

Conference Paper

Social Robots: A Bridge Between the Two Cultures

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Abstract

This paper aims to show the possible and actual synergies between social robotics and sociology. The author argues that social robots are one of the best fields of inquiry to provide a bridge between the two cultures — the one represented by the social sciences and the humanities on the one hand, and the one represented by the natural sciences and engineering on the other. To achieve this result, quantitative and qualitative analyses are implemented. By using scientometric tools like Ngram Viewer, search engines such as Google Scholar, and hand calculations, the author detects the emergence of the term-and-concept ‘social robots’ in its current use, the absolute and relative frequencies of this term in the scientific literature in the period 1800–2008, the frequency distribution of publications including this term in the period 2000–2019, and the magnitude of publications in which the term ‘social robots’ is associated to the term ‘sociology’ or ‘social work’. Finally, employing qualitative analysis and focusing on exemplary cases, this paper shows different ways of implementing researches that relate sociology to robotics, from a theoretical or instrumental point of view. It is argued that sociologists and engineers could work in a team to observe, analyze, and describe the interaction between humans and social robots, by using research techniques and theoretical frames provided by sociology. In turn, this knowledge can be used to build more effective and humanlike social robots.

Keywords: social robots, sociology, social work, meta-analysis, scientometrics.

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1. Introduction

In a famous lecture held at the Senate House in Cambridge, in the afternoon of May 7th, 1959, Sir Charles P. Snow introduced an expression which is still used today to stress the divide between the natural sciences and the humanities, namely ‘the two cultures’ [1]. Snow emphasizes a problem of incommunicability between different types of learned citizens which affects modern industrial societies. On the one hand, there are intellectuals, experts in the humanities, literary persons who read and write books. They are mostly interested in the psychological, moral or social aspects of life. For them, novels, history, poetry, plays, are like “bread and butter,” but they completely ignore physics, biology, and engineering. They are ‘natural Luddites’. On the other

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hand, there are natural scientists and engineers, which are experts in the pure and applied sciences. They feel at home in what Snow calls “the industrial society of electronics, atomic energy, automation” [2]. However, they are hyper-specialized and therefore almost completely ignorant of traditional culture and the humanities. According to Snow, they do not read books, they are in a sense illiterate. Both tribes are formed by very intelligent persons who are, anyway, incapable of understanding each other. The author recognizes that there are also hybrid figures. After all, he was one of those, being both a scientist and a writer. Still, he insisted that the existence of the cultural divide could hardly be denied. Four years later, in 1963, he wrote a new paper on the issue of the two cultures. In his ‘second look’, Snow recognizes that between the hard sciences and the humanities one can find the embryo of a ‘third culture’. There are intellectual persons that, even though are not physicists or engineers, are familiar with the human effects of the scientific revolution. They study these effects, from a factual and not just legendary point of view, in many different fields, such as “social history, sociology, demography, political science, economics, government (in the American academic sense), psychology, medicine, and social arts such as architecture” [3]. As one can see, Snow recognizes that, at least potentially, the social sciences are the ‘third culture’ which can fill the gap between ‘the two cultures’. The gap can be filled in many different ways. Snow seems to think of social scientists that reject the natural Luddism of literary intellectuals and investigate the psychological, moral and social dimensions of the industrial and scientific revolution. More than sixty years after his lecture, we can easily see that there is a massive quantity of publications falling under the label ‘science, technology and society studies’. Still, the social sciences are more often seen by physicists and engineers as closer to the humanities than to the natural or technical sciences. On the other hand, social scientists may label themselves ‘intellectuals’, on a par with literary persons, but they would hesitate to call this way a zoologist or a computer scientist. In other words, we still have two cultures around that find it difficult to integrate and comprehend each other.

