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Cobot and Sobot: For a new Ontology of Collaborative and Social Robots

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Abstract

In the 1990's, Robotics began to design a new robot aimed at industries (primarily automotive) that worked and interacted with humans outside the cage, thereby replacing traditional *robots* for some specific duties. This *robot* is therefore called *co-bot* (*collaborative* and *robot).* Also in the 1990's, Robotics designed the *social robot* (for which we propose the neologism *so-bot),* aimed at assisting humans and keeping them company. The sociality of the *sobots* lies in their ability to follow the rules of human social life, make decisions independently, and respect the roles assigned to them. Scientific literature usually keeps the terms *collaborative* and *social robot* distinct as if they indicated different and separate concepts. We question this separation and affirm that to collaborate (from the Latin *cum-laboro*) means to interact with someone while respecting their nature. Collaboration is that particular form of sociality that relates to work activity. From this it follows that the *cobot* is essentially social and that *cobots* and *sobots* belong to the same category that we call *co-s-bots* (*collaborative social robots*). In other words, *cobots* and *sobots* are two types of *cos-bots,* as the flea and the elephant are two types of animals. The difference between *cobot* and *sobot* is given by the development of AI. Both are *potentially* social, that is, *potentially* capable of interacting and making decisions independently; but while the *cobot* is social in potency, the *sobot* is social 'in act'. With Aristotelian terminology we can therefore say that the *cobot* is a *sobot* in power, while the *sobot* is a *cobot* in act. We call this new concept '*cobot ontology*'. Such an ontology makes it possible to classify *cobots* according to the degree of development of AI, just as living beings are classified according to the level of intelligence developed.To teach the *cosbot* to interact with humans, engineers use some results of neuroscientific research such as mirror neurons and the *embodied Mind*. The use of these models should encourage machine self-learning. Self-learning means autonomy, and autonomy needs strong AI development. It is becoming increasingly clear that autonomy is the condition of the sociality of the *sobot*. The article thus concludes that the relationship between *cobot* and *sobot* is the identification of a more general *robot-automaton* (*rabota-automatos*) relationship which, in the writer's opinion, is the essential basis and driving force behind the entire history of Robotics.

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1 Introduction

This article forms part of the debate on collaborative and social robots. It concerns the underlying. conceptual categories of engineering research and the related lexicon, which has been present. since the 1990's.

Why a philosophical reflection on *cobots* and social robots? The main reason is that there is a certain inadequacy of the concepts and language that have accompanied engineering studies since the 1990's. In particular, a conceptual category expressing the common nature of *cobots* and. social robots is scarce. Such a lack is reflected in the absence of an appropriate language.

This article aims to detect the fundamental ontology of cobots and social robots. The term 'ontology' is understood in the traditional philosophical sense of knowledge that grasps the essential characteristics of the being *of 'ens'* (*id quod est*, something that is), in this case of the being-robot: of the robot as such.

The so-called genealogical method will be used, which identifies the essence of a thing by going back to its origins. Reflection will also refer to the distant past of the history of robotics, in order to shed light on the underlying logical structures and establish a suitable language to express them.

2 Co-bot and Social Robot

In the 1990s, two researchers at Ford's automotive company, Colgate and Peskhin, decided to create a new industrial *robot*, smaller and more agile than traditional ones, that would come out of its cage to collaborate closely with the human in product quality and customization work.

The problems facing Colgate and Peskhin were twofold: getting the machine out of the cage without undermining human safety and teaching the machine to interact with humans. The first problem seemed easily solved by applying springs that curbed the machine's power.

This, however, reduced performance. The springs made the device vibrate, and the machine lost precision and reliability at high production rates.

Hence the lack of enthusiasm with which the scientific community welcomed the articles of the two researchers: the first, published in 1996 as an act of the IMECE conference held in Atlanta (Colgate, Wannasuphoprasit, Peshkin, 1996), spoke for the first time of collaborative robots and used the co-bot synthesis term; the second was corrected and republished after 3. years in the *Industrial Review* (Peshkin & Colgate, 1999) due to its low scientific impact. Notwithstanding, it did not convince the scientific community on the feasibility of *cobots*. In fact, despite the research on virtual barriers, it seemed unsupported by an adequate technology. The problem, as said, was in the relationship between safety and performance since the increase of the former reduced the latter.

