

# AI-supported multilingual barrier-free communication

**Dr. Claudio Fantinuoli**

**“The common misconception is that language has to do with words and what they mean. It doesn't. It has to do with people and what they mean.”**

**Herbert H Clark & Michael F Schober, 1992**





# Language and humans

## On the importance of interpersonal communication

- The capacity for linguistic expression stands as one of the most critical attributes distinguishing the human species.
- The distinct linguistic abilities inherent to humans have been pivotal in facilitating the evolution and advancement of contemporary civilization.
- Effective communication is not only essential for individual accomplishment but also proves critical on larger scales, from local community to global understanding.

**However, the opportunity to participate effectively in communication is not universally guaranteed.**

# Barriers in communication

## Reasons and effects of lack of communication

visual barriers

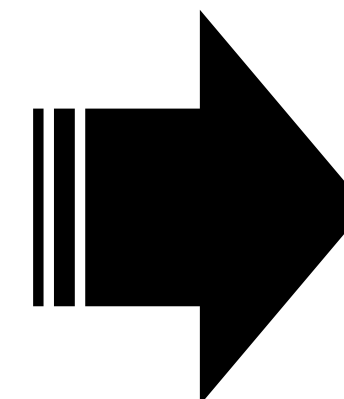
acoustic barriers

speech disorders

barriers to understanding

linguistic and cultural barriers

- 1/1000 in EU communicates through sign language
- 1/6 DHH in US (Blackwell 2014)
- 17% low literacy (PIAAC 2018)
- Increasing migration movements with limited language access
- Functional illiteracy/illiteracy (Lindholm & Vanhatalo 2021)



- Ghettoization
- Marginalization
- Exclusion from social life

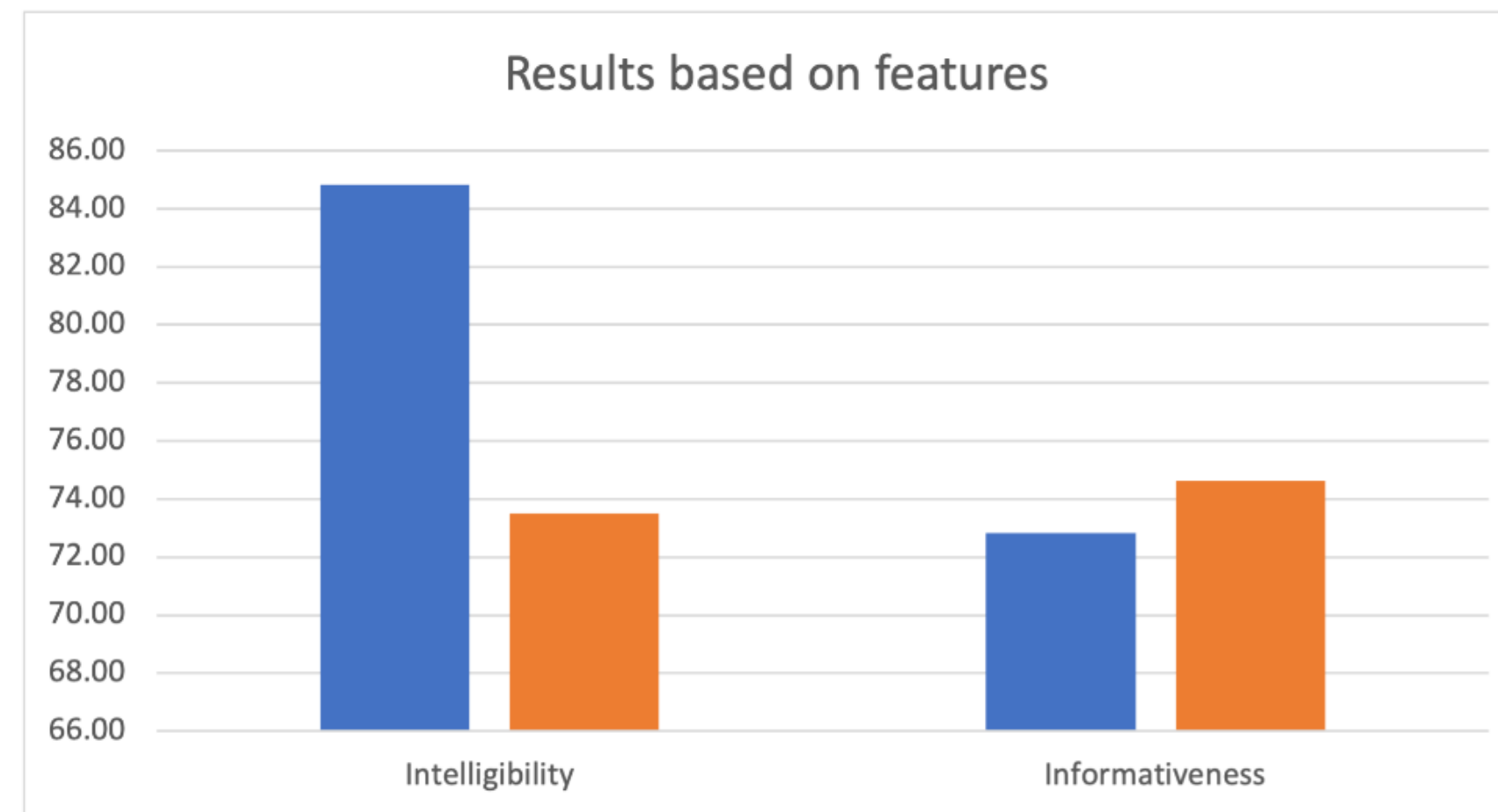
(Schubert & Heidrich-Wilhelms 2017; Rink 2019)

