Sign Language Technology: Do's and Don'ts

A Guide to Inclusive Collaboration Among Policymakers, Researchers, and End Users

White Paper – 26th December 2022

Foreword

This white paper has arisen from the three-year SignON project[1], which received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 101017255, and ran from January 2021 to December 2023. The project's primary objective is the development of an automatic translation application and service between spoken languages and sign languages. This application is the front face of a complex orchestration of tools, frameworks and models that jointly deliver the translation services. These rely on state-of-the-art machine and deep learning approaches and include sign language recognition, automatic speech recognition and natural language processing and understanding (NLP and NLU), to recognise and process users' signed, spoken or written input, then translate it via a multilingual language model in order to, finally, produce signed or spoken (including written form) language output. The sign language output takes the form of a 3D virtual character, i.e. a virtual signer or a signing avatar, that performs the signs. However, SignON encompasses much more than just sign language technology. What sets SignON apart is that it is one of the first projects to actively engage in a co-creation process with the deaf and hard-of-hearing community. Following the lessons learned from this approach, this paper focuses on sign languages and the sign language users, and draws guidelines for an effective collaboration in which the deaf communities steer the research and development processes.

In the past, such structured collaboration was lacking in similar projects. In SignON, deaf consortium members had leadership roles in the organisation and execution of these co-creation events, as well as in the project communication and dissemination activities. This presented an opportunity to create guidelines that not only highlight the best practices from the SignON project but also share insights into the challenges faced in the collaboration between predominantly hearing researchers and deaf sign language communities, as well as the attitudes of policymakers toward sign language technologies and its impact on deaf signing target audiences.

This white paper provides a concise overview of key considerations when conducting policy or research related to sign language technology. It is the culmination of insights gathered from co-creation events, surveys, workshops, as well as internal and external communications throughout the entire lifespan of the SignON project.

---

[1] www.signon-project.eu

1. Key considerations for sign language technologies

Sign language technologies have garnered significant attention in recent decades and have unexpectedly emerged as a pivotal development for deaf communities in Europe. Projects involving sign language avatars and other sign language technologies have sprung up like mushrooms. However, it is essential to question who these technologies are truly intended for and what goals they aim to achieve. Below are some general considerations when dealing with sign language technologies:

Acknowledgment of 'deaf issues'

The recognition of all daily obstacles faced by deaf individuals is of paramount importance. An illustrative topic discussed in the SignON project involves the long-term implementation of automatic translation and sign language avatars for news broadcasts. The involvement of VRT, the public broadcaster of the Flemish Community in Flanders, during the course of the project has raised questions within the deaf community. Since 2012, VRT provides an accessible version of its daily news broadcasts at 7 PM in Flemish Sign Language through sign language interpreters, who, in most cases, are hearing and not native signers. For years, the Flemish deaf community has expressed difficulty understanding these interpreters in watching these news broadcasts.[2] Deaf individuals prefer news broadcasts tailored specifically to their information and language needs. Insights from the co-creation events of SignON and internal discussions within the SignON consortium present an opportunity to address and recognise these concerns and desires of the deaf community in association with the national broadcaster.

Avoiding technosolutionism

In the domain of language technology and AI, rapid developments are underway. It is crucial that signed languages do not lag too far behind in comparison to spoken/written languages. Like other projects focusing on the integration of signed languages into Machine Translation and AI, the SignON project endeavours to bridge this current gap with other spoken/written languages. While these projects appear to be very promising, the pitfall into which the uninformed may stumble remains to exist. It is tempting to view sign language technologies as the definitive solution to the challenges faced by deaf individuals, such as the shortage of sign language interpreters, or to the challenges faced by hearing people in understanding deaf people because of the lack of knowledge of a sign language. In various (informal) conversations with both deaf and hearing individuals, there were occasional mentionings regarding whether these projects should or should not provide a solution to the shortage of sign language interpreters in mainstream education for deaf children and students. However, we must refrain from seeing technology as the sole solution. A technosolutionistic

---

[2] Dhoest, Alexander, and Jorn Rijckaert. 2021. "News 'with' or 'in' sign language? Case study on the comprehensibility of sign language in news broadcasts Perspectives." DOI: 10.1080/09767X.2021.1936088 .

attitude overlooks other possible solutions for which deaf individuals and representative organisations are advocating, such as employing sign language educators in the education of deaf children or enhancing the status, compensation, and training of professional national sign language interpreters. We need to stress, though, that technology has advanced significantly and is at a stage where it can positively impact certain use-cases (also negatively impact others nevertheless) and as such we need to stress that we do not advocate for abolishing technological solutions completely, but rather understand the realistic added values of technology and adopt such solutions in those situations where it is beneficial for society and individuals without being intrusive or overpowering the individual choice of the deaf person.