Active and fruitful collaboration between the two cultures is still on a very embryonic level. By ‘effective collaboration’ we mean specialists of the humanities and the social sciences working side by side with experts of the natural sciences and engineering on the same project, implementing researches that take advantage of the different specific competencies. Examples of this type are not lacking. For instance, archeologists are already actively collaborating with natural scientists and engineers to retrieve or make sense of some of their archeological finds.

There are also fields in which the collaboration could go the other way round. One of these fields is social robotics. As Corinna Lathan and Geoffrey Ling wrote in a popular science magazine, “like most robots, social robots use artificial intelligence to decide how to act on information received through cameras and other sensors” [4]. Social robots need to acquire the ability to respond in ways that seem lifelike and this is possible only if designers have the necessary knowledge on “how perceptions form, what constitutes social and emotional intelligence, and how people can deduce others’ thoughts and feelings.” In other words, social robots recognize “voices, faces and emotions; interpret speech and gestures; respond appropriately to complex verbal and nonverbal cues; make eye contact; speak conversationally; and adapt to people’s needs by learning from feedback, rewards and criticisms” because designers translate psychological and neuroscientific insights into algorithms, thanks to artificial intelligence.

There is a demand for more and more sophisticated social robots. The ideal of many engineers is to produce machines that are indistinguishable from humans, on the level of behavior or appearance, or at both levels. If this is the goal, at one point robotic engineers will need to collaborate with sociologists, psychologists, linguists, philosophers, literary intellectuals, etc., to elaborate algorithms capable of giving social robots the ability to understand and perform social rituals, and play with gestures and language in an increasingly sophisticated ways (for instance by understanding or producing jokes, double meaning words, ironic statements, noble lies, etc.). There is much in sociological research that can be used to achieve these goals. After all, as Rod Grupen noticed, “at bottom, robotics is about us. It is the discipline of emulating our lives, of wondering how we work” [5].

This research aims to show to which extent we are already moving in this direction. More precisely, here we intend to investigate the following cultural phenomena: 1) the emergence of the term-and-concept ‘social robots’; 2) the relative and absolute frequency of the term ‘social robots’ in the scientific literature; 3) the distribution of the absolute frequencies of scientific publications including the term ‘social robots’ in the 21st century; 4) the state of proximity of two couples of terms, such as ‘social robots’ plus ‘sociology’, and ‘social robots’ plus ‘social work’ (by state of proximity we mean the compresence or togetherness of the two terms in the same publications); 5) the theoretical or instrumental relations between, respectively, the terms ‘social robots’ and ‘sociology’, and the terms ‘social robots’ and ‘social work’.

2. Methodology and Methods

The methods adopted to investigate the above mentioned cultural phenomena, together with the flaws of these research techniques and the ways to minimize errors, have already been presented in other works [6]. Here we will present the methods very briefly. To determine the emergence of the concept and the frequency of the term 'social robots' in the period 1800–2008 we will use a combination of Ngram Viewer search and hand search. First, we will detect the peak of the relative frequency by using the scientometric online tool offered by Google, then we will determine the absolute frequency by means of hand calculation.

The distribution of the absolute frequency of the publications including the term 'social robots' will be detected by collecting data in Google Scholar. Figures will be built by entering data into Excel. The same technique will be adopted to determine the state of proximity. Finally, to reconstruct the possible theoretical or instrumental relations between the different terms-and-concepts, we will leave quantitative analysis and venture into the qualitative analysis. Given the large number of items detected, we will focus only on a few exemplary cases, chosen on the basis of the criterion of their 'influence' (which indicator is the number of citations) and 'novelty'.

3. Results / Findings and Discussion

Figure 1 provides the relative frequency of the term 'social robots' and information about its emergence in the history of ideas.