# Research in Sociology/Psychology

- Barriers to learning a foreign language among immigrants (Kim/Mattila 2011)
- Lack of a common language as the main barrier in accessing/delivering health services (Samkange-Zeeb et al. 2020)
- Language barriers in ethnically diverse workplaces (Thuesen 2016)
- Communicative interaction in people with language disorders (Manchinelli 2021)

# Research in Translation studies

- Easy and simple language (Bredel/Maass 2016; Hansen-Schirra/Maass 2020)
- Accessibility in dialogue interpreting (Meyer 2018)
- Interlingual respeaking (Romero-Fresco/Pöchhacker 2017; Davitti/Sandrelli 2020)
- Human-machine interlingual respeaking (Korybski et al. 2022)
- Automatic speech translation (Fantinuoli/Prandi 2021)



# Ethical issues

## Accessibility

- Stigmatization (Gutermuth 2020)
- Easy Language Paradox (Miesenberger 2021)
- Paternalistic approaches (Güldenpfennig 2019)

## AI

- Compulsory use (Coffee 2019; Amershi 2019)
- Marginalization of low-resource languages
- Stereotypes and prejudices (Nadeem et al. 2020)
- AI tools as cheap substitute for quality human-driven access



# Applied Technology

- Sign Language (SignON: [www.signon-project.eu](http://www.signon-project.eu))
- Speech disorders (MS Euphonia: [www.sites.research.google/euphonia/about/](http://www.sites.research.google/euphonia/about/))
- Language barriers (EP/Cedat85/RWS: [www.bit.ly/3NtJjsO](http://www.bit.ly/3NtJjsO))



Speech translator (v 1.8) Source: English United States Target: French Read aloud:  [Homepage](#)

**Bonjour mesdames et messieurs  
Je suis très heureux d'être ici aujourd'hui  
Je voudrais partager avec vous mon expérience sur ce qui est important dans  
la vie**

I am listening.



# Breaking down the language barriers for

visual barriers

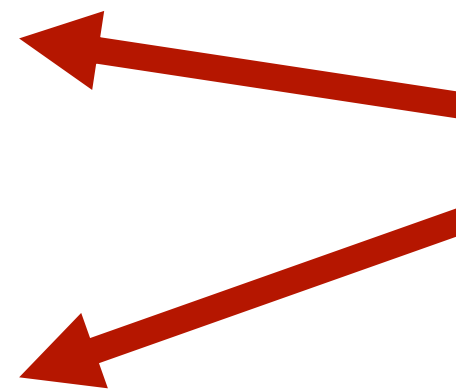
acoustic barriers

speech disorders

barriers to understanding

linguistic and cultural barriers

**How can technology  
contribute to  
overcoming barriers in  
multilingual spoken  
communication for  
people with cognitive  
disorders?**





# Artificial intelligence and accessibility

AI real-time multilingual  
translation and interpretation  
into easy/plain language





# AI real-time translation and interpretation into easy-to-understand language

what

Live transmission in written (captions) or oral form (interpreting) of what is said in a **different target language** and in a **simplified form**

why

Extension of multilingual accessibility in national/international contexts for people with disabilities (e.g. TV channels, education, institutions, etc.)



