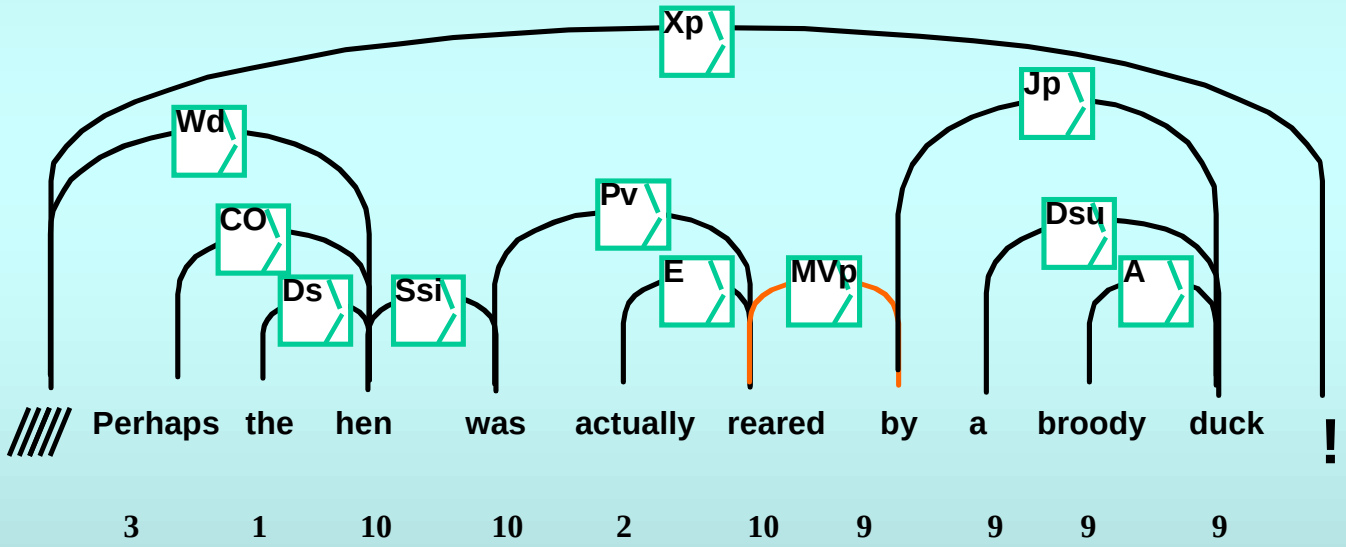


# Eliser - Prioritorising



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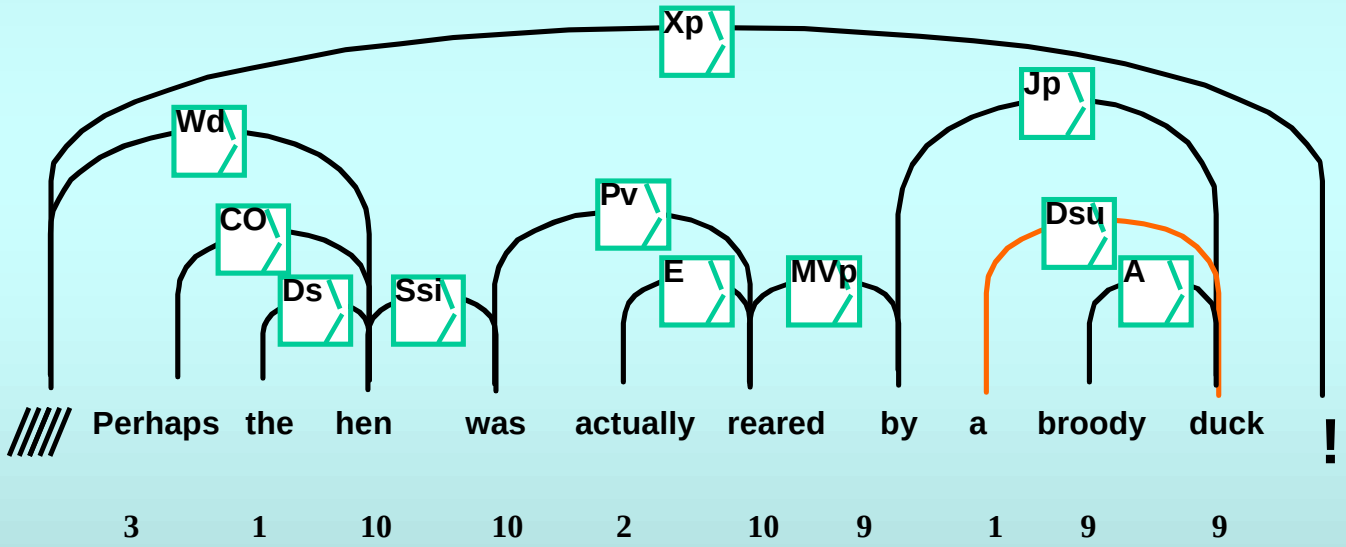

