机器提供了效率和高阶能力，但我们也需要解决过度依赖机器、人与人之间的联系减少等潜在问题。当务之急是引导和优化人机之间的协同作用，而人机传播将在这一过程中发挥着关键作用。

在这个机器驱动的传播时代，我们所有人都肩负责任。学者们有责任提供知识，促进人际传播的积极影响并降低危害。人机传播是一个不断变化的领域，能为新视角和新方法提供绝佳的机会，而这一领域的专业知识整合自多个学科，也能为相关的实际难题提供可靠的研究基础。从业人员和行业领导者应当以负责任的态度对待技术的发展，在提高效率的同时尊重错综复杂的人性和伦理。

通过持续不断的人机传播研究，我们能为人类智慧和机器能力的交融创新铺平道路。未来的社会不仅拥有先进的技术，更是一个机器负责地、包容地与人类付出互相补充的社会。展望未来，社会与技术融合带来了挑战和机遇，而人机融合正召唤着学者们去进行深入的探索。

注释

① 关于人机传播作为一个传播子领域的详细历史，详见 Guzman(2018)所编书籍的引言，以及 Spence(2019)在 *Computers in Human Behavior* 特刊中的引言。有关人机传播的模式和历史，请参阅 Etzrodt 等(2022)为《新闻学》(*Publizistik*)特刊撰写的引言。

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Communicating with Machines: Future Trajectories in the Field of Human-Machine Communication

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Abstract　Integrating machine actors into daily life blurs the line between humans and machines, presenting opportunities and challenges. Within this context, the field of human-machine communication (HMC) stands at the forefront, poised to explore this emerging phenomenon of human-machine interaction. As we look into the future of this rapidly evolving era driven by machines, this essay discusses how the field of HMC can continue to grow and expand its research paradigm.

Specifically, the essay delves into the theoretical foundations and methodological approaches of HMC, addresses two prominent research frontiers centered on social presence and trust, and then examines critical implications of HMC from various perspectives. Throughout the essay, it offers insights into future directions for HMC research.

Key Words HMC; Human-Machine Communication; Robots; AI; Social Presence; Trust

What are machines if not a reflection of human endeavor? The digital landscape of the 1990s and early 2000s painted a picture of an era where machines became participants in expanding human communication. Today, the horizon is painted with the promising and daunting silhouettes of artificial intelligence (AI) (Etzrodt & Engesser, 2019). Just one decade ago, machines speaking like humans, creating artwork, or autonomously designing other machines was only a plot in a sci-fi novel or the optimistic headline of a tech magazine. Yet, recent strides in Generative AI, such as LLMs (e. g., ChatGPT) and image generators (e. g., Midjourney), have shattered these boundaries. The machinery does not simply provide or mediate; it takes the role of communicator and interlocutor. Be it chatbots, social robots, or the myriad of "smart" devices personalized to our every need, machines designed to form relationships and communicate with humans in natural (human-like) ways.

This emergence of human-machine communication (HMC) has brought about a profound shift in how we interact with technology. HMC refers to the "collaborative process in which humans and machines use messages to create and participate in social reality" (Edwards et al., 2022, p. 517) and "involves communication with digital interlocutors including embodied machine communicators, virtual and artificially intelligent agents (e. g., spoken dialogue systems), and technologically augmented persons, either in real or virtual and augmented environments" (Edwards & Edwards, 2017, p. 487). As we continue integrating machine actors into our daily lives, the line between humans and machines becomes increasingly blurred. This presents opportunities and challenges as we navigate a new frontier of social interaction, collaborative problem-solving and decision-making. The potential

benefits of HMC are vast, and we are only beginning to understand what is possible, both positively and negatively (Prahl & Edwards, 2023).

By reconceptualizing machines as interlocutors in their own right, HMC challenges the traditional conception of them as mere tools (Spence, 2019; Fortunati & Edwards, 2020). Therefore, it opens the perspective through a more diverse set of theories, methods, and the reconceptualization of communication, enabling the field of HMC to lead the exploration of this new era of interaction (Fortunati & Edwards, 2021; Etzrodt et al., 2022).

