Senior Info-Exclusion 4.0—Emerging Digital Technologies and the Technological Singularity

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Abstract. The elderly population will continue to comprise the largest group of the info-excluded, nationally and worldwide. With the evolution and appearance of increasingly emerging digital technologies, the possibility of increasing the digital divide among the elderly population could become a much more worrying reality. The Internet of Things, augmented reality, mixed reality and artificial intelligence, especially the new versions of GPT Chat, among others, are bringing new challenges and the need to acquire new digital skills. There is an increasing feeling that the so-called technological singularity will be reached very soon. If systems and entities become more intelligent, they could benefit the most info-excluded citizens because the system will be autonomous in its decision-making, where technology will/can override humans. However, it is important that citizens have the ability and possibility to decide which solutions and proposals they feel are best suited to their quality of life in a future where environments will be more assistive under the more refined concept of Ambient Assisted Living (AAL). In this sense, there is an urgent need to discuss and present proposals so that today's info-excluded can prepare for a society that will continue to be predominantly digital but will have new contexts, resources, and organisations. In this sense, the safe use of the Internet and safeguarding autonomy and independence with dignity and security will be the objectives of exercising full citizenship within a new digital ecosystem.

Keywords: Ageing · Info-exclusion · Senior 4.0 · Technological singularity · Emerging digital technologies

1 Global Framework: The Elderly and Info-Exclusion

Please note that the first paragraph of a section or subsection is not indented. The first paragraphs that follows a table, figure, equation etc. does not have an indent, either. The world's population is growing, but it is also ageing. All over the world, people are living longer, and as the World Health Organisation [1] emphasises, longer lives are one of Humanity's most outstanding achievements. However, we do not just want to add years to our lives. We also want to enjoy good health and well-being in old age. In other words,

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healthy ageing. This is the "process of developing and maintaining functional capacity that enables well-being later in life" [2, p.2]. We are in the United Nations (UN) Decade of Healthy Ageing (2021–2030), the aim of which is to give everyone the opportunity to add life to their years, wherever they live. However, today, too many people worldwide are in worse health than they should be due to unfavourable environments preventing them from maximising their last years. Therefore, "healthy ageing is about creating opportunities that allow people to be and do what they value throughout their lives" [2, p.24]. Opportunities will undoubtedly be linked to emerging digital technologies and, perhaps, technological singularity.

Firstly, a look at some aspects of demography. World Population Day is celebrated annually on 11 July. It was proclaimed by the United Nations in Resolution 45/216, adopted by the UN General Assembly on 21 December 1990, and aims to raise awareness of population issues and recognise the importance of demographic policies in the economic development of countries.

We already have more than 8 billion people, and the trend is to continue growing, at least until 2050, when it is expected to reach 9.7 billion people. From then on, we should see a decrease, according to the United Nations Population Fund's report on the world's population 2023 [3].

The European Union (EU) also has an overview of demographic change with a sharp increase. According to [4] we will go from 446.7 million on 1 January 2022 to 448.4 million on 1 January 2023. This trend is expected to continue and peak at 453.3 million in 2026 (+ 1.5%), gradually decreasing to 447.9 million in 2050 and to 419.5 million in 2100, with an overall decrease of 27.3 million (−6.1%) projected from 2022 to 2100.

While the world population will tend to increase, Portugal will move in the opposite direction. According to INE's resident population projections between 2018 and 2080, Portugal will have approximately 8.2 million people in the central projection scenario in 2080 [5].

The United Nations Population Fund's report on the world's population in 2023 [3] jointly emphasises that we are an ageing population. The world's population is ageing, and every country is experiencing an increase in the number of older people. This demographic transformation is the result of declining fertility and increasing longevity, but also of migratory flows that have changed the age structures of the population in some countries and regions. 2018 is an example of this, as it was the first time in history that the number of people over 65 exceeded those under 5. Furthermore, it is estimated that by 2050, the number of people over 65 will be more than double that of people under 5. So, as fertility decreases and life expectancy increases, the world's population is ageing rapidly. We are ageing more and more rapidly than ever before. Between 1950 and 2022, the percentage of the world's population grew from 5.13 to 9.82%. It is estimated that 2050 this figure will rise to 16.51% [6].

The EU and Portugal are following the phenomenon of population ageing at the global level, with a significant increase in the elderly population and a decrease in the young population. In the EU, the ageing of the population is expected to continue until 2100, increasing both the size and the proportion of elderly people in the total population. Eurostat [7] forecasts indicate that the proportion of older people (aged 65 and over) in the total EU population will increase from 21.1% (94.3 million) at the start of 2022

to 32.5% (136.1 million) in 2100. As for the proportion of children (0–14 years) in the total EU population, it is forecast to fall from 15.0% (69.9 million) at the start of 2022 to 13.2% (55.2 million) in 2100. The elderly are the only leading demographic age group expected to grow, both in relative and absolute terms, indicating a continuation of the ageing of the population (see Fig. 1).