The screenshot shows a website menu with two main sections: 'Weitere Informationen' and 'Übersetzung/Translation'. Under 'Weitere Informationen', there is a link for 'Weihnachtsansprache 2021 (PDF, 67KB)'. Under 'Übersetzung/Translation', there are three links: 'Speech in English (PDF, 70KB)', 'Leichte Sprache (PDF, 267KB)', and 'Rede in Deutscher Gebärdensprache DGS'. A red arrow points to the 'Leichte Sprache' link.

Weitere Informationen

- ↓ Weihnachtsansprache 2021 (PDF, 67KB)

Übersetzung/Translation

- ↓ Speech in English (PDF, 70KB)
- ↓ Leichte Sprache (PDF, 267KB)
- Rede in Deutscher Gebärdensprache DGS

# Main challenges

- Exponential growth in complexity driven by combination of **simplification** and **translation** under **time-constraints**
- Broad spectrum of diversity, encapsulating various types and degrees of impairments and disabilities
- Wide variety of functional/communication settings (school, church, political participation, etc.)
- Maintaining factually accuracy and appropriateness while simplifying the message
- Absence of universally accepted definition of what easy/plain language is

*"The aim is to transmit the messages and the content with regard to the intention of the speaker and to adapt it linguistically to the needs of the recipient of the messages" (Hummert/Knipping 2018: 302).*



# Artificial Intelligence and Language

- Artificial intelligence applied to language means using language models
- Language models are mathematical representations of language based on the statistical principle “you shall know a word by the company it keeps” (Firth 1953)
- Following actions can be addressed – to different degrees of quality – by language models:
  - correction (Luna-Ramírez et al. 2021)
  - generation (Brown et al. 2020)
  - translation (Wang et al. 2021)
  - transcription (Li et al. 2021)
  - simplification (Mandela et al. 2020)

# Artificial Intelligence and Language

- Language models work well because machines don't have to mimic human intelligence, they can take very different approaches (Floridi 2014)
- We have detached the ability to solve problems - agency - from the need to be intelligent (Floridi 2014)

**BUT !**

- Language models are “stochastic parrots” (Bender/Koller 2020)
- They function without “being-in-the-world” (Heidegger): they do not have knowledge of the communicative context, intentions, etc.
- Limited ability to reason (Wei et al. 2022)