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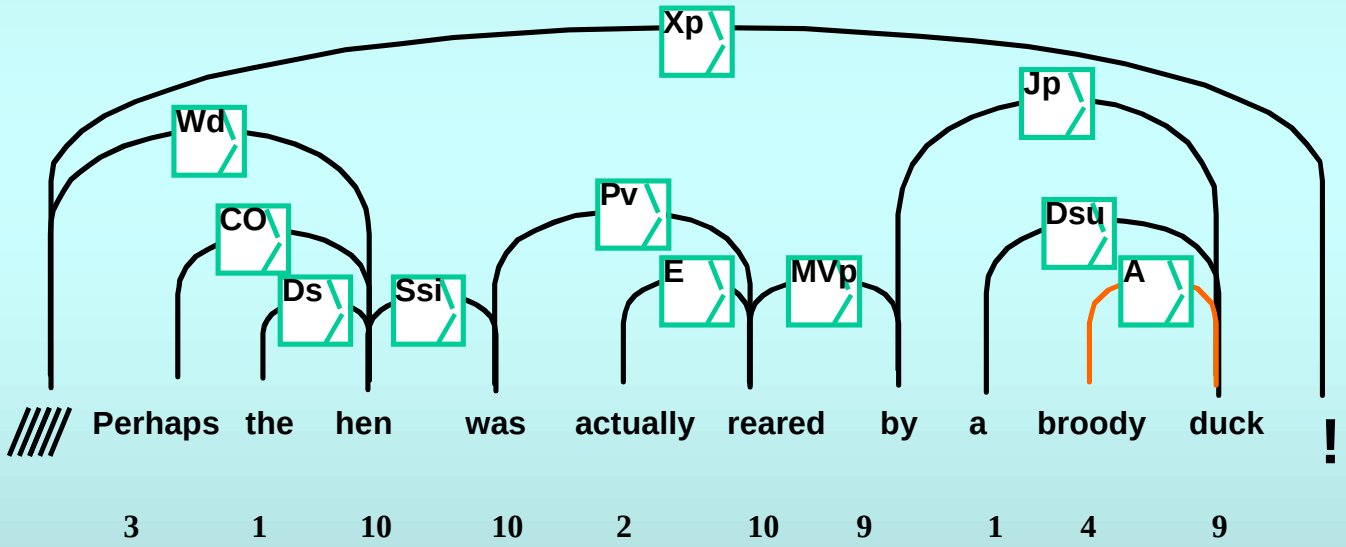
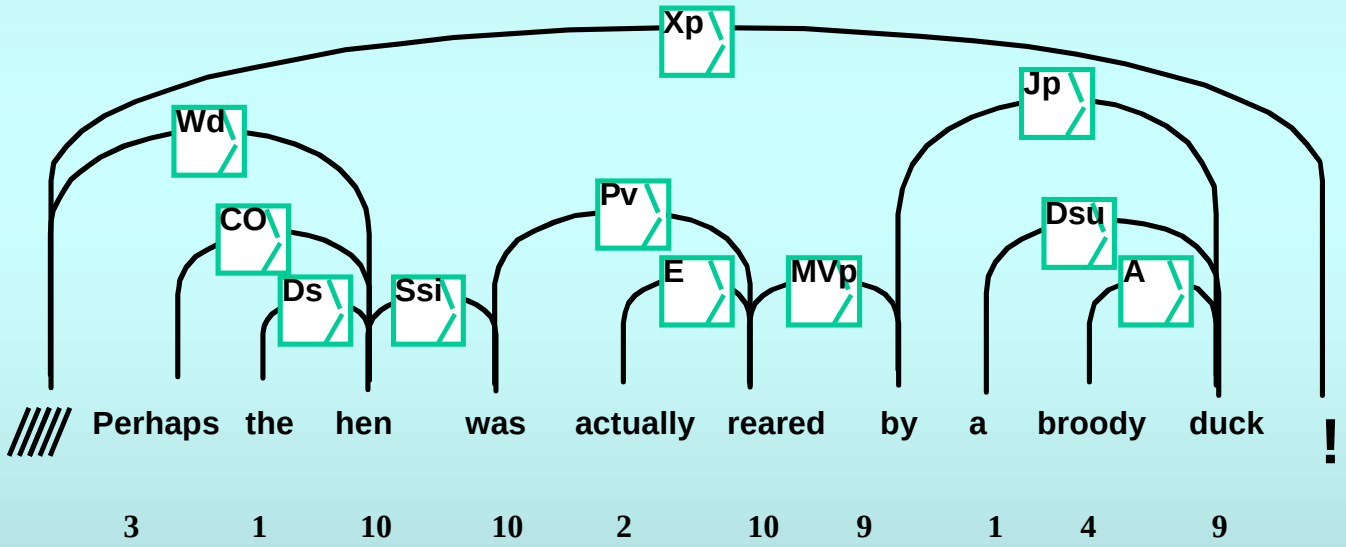
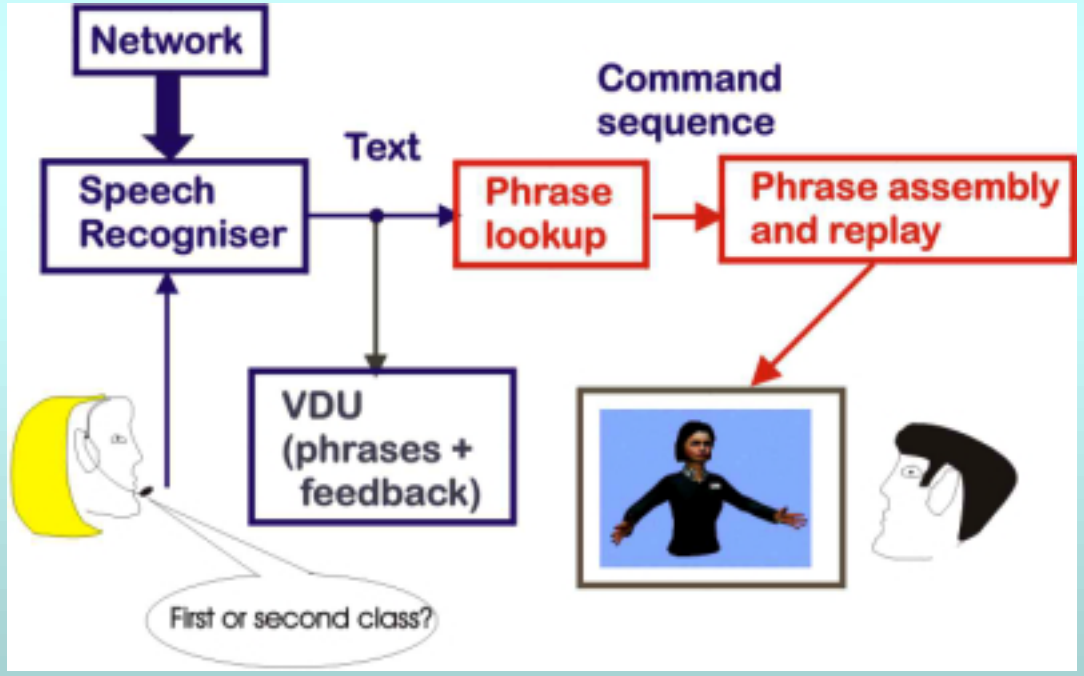


# Eliser - Elision



# TESSA - Overview

**Aim : To give access to Post Office services for those whose first language is not English.**



# TESSA Input : Speech Recognition

- Restricted Number of sentences (115)
- Variable quantities (monetary amounts, days of the week)
- Grammar defined as FSN
- MLLR acoustic adaptation
- Entropic recognition engine

# TESSA Output : BSL and Foreign Language

- BSL sign sequences
- Signs for variable quantities blended into standard phrases
- Customer may ask for phrases to be repeated
- Text translations into 4 languages for non-English speakers
- English text for the hard of hearing

## Conclusions

**SignAnim and Tessa demonstrated**

**+ replay of motion captured sequences readable**

**+ usefulness of existing NLP and speech recognition technologies**

**+ desirability of BSL (rather than SSE)**