ACCESSIBLE EUROPE 2019 BACKGROUND PAPER

ARTIFICIAL INTELLIGENCE AND INFORMATION COMMUNICATION TECHNOLOGY ACCESSIBILITY

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1 Introduction

This report provides an introduction into how Artificial Intelligence (AI) has the potential to support and enhance the accessibility of Information and Communication Technologies (ICTs). In an increasingly multimedia-heavy world where authors and developers fail to appreciate the importance of alternative formats that may suit users preferences, such as working with audio content rather than written or images rather than video, we need to develop more tools to automate accessibility tasks. Lack of accessibility means that ICTs are unable to provide ease of use and support for persons with disabilities (PwD). 'AI for Good' has the potential to remove this barrier, if it is provided with the right data and algorithms (rules and calculations) while ensuring Universal Design (UD) for all.

The Regional Initiative for Europe on Accessibility, affordability and skills development for all, to ensure digital inclusion and sustainable development was adopted by the World Telecommunication Development Conference 2017. The International Telecommunication Union (ITU) 2014 'Model ICT accessibility policy report', ITU member "recognized the need to ensure that the one billion people living with some form of disability can use information and communication technology (ICT) for their empowerment[1]." However, a lack of progress in terms of inclusion for persons with disabilities was highlighted and addressing this aspect is aligned with the United Nations Sustainable Development Goal 10, where they stress there is a need to reduce inequality in the following words , "policies should be *universal* in principle, paying attention to the needs of disadvantaged and marginalized populations." The increasing world-wide use of ICT, with the rapid evolution of different types of technologies (that have the potential to reduce the accessibility barriers faced by many individuals) should be made available to all. These technologies include built in Assistive Technologies (AT) that can work in a personalised way using Artificial Intelligence (AI) with the potential to "learn and adapt".

> *"At its heart, AI is computer programming that learns and adapts. It can't solve every problem, but its potential to improve our lives is profound... [and] we believe that the overall likely benefits substantially exceed the foreseeable risks and downsides."* Sundar Pichai, CEO Google[2]

Assistive Technology is defined in the ITU model policy report as "any information and communications technology, product, device, equipment and related service used to maintain, increase, or improve the functional capabilities of individuals with specific needs or disabilities." Assistive technologies tend to be recognised as separate hardware systems, such as a specific input device e.g. a switch or a trackball, a software application, a system or a service designed to provide a means for overcoming the barriers presented by society. However, more and more assistive applications (apps) are being integrated within an operating system or service. An example would be speech recognition that allows a user to

[1] ITU, and The Global Initiative for Inclusive Information and Communication Technologies, "*Model ICT Accessibility Policy Report, Telecommunication Bureau*", Nov, 2014 Online (Accessed 23rd April 2019) Available from: https://www.itu.int/dms_pub/itu-d/opb/phcb/D-PHCB-SIS_A.01-2014-PDF-E.pdf

[2] Pichai, S. AI at Google: our principles. Online, 2018 (Accessed 23rd April 2019) Available from: https://www.blog.google/technology/ai/ai-principles/

speak a request or dictate a message rather than type, if dexterity or spelling words is an issue.

When AT is built into systems, it supports those who do not necessarily consider themselves to be disabled but require additional support in their work or leisure time. For example, the smart phone that reads out a text message whilst carrying out another task, helps persons who have poor visual acuity or dyslexia. AT is also finding its way into wearable technologies with location services and talking timers for blind persons, also enabling joggers to hear messages whilst running. The increasingly wide range of AT can offer support across a spectrum of disabilities including cognitive, physical and sensory difficulties, as well as where mental health issues affect functional skills. AT should not be confused with the technologies used in medical or surgical situations where an implant device is used, such as a pacemaker to benefit someone with a heart condition.

Alongside the use of AT comes the necessity for alternative formats, providing options to view and interact with content in different ways and allow for personalised ICT with ease of use that enhances inclusion in our digital society. The 'Model ICT accessibility policy report' described ICT accessibility as "a measure of the extent to which a product or service can be used by a person with a disability as effectively as it can be used by a person without that disability for purposes of accessing or using ICT related products, content or services." (Page 7). Accessible ICT includes the embedding of universal design principles at the outset of its design and development and follows international accessibility guidelines that make it compatible with ATs, so that all users benefit.

A change in the field of accessible ICT that is having an impact is the introduction of collections of large amounts of data that can be used with algorithms and machine learning to enhance access to a wider range of content and digital features to support independence. As a subset of machine learning, deep learning recognises patterns in the data and is used in layers to create an artificial neural network that can learn and make intelligent decisions on its own. This type of technology can be described as Assistive or Augmented Intelligence when used to provide support for persons with disabilities, the aim being to augment a user's skills and not to replace them with artificial intelligence[3]. An example would be automated visualisation of complex data that can provide an alternative format for those who find analysing numbers or dense text hard to comprehend.