**Limitations!**

# Two approaches to accessibility enabled by AI

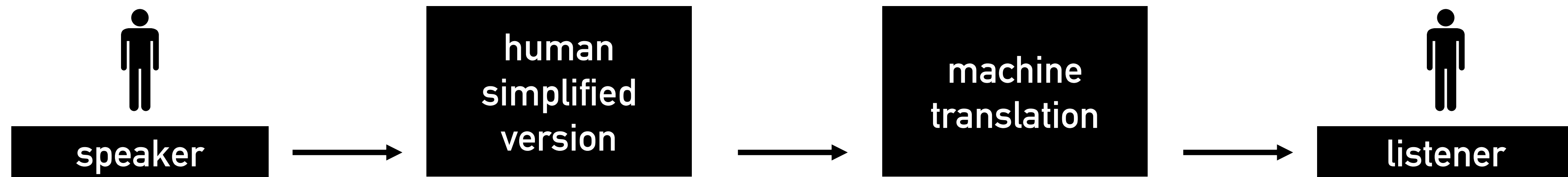
Human in the loop

Full automation



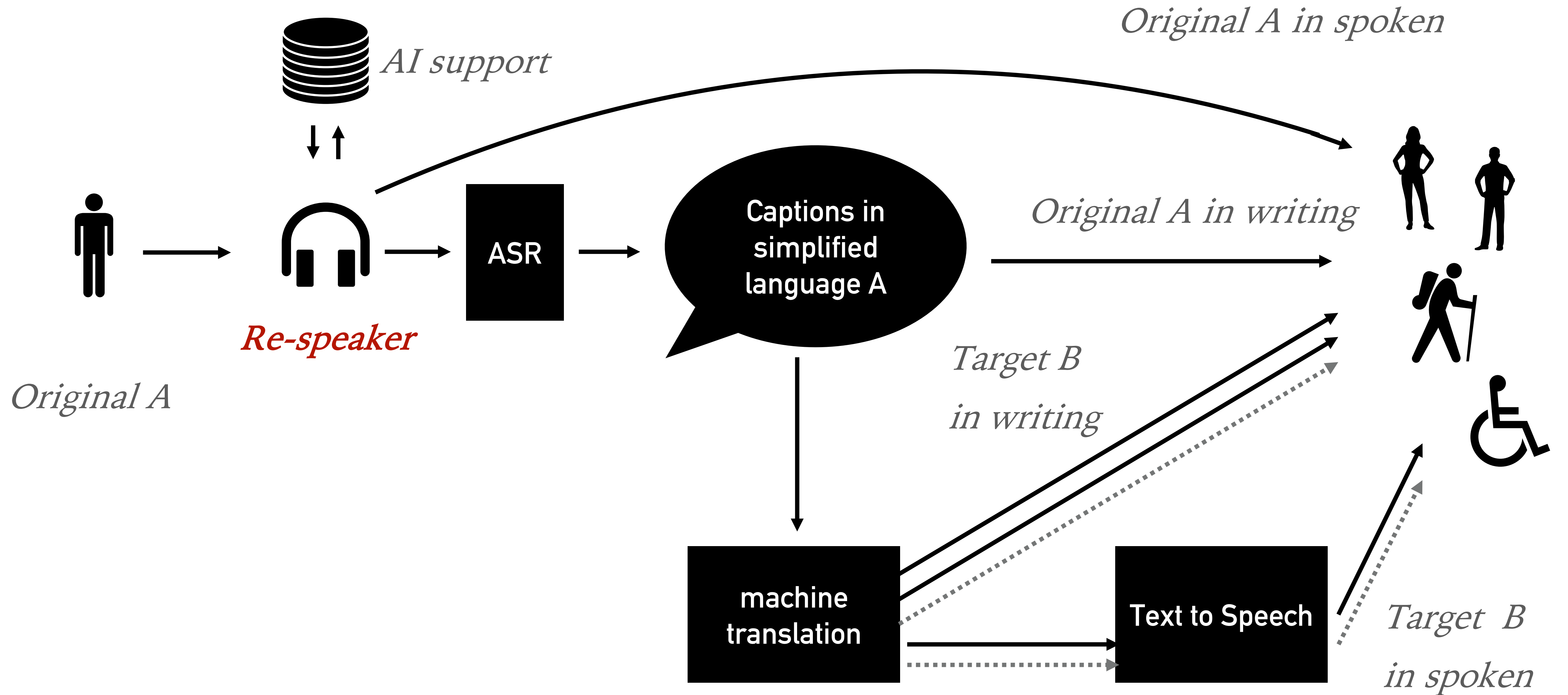
**Human in the loop**

# Human in the loop



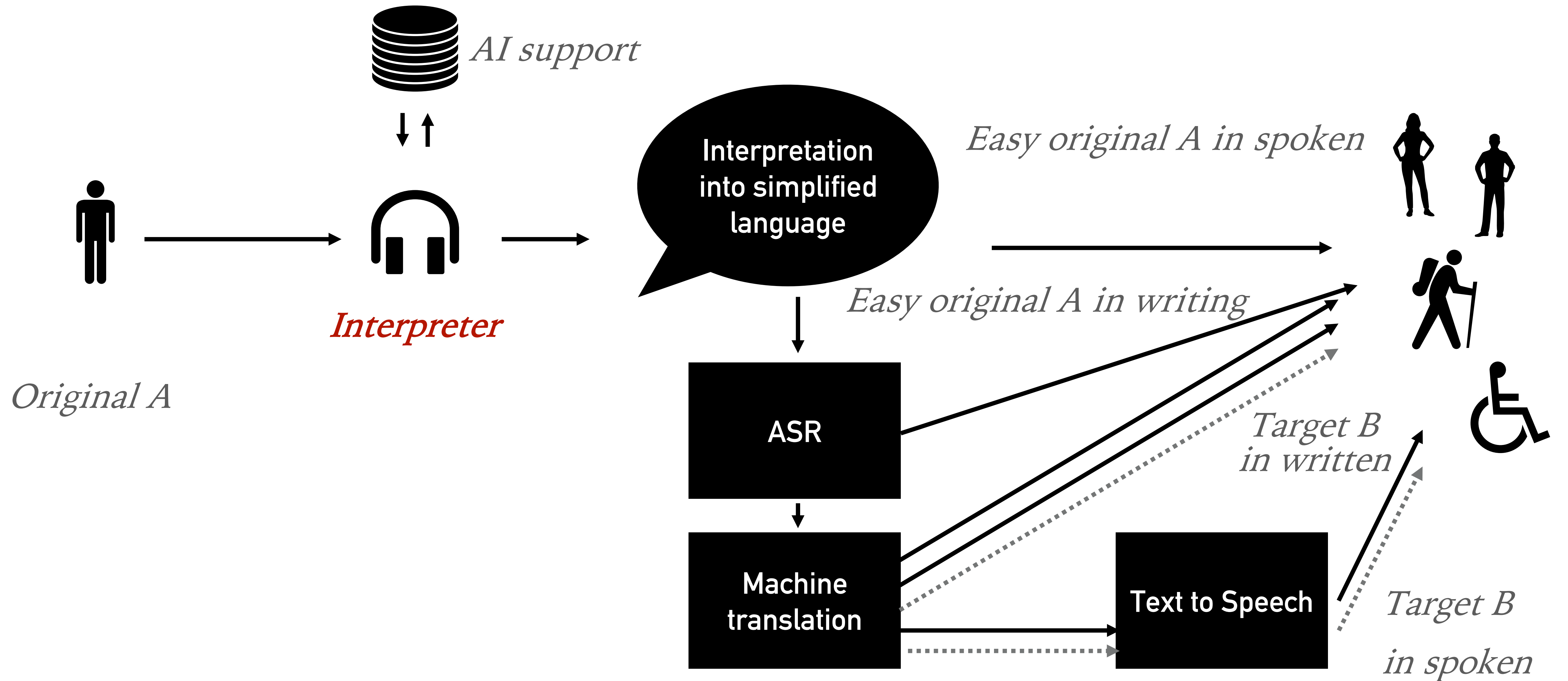
- Human takes on the task of **intralingual translation** (re-speaking in simplified language)
- Machine takes on the task of **interlingual translation** (translating from one language to another)
- Focus on high quality human-generated simplification
- Two possible workflows: with interpreters and with re-speakers