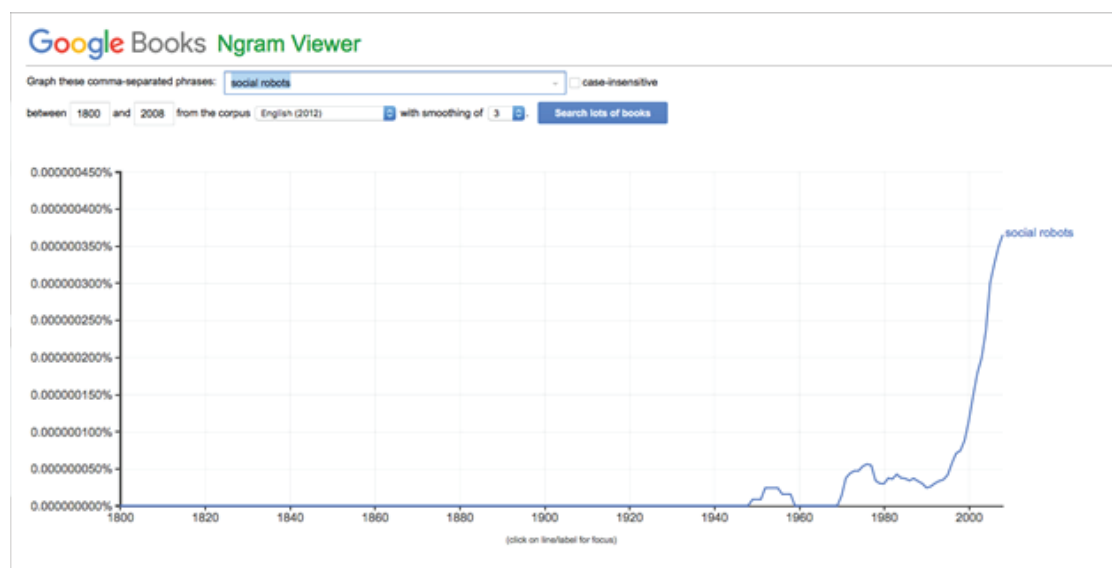


Figure 1: Relative frequency of the term 'social robots' (source: Ngram Viewer)

This term-and-concept emerged rather recently in the scientific literature. One can find sporadic early uses of the term “social robots” in the first half of the 20th century. However, initially, the expression was not used with its current meaning. As is well known, the term ‘robot’ was introduced by science fiction writer Karel Čapek in his 1920 play R.U.R. (Rossum’s Universal Robots). For some time, the expression ‘social robots’ was used metaphorically. It referred to human beings working in factories or offices in a very routinely way, or to individuals that uncritically obey to their leaders or adhere to the dominant lifestyle of society, as they were tools or machines. An example is 1952 book *Process versus power: studies in modern culture* by Eugene Newton Anderson, where we find the following statement: “Even in the case of experts, danger to society may arise from individuals who have enormous power as scientists but are emotionally unstable or hostile to the free society in which they live or are social robots willing to serve any master” [7].

In a 1974 booklet entitled *Homo Cyberneticus: Artificial psychology and generative micro-sociology*, authored by Hans Jürgen Holstein and Lennart Stålberg, the expression ‘social robots’ is eventually used to indicate a specific type of machines and not humans. We cannot say with certainty if this is the first documented use of the term with its current meaning, however, it is worth reporting a couple of fragments from that book, since they provide a definition of the object. The social robots the authors envisage “shall one day be able to go beyond advices and derive own behavior plans from their basic needs and dispositions and in relation to the environmental givens.” In other words, robots “shall be able to invent new behavior” [8]. The authors also explicitly relate the notion of social robots to the concept of artificial intelligence, as in the following sentence: “We try to computer-simulate the behavior of artificially intelligent ‘social robots’, which, as side-effects of their cognitive information-processing (or belief-system handling), generate ‘emotions’ and ‘attitudes’...” [9].