It is this alignment of Accessible ICT and Assistive Technology alongside the growing field of assistive or augmented types of Artificial Intelligence (AI) that this report explores, and from which it derives recommendations for a way forward.

[3] Beale R. *Supporting serendipity: Using ambient intelligence to augment user exploration for data mining and web browsing*. International Journal of Human-Computer Studies. 2007 May 1;65(5):421-33.

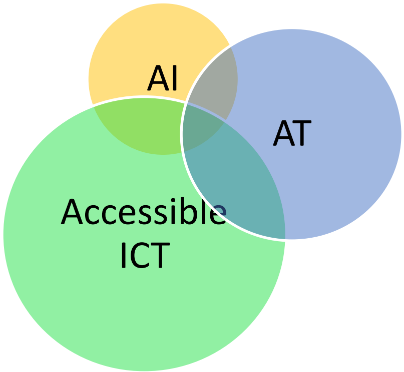

Figure 1. Venn diagram illustrating the overlaps of Accessible ICT with Assistive Technology (AT) and Artificial Intelligence (AI)

2 Setting the Scene

This report does not aim to discuss the need for accessible ICTs, as it has been debated in other documents[4], and in "many countries, non-discrimination laws requiring a certain level of accessibility are already in place. Therefore, the question is not so much about whether it is necessary to achieve accessibility, but more about how to achieve it."[5] This is not always a straightforward process, partly because accessible ICT is approached in different ways. It may be through a medical model where the user's disability or impairment is the main guide to the strategies provided or a social model where the digital barriers presented to a user are discussed and multiple or alternative strategies put in place. This report aims to use the social model that provides a Universal Design (UD) approach adopted by ITU in line with the themes of the UN Convention on the Rights of Persons with Disabilities.

> *"Universal design" means the design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. "Universal design" shall not exclude assistive devices for particular groups of persons with disabilities where this is needed."*[6]

From the point of view of ICT, to underline this concept the aim should be to offer equitable, flexible ease of use with perceptible information, tolerance for error and low physical effort in terms of access to all digital content. This benefits everyone in an equal way; it also allows for additional assistance to make devices, applications and content more adaptable depending on users' abilities, skills, settings and the tasks being undertaken.

[4] CEN, CENLAC and ETSI Standard - EN 301 549 Online (Accessed 23rd April 2019) Available from: http://mandate376.standards.eu/accessible-procurement

[5] Persson, Hans, et al. "Universal design, inclusive design, accessible design, design for all: different concepts—one goal? On the concept of accessibility—historical, methodological and philosophical aspects." *Universal Access in the Information Society* 14.4 (2015): 505-526.

[6] Convention on the Rights of Persons with Disabilities (CRPD)Article 2 – Definitions https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities/article-2-definitions.html

Universal design can ensure inequity is addressed and barriers are removed, for online situations as well as physical ones. Online cases can be web based with user agents providing author generated content or can involve different types of software applications. AI coupled with machine learning or deep learning, may enhance and speed up the ability to predict or recommend accessible alternatives with adapted systems. However, the process usually involves a large amount of data used to create a model from which an application can be built. This application provides the recommendations for a user, such as a series of directions in which to travel to avoid an inaccessible access point. In this case the usefulness of the application depends on both the accuracy of the data and the model providing a true picture of the built environment and noting where potential barriers exist. The same scenario could be applied to online information with improved image recognition being used to support brief text descriptions of photographs or pictures (Figure 2).

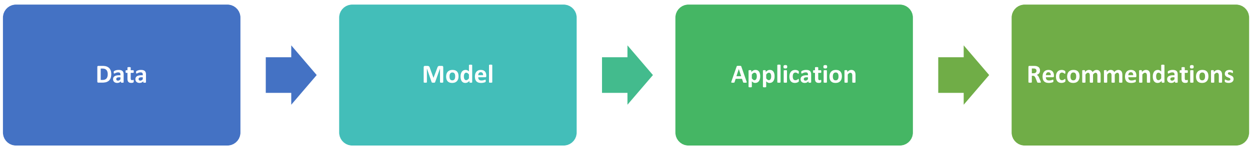

Figure 2. AI challenges for ICT accessibility

3 Universal Design, AI and Accessible ICT

"An accessible interactive experience is an experience that works for people. All people. Accessibility isn't a boring list of standards–it's a (not so) revolutionary philosophy of inclusion. You've probably heard, "The digital world belongs to everybody." It's up to all of us to make that happen."[7]

The ITU-T Technical Paper FSTP-TACL (2006) containing the Telecommunications Accessibility Checklist[8] explores where AI can enable and enhance many aspects of accessible ICT. The checklist is made up of eight elements that fit the accessibility requirements needed for a wide range of telecommunications. It is device agnostic, working with various systems and services and takes account of changes in digital tools. For example users are moving from fixed line phones to mobiles for calls and text, from desktops to tablets and laptops, plus there is an increase in the use of broadband with connected televisions, alongside the rise of online video and mobile technology used for viewing. In 2017, the ITU ICT Fact and Figures report stated that mobile-broadband subscriptions had grown more than 20% annually from 2012 and were expected to reach 4.3 billion globally by the end of that year.[9] However, the report goes on to point out that "despite the worldwide increase in high-speed fixed-broadband