# Architecture with re-speaker





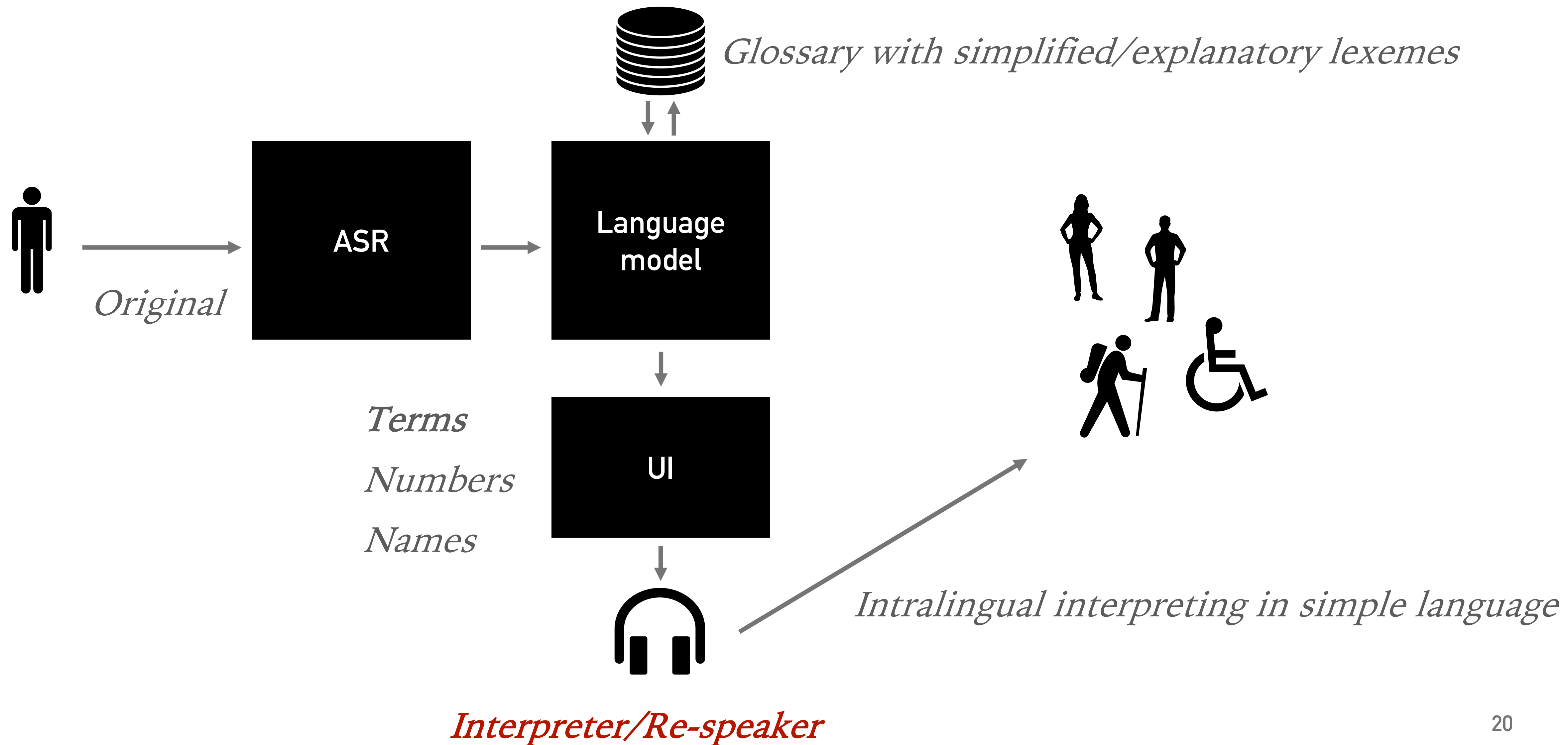
# Architecture with interpreter



# AI support for re-speaker/interpreters

- Similar to the use of TM in plain language translation (Hansen-Schirra et al. 2020), but focus is on glossaries (Lexical Simplification/Exemplification)
- Memory support for the interpreters (reduction of the cognitive load)
- Automation through speech recognition (Fantinuoli 2017)
- Existing research limited to suggestions in conventional interlingual interpreting (Defrancq/Fantinuoli 2021, Fantinuoli/Montecchio 2022)

# Architecture (Fantinuoli 2017)





# Discussion

- **Positive**

- High quality for Re-speakers+MT (Korybski et al. 2022) and for Interpreters+MT (Macháček et al. 2021)
- New professional field for language professionals

- **Negative**

- Degradation of the output because of the complexity of cascading model
- Cultural adaptation is poor because of limitations of MT
- Difficult to scale accessibility because need of humans-in-the-loop