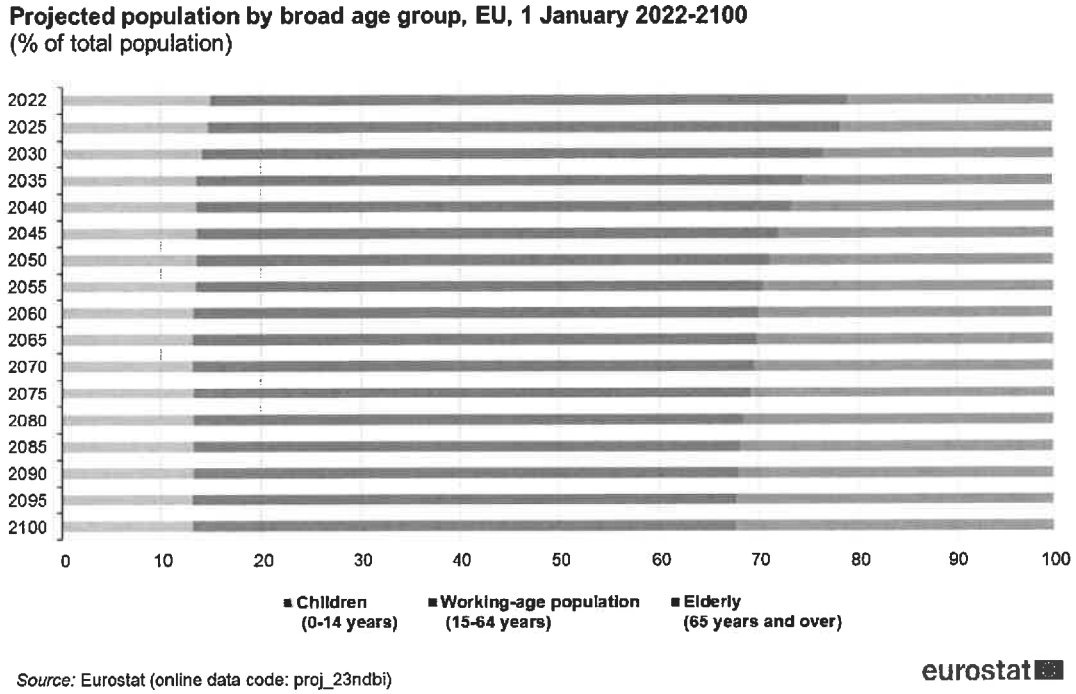

Fig. 1 Projected population by broad age group, EU, 1 January 2022–2100. (*Source* Eurostat https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:EUROPOP2023_Figure_2_Projected_population_by_broad_age_group,_EU,_1_January_2022-2100.png)

In Portugal, in 2022, the ageing index, which compares the population aged 65 and over (elderly population) with the population aged 0 to 14 (young population), reached 185.6 elderly people for every 100 young people (181.3 in 2021) [8, p.1].

People live longer and are increasingly very old, aged 80 and over. The number of these people in the total EU population is expected to more than double, both in absolute and relative terms, from 27.1 million in 2022 (6.1%) to 64.0 million (15.3%) in 2100 [7].

Figure 2 shows two population pyramids of the changes in the EU population between 2022 and 2100, where the more significant growth of the elderly population is evident, as shown by the widening at the top of the pyramid, compared to the other population groups [7].

The global ageing of the population will significantly impact countries' economies, and, as a result, demographic policies are becoming progressively more urgent and relevant, hence the UN's reminder of the importance of World Population Day and the Decade of Healthy Ageing.

Like the increase in population, ageing and longevity, we are also witnessing an accelerated digital transformation driven by scientific and technological advances and