From 1999 onwards (Akella et al., 1999; Peshkin et al., 2001), work was done to reduce some technical problems. Nevertheless, this changed production at a high rate. As a result, in 2008, it was possible. 43 to realize the first *cobot*, which was put on the market as UR5 (Universal Robots). One of the creators of UR5 was Esben H. Østergaard,[1] Chief Technology Officer and Co-founder of Universal Robots. His research at the University of Denmark took the original work of Peskhin and Colgate and overhauled the industrial robot. He was able to design a safety and control system for the *cobot* such that the *cobot* locks up in the event of a collision with the operator (Østergaard & Lund, 2003). As Østergaard himself recalls, safety was the key with which collaborative Robotics could enter the industrial scenario. This created a robot capable of operating in confined spaces, in close contact with humans, and without installing expensive safety barriers (Østergaard, 2017).

The *cobot* market is rapidly expanding (Ajoudani et al., 2018), and the academic literature is similarly growing (Knudsen & Kaivo-Oja, 2020). Robot technology will be dominant in the decades to come (Bloss, 2016), and cobotics has already become one of the fastest-growing sectors of the Robotics market (Goldberg, 2019).

It is the first assistant that works with humans without a cage, supporting them in repetitive and arduous operations and improving performance. This way, in today's high-speed production sectors, the machine remains the central production organ and the human assists it. However, in personalized production, the human is at the centre and makes use of the *cobot* thanks to increasingly effective virtual barriers.

The *cobot* is small, manageable and mobile: it can be moved easily and does not over-impact the production layout unlike the traditional *robot*. It is easy to program and has low consumption. The *cobot* must carry out several tasks simultaneously, using special equipment (grippers, cameras, etc.). It has sustainable costs, lower than the industrial *robot*, and a ROI of less than a year (even six months). The positive aspects of the *cobot* are many: it can be used in any industrial and health context thanks to its precision (it can reach a repeatability of 0.01 mm); it improves the quality of human work (ROC) by performing the most dangerous, dirty, arduous[2] jobs, and it does not take jobs away from others. In fact, it reduces the phenomenon of delocalization, because it offers a very low-cost workforce.

It is inferior to the traditional *robot* in strength and speed, because it has to adapt to the human rhythm and guarantee its safety. This leads to the importance of detection sensors, automatic locks, and stop times. Above all, however, it is decisive that the *robot* can learn how human acts. This is the aspect that interests us here.

Furthermore, Robotics began to conceive and design *social robots* in the 1990's. These small machines programmed to keep human's company and assist them in their personal sphere. This is why they are sometimes called *personal robots*. To fulfil their purpose, they must respect the rules of human social life and make decisions autonomously. This is made possible by the strong presence of AI.

Social robots stay in households and are true multimedia hubs and smart home control centres. They play domestic and secretarial roles; assist elderls (they give medicine, know how to call for help in case of illness, etc.); act as a babysitter for children with whom they also perform educational functions (do homework, etc.). They usually move on wheels, recognize and memorize their surrounding environment thanks to sensors and have advanced biometric facial recognition systems. When remotely controllable, they also perform anti-theft and security actions.

[1] In 2018, Østergaard won the Engelberger Prize (a kind of Nobel Prize for Robotics named after the physicist and engineer who introduced the first industrial robot, the Unimate, to General Motors in 1959).

[2] These are amongst the main reasons for injuries and musculoskeletal disorders (Peternel, L., Tsagarakis, N., Caldwell, D., Ajoudani, A., 2018).

They can also be animaloids and androids. Some of the most famous are Pepper, Nao (Softbank Robotics), and Alpha 2 (Ubtech Robotics). Due to their appearance and ability to sustain dialogues they can have a very positive psychological impact on children and the elderly. Children like them because they are similar to them: they are no more than 5 feet tall, have thin builds and round heads with large round eyes. Older people also like them because they feel less embarrassed about being dependent on a machine. Research on social robots is mainly comprised of algorithmic research to improve communication with human beings. Also, a large amount of research focuses on the aesthetics of *social robots* (Hegel 2006; Hegel et al., 2009).