Holstein and Stålberg write about social robots as a possibility, by taking a futuristic perspective. It is worth reporting also an example from recent literature, where social robots are discussed as a reality. In 2009, Wendell Wallach and Colin Allen, in their book *Moral Machines: Teaching Robots Right from Wrong*, write: “While Leonardo and GRACE are behavior-based robots with faculties that are, at least theoretically, presumed to be similar to those of humans, roboticists, for example Hiroshi Ishiguro at Osaka University, are experimenting with social robots that have access to information a human might not have” [10].

A second important aspect revealed by Figure 1 is that, since the emergence of the term, its use enjoys a rapid and steady growth. Quite significantly, the peak of the

relative frequency is located in 2008, which is the last year covered by the Ngram Viewer. The scansion of the paper volumes published in the last few centuries is still a work-in-progress, and after 2008 the database is largely incomplete. It is interesting, at this point, to determine the absolute frequency of the term, at least in the year of its momentum.

This calculation must be done by hand. In 2008 the relative frequency amounts to 0.0000003649%. Google makes raw data available to all ngram corpora online. In particular, we are interested in the total counts for the English corpus. A file can be downloaded that contains the total number of tokens per year. The last line of the file is the following one: 2008,19482936409,108811006,206272. Basically, it means that in 2008, 206272 books in English were published, containing 108811006 pages and 19482936409 words. With a simple formula, we can calculate the absolute frequency of the term 'social robots'.

$$0.0000003649 \times 0,01 \times 19482936409 = 71.093 \approx 71$$

As one can see, the absolute number of occurrences was not particularly high in 2008, as social robotics was still a relatively new subdiscipline of robotics. At this point, we need to extract data from a different and more inclusive database, namely Google Scholar, because of the following reasons: 1) Ngram Viewer does not cover the period 2009–2019; 2) robotic engineers tend to publish their research in form of conference papers or articles in scientific journals, rather than monographs; 3) Ngram Viewer search engine provides the frequency of terms, while we are also interested in the frequency of the publications.

As one can see in Figure 2, in the last two decades the annual distribution of scientific publications including the term 'social robots' takes the form of continuous growth.

By following the criterion made explicit in the section about methods, we provide only two examples. The article "Assistive social robots in elderly care: a review", which appeared in the journal *Gerontechnology*, is exemplary of influential research. Indeed, up to now, Joost Broekens, Marcel Heerink, and Henk Rosendal's article has been quoted in at least 663 scientific works. The authors focus on assistive social robots, which are "a particular type of assistive robotics designed for social interaction with humans" [11]. They maintain that such robots "could play an important role with respect to health and psychological wellbeing of elderly". In particular, they could provide companionship.

The second example we provide is Lihui Pu, Wendy Moyle, Cindy Jones and Michael Todorovic's article "The Effectiveness of Social Robots for Older Adults," published in