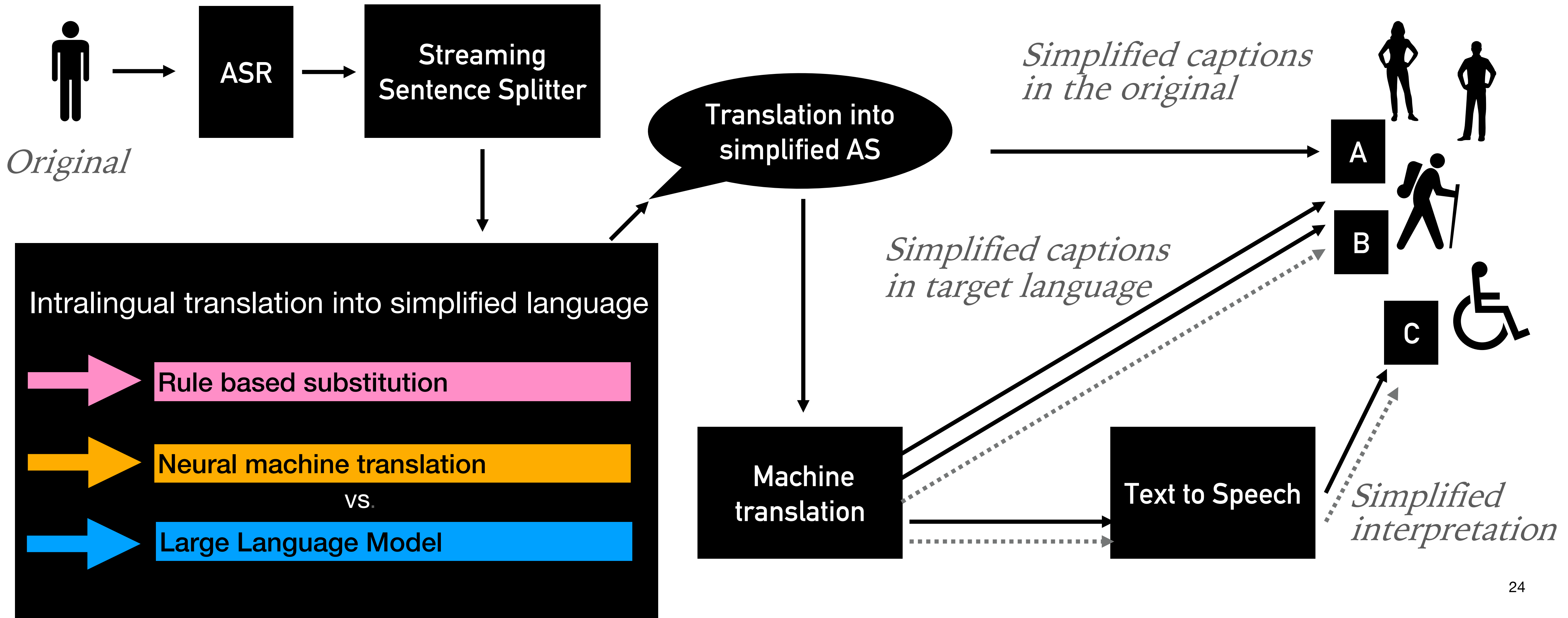
**Full automation**

# Full automation

- Forging a path towards **universal access to information**, unrestricted by cognitive disabilities, language impairments, or language deficiencies.
- The ultimate goal is to ensure **ubiquitous communication accessibility** for all individuals, irrespective of their circumstances or challenges.
- This process is central to the **democratization of knowledge**, as we strive for a society where information is equally available and accessible to everyone.