This paper delves into the dynamic realm of HMC. In the following sections, we provide a brief background of the field's current state in theory and research, complemented by a discussion of future directions. In detail, we will first portray the foundational theoretical and methodological approaches to HMC and its challenges. We consolidate this portrait by exploring two prominent research frontiers in HMC: social presence and trust. Then, we discuss critical implications of HMC from various angles. In each section, we suggest future directions for HMC.

Origins of Human-Machine Communication

The study of human and machine interactions has been around for many years and can be found in various fields (Suchman, 2007). HMC, as a formal field of study, can be traced to the late 2010s (Dehnert, 2023) and has emerged from various subfields within communication and related disciplines (Richards et al., 2022). As Guzman (2018) argued, "Human-Machine Communication as an area of study is not a competitor to HCI, HRI, or HAI within communication or related research; it subsumes them. HMC can be thought of as an umbrella encompassing the many approaches to people's communication with various technologies" (p. 7). Before this time, the focus of Communication Science/Studies has primarily been on the use of technology as a tool to enable individuals to interact, known as computer-mediated communication (CMC) (Westerman et al., 2020), which focuses on the channel of communication (mediated by technology) and not when a machine is a communicative partner. For a detailed history of the creation of HMC as a subfield, see Guzman's (2018) introduction in her edited book and Spence's (2019) introduction to a special issue of *Computers in Human Behavior*. For

a model and the history of HMC, see Etzrodt et al.'s (2022) introduction to the special issue in *Publizistik*.

The first instance of text-based communication between humans and machine interlocutors can be traced back to the 1960s with the development of ELIZA by Joseph Weizenbaum (Gunkel, 2012). ELIZA was designed to simulate conversations using simple pattern-matching techniques. It was a breakthrough in AI, demonstrating the potential for machines to engage in text-based exchanges resembling a human conversation. The Internet and computing power advancements led to the proliferation of chatbots and virtual assistants in the early 21st century. Agents like Microsoft's Clippy and Apple's Siri paved the way for modern conversational agents.

At the same time, this technology was being applied to embodied social robots. These social robots are designed to interact with humans naturally and can be used for various purposes, such as providing companionship, education, and healthcare. Embodied social robots (e. g., Pepper, Nao, Sophia) are designed for natural interaction with humans and have the potential for companionship (Abendschein et al., 2022; Merrill et al., 2022; Dang & Liu, 2023), education (Edwards et al., 2018; Abendschein et al., 2021) and healthcare (Blindheim et al., 2023; Kim et al., 2023b, 2023c). Researchers seek to train these robots to recognize emotions, hold conversations, and learn new skills. These explorations with social robots and AI systems have led to new theories about communication—for the human-to-human interaction script theory (see Spence et al., 2014; Edwards et al., 2016b, 2019; Craig & Edwards, 2021) and extensions/modifications on the CASA paradigm (see Gambino et al., 2020; Lombard & Xu, 2021; van der Goot & Etzrodt, 2023).

HMC is an interdisciplinary and vital field of research (Fortunati & Edwards, 2021), with different areas that can work together successfully (Richards et al., 2022) benefiting from diverse approaches (e. g., Dehnert, 2023). This success is confirmed by the massive growth and diversity of research on HMC contexts in communication journals. For example, from 2020 to 2021, published research articles examining HMC grew by 119% (see Richards et al., 2022). HMC has incorporated diverse subfields of communication, such as the investigation of machine actors as interpersonal partners (Ling & Björling, 2020; Lutz & Tamò-Larrieux, 2020; Rodríguez-

Hidalgo, 2020; Merrill et al., 2022; Kim et al., 2023a) or communicators (Etzrodt, 2021, 2022; Etzrodt & Engesser, 2021), instructional resources (Edwards et al., 2016a, 2021), and health advisors (Kim et al., 2023b). Additionally, chatbots have been explored in various capacities (Banks & Van Ouytsel, 2020; Beattie et al., 2020). Scholars have considered the implications for HMC in journalism (Lewis et al., 2019; Johanssen & Wang, 2021; Kim et al., 2022c), work teams and automation (Piercy & Gist-Mackey, 2021; Utz et al., 2021; Stephens et al., 2023), and issues of identity (Davis & Stanovsek, 2021; Dehnert & Leach, 2021; Liu, 2021).

