Intelligence Augmentation and capability co-elevation in healthcare enabled by reasoned transparency

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Abstract. Artificial intelligence (AI) systems in healthcare can have a significant impact on the performance of the actors involved, encouraging, for example, increasingly early diagnoses, personalized treatments and more accurate data management and processing techniques. However, these results may depend on increasingly profitable human-machine interactions, Intelligence Augmentation, and potential in terms of capability co-elevation. Starting from this assumption, this study aims to understand which can be the Intelligence Augmentation and capability co- elevation driver in healthcare. This conceptual paper has been carried out with the conceptual goal of delineating, so, to address the research question, a deductive reasoning approach was applied and the methodological approach followed has been based on the description of the theoretical background, definition of evidence from an illustrative case, Livongo Health, addressed by analyzing secondary data extrapolated from the website contents, and development conclusions. From the illustration case, insights have been outlined to understand how to achieve the objectives of Intelligence Augmentation and capability co-elevation: it has been observed how the reasoned transparency in AI systems can be understood as an enabling factor.

1 Introduction

Artificial Intelligence (AI), defined as the combination of software techniques and IT infrastructures, allows actors to achieve human-like performance [1]. The issue of AI is widely discussed in the literature; in fact, there are even people who believe that over time it can exceed human capabilities [2]. It aims to imitate human cognitive functions and allows the collection and analysis of large amounts of data [3]. There are various potentials in different fields; for example, in the healthcare sector, AI can help detect early risks of diseases as the system uses past and present information on health problems and can identify whether the patient is at risk of contracting a disease or not [4] and could lead to greater patient empowerment [5]; in general, it is interesting to recognize AI ability to support and improve human roles [6]. In fact, recently, more and more AI scholars have focused on improving

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decision-making and enhancing human skills, providing otherwise inaccessible data-based information [7] through AI systems. AI systems can analyze complex data in real-time to support human decision-making in healthcare: AI can help health professionals in early diagnosis, personalized treatment and management of health data; this can lead to more efficient and personalized care which can lead to successful outcomes such as Intelligence Augmentation and capability co-elevation.

Intelligence Augmentation refers to the use of technology, particularly AI, to enhance human capabilities rather than replace them; it implies that AI can collaborate with humans for amplifying their cognitive and decision-making capabilities in various contexts [8].

Capabilities co-elevation implies upskilling opportunities through the overcoming of an individual learning in favour of a collective learning.

However, many AI algorithms are difficult to understand or explain and actors fear errors with respect to the released automatic decision, particularly in healthcare [9], where decisions concern particularly delicate and critical issues, with negative effects on the trust of actors in AI systems [10] and we are increasingly questioning the prospects of the automation of intelligence and how much this can allow an effective increase in human intelligence. This can also impact the use by actors of AI systems designed for healthcare: low trust can impact the degree of acceptance of the technology, not only that, the fact that these systems are often difficult to understand could impact their use optimal [11, 12]. These gaps could undermine the possibility of pursuing, through the use of AI systems, results in terms of Intelligence Augmentation and capability co-elevation; for this reason, this conceptual work aims to understand what to focus attention on in order to pursue them, while at the same time mitigating the risks associated with the non-acceptance of technology and its inadequate use.

Thanks to Intelligence Augmentation and co-elevation capability, the fears related to automatic decisions, automatically released by the machine, could be mitigated by augmented decisions, i.e. an automatic decision enhanced by the knowledge of the decision makers. For this reason, this work asks the following research question:

R.Q.: how to pursue Intelligence Augmentation and capability co-elevation for an augmented decision?

The paper is structured as follows: the theoretical background (par. 2) is described within three sections, to frame the study in the literature on AI, Intelligence Augmentation and capability co-elevation. Subsequently, the method followed for the development of the work is clarified (par.3) and an illustration case is described (par. 4).

Based on the key concepts that emerged from the literature, some insights are outlined from the illustration case to develop theoretical deductions (par.5). At the end of the paper, non-conclusive considerations are proposed (par.6).

2 Theoretical background

Today, innovation is increasingly associated with the function of encouraging companies to pursue and maintain their survival, through the achievement of a competitive advantage [13]. Service innovation is achieved through a fruitful combination of technological elements, social relationships, organizational adjustments and commercial interactions, based on a human-centered perspective [14]. Service innovation occurs within networks [15] when existing value propositions are modified through a process of integrating existing resources or inventing new resources [16] and involves the creation, renewal and transformation of existing foreknowledge. Innovation cannot be linked exclusively to the use of new technologies [17]; they have the "task" of providing the data. The use of data

and technologies is closely linked to human behavior [18]. Innovation implies that through technologies responsible entities can improve themselves [19] and, since service systems are people-centered, this happens when people, thanks to technologies, are able to optimize the functioning of service systems [20].