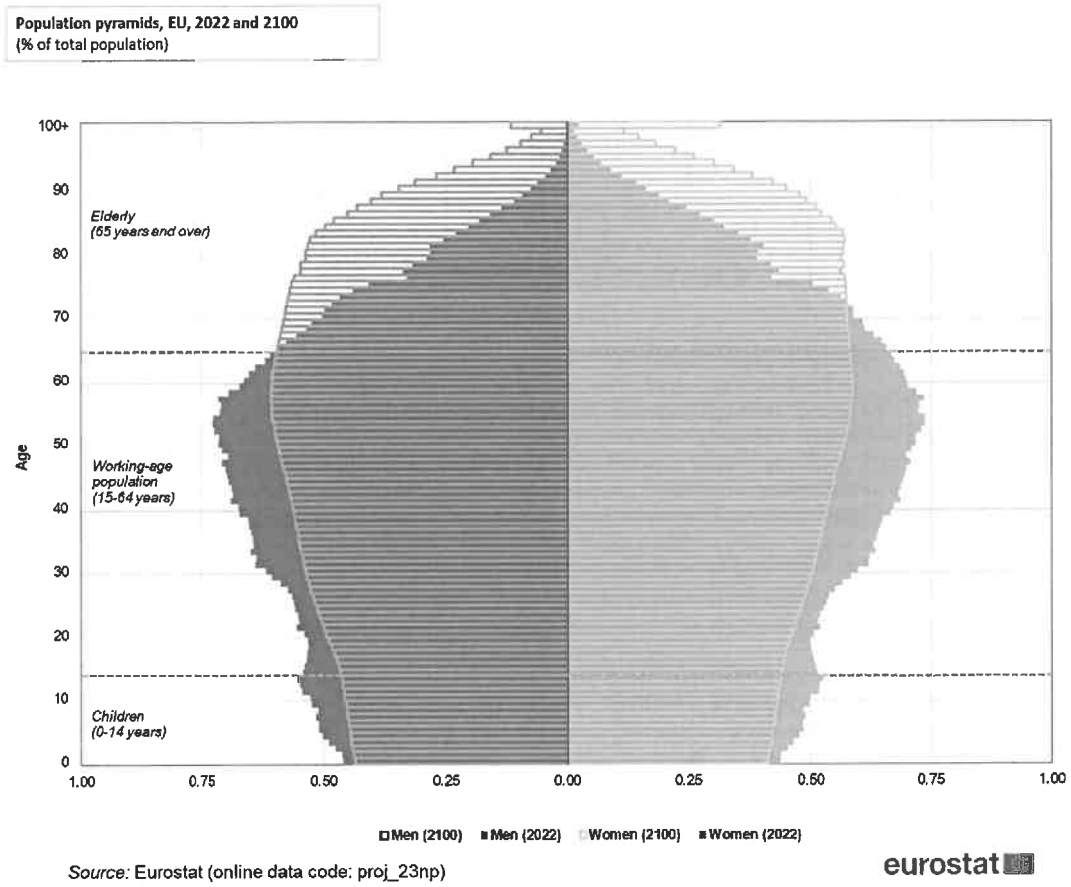

Fig. 2 Population pyramids, EU, 2022 and 2100. (*Source* Eurostat https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:EUROPOP2023_Figure_3_Population_pyramids,_EU,_2022_and_2100.png)

demographic changes that will affect all sectors of society. Basso and Jimeno [9] even consider that: "Demographic changes (baby boomers reaching retirement age, the decline in fertility and the continued increase in longevity) and technological changes (the new wave of automation stemming from developments in robotics and artificial intelligence) are two structural trends that will frame the macroeconomic context in the coming decades" (p.833).

In addition, the phenomenon of global ageing has further accelerated the debate on the position of older people in digitalised societies [10].

While digitalisation and the use of digital technologies have brought many societal and economic benefits and opportunities with a profound impact on all areas of society, their potential is ambivalent in that they can negatively affect people and accentuate social and economic differences. It is, therefore, imperative to ensure the participation of seniors in society by helping them adapt to the changes brought about by digitalisation and promoting their digital empowerment.

However, the impact of ageing on technology adoption depends on several factors, such as the availability of capital [9] and skills [9, 11–13] or even social support [13]. For [14] "the role of peer support, especially from family, is vital in helping older people adopt ICT and benefit from it" (p.3).

Ageing is a factor that has a strong association with declining Internet use [15]. We agree with [10] that older people's non-use of the Internet and their limited digital skills can pose challenges to the use of digital services and the current digitalisation of society.

The digital inclusion of older people is also a concern for international organisations. The United Nations Economic Commission for Europe has announced four policy priorities for the digital inclusion and empowerment of older people in the digital age, which are: 1) ensuring equal access to goods and services involving digital technology; 2) improving digital literacy to reduce digital skills gaps; 3) leveraging the potential of digital technologies for active and healthy ageing, well-being and empowerment of older people; 4) ensuring the protection of the human rights of older people in the digital age [16].

To this end, the European Commission has been promoting digital inclusion to ensure everyone can contribute to and benefit from the digital world, as is the case with the Digital Competence Framework for Citizens (DigComp), the EU-wide framework for developing and measuring digital competencies. Despite this, the European Commission [17] has recognised the existence of several obstacles to digital inclusion: "For some people, the digital world is not yet fully accessible. For others, it is not affordable. And for others, they have not been taught the skills needed to participate fully" (para. 3).