Conceptual Foundations in HMC

The advent of HMC theory could be viewed as a "paradigm shift" within conventional communication science/studies, which emerged in response to technological innovations that challenged the established frameworks of CMC (e. g., Gunkel, 2020). Due to specifically addressing modern agent technologies, including AI, social robots, digital assistants, or Internet-of-Things devices, as communicators and conversational partners, HMC theories spotlight the social interaction and relationship between humans and machines within communicative settings. Thereby, the intentional use of the term "machine" over "technology" serves the specific purpose of invoking the cultural, philosophical, and technological traditions that underpin the field of study (Guzman, 2020).

A cornerstone of HMC's conceptual foundation is the reconceptualization of both the definition of communication and its constituent actors to allow for the incorporation of machines as legitimate communicators (e. g., Edwards & Edwards, 2017; Guzman, 2018; Edwards et al., 2020; Etzrodt et al. 2022), although it is acknowledged that interactions with machines may not perfectly mirror classical human-human communication (e. g., Fortunati & Edwards, 2020). As summarized by Etzrodt et al. (2022), HMC can be characterized as the exchange and interpretation of messages between a human and a digital interlocutor, where both interlocutors engage in some form of meaning-making and social interaction or relationship. Importantly, Etzrodt et al. note that it is sufficient for the communication to be classified as such, if just one of the parties involved defines it as a communicative exchange. The facets of

exchange, interpretation, meaning-making, social interaction, and relationship are multi-layered, operating and being shaped at the micro, meso, and macro levels (Etzrodt et al., 2022).

Meaning-Making in HMC

HMC places a strong emphasis on the humans engaged in communication with the machines, along with their cultures and practices (e.g., Natale & Guzman, 2022). The concept of ascribed machine-actorness—how, when, and why we define and treat machines as agents or actors in communicative settings—and the normative discussions that stem from these ascriptions occupy central roles in the theoretical framework. In this context, theories of interpersonal human-human communication (HHC) often serve as the foundational framework for exploring machine agency within the communication process. Moreover, this comparative approach frequently evolves into exploring "what it means to be human" (Spence, 2019, p. 286). In a nutshell, HMC primarily relies on a co-constructivist perspective (Rammert & Schulz-Schaeffer, 2002; Edwards et al., 2020) by considering both machinic and human actorhood as socially constructed, negotiated, or ascribed by human agents. Consequently, despite the need for distinction between HHC and HMC in specific situations, the co-constructive approach challenges the necessity for a general distinction of the conceptual framework of communication and its actors. Thus, future research must delineate clear criteria for when a conceptual distinction between HMC and HHC is warranted and superfluous. In this regard, we will briefly elaborate on two influential paradigms that have significantly shaped the discourse on this issue.

Equation or Evocation, That is the Question

CASA (Computers as/are Social Actors), which serves as a cornerstone of the Media Equation paradigm, the argument from the 1990s that HMC equates to HHC (Nass et al., 1993, 1994), stands as one of the most influential acronyms in the field of HMC. For a considerable period, scholarly discussions about CASA were largely confined to the framework of this particular paradigm (Fortunati & Edwards, 2021). However, this framework

faces increasing scrutiny today, resulting from replication issues and the discovery of notable discrepancies when applying interpersonal theories to HMC (van der Goot & Etzrodt, 2023). There has been a consistent trend in the literature towards subtle re-interpretations, as scholars adapt or nuance the paradigm without overtly breaking away from it.

To address this issue, a recent reframing by van der Goot & Etzrodt (2023) introduces a new perspective on this conventional reading of CASA: the "Media Evocation" paradigm, which draws on Sherry Turkle's foundational work on evocative objects. Like the Media Equation paradigm, the Media Evocation paradigm aims to explain why humans interact socially with machines. In contrast to the Media Equation, Media Evocation delves into the conscious aspects of interacting with machines, treating them as catalysts for deeper exploration and negotiation of new ontological categories, raising questions about human identity and the nature of emotion and cognition (Fortunati & Edwards, 2020). While this paradigm has not yet received as much overt scholarly attention as the Media Equation, it has quietly exerted a comparable influence on the intellectual terrain of HMC research.