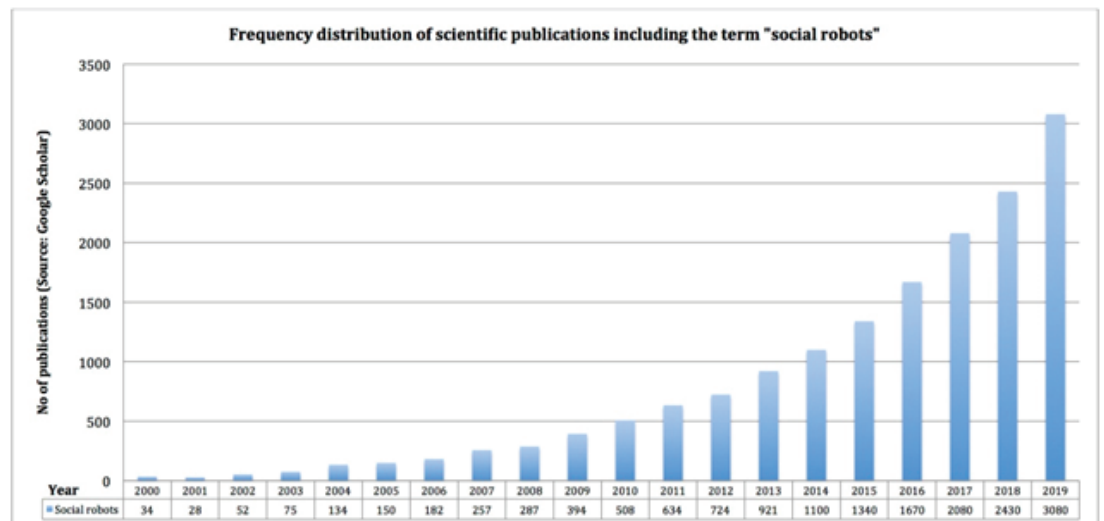


Figure 2: Distribution of the publications including the term 'social robots' (source: Google Scholar)

The Gerontologist, in 2019. The authors provide a meta-analysis to check if social robots are beneficial to older adults. Their conclusion is not univocal for lack of compelling evidence in the existing literature. Indeed, they write that “social robots appeared to have positive impacts on agitation, anxiety, and quality of life for older adults but no statistical significance was found in the meta-analysis” [12]. In their view, due to the lack of high-quality studies, no firm conclusion can be reached. Therefore, we need more randomized control trials (RCTs) “with larger sample sizes and rigorous study designs.” This article, though recent, has already been quoted 41 times.

In Figure 3 we can see the distribution of scientific publications including both the term 'social robots' and 'sociology'. It gives us an idea of the state of proximity between the 'two cultures', one represented by social robotics and the other by social science.

As one can see, once again, the trend is very clear. More and more publications concern both robotics and sociology. This does not mean that all this research is directly focusing on possible or actual synergies between the two disciplines. Some articles mention one of the two concepts, or both, in a very superficial way. However, the number of publications is rather large and gives an idea of the trend. By following the same criterion, we present two significant exemplary cases of this trend, that is two publications – one influential and one recent.

An influential work is Shanyang Zhao's article “Humanoid social robots as a medium of communication,” which appeared in *New Media & Society* in 2006 and has been quoted 136 times. Zhao points out that “humanoid social robots belong to a special type of robotic technology used for communicating and interacting with humans” [13]. He adds that these robots are autonomous, interactive and humanlike, and they can

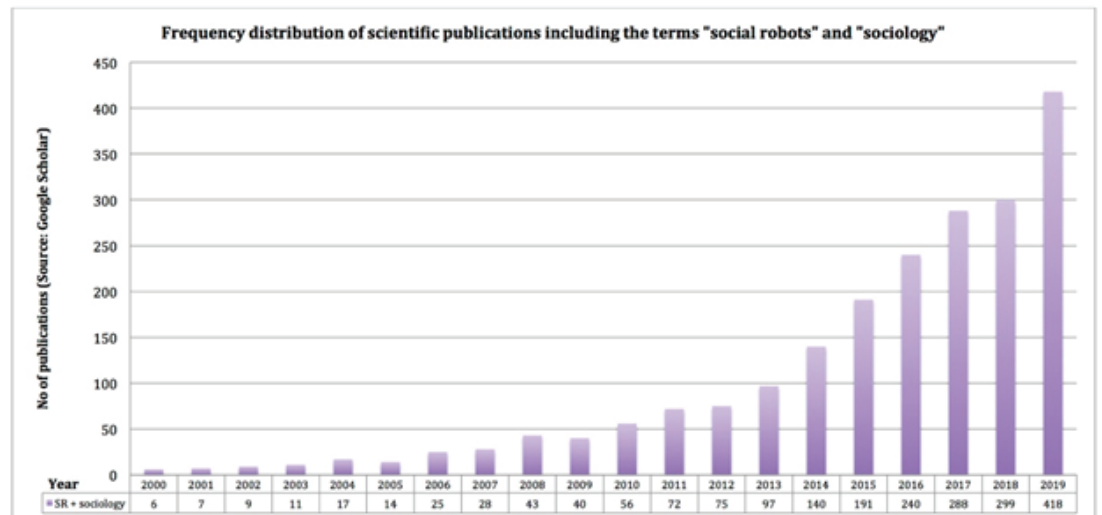


Figure 3: Distribution of the publications including the terms 'social robots' and 'sociology' (source: Google Scholar)