2.1 Artificial Intelligence (AI) in literature

AI serves as a catalyst for implementing data-driven decision-making processes [21] and facilitates value co-creation by enabling effective resource integration [22]. However, it also poses risks and threats to safety and security. In the realm of healthcare, AI is progressively reshaping medical practices by updating healthcare offerings and service delivery processes based on data-driven decisions. The goal of AI is to emulate human cognitive functions, potentially leading to a paradigm shift in healthcare, driven by the growing collection of health data (structured and unstructured) and the rapid advancement of data analytics techniques [3].

Recent strides in digitized data acquisition, machine learning, and IT infrastructure have expanded AI applications into domains traditionally reserved for human experts [23].

In healthcare, for example, virtual assistants powered by AI enable doctors to focus on high-value operations by automating mundane tasks. Patients, in turn, gain access to prompt and accurate responses from chatbots trained on vast datasets. These chatbots can even comprehend symptoms from received questions and trigger an alert system for specific pathologies if necessary, streamlining administrative processes. AI includes areas such as patient administration, clinical decision support, patient monitoring, and health interventions [24]. Notably, the doctor-patient relationship is evolving with the integration of virtual assistance, benefiting both parties.

The implicit promise of AI is to enhance healthcare accessibility by creating an efficient healthcare environment. Some applications empower patients to understand their symptoms (without self-diagnosis) and communicate with their doctors remotely, alleviating facility congestion while ensuring necessary treatment and this can be very relevant due that patient empowerment can allow results in terms of value co-creation [25, 26]. Additionally, AI aids in early disease risk detection by analyzing past and present health information, identifying potential risks [4].

Furthermore, AI has the potential to empower patients, allowing them greater control over their healthcare and a deeper understanding of the evolution of their health needs.

2.2 Intelligence Augmentation in literature

This last idea is closely aligned with the Intelligence Augmentation for which AI should collaborate with humans, amplifying their cognitive and decision-making capabilities in various contexts [8].

Unlike the common fear of a total replacement of humans by machines (automation), intelligence augmentation emphasizes collaboration between people and intelligent systems. AI is seen as an ally that can improve human performance and solve complexities. Intelligence augmentation aims to create a symbiotic relationship between humans and machines, capitalizing on the unique strengths of both. This approach can lead to more powerful and adaptable solutions to the complex challenges we encounter in different spheres of life. AI allows us to extend and enhance human capabilities in terms of memorization, data analysis, learning and decision-making; not only that, it can be used for educational objectives, providing personalized support adapted to individual learning needs, through virtual tutors, intelligent online learning platforms or personalized recommendation systems.

Intelligence augmentation can also have implications in terms of value co-creation, in fact, it can facilitate collaboration and innovation within heterogeneous teams, it can provide in-depth analyses and predictive models that support strategic decisions, enhancing decision-making capabilities for more informed and results-oriented business management, can, in general, improve user experiences.

In essence, intelligence augmentation paves the way for new ways of collaboration and interaction between humans and intelligent systems, enabling the co-creation of value in different contexts. Effectively integrating AI can lead to more targeted, efficient and effective solutions, generating value for both end users and organizations.

In the healthcare sector, in a complex context that is increasingly patient-centred, the collection and analysis of patient data could allow doctors to intervene in an increasingly timely and precise way [27], with an overall improvement in general performance [28] and response times [29]. The ability to acquire and analyse data in real-time thanks to the application of AI algorithms allows companies to better meet corporate objectives and initiatives [30].

In fact, Intelligence Augmentation implies a synergy between AI technologies and individuals: people can amplify their abilities and optimize their thinking by improving their interpretative models [6]. In this context, AI fosters optimal human-machine collaboration, where machines do what they do best to assist humans in their distinctive capabilities, such as thinking [7]. Intelligence Augmentation can help mitigate concerns regarding the use of AI systems [31]. Ultimately, Intelligence Augmentation represents an intelligence that emerges from the collaborative and effective interaction between humans and machines, allowing systems to evolve into smarter and wiser configurations based on rational and emotional elements [6, 32].

2.3 Capability co-elevation

Capabilities co-elevation requires thinking more about upskilling opportunities [33].

To pursue capability co-elevation, responsible actors should be able to overcome individual learning in favour of collective learning, which can be pursued by considering the improvement of Run-Transform-Innovation skills by focusing attention on what to invest in carrying out activities routine (Run), understand what to invest in copying best practices from others (Transform), and understand what to invest in exploring and creating new knowledge and activities best suited to future opportunities (Innovate) [19]. Capability co-elevation can enable wiser systems [34] because it implies the collective improvement of the capabilities of a system, which can be an organisation, a team or a process, in order to collaboratively improve the skills, resources and overall performance of the system, it favours collective learning which implies that all actors involved, whether individuals, teams or entire departments, learn together and contribute to the continuous improvement of the system as a whole and stimulates adaptation, allowing the system to deal more effectively with changes and generate new solutions innovative.