Eurostat data proves the point. In 2021, in the European Union (EU), only 17.18% of people aged between 65 and 74 had basic global digital skills. Portugal is below the European average of 12.73% [18]. Also, in this age group, 65–74, we can see that Portugal is slightly higher (5.26%) than the EU average (5.54%) when it comes to the indicator of individuals without global digital skills [18]. It should be noted that this indicator of overall digital competencies reflects the five areas of competence of the Digital Competence Framework—DigComp 2.2: information and data literacy competencies, communication and collaboration competencies, digital content creation competencies, security competencies and problem-solving competencies.

Concerning the level of basic global digital skills of individuals aged 75 and over, Eurostat has yet to have data available for the average of European Union countries or for Portugal. It only has data for Spain, Italy and Latvia, 5.64%, 2.76% and 3.69% respectively [19].

In Portugal, the statistical data from INE and Pordata do not show the digital skills indicator or the age group of 75 and over. Nevertheless, we were able to ascertain that, in 2022, 51.2% of people aged between 65 and 74 used the Internet [20] and, in this same group of people, 49% accessed the Internet, on average, once a week, a figure lower than that estimated for the EU, which, in 2020, already reached 65% [21].

This data reinforces the importance of digital skills training for the digital literacy and inclusion of older people. Several studies have shown that older people who use digital technologies improve their quality of life [22] that Internet use positively influences cognitive functioning in old age, and that this relationship is partially mediated by the number of social activities in which individuals participate [23].

Adapting seniors to technological and digital innovation is necessary to avoid a situation of digital exclusion. As [24] point out, the digital transformation process is increasingly essential for economic, social and environmental development, which gives it a more holistic scope. This exclusion is digital and social regarding access to services,

particularly health services [14]. Social inclusion is crucial for the health and well-being of older people [25] and this can be achieved through engagement with digital technologies [26] for successful ageing.

Trends in digital innovation indicate that health services will become increasingly digital (e-health), and, at the same time, demographic trends point to an increase in the ageing population. Digital inclusion is, therefore, an imminent priority. This could be a way to motivate them to learn digital technologies. In this context, the World Health Organisation has called for the development of strategies to improve the digital literacy of the elderly [2]. The Conference on the Future of Europe [27] also recommended that the EU "make efforts to make technology more accessible to older generations by promoting programmes and initiatives, for example, in the form of classes tailored to their needs" (p.115).

The digital inclusion of older people can help prevent dependence on specialised care, as well as provide autonomy and independence for a longer, better quality of life and well-being [28]. We believe that, in this regard, emerging digital technologies can help to overcome info-exclusion to support their inclusion in society, as we will try to show below.

2 The Concept of Singularity: Its Implications, Advantages, and Disadvantages

In a more simplistic approach to the concept of technological singularity, we can say that it is a speedy and accelerated technological process that brings about radical changes. These radical changes are achieved when a machine considered super-intelligent manages to surpass all the potential intellectual activities of the 'most intelligent man'. As [29] states, robots and/or other digital entities or agents will enjoy a capacity for self-improvement and self-learning that will endow them with a superintelligence that could supplant human intelligence. This concept was first presented by Irving John Good in 1965, but as early as 1950, Alan Turing referred to Thinking Machines, which is now closer to Machine Learning when it is strongly associated with Artificial Intelligence (AI). In other words, there has been reflection based on and looking towards the emergence of machines/robots that can learn through their own experiences, adapting to new situations and contexts, manifesting some capacities for abstraction and analogies with total autonomy [30]. To this end, [31] states that the technological singularity could be reached as early as 2045, when the conditions will be in place, according to [32] "(...) the point in time at which we built a machine of sufficient intelligence that can redesign itself to improve its intelligence, and at which its intelligence starts to grow exponentially fast, quickly exceeding human intelligence by orders of magnitude" (p.59).

However, it is important to distinguish and clarify the concept of intelligence to perform tasks and/or routines and intelligence associated with the ability to improve oneself and one's performance [32]. In principle, digital systems can be faster, but intelligence and intelligent acts may not be better when only the speed or processing speed variable is considered. The issue needs to be considered from another perspective beyond speed, which can sometimes be a decisive factor and has to do with long accumulated experience and a long history of training and practice. As [32] states, it is necessary to

make clear and clarify the differences between: "(...) intelligence to do a task with the capability to improve your intelligence to do a task" (p.60).