Awareness of potential cultural appropriation

We should also examine the potential cultural implications of sign language technologies. It is crucial to ensure that the technology is not used in a way that exploits the cultural and linguistic identity of deaf communities as marginalised and minority groups. We must avoid situations where those developing sign language technologies benefit by personal gain at the expense of the appreciation and respect owed to (national) sign language communities, which are still in the process of recovering from decades of oppression. An illustrative example from the SignON project involves a museum that contacted the SignON consortium members with a commitment to enhancing the accessibility of its content in providing sign language rendering. The contact persons working at the museum expressed interest in exploring the option of automatic translation. While, on the one hand, this shows that hearing-led organisations are evolving and attempt to provide solutions for deaf users and/or customers, it is, on the other hand, an example of the amount of extra work that still needs to be done in the field. Aside from the fact that the technology is not yet sufficiently advanced to provide high-quality translation for the museum context, it is essential to consider whether it is appropriate for "sign language avatars" to potentially take away job opportunities from deaf translators and/or guides. Given the longstanding barriers faced by deaf individuals in education, they have fewer job opportunities in which direct communication in their sign languages is possible. In recent years, efforts have been made to train and recognise deaf translators, interpreters and guides, providing them with increasing opportunities in the cultural sector, including translating and guiding tours in museums using sign languages. However, it should always be emphasised that the use of automatic translation remains an individual choice, it is important to consider that automatic translation should not pose a threat to the job opportunities that deaf individuals have fought for over the years. The correct approach for addressing such a use case is to engage with an organisation of deaf people and/or specialising in sign language, for deaf people, like no other, are able tothoroughly comprehend the use case and offer appropriate guidance.

Embracing the principle of 'nothing about us without us'

The motto of the UN Convention on the Rights of Persons with Disabilities (UNCRPD), "nothing about us without us", further supported by Article 4.3 and the General Comment n°7 of the CRPD Committee, recognises that any initiative, programming, policies and legislation concerning deaf people and national sign languages must meaningfully involve the deaf people through their representative organisations. The General Comment operates a distinction between Organisations *of* Persons with Disabilities and Organisations *for* Persons with Disabilities, with absolute priority given to the former. For deaf communities, the representative organisations are the deaf-led National Associations of the Deaf (NADs).

More practically, sign language technologies are often introduced to deaf signers by parties such as policymakers and researchers, without initial requests from the deaf community. Sometimes they are even imposed on deaf signers, without their asking. It is of paramount importance that deaf people are actively engaged in every aspect of sign language technologies, from the planning and inception stages to research and development. In the SignON project, this principle of "nothing about us without us" is reflected in involving the European Union of the Deaf and VGTC (Flemish Sign Language Center) in the formulation of the project application. Throughout the entire process, including every (physical and online) meeting, sign language interpreters were consistently provided. In this way, deaf consortium members were engaged in every aspect of the project, allowing for their full insight and meaningful contribution. Our project has also been heavily driven by co-creations with the target audience of deaf and hard-of-hearing individuals and communities.

After all, deaf individuals live day in and day out with their deafness, which inherently grants them the right to proactively make decisions regarding sign language technologies. Deaf signers' lived experiences make them the foremost experts on how sign language technologies can best be accepted and integrated into their daily lives. It is not just ethical to involve them in the research and development process but it is also critical to develop a sensible product that suits their wishes and specific requirements. Put differently, **inclusion should be viewed from the perspective of those who require it**, rather than being imposed by those who believe it is the most efficient course of action, particularly from a financial standpoint.