As pointed out by van der Goot & Etzrodt (2023), the choice of paradigm serves as a crucial determinant in three key areas: (1) it influences which research questions are considered relevant; (2) it guides the selection of methodologies; and (3) it shapes the conclusions that can be drawn from the research. In this regard, HMC scholars are encouraged to test and examine this new framework in diverse HMC contexts and explicate both perspectives to grow and strengthen our understanding of HMC.

The Micro-, Meso-, and Macro-Levels

The last aspect of theoretical inquiry in HMC is the need to increase engagement with societal levels. Initially, theoretical explorations in HMC primarily centered on micro-level phenomena, emphasizing social interactions and interpersonal relationships (see Richards et al., 2022). Recently, we are witnessing a shift toward incorporating macro-level dimensions, particularly concerning cultural factors (e. g., Natale & Guzman, 2022) and broader contextual elements (Hepp et al., 2022, 2023). However, the meso level, which encompasses group and institutional dynamics, has not yet received as much scholarly attention in HMC. Although some scholars consider the meso

level in their research (e. g. , Etzrodt, 2022; Etzrodt & Engesser, 2021), a dearth of research explicitly addresses institutional processes and influences in HMC across all machine types. In fact, this is not just an academic oversight; it is a critical gap that demands urgent attention. As businesses increasingly adopt and commercialize agent technologies and these technologies are embedded more intensely into our daily social fabric, the meso level will become particularly pivotal for power dynamics, ethics, and governance questions. In this regard, there is a strong need to engage with societal levels in HMC research.

Methodological Approaches in HMC

While HMC understands itself as a theoretically and methodologically open-minded field, the advancement in methodological approaches appears to be developing at a slightly slower pace compared to the growing potential of theoretical innovations. Given that the field is still in its early stages, comprehensive meta-analyses or reviews that could offer a clear picture of the current HMC landscape are rare. Against this backdrop, the following brief reflection draws upon the findings of three foundational studies: Richards et al. 's (2022) meta-study of HMC scholarship trends over the past 10 years, Makady & Liu's (2022) meta-study of empirical studies over the past 11 years, and Greussing et al. 's (2022) overview discussion of methodological challenges to HMC experiments. The realm of HMC stands at the threshold of vast untapped potential, not only in the diversification of methodologies but also in the refinement of analytical frameworks capable of decoding the data these methods produce. Tapping into this potential will drive the field forward and enrich our understanding of increasingly complex human-machine interactions.

Methods

According to the results of Richards et al. (2022), HMC's empirical research exhibits only limited diversity: It is heavily leaning toward quantitative data collection methodologies, supplemented by a modest fraction of qualitative or mixed-method studies. As confirmed by Makady & Liu (2022), roughly two-thirds of empirical studies resemble the approach of the Media Equation paradigm (see van der Goot & Etzrodt, 2023) by relying on

(mainly lab-based) experiments. Although the remaining third employs various methods (e.g., rhetorical or discourse analyses, case studies, content analyses, surveys, interviews), mixed methods, physiological surveys, and observational studies are relatively uncommon. This constrained methodological scope and reliance on standardized procedures stand in stark contrast to HMC's diverse and evolving research landscape.

Additionally, it is imperative to find ways to engage in longitudinal research as this approach poses specific complications in the HMC domain, such as achieving consistent interactive capabilities over extended periods or handling massively generated user data (see Greussing et al., 2022). If the field aims to continue to evolve, an expansion of methodological diversity and a long-term perspective is vital. In this regard, HMC provides an ideal setting for exploring and developing novel methodological approaches, combinations, and paradigms, given its eclectic research objects and intellectual openness.

Analysis

Yet, it is not just the research design that requires attention; how we approach data analysis in HMC also calls for a reevaluation. To date, meta-studies have largely overlooked the intricacies of data analyses. This oversight is notable given that the data often exhibit pronounced skewness due to the direct application of interpersonal theories. Furthermore, the variance between groups can be significantly different, especially when comparing human and machine interactions. As a result, conventional analytical techniques, such as the analysis of central tendencies or variance analyses like AN(C)OVA, may not be appropriate for generating stable and meaningful insights (Rousselet et al., 2017). Moving forward, HMC research must innovate data collection methods and critically reassess how the data are analyzed. This entails the development of more robust standard procedures for data scrutiny to yield reliable and valuable findings (e.g., Etzrodt, 2022).