The problematic nature of this concept has given rise to several discussions and reflections, with some of its aspects being enunciated, such as 'True Singularity' and 'Essential Singularity'. However, [33] states that these concepts should be taken into consideration, but with some caution: "(...) is a straightforward predictive model which does not exhaust the phenomenon" (p.8). Although many authors are sceptical about the possibility of a technological singularity occurring, we must remember the gigantic advances in AI, Deep Learning, Machine Learning and the increasingly efficient processing and analysis of data, known as Big Data. It will be all of these dimensions, as well as others that will emerge, that, working in a network and complementarity, will make today's society evolve in such a way as to create new contexts for Humanity where digital will be omnipresent.

In the view of [34] AI will underpin technological singularity, and it is only when AI is combined with humans that adequate results can be obtained. We must remember that the vast majority of data managed by Big Data and made available to AI is unreliable and contains errors, hence the importance of human presence to critically and reflectively disentangle it. What cannot be overlooked is that digital technologies and resources are faster and easily overcome distances. This new reality has made it easier to disseminate data, information and innovations more economically, giving more citizens access to all this new knowledge in real-time. In this regard, [35] states that: "Thus, that "single time" will be experienced by more and more people, all of whom will be reacting and reacting to reactions over and over again" (p.19).

From a more optimistic perspective and in defence of Humanity, [36] argues that a human reinvention of language must emerge which will be able to oppose AI, continuing to manifest its capacity for creation and its inventive power, combined with its strength and resistance, as has been observed since the emergence of Humanity. The ability to surpass itself and evolve in different contexts, in an adaptation that has allowed it to survive and achieve successes and advances unimaginable centuries ago. It is this ability to analyse in a holistic and non-compartmentalised way that makes it possible to rehearse new scenarios and new proposals that make humans different from AI or other digital resources that, as a rule, are based on rigid algorithms that are unable to adapt or assimilate new and different contexts that go beyond 'simple' algorithms.

With the aim of avoiding this rigid constraint that algorithms can include, we agree with the perspective of finding more flexible and adaptable ways that facilitate a better understanding of human needs. In this sense, [37] proposes that robots need to be context-aware: perceiving and understanding their surroundings and adapting their functionalities accordingly. In this way, a digital environment is created, a more harmonious and, at the same time, more effective digital ecosystem.

3 Emerging Digital Technologies: Effects on Quality of Life

The Internet of Things (IoT) concept originated in the late 1990s and has been attributed to Kevin Ashton. A more basic definition or framing of IoT refers to the connection to the Internet of 'anything' or 'all things', from light bulbs to sensors and any other

household appliance. Weiser [38] had already anticipated this and called it ubiquitous computing. In this IoT digital ecosystem, as [39] point out, all things will form a fully integrated unit: a 'unified framework'. In this regard, [40] point out that this ubiquitous computing goes a little further: "The known dimensions of the common Internet—from anytime, anyplace, connectivity for anyone—are supplemented by the dimension anything" (p.804). However, this concept needs to be explored further and its actual scope understood. In this context [41] states that beyond a 'mere' internet connection, this connection generates a flow of data and networked technology is now capable of generating systems that make decisions autonomously. In practice, according to the data collected about a family's eating habits, a 'smart' fridge can take the initiative to make food purchases automatically. Of course, this can be an advantage because it frees us from making shopping lists and worrying about our food stocks.

On the other hand, this action clashes with our autonomy and our free will. After all, we can change our eating routines because we may want to try other foods and change brands. Ultimately, this situation can raise ethical and independence issues. For, as [42] states, this network of intelligent systems becomes capable of continuous and systematic learning that will allow them to control and regulate the behaviour of humans, despite not having the awareness, as we humans have and understand it, to act in such a way or orientation. This issue has also been reinforced by [43] when they refer to the potential negative impacts on individual privacy and, consequently, in association with security-related issues.

Despite some opinions to the contrary, the influence of Big Data, which corresponds to the global collection of data that takes place daily and systematically, Tosun [44] mentions the contribution of more than three billion users, especially those associated with social networks, who contribute to this enormous flow of data/information. It is clear that the human capacity to access and process this data needs to be more comprehensive compared to digital systems and platforms. Due to their internet connections with the association of AI, machines can now collect and process all this data/information flow in a dimension that includes a dynamic learning process. This evidence is hard to dispute, but the questions and doubts it raises are worrying. Köse [45] reflects on these questions and wonders if some kind of 'Machine Ethics' can interpret what it means to have a human conscience. After all, AI is a product of humans, so this control should be under their control.