3 Method

This work is a conceptual paper carried out with the conceptual goal of delineating [35]. To address the research question, a deductive reasoning approach was applied and the methodological approach followed was: (i) describe the theoretical background; (ii) provide evidence; and (iii) develop conclusions. Coherently, the work (i) presents a concise review of the literature on innovation in a service perspective, by focusing on the impact of technologies in terms of Intelligence Augmentation and capability co-elevation; (ii) provides evidence from an illustrative case, Livongo Health, addressed by analyzing

secondary data extrapolated from the website contents; (iii) takes up the key concepts that emerged from the literature and from the illustrative case to develop deductions and to understand how to achieve Intelligence Augmentaation and capability co-elevation objectives by leveraging transparency in AI systems as enabler.

4 Illustration case: Livongo Health

Livongo Health is a company that offers a chronic disease management platform, with a particular focus on diabetes management; is committed to providing personalized and targeted support to patients.

The company uses remote monitoring devices to collect real-time data from patients, including blood glucose levels, blood pressure and other relevant parameters. Through AI and Machine Learning systems, it analyzes the data collected by processing patterns, trends and correlations in patient data.

Based on data analytics, Livongo Health provides personalized coaching to patients that may include advice on lifestyle changes, adjustments in diabetes management and promotion of healthy behaviors. The coaching service can involve a combination of human health professionals, AI algorithms and interactive resources to provide a comprehensive and personalized approach to managing patients' health.

Users receive real-time feedback on the impact of their lifestyle choices on their health parameters, with the aim of motivating and helping to improve patient engagement.

Coaching can be carried out by health coaches, who could be health professionals, such as nurses, diabetes educators or other specialized healthcare professionals, who can provide personalized support to patients, guiding them in diabetes management, interpreting the data collected and offering advice on lifestyle, nutrition and more; or it could be managed through machine learning and AI algorithms that, by analyzing patient data, could provide personalized feedback or suggestions based on this automatic process.

The Livongo Health platform helps patients set and track personalized health goals. AI can help adjust these goals based on patients' responses and their evolving health conditions.

5 Delineating insights from the illustration case Livongo health

5.1 Intelligence Augmentation can be pursued with Livongo Health systems

Livongo Health's primary goal is to improve self-management of chronic diseases, particularly diabetes, through a personalized, data-driven approach. This system allows for more sophisticated management of patient data, providing more targeted support tailored to individual needs.

The Livongo case aims at Intelligence Augmentation, in fact, AI tools are used to actively involve users in managing their health. By providing personalized advice, lifestyle suggestions and health goals, Livongo leverages AI to make users an active part of the chronic disease management process.

Through continuous monitoring, data analysis and personalized coaching, Livongo helps to enhance patients' health management capabilities, falling within the scope of Intelligence Augmentation.

5.2 Livongo health systems can foster capability co-elevation

The idea of capability co-elevation refers to a context in which a technology or service not only enhances individual capabilities, but collectively elevates the capabilities of an entire group or community [19]. Livongo users can benefit from sharing their experiences through the platform, for example, if a patient discovers an effective approach to diabetes management, she can share her experience with other users, contributing to collective learning; Livongo Health can facilitate the formation of online communities or forums where users share advice, tips and mutual support, in this way, the platform creates an environment where users support each other, collectively elevating their diabetes management skills ; the platform can encourage active participation of users not only in individual disease management, but also in promoting collective health initiatives. ; Livongo's AI can learn from all users' data and use this information to continuously adapt and improve the quality of the support offered, and this continuous learning process benefits all users, contributing to a collective improvement in diabetes management capabilities.

Considering some of the main players in the healthcare system, we see below how Livongo Health systems can potentially impact in terms of co-elevation capability:

- Patients' capability elevation: Livongo could improve patients' ability to manage their conditions through real-time monitoring, personalized feedback and ongoing support; this could lead to greater awareness of one's health and improved management of chronic diseases.
- Doctors' capability elevation: doctors could benefit from improved patient management thanks to the real-time data provided by the Livongo platform; this could allow for more accurate personalization of treatment plans and greater effectiveness in care.
- Healthcare operators' capability elevation: they could enjoy a reduced workload through patients' greater autonomy in managing their conditions; this could allow healthcare staff to focus on more complex and specific cases.
- General practitioners' capability elevation: primary care physicians could benefit from a reduction in visits related to conditions that can be managed remotely, allowing them to focus on patients with more urgent or complex needs.
- Hospitals/facilities' capability elevation: Livongo could help reduce the number of hospital admissions related to chronic diseases through proactive management of patients' conditions on an outpatient basis.
- Families' capability elevation: patient families could benefit from greater peace of mind through continuous monitoring and simplified access to information about their loved one's health.