[7] Intuiface quote Online (Accessed 23rd April 2019) Available from: https://www.intuiface.com/design-for-accessibility

[8] ITU FSTP-TACL - Telecommunications Accessibility Checklist 2006 Online (Accessed 6 May 2019) Available from: https://itu.int/pub/T-TUT-FSTP-2006-TACL

[9] ITU, ICT Fact and Figures 2017 Online (Accessed 6 May 2019) Available from: https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2017.pdf

subscriptions, there remains a lack of high speed connections in the developing world, with a penetration rate of 6% (1.6% excluding China) compared with 24% in developed countries."

The use of any form of AI that depends on good online connections will be affected by this lack of speed, especially when thinking about the way streaming synchronised accessibility options are delivered. This may make video content 'in time-sync' very difficult to achieve. This section works through the elements of the ITU checklist, looks at the different ways Assistive and Augmentative Intelligence can have a positive impact on accessible ICT whilst being aware of some of the issues that can arise.

4 Control of devices through a user interface

- **Offering visual and auditory controls in accessible and alternative ways**

The use of natural language processing (NLP) and neural network (NN) technology has improved speech and voice technologies that have been integrated into the management of phone calls and the sending of instant messages. Speech to text and text to speech, (where speech synthesis is used just to read the content of a window on a computer, not everything on the screen), has become more accessible with increased use of built in speech recognition, speech synthesis and voice assistants rather than the need for additional assistive technologies. Efforts have been made to avoid the latency and at times, unreliability of communication networks by hosting new speech recognition models directly on the device, but still broadcasting signals via large networks can be slow. Nevertheless, there have been improvements when coping with different languages, and accents. This has allowed many more users in different countries and persons with visual impairments and/or dexterity and motor difficulties to initiate and manage conversations with others independently. Some specialist apps also analyse poorly articulated speech samples to provide clearer results. Commands can be given to alert the phone to hands-free operation, speech macros developed to use different aspects of a device and built in text to speech or screen reading (where all parts of the operating system and content are read aloud) provides feedback when required. In the future, it is felt that it will be possible for deaf persons to receive automated live translations of speech as streaming text or captions although presently, these tools do not always produce acceptable/usable results[10].

- **Provide interoperability for input and output alternatives**

Common interactions between devices and operating systems are still an issue when considering alternatives for input and output. For example a keyboard user on a Windows laptop has access to a delete key to take out a mistake in front of the cursor – this is not the case on a Mac small keyboard. The user has to select a function key plus the delete or remember a combination access key such as Command+D. For persons with disabilities who use additional input/output peripherals (such as switches for those unable to type due to

[10] Ball, L. *Accessibility in 2018 — Cloud, AI, and Closed Captioning*. 2018 Online (Accessed 23rd April 2019) Available from: https://medium.com/evia-events/accessibility-in-2018-cloud-ai-and-closed-captioning-dccc26a8db25

motor or dexterity difficulties), there is the requirement for personalised software that has been designed to work with both operating systems and with differently configured hardware. These assistive technologies may not always be using AI, but increased interest is occurring in haptics, using the senses of touch and motion and incorporating large amounts of data to increase speed of interactions and offer further opportunities for innovation. The use of vibration can be essential for deaf and/or blind persons. For instance, by using wrist bands or vests it is now possible to learn to distinguish sounds from other devices, such as phones and even speech[11]. This occurs thanks to the data streams received by the brain via a wide range of minutely different vibrations. There is also the potential to help lip readers where similar looking sounds are hard to distinguish by recognising the feeling of the sound. Braille users with good fine tip sensitivity can access an A4 tactile graphics display with thousands of tactile points, speedily providing changing information thanks to AI. This device allows for the perception of much more complex data than can be supplied by a single line of Braille and can mean more than just using screen reading[12].

- **Privacy, security and safety ensured where user information is being shared**

There is a need to ensure that ethical procedures are followed, regulating the use of data with the consent of the user, so that where privacy issues or any hint of bias occurs (against a person with disabilities), it can be addressed at source. It is also important that transparent algorithms are used so that procedures can be checked and replicated to ensure a safe ICT environment. This is particularly important when allowing AI powered assistive technologies access to controls and user interfaces. In recent years, there has been some disquiet about the way big data, machine /deep learning and the use of neural networks have become known as “black boxes”[13] within systems. The outputs have not always produced expected results and predictions or recommendations have not necessarily helped users. Explainable AI is essential so that corrections can be made and results understood[14]. Where individuals **need** to use certain technologies rather than just **want** to use them, there is a requirement to have understandable systems that offer as accurate results as possible and this applies across all the following sections.