In a more optimistic vision, which we hope will be realised, AI could play a significant role in promoting and improving the ageing process through more innovative solutions for a better quality of life. As stated by [46] AI, through the algorithms associated with it, will enable more systematic monitoring that will make it possible to immediately identify a citizen's health problems and, at the same time, access all their data/clinical history and be able to intervene more assertively. This is inevitable, especially for the older population. In this regard, [46] refer to the great possibilities of AI, with which we agree, and which can be translated into an 'AI-driven' dimension that can include using robots as virtual assistants to carry out daily activities. Reducing costs by automating processes; freeing doctors from bureaucratic tasks by allowing more time for observation and emotional support with patients; aiding in diagnosis based on Big Data analysis that makes medical acts more effective and efficient; the fact that systematic monitoring

will have a proactive effect on disease prevention; and, perhaps one of the most relevant aspects has to do with the fact that this 'AI-driven' dimension can be implemented tailored to the specific needs of each individual. Although AI can make a positive contribution, we must be aware that human intervention must be the ultimate decider.

As [47] point out, there is an increasing concern about creating measures and conditions that allow the elderly to be supported in their routines, considering the progressive and accelerated ageing of the world's population. In this sense, these measures must create conditions generally associated with Ambient Assisted Living (AAL). Overall, we can say that the concept of AAL brings together the functionalities of IoT, Machine Learning, Deep Learning and Big Data. The aim is to provide a digital ecosystem capable and efficient at monitoring daily routines through messages that allow the elderly to be as autonomous and independent as possible. Mainetti, Patrono, Secco, and Sergi [47] also point out that the aim is to go further in order to promote broader inclusion: "(...) provide personalized intervention that can help the elderly population to improve their daily life and also promote r changes" (p.70). The main aim of the technologies associated with AAL is to create conditions of safety and to be able to issue emergency responses whenever the elderly are in potential danger, such as the possibility of falls, anomalous biometric data, medication reminders and other situations that may involve heating the house, the cooker, water consumption, their movements inside and outside the home, among others. This means that in an AAL, the monitoring system is constant, which can lead to questions of ethics and data security, and there must be certainty that such monitoring is confidential. This is the only way to validate the possibility of implementing AALs, which is why legislation is urgently needed.

In this context, public policies and social and health services related to ageing must consider incorporating emerging technologies to support the elderly to live safely and comfortably in their own homes and communities, with complete privacy.

Ageing in Place is fundamental to the future of ageing societies, as it is essential for long-term health and well-being. According to the [48] "ageing in place is the ability to live safely, independently and comfortably in one's own home and community, regardless of age, income or ability. Ageing in place extends this concept to the ability to live in the place that best suits the person's needs and preferences, which may or may not be their own home" (p.vii).

In recent years, the concept of ageing in place has been given great importance by international organisations, national authorities, and other bodies, as well as among the elderly population and their families, driven not only by demographics but also by technological developments. Smart technologies, such as IoT and AI, can provide the assistance needed for older people to age autonomously and independently in their homes.

However, older people face major challenges in implementing technology to age in place, including privacy concerns, low digital literacy and a lack of confidence in their ability to understand or access them [49].

Therefore, we need to recognise digital inclusion as a social determinant of health. Emerging digital technologies are key to promoting and encouraging ageing in place, bringing immediate and long-term benefits for the health, quality of life and well-being of older people, and consequently for society, the economy and improved efficiency

and effectiveness of health systems. Nevertheless, it is crucial to ensure that these technologies are accessible and acceptable to the elderly and effective in supporting their independent living, particularly in health monitoring, social interaction and safety.

In this current social context, we can say that the IoT enhances and/or increases the potential of AAL by promoting a bridge between the physical world, the world of things and the social world. As [50] state, emerging technologies, which they also refer to as 'gerontechnologies', "(...) constitute a wide range of technological solutions aimed at improving the well-being of older people. These technologies are used for personalised medicine, smart health, health tracking, telehealth, health-as-a-service, smart drugs, and multiple other applications" (p.2). As is evident, these emerging digital resources enable action in different dimensions and/or valences. To this end, we present some proposals based on research carried out by [51–54], which can be organised into five categories:

1. e-Health and Telemedicine: this category could potentially be the most necessary, taking into account the fact that the ageing process is more likely to lead to illnesses, so online services could be a more systematic way of monitoring the elderly through a process of distance monitoring that becomes faster and more efficient through digital support;
2. Human-computer interaction: in this category, the needs of each user are taken into account so that it is possible to provide responses that are perfectly adapted to individual needs so that interaction with digital technologies is the most appropriate and adapted to the real needs of each individual;
3. Monitoring and sensors: the presence of sensors in elderly people's homes allows for synchronous monitoring, which also makes it possible to get to know and understand their routines and, perhaps most importantly, to immediately report any anomalous or dangerous situations that may occur so that rapid intervention can be carried out;
4. Social inclusion: taking into account, in particular, the potential and advantages of digital social networks that allow the elderly to maintain their family and friendship ties, making their levels of sociability prevent situations of loneliness and isolation, in order to promote higher levels of self-esteem and well-being and, ultimately, to be able to exercise full citizenship;
5. Entertainment: gamification and, in particular, serious games are powerful digital resources for increasing cognitive and physical training that promote better levels of mobility and conditions to combat mental illness.