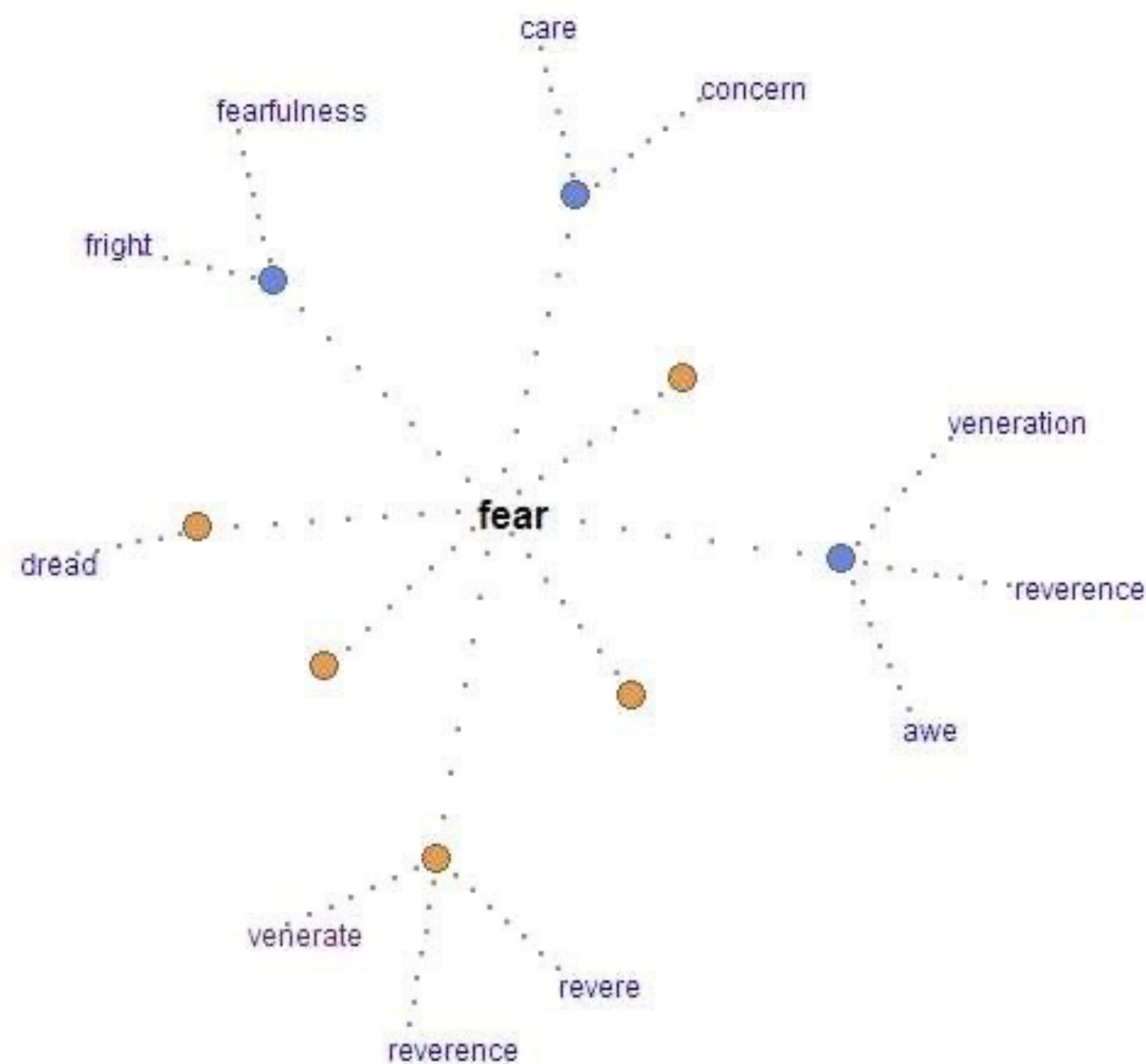


# Architecture for full automation



# Simple substitution

## Lexical transformation using thesauri



- Generic term extraction with WordNet (Miller 1995)
- Extraction of synonym with higher frequency
- E.g.: Fearfulness -> Fear
- Limited vocabulary and languages
- Hyperonyms are not always easier!

# Simple substitution

## Lexical transformation through semantic embeddings

```
# predict the next word
dict(model["today", "the"])]
```

```
{'Bank': 0.05555555555555555,
 'European': 0.05555555555555555,
 'Higher': 0.05555555555555555,
 'Italian': 0.05555555555555555,
 'Turkish': 0.05555555555555555,
 'company': 0.16666666666666666,
 'emirate': 0.05555555555555555,
 'increase': 0.05555555555555555,
 'newspaper': 0.05555555555555555,
 'options': 0.05555555555555555,
 'overseas': 0.05555555555555555,
 'pound': 0.05555555555555555,
 'price': 0.11111111111111111,
 'public': 0.05555555555555555,
 'time': 0.05555555555555555}
```

- overcomes the limitations of the thesaurus-based method
- pre-trained *word vectors*, such as Glove, Word2Vec, FastText, etc., and replaces words with other words that are closest in vector space
- Problem of ambiguity is not solved



# Neural translation approach

## Intralingual machine translation



- Translation model trained with original and its simplified version
- Scarcity of data
- Problem of ambiguity is not solved

# Large Language Models

## Using generative models to simplify sentences



- Language models like GPT/BERT are very powerful (Devlin et al., 2019)
- hyperonyms through *prompting*: “A hammer is a [ MASK ]”
- Very flexible
- Still empirically underexplored

# Simplification for easy language

## Lexical

- Shorter words: omnibus -> bus
- Concrete instead of abstract: public transport -> bus and train
- Explanation of difficult words: unemployment benefit -> money for people who have no work
- Separation of long words: leader -> leader

## Syntactic

- Short sentences (only one proposition per sentence)

# Machine generated easy language

## Original

There is still sadness in parts of our society, but also resentment and disappointment as the pandemic continues.

*(In Teilen unserer Gesellschaft herrscht immer noch Traurigkeit, aber auch Unmut und Enttäuschung über die anhaltende Pandemie.)*

## Simplified language (variants)

- Sadness, anger and disappointment reign in our society as the pandemic continues.
- Many people are still feeling sad and upset because the sickness is not over yet.
- Many people are still sad and upset because the illness is still here.



# Machine generated easy language

## Original

Da weniger als 1 % der weltweiten Impfstoffdosen in Ländern mit niedrigem Einkommen verabreicht werden, sind das Ausmaß der Ungerechtigkeit und die Dringlichkeit klar.

*(With less than 1% of the world's vaccine doses being administered in low-income countries, the magnitude of the injustice and the urgency are clear.)*

## Simplified language (variants)

- Less than 1% of the world's vaccine doses were administered in poor countries. The extent of the injustice and the degree of urgency are clear.
- Very few of the world's sickness shots are given in poor countries. This isn't fair, and it's important we fix this fast.
- Few of the world's sickness shots go to poor countries. This isn't fair and we need to act fast.

# Discussion

- Real-time segmentation of speech
- Text simplification in END-TO-END approach:
  - Translation model trained with original and simplified versions
  - But: difficult because of scarcity of parallel data, but new possibility through unsupervised data (Lample et al 2018), e.g. Wikipedia Standard vs. Wikipedia Plain
- Text simplification in CASCADING approach:
  - lexical substitution with thesauri or *Semantic embeddings*(60% accuracy)
  - Sentence simplification or rephrasing (Einolghozati et al. 2020) or simplifier (Huggingface T5 2021)

# Closing remarks

- Spoken barrier-free communication is an important but extremely difficult task for both humans and machines
- AI can contribute to the goal of "universal accessibility".
- Human-machine combination is a promising path for high-quality results, but it prevents scaling of adoption
- Emerging of new professional fields for translators through the use of AI
- Full automation has intrinsic limitations, but advances (Large Language Models) makes this path worth exploring

**THANKS**