Key Research Frontiers: Navigating Social Presence and Trust in HMC

Social Presence of Machines

What distinguishes HMC from other communication areas is the nature of

the interaction partner, machines instead of humans. In that regard, social presence plays a pivotal role in HMC. Lee (2004) defines social presence as "a psychological state in which virtual social actors are experienced as actual social actors" (Lee, 2004, p. 45). This tendency occurs because users perceive machines as a kind of social being rather than objects (Lee, 2004). Research highlights its influential role in users' attitudinal and behavioral outcomes, such as trust in, acceptance of, and conformity to technologies (see a meta-analysis by Oh et al., 2018). In particular, the implications of social presence have been well documented in diverse HMC contexts, such as education (e. g., Edwards et al., 2021; Kim et al., 2021, 2022a, 2022b), health (e. g., Kim et al., 2023c), and entertainment/relationships (Kim et al., 2023a). The increased design of machines with natural, intuitive, and anthropomorphic characteristics emphasizes the growing importance of social presence.

However, we still need to clarify further the conceptual understanding of social presence in the HMC context. Although considerable effort has been invested regarding the multifaceted nature of the concept (e. g., Biocca et al., 2003; Lee, 2004) since its introduction (Short et al., 1976), the notion is still not firmly or universally defined or conceptualized. Whereas some scholars rely on definitions from the human-to-human context (e. g., Short et al., 1976), others base their conceptualizations on a broader scope, covering various agent types beyond humans (e. g., Biocca et al., 2003; Lee, 2004). Accompanying this, there still is a lack of consistent measures that correspond to the conceptualization. As a result, the insights differ tremendously. To continue to advance the role of social presence in HMC, it is essential to address how we conceptually and operationally define the notion in a more synthesized way.

The multidimensional nature of social presence is insufficiently covered in HMC research. While scholars have identified several dimensions of social presence such as copresence and psychological involvement (e. g., Biocca et al., 2003), there is a shortage of empirical research on this subject across different types of machine agents (e. g., robots, chatbots, voice assistants). As the field moves forward, we encourage HMC scholars to address this matter.

While social presence is often treated as a positive experience, we further advocate for addressing the essential question of to what degree social presence needs to be evoked or cultivated in HMC. The uncanny valley suggests that if a machine agent has too much human-likeness, users may develop negative

emotional responses toward the machine (Kätsyri et al., 2015). Relating this approach to social presence, to what degree should we consider fostering or evoking social presence? At a broad level, the ethical issues of machines becoming more like humans have already been discussed (e.g., Hancock & Bailenson, 2021). However, little research has addressed the potential perils of social presence in the HMC context. While social presence could lead to interaction experiences that feel like conversing with another human, this could potentially result in destructive consequences. When users continually and strongly feel social presence of their AI companion, this may lead to behaviors like reliance on a machine over a human, creating unrealistic views and perspectives of relationships, and isolation from natural human interactions. Acknowledging that technological advancement will continue to provide affordances that evoke a more substantial social presence, HMC research calls for finding ways to negate the potential perils of social presence.

Trust in Machines

The relationship between humans and machines, characterized by trust, has a long history. Famously, groups such as the Luddites, dating back to the 18th century, expressed deep mistrust by actively destroying machines they perceived as threats (Jones, 2013). By the mid-20th century, important figures like Alan Turing and Joseph Weizenbaum raised critical questions about the foundation of trust in machine counterparts regarding human cognition and conversation (Weizenbaum, 1966; Turing, 1950). Today, trust in machines is still pivotal due to technological advancements and industries' rapid integration of automation, wishing to nurture trust between their workforce and machines (Moritz & Smaje, 2022). Although human-machine trust relies on a vast expanse of research, it still faces challenges.