[11] NeoSensory Buzz wrist band. Online (Accessed 23rd April 2019) Available from: https://neosensory.com/buzz/?v=79cba1185463

[12] Blitab Braille tablet. Online (Accessed 23rd April 2019) Available from: http://blitab.com/

[13] Babel, B., Buehler, K., Pivonka, A., Richardson, B. and Waldron, D. *Derisking machine learning and artificial intelligence*. 2019. Online (Accessed 23rd April 2019) Available from: https://www.mckinsey.com/business-functions/risk/our-insights/derisking-machine-learning-and-artificial-intelligence

[14] Doran, D., Schulz, S. and Besold, T.R., *What does explainable AI really mean? A new conceptualization of perspectives*. 2017 arXiv preprint arXiv:1710.00794. Online (Accessed 23rd April 2019) Available from: https://arxiv.org/pdf/1710.00794.pdf

5 Control of services

- **Where ICT services are supplied, digital accessibility is essential for all.**

Multiple means of representation and accessible interactions with others when using ICT has increasingly become more available with built-in assistive technology (AT) options such as keyboard, mouse and gesture adaptations, magnification, screen reading, colour changes and speech recognition. Some office applications offer automatic alternative text for embedded images using AI image recognition. The appropriateness of the labels may still need to be checked, but the time taken to make these changes has been considerably reduced. Text clarification can be used where complex content needs to become 'easy to read' e.g. for people with literacy and learning difficulties[15] and an increasing elderly population who are becoming digitally more able, but may benefit from these affordances. In 2017, the United Nations stated that it was estimated the over-60s made up 13% of the global population with the percentage rising to 25% in Europe[16]. On average 46% of those over 60 develop disabilities[17]. The type of disabilities often mentioned include poor visual acuity, dementia, stroke with aphasia, short term memory and a lack of concentration, all leading to reading and writing difficulties. Natural language processing can help with spelling and grammatical corrections, whilst also offering automatic on-line translation for those needing to work in multiple languages. Although the results in some languages may not be perfect, manual online corrections can be offered, enhancing the machine learning process. Converting certain file formats to ones that are accessible has also been made possible by the use of cloud based services combining AI with optical character recognition (OCR) systems allowing for better navigation and text to speech output[18].

- **Provide multiple input and output alternatives**

Standards such as those developed across Europe and the world by ITU, ETSI, ISO/IEC and the W3C Web Accessibility Initiative[19] offer techniques as to how input and output devices and software need to work with what has been created in documents and web pages as well as how navigation and controls need to be made accessible. As already suggested the use of speech recognition offers one input method using natural language processing to produce text, whilst speech synthesis provides an alternative output to reading the text. Other

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[15] IBM Content Clarifier. Online (Accessed 23rd April 2019) Available from: https://www.ibm.com/able/content-clarifier.html

[16] United Nations. Ageing Online (Accessed 2nd July 2019) Available from: https://www.un.org/en/sections/issues-depth/ageing/

[17] United Nations. Ageing and Disability Online (Accessed 2nd July 2019) Available from: https://www.un.org/development/desa/disabilities/disability-and-ageing.html

[18] Google Chrome Detect Text (OCR). Online (Accessed 23rd April 2019) Available from: https://cloud.google.com/vision/docs/ocr and ABBYY FineReader Engine. Online (Accessed 23rd April 2019) Available from: https://www.abbyy.com/en-gb/ocr-sdk/

[19] W3C Web Accessibility Initiative. Online (Accessed 23rd April 2019) Available from: https://www.w3.org/WAI/)

alternative input methods, also using AI, include face and eye tracking, brain computer interfaces, signing and gesture input linked to cameras. As already mentioned, Braille and touch sensitive surfaces can offer output as well as input, but these tend to be in addition to built-in accessibility options.

- **Allow options for actions to take place in the users' own time avoiding timeouts (or offer an alternative if security is an issue).**

Anxiety can build up when faced with a 'timeout' situation such as filling in a secure form or completing a task such as banking or booking tickets. The difficulties may be due to user skills, or how well the AT works with the content, delaying input. Text completion with automatic form filling is possible where field values can be predicted using previously trained contextual data[20] and timeout controls can be offered with personalisation. This is where user information about time requirements is gathered prior to the use of webpages along with text clarification where necessary[21].