2. Key action points during research and development

Respecting the principle of "nothing about us without us" will not only result in more effective and inclusive sign language technologies but also empower deaf communities in determining their own future and well-being. Below are some recommended action points:

Utilise a co-creation strategy for collaborative design and development

Engage deaf individuals as stakeholders in the specification, application, research, design development, evaluation and validation phases. Solicit input and feedback from end-users at each stage of the process and establish a robust interactive methodology centred on continuous information and ideas exchange between the deaf communities and technical experts. Keep in mind that there is significant diversity among deaf and hard-of-hearing people, each with their own unique requirements. This also means that end-users need to be consulted widely across different demographics. At SignON co-creation events, we have consulted not only National Associations of the Deaf as representative organisations as, within the consortium, awareness exists that not all deaf individuals are members of these associations. SignON co-creation events have consistently strived for diversity among deaf and hard-of-hearing individuals participating in surveys, interviews, workshops and data collection. The needs are highly varied, and the (linguistic) backgrounds of our participants have proved to be extremely diverse.
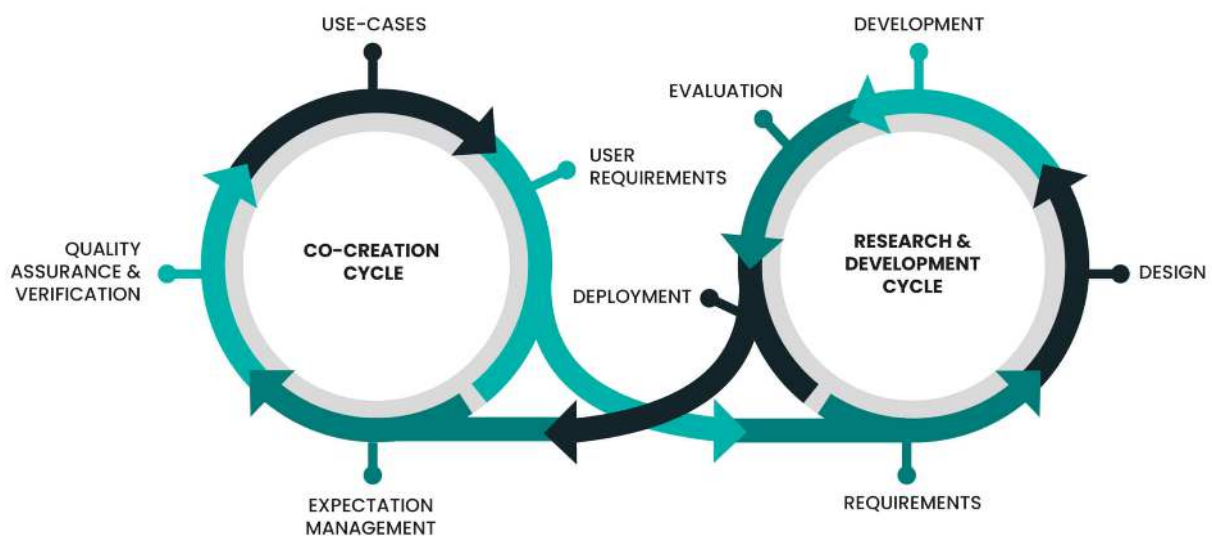
The above illustration summarises the co-creation process applied within the SignON project. At SignON, we consider it crucial to involve deaf experts and researchers in co-creation events as such they have consistently been engaged in every event. Direct communication in sign language is a key element. The deaf people involved have also served as a vital bridge between deaf individuals and hearing researchers. This entails practical considerations such as allocating sufficient time to find the people, location and sign language interpreters and translators, as well as more ideological and conceptual considerations. Technical experts involved in projects related to sign language technology often need to familiarise themselves with sign languages and their respective communities, and this requires time and repetition. Furthermore, deaf signers must receive enough accessible information to be fully engaged in the research domain and jargon of sign language technology.

Understanding and embracing attitudes from deaf people

By engaging in meaningful consultations with deaf individuals and communities through their representative organisations and demonstrating openness, we can gain a deeper understanding of how deaf signers perceive sign language technology. The openness may sometimes be misconstrued as naivety in response to the daily obstacles stemming from interpreter shortages. It is also essential to acknowledge the resistance by deaf individuals, which may have developed over years of their genuine concerns being overlooked and the execution of sign language technology projects without their involvement. Outsiders to the consortium have expressed discontent that the SignON project demonstrates that not all deaf people are willing to embrace sign language technology for any use case, including education. However, the SignON consortium firmly believes that it is not for hearing non-signers to pass judgement on whether this openness or frustration is justified. By understanding and incorporating these attitudes of deaf communities, sign language technology projects are better positioned to meet communities where they are, and to integrate communities into the research and development process, and to better frame communication and dissemination appropriately.