5.3 Reasoned transparency in Livongo Health systems for Intelligence Augmentation and capabilities co-elevation

Although the proposed tool is perfectly consistent with the objectives of enhancing human capabilities (Intelligence Augmentation) and capabilities co-elevation, doubts persist regarding user acceptance due to possible gaps in terms of trust due to the problem noted in the introduction regarding the lack of transparency of AI systems. This problem seems to be overcome in Livongo Health thanks to some proposed solutions. Transparency in AI systems is a crucial element for user trust and for ensuring that the impacts of automated decisions are understandable and justifiable. The Livongo Health case, with the coaching activity, contributes to a better reasoned transparency in AI systems, in fact it guarantees first of all a greater explicability of the processes as the coaching processes are designed in such a way as to be explainable and understandable by the users: for example, users receive clear explanations on how data is analyzed, how recommendations are generated and what

recommendations are based on certain data; promotes user involvement in the decision-making process, for example through feedback sessions or clear explanations on how their data is used, with the aim of helping to create, through the active participation of users, awareness and understanding of AI processes; activated clear communication on the benefits of coaching, such as improved diabetes management and personalized support; takes robust measures to protect the privacy of patient data and communicates transparently about how personal data is handled and used.

In general, transparency can be achieved through a set of practices and Livongo Health has implemented these practices, providing understandable information and explanations to users on the management of chronic diseases.

6 Non-conclusive considerations

There are doubts about the adequacy of the information released by AI systems and fears in terms of privacy protection, reliability, accuracy and safety of the tool which could affect its use by healthcare professionals and patients; not only that, the data available to healthcare decision-makers is often partial, fragmented and unstructured, with doubts about their quality.

The biggest challenge for AI in healthcare is its full applicability in daily clinical practice. Several limitations can be highlighted mainly related to fragmentation and data quality, given the reluctance of patients to share data, regarding privacy issues. Having little data available, of poor quality and unstructured which could represent a problem as artificial intelligence can also have great potential in emergency medicine, for example through differential diagnoses which would accelerate and improve diagnostic accuracy, making saving valuable time and resources and potentially improving patient outcomes [36].

This shows that it is not enough to use new technologies, it is necessary that the data used for decisions, provided by new technologies, are complete and reliable.

This work suggests that the impact of AI systems in healthcare should be treated with a multidisciplinary interpretation and also suggests that new technologies can improve people's cognitive functions, thanks to an information flow that would otherwise be difficult to process, but this information flow must derive from good quality data for which a good predisposition for release and a good degree of acceptance of the technology by users are necessary.

In this sense, transparency seems to play a fundamental role. Greater transparency on the functioning of these systems could lead to a more profitable collaborative relationship between the parties, stimulating an environment capable of encouraging value co-creation phenomena.

Reasoned transparency implies that risk disclosure is also transparent through clear explanations of risks and mitigation measures [37]. Automated decision-making carries risks in terms of discrimination, violation of privacy and obscurity in the processing of data. Understanding the risks would enable users to control the functioning of AI systems.

In the present work, through logical reasoning based on the deduction, it was observed how reasoned transparency can allow a decipherable and intelligible functioning of the black box of artificial intelligence systems and allow the pursuit of intelligence augmentation and capability co-elevation (**R.Q.**): tools more understandable, easy to use, usable, explainable and effective would favour clearer, more reasoned and evidence-based decision-making processes. Thanks to Intelligence Augmentation and co-elevation capability, the fears linked to automatic decisions, released automatically by the machine, could be mitigated by augmented decisions, i.e. by an automatic decision enhanced by the knowledge of the decision-makers.

However, capability co-elevation, while offering significant opportunities to improve decision-making and cognitive functions through the use of artificial intelligence (AI) in the health sector, also brings with it potential risks in other fields, for example in educational contexts, where AI can be used to facilitate learning and improve the student experience, but awareness and careful management of potential risks are essential to ensure a positive and sustainable impact on individuals' learning and development. A major concern is the possible overreliance on technology by students and educators. The indiscriminate use of AI-based tools could lead to a dependence on these resources, with the risk of reducing individuals' ability to carry out tasks independently. This could undermine the development of cognitive and critical skills, as well as creativity, as users could become too dependent on automated solutions without developing their own problem-solving skills.

Furthermore, there is a risk of deskilling, where the automation of some tasks could lead to a reduction in the need for specific human skills. Educators may feel threatened by the replacement of traditionally human tasks with AI-based solutions, with possible negative consequences on motivation and engagement in the educational process.

To mitigate these risks, it is essential to adopt a balanced approach that promotes the co-elevation of capabilities without compromising the autonomy and quality of human skills.

Furthermore, continuous training of educators on the effective integration of AI into the educational process can help minimize threat perceptions and facilitate a more harmonious transition to an AI-enriched educational environment.

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