To be able to present other dimensions that can complement the previous ones, we intend to mobilize IEEE Std 7007:2021 [55]. Although they may seem similar, when applied to AI ecosystems monitoring elderly individuals ageing in place, IEEE Std 7007:2021 emphasizes what we now present:

1. Continuous Monitoring: Systems should be designed to continuously monitor the health and well-being of elderly individuals while respecting their privacy and autonomy.
2. Alert Mechanisms: Implement mechanisms to alert caregivers or medical professionals in case of emergencies or unusual patterns in the monitored data.
3. Adaptability: Ensure that the system can adapt to the changing needs and conditions of elderly individuals.

4. User-Friendly Interfaces: Develop interfaces that are easy for elderly individuals and their caregivers to use and understand.
5. Ethical Data Use: Use the collected data ethically to improve the quality of care and support for elderly individuals, ensuring that data is used to enhance their quality of life.

To summarise, when AI and IoT are combined in an AAL environment, these processes are dynamic and proactive, as stated by [56] "(...) true intelligence does not just mean simple automation according to predefined rules (smart behaviour). It means learning, adapting and making decisions based on AI methods, according to the habits and behaviours of the users of the smart environment, as well as changes in the environment" (p.383). In the same vein, [39] have already pointed out that an AAL context is characterised by establishing links at various levels: "(...) connected, context-sensitive, personal, adaptive and anticipatory" (p.805).

Despite all this potential, as [49] argue that there is a need to strengthen the security conditions in which the IoT is present in terms of data protection from the malware and botnet attacks to which these systems are subject. In summary, IEEE Std 7007:2021 provides a comprehensive ethical framework for developing AI systems that monitor elderly individuals ageing in place. It ensures that these systems are designed and implemented in a manner that respects the rights, dignity, and well-being of the elderly, while also providing practical guidelines for developers and practitioners.

4 Critical Reflections

As [29] warns, there is widespread agreement and consensus that the exponential advance of technological-digital progress makes the technological singularity an inevitable target. In other words, in [31] opinion, the advantages and disadvantages of this new reality must be taken into account, given that it will directly influence the economy and society. Moreover, as [29] also points out, instead of trying to prevent technological singularity, preparing humanity for its arrival is more pertinent and fundamental to minimising its main negative consequences. In this sense, [57] advocates the need to develop new and better control mechanisms that, in his opinion, should already exist so that Humanity can protect itself and adopt strategies to safeguard it from a technological-digital society that could come to subjugate and control it. On the other hand, [30] wants to take a more optimistic view by referring to the opportunity that the existence of artificial superintelligence could create the conditions for humans to know and adapt to it, promoting a 'human singularity' that would result in the generation of supermen and superwomen with significantly increased biological and cognitive capacities. This new dimension leads us, in turn, to the concept of transhumanism, which, in an extreme situation, could lead to biology being replaced by technology. This possibility was put forward by Stephen Hawking in 2014, warning of the danger that super-intelligent machines could ultimately lead to the destruction of our civilisation.

From a more optimistic perspective, [58] has been saying for some years that these new technological-digital developments will positively impact medicine. In this context, advances related to bioengineering and nanotechnology may become capable of repairing human organs/tissues and replacing them, which will have very positive consequences

for the health and well-being of citizens. We cannot ignore the advances made at the molecular level with the evolution of genetics, such as the COVID-19 vaccines, which have made it possible to manipulate the mRNA molecule. Furthermore, in this respect, older citizens are the ones who could benefit the most from these advances, as they are the ones with the most degenerative problems as a natural consequence of their ageing process. Alternatively, exploring another possibility, as [29] puts it, a human singularity could emerge that is capable of generating supermen and superwomen who will enable them to survive pandemics and other catastrophes and who will enable them to leave the planet and undertake space travel, just as science fiction films seem to anticipate this possible future reality. Alternatively, as [42] puts it: "(...) improved humans or ameliorated humans, will constitute a new, bio-technological species" (p.79). In this regard, [46] emphasise the potential of AI to provide personalised solutions adapted to each individual, making healthcare more efficient and effective within a global network at reduced costs. For, as [46] add: "Artificial Intelligence systems can quickly process large amounts of data, identify patterns, and make [better and adequate] decisions based on the results" (p.10). This is possible because AI-processed algorithms can help doctors and healthcare professionals diagnose diseases more accurately and objectively. However, governments must promote policies and initiatives so that doctors and health professionals have adequate additional training to be able to use these new digital resources (e.g. machine learning; AI) in a way that respects patients' privacy and data only for health treatment, in an environment where safety is also prioritised. In this regard, emerging technologies will provide new possibilities associated with greater and better prevention, from a proactive perspective, arising from Big Data and recent generative applications that are increasingly present and available given the continuous and accelerated advances we are seeing in AI.