Invest in education and training for deaf signers

Sign language technologies represent a completely new field for many deaf signers, replete with specific terminology such as AI, machine learning, sign language recognition, sign language synthesis, virtual signers, and more. Given that this research domain directly concerns deaf signers, it is essential to allocate sufficient resources, possibly in collaboration with National Associations of the Deaf (NADs), to familiarise deaf communities with the subject matter and terminology. In the case of SignON, the communication team has produced a video explaining the subject of sign language technology in International Sign. Additionally, collaborative efforts were made, such as working with the NAD in Flanders to organise a session and workshops during their World Day of the Deaf event. During these activities, the SignON project was presented in an educational and interactive way. Moreover, it is crucial to highlight the added value and potential of sign language technologies in deaf people's daily lives, but also the limitations and challenges from the perspective of managing expectations. This effort will not only contribute to changing attitudes but also foster greater engagement with, and use of, sign language technologies.

Work on use-cases determined by deaf communities

In co-creation activities involving potential deaf end-users and stakeholders, it is crucial to identify the specific use-cases where sign language technology, especially automatic translation, is most relevant as well as where it is not suitable. For instance, previous co-creation events have indicated that deaf individuals may be inclined to use the application for low-stakes use-cases, such as daily communication, but not for high-stakes scenarios like press conferences, news broadcasts, education, or medical settings. However, it is also important to recognise that each setting may encompass various use-cases. For example,

within a medical setting, there is a distinction to be made between communicative events at the registration desk in comparison to a doctor's appointment. These use-cases should be assessed individually in consultation with deaf end-users.

Involve deaf employees and researchers

When working on the research and development of sign language technology, it is crucial to not only engage in co-creation with deaf end-users but also to hire deaf individuals. This is especially important for executing co-creation activities, communication, and dissemination. In the fields of sign language recognition and synthesis, the perspective of deaf individuals is an invaluable asset. Moreover, in any aspect of the technology where there is a human-machine interface, it is absolutely critical to have deaf people involved in the development. This includes developing applications that deaf end-users will interface with, developing algorithms to automatically recognise sign language input and developing signing avatars. For example, directly involving a deaf person in the creation process of a sign language avatar enables the early detection of issues with facial features or signing, often before a hearing non-signer would notice or would have to spend time showing it to a deaf person for feedback, leading to shorter development cycles. However, it is important to note that there is still a shortage of deaf scholars trained in machine learning and AI compared to their hearing counterparts and to acknowledge that deaf individuals may not always have the same access to educational opportunities as hearing people do. For example, especially in the field of sign linguistics, deaf research assistants provide very valuable native language intuition in tasks such as data collection and annotation.

It is advisable to incorporate enhanced training opportunities for deaf individuals within sign language technology projects, particularly in technical domains such as artificial intelligence (AI) and machine learning, as well as linguistics. When academic disciplines collaborate on projects with university partners, a concerted effort should be made to provide a diverse range of training opportunities. These opportunities could span from funded research internships designed for Bachelor's and Master's level participants to fully funded PhD programs tailored for deaf scholars. Instead of accepting the notion that 'deaf individuals with expertise in machine translation are scarce, initiative takers should consider investing in training programs to cultivate this expertise within the deaf community. Furthermore, it is recommended that funded internships be extended beyond academic institutions to include non-academic organisations, thus broadening the scope of training and skills development.

Work interdisciplinarily with Deaf and Sign Linguistics Studies

Collaboration between various research fields is inherent to working on sign language technology. The SignON consortium consisted of diverse technological partners and partners specialising in (sign) linguistics. For instance, the SignON consortium conducted research on the potential impact of video-mediated and video-recorded communication on the sign language production of Flemish signers. This is crucial for Sign Language Recognition because

the other language strategies must also be comprehended by AI. Deaf Studies should not be overlooked. Recognising the lack of sufficient expertise in Deaf Studies within the consortium, SignON consistently collaborated with deaf scholars from other universities, particularly regarding ethical considerations on sign language technologies.

Avoid tokenism

Sign language technology projects should never hire deaf people just to have someone deaf on board, or list them as co-authors in publications without their genuine contributions, as a way of avoiding or replying to criticism and worries of deaf communities. Deaf people should have an actual say and an actual impact within the project. In the SignON consortium, deaf members were recruited based on their qualifications and essential skills. They play a significant role in (co-creation) research and communication. Deaf consortium members also consistently emphasise that they do not necessarily represent all deaf people solely because they are deaf as well. The hearing researchers should be mindful not to automatically assume the right to speak for or make decisions on behalf of the deaf communities. It is also vital to constantly be aware of power dynamics and the privileged position of hearing researchers in relation to deaf communities.