- **Suggest error prevention techniques, anomaly support and offer recovery mechanisms.**

Error detection and anomalies made when completing interactions and filling in forms can be very poorly explained when failure on submission occurs. However, automated error correction and recommendations for how to complete certain actions can be achieved using machine learning prediction and classification models, based on the specific document and field types. Temporary data storage has been possible along with returning to where the user left off in a form, but now corrections can be more specific and faulty submission captured for user modifications. This comes thanks to the way data and classification models can be built around typical errors and many incorrect activations can be resolved. But care needs to be taken to check the end results. "Neural nets are good at recognizing patterns—sometimes as good as or better than we are at it. But they can't reason." Roger Parloff (2016)[22]

- **Privacy, security and safety ensured where user information is being shared**

Just as AI can enhance privacy, security and safety with the development of evermore ingenious bots (automated programs that run over the Internet), there is a need for reCAPTCHAs to become even cleverer to prevent fraudulent activities. However, with machine learning delivering increasingly hard challenges at least one fifth of the population

[20] Branting, L.K., *Cognitive Assistants for Document-Related Tasks in Law and Government*. In 2015 AAAI Fall Symposium Series. Online (Accessed 23rd April 2019) Available from: https://www.aaai.org/ocs/index.php/FSS/FSS15/paper/viewPDFInterstitial/11699/11469

[21] Easy Reading Horizon 2020 Project. Online (Accessed 23rd April 2019) Available from: https://www.easyreading.eu/?page_id=417

[22] Parloff, R., *Why deep learning is suddenly changing your life*. Fortune. New York: Time Inc. 2016 Online (Accessed 23rd April 2019) Available from: http://fortune.com/ai-artificial-intelligence-deep-machine-learning/

are finding these security checks a barrier to access[23]. The indecipherable image cards presented or the alternative unintelligible audio options are becoming harder to recognise for persons with sensory or intellectual disabilities. It is hoped that a scoring system using a collection of input methods will make it easier and Google's "reCAPTCHA adaptive risk analysis engine can identify the pattern of attackers more accurately by looking at the activities across different pages."[24]

6 Media presentation to the user

- **Offer all visual and auditory real time, streaming and stored media with alternative formats such that assistive technologies can be used with the content.**

Videos, podcasts and streaming audio can be automatically captioned with transcripts using increasingly accurate automatic speech recognition (ASR) and speech to text natural language systems[25]. However, the quality of the automated output cannot be guaranteed to be 100% accurate to be acceptable, and standardised key performance indicators have yet to be written. The same is true when considering localisation and sign languages. Despite the work being done to translate spoken English into American Sign Language with avatars[26] and the building of a machine readable dataset of British Sign Language, there remain issues with videos where facial expressions and actions have been captured as well as the specific signs to produce automatic translations[27]. These possibilities are also being trialled with some books made available to deaf children via an app using OCR and avatars[28] or via videos using a range of avatars for any specifically requested spoken or text translations [29] but more research is required in this area.

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[23] Christopherson, R. *AI is making CAPTCHA increasingly cruel for disabled users.* 2019 Online (Accessed 23rd April 2019) Available from: https://www.abilitynet.org.uk/news-blogs/ai-making-captcha-increasingly-cruel-disabled-users

[24] Google Webmaster Central Blog. *Introducing reCAPTCHA v3: the new way to stop bots*. 2018 Online (Accessed 23rd April 2019) Available from: https://webmasters.googleblog.com/2018/10/introducing-recaptcha-v3-new-way-to.html#gpluscomments

[25] Roach, J. Microsoft: *AI technology helps students who are deaf learn* 2018 Online (Accessed 23rd April 2019) Available from: https://blogs.microsoft.com/ai/ai-powered-captioning/ and Salva, S. Google AI Blog: Real-time Continuous Transcription with Live Transcribe 2019 Online (Accessed 23rd April 2019) Available from: https://ai.googleblog.com/2019/02/real-time-continuous-transcription-with.html and IBM Watson *AI powered captioning* 2019 Online (Accessed 23rd April 2019) Available from: https://www.ibm.com/watson/media/watson-captioning/

[26] The American Sign Language Avatar Project at DePaul University 2018 Online (Accessed 23rd April 2019) Available from: http://asl.cs.depaul.edu/

[27] University of Surrey *ExTOL: End to End Translation of British Sign Language*. 2018 Online (Accessed 23rd April 2019) Available from: https://cvssp.org/projects/extol/

[28] Huawei Storysign across Europe. Online (Accessed 23rd April 2019) Available from: https://consumer.huawei.com/uk/campaign/storysign/

[29] Simax signtime and simessenger https://simax.media/?lang=en

Automated captioning, transcription creation and avatar sign language systems hold the promise to allow for the production of multilingual versions of all these alternative formats at less cost and with greater speed. However, as mentioned the quality / accuracy of the automated output is not always acceptable, the nuances of localisation fail to be considered and the vocabulary used may be inappropriate in some settings.

Audio descriptions for certain types of media such as films, drama, wildlife programmes and documentaries[30] are helpful for persons with visual and hearing impairments. While AI holds potential, finding methods to automate audio descriptions is still a challenge[31] due to the huge variation and context of sounds and the need to set up many different applications such as "audio classification, audio fingerprinting, automatic music tagging, audio segmentation, audio source separation, beat tracking, music recommendation, music retrieval, music transcription, and onset detection"[32]. Nevertheless, it is now possible to speed the human process with the aid of automatic synchronisation applications and speech recognition.