The primary challenge that we encourage HMC researchers to address is establishing a more solid understanding of the concept, both conceptually and operationally. Trust has been depicted in various theoretical models, encompassing everything from trust in fellow humans to animals, virtual agents, and social robots (Sundar, 2020; Banks et al., 2021). These models collectively contain an almost innumerable number of sub-concepts. As a result, trust is operationalized very differently among studies, ranging from the simple realization of the "Godspeed Questionnaire" (Bartneck et al.,

2009) to elaborated multidimensional measures (e. g. , Weidmüller, 2022). In addition, the discourse is further complicated by the repercussions stemming from (dis) trust in machines. Trust research is home to terms like "over-trust", signifying excessive reliance on automation (Wischnewski et al. , 2023), while on the other spectrum, phenomena like "algorithm aversion" are synonymous with "under-trust" or "mistrust" (Parasuraman & Riley, 1997). To establish a more systematic understanding of trust in machines, we advocate for a more careful conceptualization and operationalization of the concept in future HMC research.

Related to the above, another challenge is that perspectives on trust differ tremendously. Some studies conceptualize trust as a mental state or attitude. Such an approach is common in HMC literature where the technologies studied may be cutting edge or used in private home settings and thus unavailable for laboratory studies (e. g. , home assistants) (Lutz & Tamò-Larrieux, 2020; Weidmüller, 2022; Rosenthal-von der Pütten & Bock, 2023). Other studies conceptualize trust as a behavior, which is a common perspective on human-automation trust (for examples, see Dzindolet et al. , 2003; Huang et al. , 2021) and also in some HMC research (e. g. , Prahl & Van Swol, 2021). Whereas the former perspective invites the use of survey instruments and self-reports to measure trust, the latter demands actions to be taken and behaviors measured. While different perspectives provide diverse angles, these can prevent us from assessing comparability across studies. As the field advances, we, therefore, encourage future HMC scholars to carefully consider how we approach the notion of trust to produce a systematic understanding.

The third challenge is to distinguish the concept of trust from related concepts, such as trustworthiness. Trust and trustworthiness, for example, are often used as synonyms, although the first describes a mental state (or behavior) by the receiver of a message, whereas the second refers to the sender (Weidmüller, 2022). This ambiguity creates challenges for synthesizing the findings of the extant literature. The challenge demonstrated in this example does not just concern the conceptualization of trust. Therefore, we strongly suggest that HMC scholars further explore the boundary conditions of conceptualizations in trust research.

Last but not least, we consider it crucial for HMC research to identify the optimal level of trust in machines. Trust determines how people interact with (Li et al. , 2008) and influences the adoption of (Gefen et al. , 2003) a

particular machine. From a designer's perspective, it is reasonable to induce maximum trust. However, from an ethical and societal perspective, we observe an unrealistic automation bias (Cohen et al., 1998), inducing the potential harm of over-reliance on machines (Bussone et al., 2015). Therefore, despite the numerous benefits of machines, e.g., in the healthcare context (e.g., Abbas et al., 2018), we exhort HMC scholars to examine what the optimal level of trust is by taking into account various perspectives.

Implications for the Future of HMC

The proliferation of HMC scholarship corresponds with the escalating adoption of automation in both personal and professional spheres. This growth has enabled industry professionals, corporations, and policymakers to tread more confidently within the continually evolving maze of automation in communication. In this context, we delve into the ripple effects of HMC studies across practice, industries, and society, and discuss the implications for the future of HMC.

Implications for Practice and Industry

In the evolving landscape of HMC, interactions with machines are becoming more conversational, signaling a shift in traditional dynamics. However, there is an increased potential for reluctance to engage with machines if they fail to meet certain standards, whether in terms of the communication quality itself, anthropomorphization, privacy concerns, application in inappropriate contexts (e.g., empathy-driven roles), or other ethical concerns. Moreover, as we traverse this nuanced space, there is a burgeoning potential for uncanny valley effects as well as over-trusting machines. These dynamics underscore the urgent need for careful design and regulation to navigate the complex pathways that lie ahead in the realm of HMC. In this regard, the ramifications for practitioners and industry sectors are profound. Current observations offer glimpses into a future marked by deepening human-machine collaborations, challenges, and spaces for HMC research to contribute to practitioners and industries spawned by nascent technologies.

When machines make their mark in the workplace, professionals have to

rewire their routines, especially considering that today's machines assume a more dialogic stance than the past. Despite this advancement, a recurrent theme emerges: individuals mold workflows tailored to their unique strengths. Injecting enforced automation disrupts these processes, potentially leading to dissent, morale dips, and even rejection of the technology (Olakotan & Mohd Yusof, 2021). In this area, we see future research trajectory moving further from technological determinism perspectives as HMC researchers investigate how individuals shape technology/machines to complement their personal workflows.