Avoid linguicism

Linguicism is a term used to describe discrimination or prejudice based on language or linguistic differences. Throughout the research and development of sign language technologies, it is crucial to remain aware of the history and marginalised status of the deaf communities and sign languages. In SignON, internal seminars were organised delving into the global history of suppression of sign languages and its impact on the languages itself, their usage and existing policies. The SignON Encyclopedia, a video series produced by the communication team, provides additional insights into sign language for researchers and general audience. Sign languages are equally as valid as spoken languages, so they should be treated with the same level of respect. Non-signing researchers involved in sign language research, including synthesis, recognition, or data annotation, are encouraged to learn national sign languages through courses and interactions with deaf people, and delve into their linguistic aspects to deepen their linguistic and cultural understanding. For example, at one of the SignON partner institutions, SignON members have engaged with a deaf sign language teacher and organised a course in Dutch Sign Language (NGT) with people from different departments (not only SignON colleagues). It is crucial to become and remain aware of the history and marginalised status of the deaf communities and sign languages within any project in which deaf and hearing people work together.

3. Ethical considerations

There is a tension between 1) policymakers and funders who have hopeful beliefs in technosolutionism for various 'deaf and sign language' issues, ambitious researchers and developers seeking innovative 'solutions' for deaf people, and 2) deaf individuals who did not request these technological solutions. In these discussions, it is essential to keep the following ethical considerations in mind.

Recognise that sign language data is scarce and scattered
Research on sign language technologies lags behind spoken language technologies such as automatic speech recognition and machine translation, which have been built upon decades of human effort and machine training. These AI applications thrive on data generated from frequent use of the spoken and written media. The problem with sign language technologies is that there is very little sign language data available compared to that of (institutional) spoken languages. Sign languages are considered low-resourced languages. It is imperative to underline the profound impact of decades and even centuries of linguistic and societal oppression in shaping the current landscape. Today's policymakers often gravitate towards high-profile projects that promise immediate results, while more fundamental, yet equally critical initiatives centred on data collection and enhancing data computability struggle to secure approval and funding. Shedding light on the historical suppression of sign languages and the reasons behind the scarcity of data could potentially lead policymakers to reconsider their priorities, fostering a greater likelihood of support for foundational projects. An understanding of the deep-rooted challenges can pave the way for a more holistic approach to addressing the complexities of linguistic diversity and technological advancements. The development of sign language technology is closely linked to the generation of more sign language data. The data needs also to be made searchable and machine readable. This type of processing and annotation is very time-consuming and mostly involves manual labour. To achieve this, collaboration with organisations specialising in sign language and related research expertise is essential, and critically, deaf researchers must be involved to ensure that quality control is being done.

Be aware of bias in sign language data
To enable automatic translation between spoken and signed languages, a significant amount of data is required for training recognition, synthesis, language and translation models. However, it is crucial to exercise caution when selecting sign language data for AI training. Online sign dictionaries often contain de-contextualised single signs, which may be articulated quite differently when used in natural conversation e.g. embedded in a sentence. Corpus data may be insufficient and can consist of elicited data. This poses a risk of bias in the data. There are also different types of signers (and sign language data). As not all deaf and hard-of-hearing individuals have (had) equal and consistent access to sign language acquisition and maintenance, significant linguistic variations can be observed in their sign

language use. This can be attributed, for example, to the hearing status of their parents, their own exposure to sign language or spoken language dominance, or limited access to sign language education, etc. All data from these various types of sign language usage is equally valuable and useful for training AI, because Sign Language Recognition needs to equally comprehend all of the varieties at hand. Another issue arises because of the scarcity of sign language data, which leads to the exploration of alternative data sources, such as data from (hearing and non-native) interpreters. It is essential to recognise that this data primarily represents interpreted sign language, which may not necessarily reflect how deaf individuals use the language.

Be aware of risks of using 'L2 / non-native signers' data

To train AI, sign language data is widely sought by researchers and developers. Here, one should take a moment to consider who is generating this sign language data. For example, there is an abundance of data from news broadcasters that could potentially be used to develop AI models. This data provides news content in sign language through sign language interpreters. As such, the evening news broadcast on Flemish televisionanders has been interpreted daily since 2012, with each broadcast lasting approximately 40 minutes. It is tempting to consider utilising all this data to train AI, but researchers and developers need to keep in mind that most news broadcasts are interpreted by hearing interpreters who learned sign language as a second language as an adult. The latter may not use sign language in the same way that deaf individuals do, leading to lexical and grammatical differences or even errors in their sign language production as well asdropping source text information when translating. Furthermore, as live news broadcast interpreting happens under immense time pressure and with little to no time for preparation, it results in "translationese" sign language output. If only this data is used to train AI systems, sign language recognition and synthesis systems may exhibit distortions in their representation of sign language. Deaf fluent signers might then be required to adapt their sign language to the level of a second-language learner for effective communication with AI. It is also important to take into account the different language backgrounds of different deaf and hard-of-hearing people. Not everyone, due to the marginalised status of sign language, has access to it and/or learnt it later in life. These end-users also need to be able to be understood by AI (sign language recognition) and to understand AI (sign language synthesis).