7 Media entry by the user [media capture]

- **Ability to capture images, sound, animation and videos using devices independently or with assistive technologies**

There are now many applications (apps) that are using machine learning or various forms of deep learning to provide image capture to support for persons with disabilities. The apps range from those providing the description of scenes, people and other items such as menus with speech synthesis to aid persons with visual impairments or sound capture for persons with hearing impairments. Accessing the apps on a device has also been made easier using face recognition, iris scanning or fingerprint recognition. These tools can help those who forget passwords and may also be useful when dexterity difficulties arise[33].

There are reading apps that take selected text, simplify it, read it aloud and smart phone built-in dictation that eases message and note writing using speech recognition.

Augmentative and Alternative Communication (AAC) apps can recognise a user's settings and tasks being undertaken, when using symbols or predicts and finishes text input to support dexterity difficulties.

[30] Access Services Literature Review – Ofcom 2006 Online (Accessed 23rd April 2019) Available from: https://www.ofcom.org.uk/__data/assets/pdf_file/0027/47079/litreview.pdf

[31] Kurihara K., Imai, A. et al. *Automatic generation of audio descriptions for sports programs* 2017 Online (Accessed 23rd April 2019) Available from: https://www.ibc.org/production/automatic-generation-of-audio-descriptions-for-sports-programs-/2490.article

[32] Medium: *Deep learning, Audio Classification, and Beyond* 2018 Online (Accessed 23rd April 2019) Available from: https://medium.com/@franky07724_57962/deep-learning-audio-classification-and-beyond-4d2533080a33

[33] Windows Hello Online (Accessed 23rd April 2019) Available from: https://www.microsoft.com/en-ie/windows/windows-hello

8 Media processing including transport, coding, transposition, etc.

- **Ability to speed real-time communication so that the alternatives offered such as sign language or captions are not impacted.**

Trained machine learning models offer the potential for deployment of automated alternatives on less powerful devices such as smartphones. These devices can offer increased accessibility to the sorts of applications that were once only found on computers and provide a level of independence that allows better chances of being employed with examples of way finding plus screen reading or conversations in meetings with streaming AI enabling speech to text translations for the deaf and lecture capture when in education.

Machine learning techniques can also be applied to networked systems to offer enhanced prediction, classification and error correction such as specialised speech recognition being used by individuals with poor articulation[34].

- **AI enabled networked systems for speedier transport of data to aid search results.**

Increased speed and accuracy of web indexing and page ranking when using search engines helps everyone, often with localisation support, but only limited personalisation of user's results[35]. There remains a gap in the metadata provided when searching for content. There is no way of knowing, prior to downloading or viewing, whether videos will have captions and transcripts, and electronic books or texts will be available in alternative and/or multiple formats. There is also a lack of information as to whether they offer accessibility options, such as speech synthesis or text to speech, (where just the authored content is read not the entire computer screen), which has been found to help persons with dyslexia.

9 User and device profile management and use

- **Users often require enhanced personalisation of ICT to support memory, language, literacy, planning and organisation, physical and other sensory skills.**

Personalised applications supported by AI such as electronic mail and word processing packages will learn how users carry out regular tasks[36] and provide prompts, organise mail boxes and calendar reminders, offer autocomplete and improved spelling and grammar

[34] Kolodny, L., *Voiceitt lets people with speech impairments use voice-controlled technology* Online (Accessed 23rd April 2019) Available from: https://techcrunch.com/2017/06/01/voiceitt-lets-people-with-speech-impairments-use-voice-controlled-technology/?guccounter=1&guce_referrer_us=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_cs=jTEUoq8WcLEuNEXibXFrSA

[35] Schwartz, B., *Google admits it's using very limited personalization in search results* 2018 Online (Accessed 23rd April 2019) Available from: https://searchengineland.com/google-admits-its-using-very-limited-personalization-in-search-results-305469

[36] Heltzel P. Computer World: *How AI is changing office suites* 2019 Online (Accessed 23rd April 2019) Available from: https://www.computerworld.com/article/3340126/how-artificial-intelligence-is-changing-office-suites.html

checking. These features have the potential to be particularly helpful for persons with cognitive impairments such as dyslexia and ease accessibility in the widest sense of the word.

Automated machine learning (AutoML)[37] can be trained on models for specified tasks to give users for example, more accurate image recognition and speech processing in many languages. These developments can be used to provide enhanced alternative formats, such as symbol support for text and improved screen reading, text to speech and speech recognition.

Further assistance can include just-in-time support with the use of online chat bots and widgets. These technologies react to user interactions, providing alerts when there are unexpected changes occurring on parts of the screen, such as modal windows that require attention or recommend colour contrast changes to enhance readability.

These options plus personalised management settings linked from the user's computer, as offered by the EU funded Easy Reading Horizon 2020 Project[xxi] could all provide enhanced AI enabled accessibility.