HMC's wave will herald the decline of certain industries, simultaneously giving rise to novel ones. With the advent of Generative AI tools, traditional communication roles like editing, copywriting, and design might be overshadowed by faster, cost-effective machine communicators. Yet, this AI-driven landscape is not entirely bleak. Challenges like AI's propensity to generate spurious information spotlight the need for "veracity industries" that vet credibility (Alloway & Weisenthal, 2023). This domain necessitates human-machine collaboration, hinting at a symbiotic future. For HMC scholars, the direction is evident: delve into trust and credibility in human-machine interactions. While our earlier discussion on trust offers industry leaders a starting point, extensive research still beckons.

As we look further into the future of HMC research, there is a critical need for delineating roles between humans and machines. People view machines as experts in managing objective data (Prahl & Van Swol, 2021), while machines are less suited to the intricacies of emotion and creativity where humans excel (Takayama et al., 2008). There is a clear place for HMC research in this future: machines may outperform humans in specific communication tasks, but the challenge is designing machines that strike a balance between customization, task aptitude, and communication nuance. Such innovations will be informed by HMC research.

Implications for Society

The surge in the integration of conversational and social machines into our daily lives has begun to reshape previously unquestioned worldviews and ethical standpoints. In recent years, it has become clear that these developments provoke social reactions and empower us to redefine and expand

traditional categories, deepening our understanding of machines, the intricacies of the world, and human nature itself.

One of the most significant transformations occurs in the realms of sociality and our perspectives toward social machines, as highlighted in the respective sections on social presence and trust. With machines soon discerning our personalities and beliefs to communicate on our behalf, society is wrestling with the potential diminution of personal connections and the birth of new digital etiquettes and norms. As we move towards this era driven, in part, by machine communicators, the concerns intensify, necessitating comprehensive research explorations. The future of HMC research will continue to explore the reshaping of not only human-machine but also human-human connections, ensuring that machines do not distance us from our human essence.

Alongside, a growing concern is the inherent bias that machines may acquire. Because bias is an age-old human flaw, machines that draw insights from human-sourced data would inevitably acquire and replicate humans' inherent biases. Such complexities lead to imperative questions on bias recognition, resource allocation for de-biasing efforts, and moral obligations developers might hold (Sargent, 2021). Hence, future HMC research ought to address how to develop and integrate fairness in human-machine interactions.

Conclusion

In the fast-growing realm of human-machine communication, we are witnessing a transformative era characterized by collaborations between humans and machines, reshaping established norms, expectations, and ethical considerations. The field of HMC has explored this shift from perceiving machines merely as tools to recognizing them as digital interlocutors that shape our social realities. Through this lens, we examined theoretical foundations and methodological approaches, two prominent research frontiers centered on social presence and trust with machines, and wider implications.

As we move towards a future driven by machine-driven conversations, the challenges and opportunities multiply, touching diverse sectors, such as education, healthcare, legal, entertainment, and new industries spurred by emergent technologies. While machines offer efficiencies and advanced capabilities,

addressing the potential harms of over-reliance on machines and the decline in personal human connections is essential. We see the imperative of navigating and optimizing the synergy between humans and machines and the critical role of HMC research in doing so.

The onus is now on all parties involved in this era of machine-driven communication. Scholars are responsible for producing knowledge that can promote positive effects and negate the perils of machine-driven communication. Considering that HMC is a dynamic field with remarkable opportunities for fresh perspectives and approaches, the field's expertise in communication integrating various disciplines opens up sound investigation of relevant practical challenges. Practitioners and industry leaders ought to embrace a responsible evolution, fostering technology that amplifies efficiency and respects the intricacies of human nature and ethics.

Through diligent HMC research, we can pave a path for innovations that meld the best of human intellect and machine proficiency, steering towards a future that is not only technologically advanced but also nurturing a society where machines complement human endeavors responsibly and inclusively. Moving forward, the amalgamation of humans and machines beckons HMC researchers to engage in a deeper exploration of the challenges and opportunities arising in the melding of societal and technological landscapes.

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