be either mechanical or digital entities. These machines can have different uses. They can either be used to trigger human emotions or to achieve utilitarian purposes, but always through interaction with humans. The conclusion of the author is sociological in character, as he underlines that the “incorporation of such robotic entities into the realm of social life invariably alters the condition as well as the dynamics of human interaction, giving rise to a synthetic society in which humans co-mingle with humanoids.”

Sociological in character is also the recent article by Nicola Righetti and Marco Carradore, “From Robots to Social Robots”, published in the Italian Sociological Review. This 2019 article emphasizes that “in recent decades, robots, social robots and artificial intelligence have increasingly entered daily life, affirming their presence not only in traditional spheres such as industrial production, but also gaining access to social reproduction, expressive functions and domestic activities” [14]. As a consequence, the authors decided to investigate the cultural representations of robotics in online news media, by means of text mining techniques. Their focus is limited to Italian media. As the authors specify, their research “relies on a dataset of about 3,000 news stories published between 2014 and 2018 by some 100 different Italian news media,” and the results “show a constant increase in news relating to robots, a major interest in work issues and a thematic shift over time: more recent topics describe the social-reproduction functions of robots.”

Finally, Figure nr. 4 focuses on the state of proximity between the terms 'social robots' and 'social work'. Social work is a scientific discipline and practice which is strictly related to sociology. This connection is not exclusive, as social work is inherently interdisciplinary in character, and involves other disciplinary areas such as psychology

or pedagogy. However, in many departments around the world, social work is often seen as a form of ‘applied sociology’.

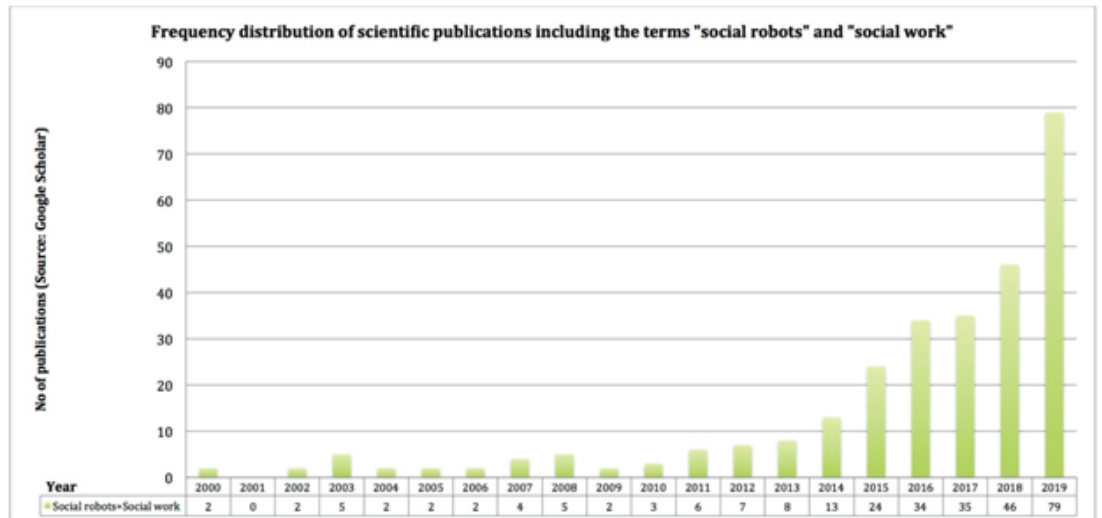


Figure 4: Distribution of the publications including the terms ‘social robots’ and ‘social work’ (source: Google Scholar)