In this context, in this new digital ecosystem, we share and support the opinion of [41] when he states that debating the impacts of current technological-digital advances will be the appropriate way to avoid becoming merely social individuals "(...) like happy bees wandering the world" (p.44). In this sense, we agree with [33] with special attention and concern for the elderly and those with higher levels of info-exclusion in an increasingly digital society: "It can be regretted that progress does not enhance all the components of the human mind in equal degree. It is curious to note that the least affected components may be more difficult to reproduce with computers" (p.7). However, as [45] points out, what we want is the 'best of both worlds' to reconcile and/or bring together in a single dimension the advantages and positive aspects of a future society that can support and utilise intelligent digital systems that are compatible and safe for Humanity. For, as [42] states: "(...) it is not technology that will save our species, but a radical change of our vision of reality" (p.81). Bearing this in mind, it seems reasonable and appropriate that there should be a balance in cognitive and affective terms so that the IoT can accommodate and respond to the needs of older people, creating intelligent environments that are adaptive, interactive and contextualised so that technological skills are not decisive in this process. In this context, [40] believe that mere technological-digital communication through the IoT will not make a difference or introduce significant changes, but rather communication between people: "(...) the so-called people-to-people (P2P) communication, which is as important aspect in Assisted Ambient Living. P2P communication

will become intelligent and goal-orientated through the IoT" (p.808). To this end, we stress the importance of a user-centred approach that includes the elderly within a digital ecosystem encompassing demographic, educational, psychological, social, cultural, emotional, religious, economic and other relevant dimensions.

In this context, [59] believe that the so-called 'human–computer interaction' is crucial to make integrating a digital context with an analogue context more fluid. In this way, the adoption of digital technologies by older people will be much easier and more systematic, which is in line with the opinions of [60]: "Involving older people in the process of developing new gerontechnologies leads to a better acceptance and/or use" (p. 18).

Several authors, including [46] refer to the emergence of global megatrends that have a direct and indirect influence on individuals, organisations and governments, which must be responded to proactively based on mitigating potential negative aspects in order to turn them into opportunities to find more innovative and creative responses. In this context of new megatrends that include robotics, deep learning and machine learning, it is crucial to understand and anticipate their consequences, as advocated by [46] "Understanding these megatrends is essential for any society or addressing important issues such as inequality, health promotion, sustainability, and economic growth" (p.2).

Because of these new challenges, we are sure they pose dangers for which citizens must be aware and, at the same time, protected. In this sense, the European Union recently approved the Artificial Intelligence Act [61] with the aim of regulating the use of artificial Intelligence to guarantee the security and protection of citizens' data, especially among the most info-excluded citizens. As an example, the Artificial Intelligence Act presents those areas in which the use of artificial intelligence is prohibited, and which may be closer to the most info-excluded citizens [61]:

1. deploying subliminal, manipulative, or deceptive techniques to distort behaviour and impair informed decision-making, causing significant harm;
2. exploiting vulnerabilities related to age, disability, or socio-economic circumstances to distort behaviour, causing significant harm;
3. social scoring, i.e., evaluating or classifying individuals or groups based on social behaviour or personal traits, causing detrimental or unfavourable treatment of those people:
4. assessing the risk of an individual committing criminal offenses solely based on profiling or personality traits, except when used to augment human assessments based on objective, verifiable facts directly linked to criminal activity;
5. inferring emotions in workplaces or educational institutions, except for medical or safety rea that, as a rule, are based on rigid algorithms that are unable to adapt or assimilate new and different contexts that go beyond 'simple' algorithms sons;
6. biometric categorisation systems inferring sensitive attributes (race, political opinions, trade union membership, religious or philosophical beliefs, sex life, or sexual orientation), except labelling or filtering of lawfully acquired biometric datasets or when law enforcement categorises biometric data.

In summary, after the critical reflections presented throughout this text, there is the feeling that there is still a lot to be done and the future is increasingly the present, so

these efforts will have to be maintained to create a society with more justice, with more equality and more inclusive.

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