10 Conclusion

When considering ICT accessibility (having settled on suitable input and output methods), users who may have a wide range of disabilities still find issues with online and off line content. Despite its growth, with improved machine learning systems and related algorithms, AI use in the field of ICT accessibility is still in its infancy. For example, problems remain with attempts to auto correct certain types of navigational elements or automatically create accessible website and document structures, forms, image descriptions, videos and podcasts. Klaus Schwab describes this rise in automation and the use of machine learning, robotics and 3D printing (that has had an impact on personalised peripherals, such as keyguards for persons with dexterity difficulties) as the "Fourth Industrial Revolution".[38] In his book he also mentions fifth-generation wireless technologies (5G), which have the potential to reduce latency, enhance geo location and navigation services, to name just a few of the benefits this speedier wireless option can offer to persons with disabilities[39].

Increased internet coverage across the world means yet more multimedia will be available, despite the paucity of access in some areas mentioned at the beginning of this report. "By 2021, a million minutes (17,000 hours) of video content will cross global IP networks every single second"[40]. As Internet coverage and media content is incredibly helpful for many people, there has to be an improvement in areas such as automated captions, transcriptions

[37] Wikipedia *Automated machine learning* Online (Accessed 23rd April 2019) Available from: https://en.wikipedia.org/wiki/Automated_machine_learning

[38] Schwab, K. The Fourth Industrial Revolution. New York: 2017.Crown Publishing Group. ISBN 9781524758875.

[39] CTIA 5G Will Spur New Opportunities for Americans with Disabilities 2018. Online (Accessed 2nd July 2019) Available from: https://www.ctia.org/news/5g-will-spur-new-opportunities-for-americans-with-disabilities

[40] McCue, T.J. Forbes : *Video Marketing In 2018 Continues To Explode As Way To Reach Customers* Online (Accessed 23rd April 2019) Available from: https://www.forbes.com/sites/tjmccue/2018/06/22/video-marketing-2018-trends-continues-to-explode-as-the-way-to-reach-customers/#24f4a199598d

and audio descriptions so even more people can enjoy this type of media. But, at present we need to accept that AI has the potential to enable ICT accessibility changes, but still cannot cope without the reasoned input of digital accessibility experts.

As long as the training data used for the machine learning and the complex algorithms used for decision making fail to include both young and old with a wide range of disabilities, human input remains vital. This exclusion of a section of the population means that factors that are important to technology users with disabilities will be ignored. Time outs based on average speeds of interaction with no options for slower speeds are an example. Similarly complex haptic gestures only suitable for dextrous users that cause problems when using mobile technologies might remain excluded from accessibility consideration.

Developers, content creators and all those within the ICT world need to address the difficulties encountered by minority groups and AI often fails in this task. Data management, machine learning including deep learning and neural networks, along with all their rules and calculations, need to be transparent. The inclusion in the data collection of any one who lies outside what may be considered a normal range is essential and has to be seen to be in place. There also needs to be clarity as to the way the machine learning occurs with an awareness that the more convoluted the system becomes, the further away it will be from the original structure and falsehoods can develop. “People are complex, multi-dimensional and evolving. Trying to fit people into classificatory boxes is very problematic,”[41] and yet AI largely depends on pattern recognition. So it is important to remember in the world of ICT and disability, as it is at present, the aim is to augment users’ skills, not provide artificial intelligence to replace them.

[41] Treviranus, J. 2018 If you want the best design, ask strangers to help. Online (Accessed 2nd July 2019) Available from: https://medium.com/ontariodigital/if-you-want-the-best-design-ask-strangers-to-help-e37bdb73567

Glossary

3D printing	Making a physical object from a three-dimensional digital model, by usually building up thin layers of plastic in succession.
Accessibility	The extent to which a product (including software, websites and documents) or service can be used by everyone, regardless of disability
Accessible documents	Documents that can be accessed by those with disabilities.
Accessible eBooks	Electronic books that can be accessed by those with disabilities.
Accessible mobile apps	Applications for mobile devices that can be accessed on a mobile device by those with disabilities.
Accessible videos, podcasts & TV	Videos and television programmes that provide captions, sign language and audio description.
Accessible websites	Websites that can be used by assistive technology users and those with disabilities.
Algorithms	Computer programmed rules and calculations
Alternative formats	Provide users with the chance to view and interact with content in different ways that are compatible with assistive technologies.
Approaches to inclusion	Steps taken not to exclude minority groups.
Artificial Intelligence (AI)	A type of intelligence that attempts to simulate human intelligence using computer systems and various types of machine learning
Assisted AI	Designed to help human intelligence rather than replace it.
Assistive technologies	Technologies, both hardware and software, that assist those with disabilities.
Audio description	Spoken description of important information (in a video) that is otherwise only available visually.
Augmentative and alternative communication (AAC)	Augmentative and alternative communication, an umbrella term for methods and technologies (e.g. communication boards and speech-generating devices) that help people with a wide range of speech and language impairments to communicate with family, carers and other people.
Augmented AI	Designed to build on and support human intelligence rather than replace it.
Automated Machine Learning (AutoML)	Automating all the processes involved in machine learning to solve problems.