4. Key points for communication and dissemination

How sign language technologies are communicated in the press and (social) media conveys a great deal, whether consciously or unconsciously, about the representation of deaf communities and their language. Therefore, a degree of monitoring and regulation in external communication is necessary, ideally led by deaf signers with the appropriate marketing, communication and PR skills at hand.

Exercise caution in how to communicate about sign language technologies

Avoid making empty promises or using sales pitches that do not apply. For example, refrain from stating that a translation application will resolve all communication issues for deaf individuals. Also, explicitly mention that reducing the communication gap between deaf signers and non-signers is a shared responsibility, not only that of deaf people who "can't speak or hear". Emphasise that sign language technologies are not the solution but merely an addition to the range of communication tools used by deaf individuals. Acknowledge this, instead of elevating hearing researchers or sign language interpreters as heroes who "help" deaf people.

Manage expectations in the media

Even if sign language avatars and applications are not yet at an advanced level, they often receive immediate exposure in the media or capture attention from funding sources. This poses the risk of creating unrealistic expectations among potential end-users. This not only affects deaf individuals who will encounter the current realistic limitations of automatic translation applications, for instance, but also when hearing employers, services, governments and other authorities impose the application on deaf people with unrealistic expectations, instead of professional sign language interpreters. A compelling example from the SignON project highlights this issue. Following a workshop about the project at the European Parliament in 2022, a press release was drafted where we explicitly outlined the nuances and challenges inherent in sign language technologies. However, a news website published an article about the event, ignoring all realistic challenges and showcasing only the positive aspects, overhyping this phenomenon and as such creating false hope.

Promote transparency and accessibility in communication and dissemination

Given that the development of sign language technologies is currently predominantly hearing-based and hearing-led, it is advisable to communicate information to deaf communities about the funding sources, researchers, and developers in the field. For instance, consider having a 'Who are we?' page on a website. This not only provides deaf communities with valuable insights into who is making decisions about technologies which may impact their daily lives but also offers them contact points. Also ensure that, on the contact page, signers have the option to send a video in sign language rather than having to type text in a form. Of course, it is more accessible for deaf individuals if there are deaf staff members they can directly contact in sign language. Additionally, in external communication and dissemination, careful consideration should be given to the use of English and/or International Sign, which many deaf individuals may perceive as high-brow or elite. Their preference often leans toward communication and information dissemination in their own national written and signed languages.

Conclusion

In this paper we presented critical attention points to be considered when developing sign language technologies. These are summarised below:

- **Utilise a co-creation strategy:** Engage deaf individuals as stakeholders in all stages of design and development through a co-creation strategy.
- **Understand the attitudes of deaf signers**: Incorporate diverse perspectives and attitudes from the deaf individuals and communities in research, development, and communication efforts.
- **Invest in education and training for deaf signers**: Allocate resources for education and training initiatives to familiarise deaf communities with sign language technology and its potential impact.
- **Work on use-cases determined by deaf people**: Identify specific use-cases for sign language technology through consultation with deaf end-users, avoiding the imposition of solutions.
- **Involve deaf employees and researchers**: Actively involve deaf experts and professionals in the research and development process.
- **Avoid tokenism**: Hire deaf individuals based on qualifications and contributions, avoiding token representation without genuine involvement.
- **Beware of Linguicism:** Remain conscious of discrimination based on linguistic differences, treating sign languages with the same respect as spoken languages.
- **Handle the sign language data with ethical responsibility:** Recognise that sign language data is scarce and scattered, as well as the presence of potential bias in the data.
- **Careful communication and dissemination**: Exercise caution in the communication about sign language technologies, refraining from making unrealistic promises, and maintaining transparency regarding the current limitations of these technologies.
- **Ensure transparency and accessibility**: Provide transparent information about funding sources, developers, and decision-makers, ensuring accessibility for deaf signers in communication and dissemination efforts.