Here, the numbers at our disposal are limited. This is quite surprising, as social robotics can more easily find a pattern of collaboration with applied sociology than with theoretical sociology. Still, the trend is encouraging. The absolute frequency including both terms keeps growing by following a pattern that seems almost exponential. Concerning examples of articles exploring this possibility, we may mention “The rise of social robots,” which appeared in the *Journal of Evolution and Technology* in 2016. The first section of the article is entitled “Social robots and social work.” The work is addressed to “engineers interested in cooperating with sociologists” and to “sociologists interested in the social dimensions of robotics” [15]. The former are invited “to get acquainted with the problems of social work and other social services,” while the latter “to have a closer look at technical aspects of new generation robots.” The article mainly focuses on Human-Computer Interaction (HCI) and Human-Robot Interaction (HRI). The conclusion is that “as robots become more and more sophisticated, engineers will need the help of trained sociologists and psychologists in order to create personas and scenarios and to ‘teach’ humanoids how to behave in various circumstances.” By now, the work has been cited 36 times, by both sociologists and engineers.

It is worth mentioning that not everybody likes the idea of using social robots for social work purposes. Indeed, the last example we propose – namely, the article “Technician education: paving the way for the rise of the social work robots?” – is critical about this perspective. Published in 2019, the research raises questions “about the role of technician education in reducing social work practice to a set of tasks that are repeatable,

formulaic and linear (i.e. tasks that robots are capable of performing)” [16]. According to the authors, the growing literature on the topic poses the basis for the replacement of the human social work workforce by social robots. Still, the main concern of the researchers is not technological unemployment, but the potential impoverishment of professionalism due to the fact that robots, at this stage of development, are incapable of grasping the social justice values of social work. They conclude that social workers “need to reclaim a broader understanding of social work education and practice if we intend to retain human social work practitioners into the future.”

4. Conclusions

The quantitative analysis presented in this article shows rather unambiguously that there is a growing interest in sociological aspects of social robotics, as in social robotics per se. It seems that the next ‘big thing’ in the field of robotic technologies will be machines capable of interacting with humans in a very sophisticated way and working either in the field of services or performing the role of companions in everyday life. The trend we found in scientific literature is confirmed by the trend in the manufactory. ‘Service robots’ is a wider concept than ‘social robots’, as it includes also intelligent vacuum cleaners or drones. In other words, the concept is designed to include all non-industrial robots. Still, social robots used for social work purposes are included in the figure of ‘medical robotics’, and in this field — as in all other fields of robotics — the number of items keeps growing, as the data provided by the International Federation of Robotics shows [17].

Our qualitative analysis showed that there are different ways to deal with social robotics from a sociological point of view. We briefly summarize them here. First of all, a team of sociologists and engineers can observe, analyze, describe the interaction between humans and social robots, and check the quality and the effectiveness of this interaction. Here, some research techniques typically implemented in sociological research, such as questionnaires, participant observations, focus interviews, etc., could be useful. Not all these research techniques can be implemented, as it is difficult, for example, to collect information from people affected by dementia, or from very young children. However, even observation and interpretation through the lens of sociological theory could be helpful. Engineers maybe not acquainted with symbolic interactionism [18] or ethnomethodology [19], but most sociologists certainly are. In turn, the knowledge acquired from a sociological perspective can be applied by engineers and programmers to improve their machines. Sociologists can also study the process of robotization ‘from

the outside', that is by assuming a macro-sociological perspective, and try to figure out how our society will change when legions of social robots will populate our homes, streets, and workplaces. Critical viewpoints could also be helpful to better understand and control the process. In this case, however, it would be useful for social scientists to learn more about robotics from a technical point of view. This can be done with the help of engineers, by resorting to expert interviews. In any case, the development of real dialogue and effective collaboration between the two cultures, and in particular between robotics and sociology, cannot be further postponed.

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