Avatars	In computing, an avatar is the graphical representation of a user or character.
Bias	Systematic deviation of study results from the true results, because of the way(s) in which the study was conducted including the way data was collected.
Big Data	Large sets of information that are collected about people, interactions and things that can be categorised, labelled and used for pattern recognition with machine learning, deep learning and neural networks.
Black boxes	In computer terms this might be a complex system or device that is not readily understood because the way it works is hidden.
Bots	Automated programs that run over the Internet
Braille	Tactile writing system using raised dots that is used by blind people.
Broadband	Fast connections because multiple streams of data can be carried simultaneously.
Captions	Text alternative for speech and non-speech sound in a video typically displayed at the bottom of the screen.
Deep Learning	A subset of machine learning that automatically works through several layers of data finding patterns without tagging and does not have to have rules.
Ease of use	The extent to which a particular user or group of users can use a digital technology to achieve their goals.
Fifth-generation wireless technologies (5G)	5G will increase the speed and responsiveness of wireless networks so providing better data transfer improving media streaming.
ICT	Information and communications technology, i.e. the tools, both hardware and software, that people use to access, store, transfer and manipulate information.
Keyboard accessible	Accessible with a keyboard or through a keyboard interface, so that it is usable by those who cannot or do not wish to use the mouse and so that it can be reached by pressing a key or combination of keys.
Keyguard	A keyguard is a sheet of thin plastic that is laid over the top of a communication display or keyboard, and has holes cut out over the locations of different buttons on the display.
Legislation & standards	Laws and standards (“rules”), which may vary by country.

Machine Learning	Computer programs used to learn for themselves once they have been trained on sets of data that have been labelled or tagged
Natural Language Processing (NLP)	Interaction between computers and the languages we speak to provide apps/services such as speech recognition.
Navigation	An ICT term used to define the user's ability to move between items on a device or within an operating system, software application, between pages on a website or document,
Neural Networks	Computer systems modelled on the way the human brain and nervous system works.
Optical Character Recognition (OCR)	Where an image of printed text can be recognised and turned into real text that can then be edited or read aloud using assistive technologies.
Personalisation	The process of adapting user interfaces to include the user's personal preferences and needs (e.g. due to disability)
Podcast	Digital audio or video files which a user can download and listen to at any time.
reCAPTCHAs	A way of offering a security service to protect websites from spam and abuse.
Screen reader	Software program that enables a blind person to get information from the screen through synthetic speech, Braille, or both, and that goes beyond pure text-to-speech software because it also reads user interface elements such as navigational features and menus.
Sending Messages	There are many ways to send messages. You can use speech, gestures, writing, and head movements if you can control your body.
Sign language	A language that uses manual gestures and other body movements such as facial expression etc as the communication modality.
Social model of disability	Social theory that regards people as being disabled by society's lack of accommodation for their needs, and that is a reaction to the medical model of disability.
Speech recognition	Computer software that transcribes speech to text and/or follows voice commands.
Switch	A single button device the replicates an input method used with single or double pressing and holding for those with physical difficulties.

Switch access	A device that offers activation and entry to an application in a similar way to an input device - it may be a button, pad or mini type for those with physical difficulties.
Synthesised speech	A system that generates speech for each utterance, through letter-by-letter spelling, word retrieval, or phrase retrieval.
Tactile graphics	Images that use raised patterns that can be perceived through touch.
Text equivalent	Text information explaining the purpose of an image or other non-text object.
Text-to-speech software	Type of application that uses synthetic speech to read selected text aloud and that can be used to help those with reading difficulties. Unlike screen reading, not all the items on a screen are read unless chosen.
The International Telecommunication Union (ITU)	The International Telecommunication Union, a United Nations agency responsible for issues that concern information and communication technologies. (Wikipedia)
Transparent Algorithms	Easy to understand rules and calculations used to work with machine learning.
Universal Design	The design of an environment so that it can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability.
Web accessibility	The extent to which a web technology can be used by everyone.
Word prediction	Memory-resident utility software that provides keyboard assistance. As the user inputs each keystroke, the software presents a list of possible words or phrases that it thinks the user is typing. The user then selects the appropriate word from the prediction list. Statistical weighting and grammatical knowledge is often incorporated into the software to improve prediction tasks.

References

Convention on the Rights of Persons with Disabilities (CRPD) Article 2 – Definitions https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities/article-2-definitions.html

ITU FSTP-TACL - Telecommunications Accessibility Checklist 2006 Online (Accessed 6 May 2019) Available from: https://itu.int/pub/T-TUT-FSTP-2006-TACL

ITU, ICT Fact and Figures 2017 Online (Accessed 6 May 2019) Available from: https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2017.pdf

United Nations. Ageing and Disability Online (Accessed 2nd July 2019) Available from: https://www.un.org/development/desa/disabilities/disability-and-ageing.html

W3C Web Accessibility Initiative. Online (Accessed 23rd April 2019) Available from: https://www.w3.org/WAI/)