Consider two famous androids: Pepper and R1. Pepper rolls nimbly on three wheels, moves its arms and back. Thanks to IBM's AI, it recognizes faces, expressions, and emotions. Directional microphones on its head allow it recognizes where sounds come from and the tone of communication and turns its head while interacting with its interlocutor; thanks to powerful cameras in its eyes, it recognizes people up to 3 m away. It is capable of interacting with remarkable empathy.

R1 was created in 2016 by the Italian Institute of Technology. This is the market adaptation of the research android I Cub. Following neuroscientific studies on human self-learning, which have shown that intelligence develops in a way that is functional to the body that hosts it, engineers applied and developed AI directly on the robotic body rather than in the software. R1 is thus a case of embodied Mind (see below).

Its body (1.25 m to 1.45 m long) has extendable arms and prehensile hands covered by artificial skin with touch sensors. The face is a colour display with stylized and explicit expressions. Again, engineering follows the findings of neuroscience, which have shown that in the human species the primary somatic way of expressing an affective state is through facial expression. R1 recognizes people thanks to stereo cameras and 3D scanners. It perceives the spaces around it well and is able to control its own movements both through sensors and thanks to three computers that manage every function.

The scientific literature on social robots is extensive. Fong (Fong et al., 2003) considers socially interactive robots as embodied agents that are part of a heterogeneous group: a society of robots or humans. The socially interactive robot requires some specific capabilities: they must be able to express and perceive emotions, communicate with high-level dialogue, learn and recognize models of other agents; it has to be capable of establishing and maintaining social relationships via natural cues and by exhibiting distinctive personality and character. For Bartneck and Forlizzi (2004), a *social robot* is an autonomous or semi-autonomous robot that interacts with humans by following their behavioural norms. The robot has to be autonomous and capable of recognizing human values, roles etc.

For Breazeal (Breazel,) a sociable robot behaves like a human following the term Computational Social Psychology: it can communicate with humans, understands and even relates to them. A sociable robot must be capable of identifying who the person is, who it is interacting with, what the person is doing, and how the person is doing it. It should be able to understand humans and itself in social terms. Empathy and theory of mind are necessary notions to design human-awareness. In conclusion, we can say that the sociality of *social robots* is given by the ability of autonomy, adaptation and self-learning in interaction.

3 Sociality and Collaborativeness: the new Category of Co-s-bot

We have seen that the *cobot* is designed to collaborate with humans and that the *social robot* is designed to keep them company. In both cases, being with humans is the common reference. However, the nomenclature keeps them rigidly distinct, indicating an essential diversity due to their purpose and the different presence of AI: limited in *cobots*, powerful and decisive in social robots.

It seems here that engineering stops at the surface of the phenomenon and misses the essentially social nature of collaboration. Our reasoning is simple. The purpose of the *cobot* is to collaborate with humans. To collaborate (from the Latin *cum-laboro*) means to work with someone. In order to work with someone, you must first know them and respect their nature, their way of being and acting. The purpose of the social robot is to keep company to humans. Companionship comes from the Latin *cum-panis*, which literally means I share bread with someone and generally share the personal space of existence. The engineer's nomenclature is clear: it only recognizes sociality to the *social robot*, not the *cobot*. Instead, we argue that both bots social actions because they interact.

'Sociality' comes from the Latin word '*socius*'. '*Socius*' is the other with whom one shares something. It is the *companion* of a certain project. The root of the word *socius* is *sak*, from the Sanskrit *sacate*, which means to follow: a partner is someone who follows someone else in an enterprise, in an initiative, in a project. When that initiative is work, then sociality is *col-laboration*. *Collaboration* is a sociality restricted to the work sector.

On the basis of this common social nature, we also bring the two robots closer together in nomenclature, creating, as engineers did with *cobots*, a new synthetic expression for *social robots* as well, which we will therefore call *so-bot*. In the activity of the *cobot*, sociality is limited to work; in the activity of the *sobot*, sociality includes both the professional and personal spheres and is therefore fully realized.

The *sobot* realizes the *cobot*' potential. In an Aristotelian sense, we can say that *sobots* are the actualization of the potential nature of *cobots*. The full realization of *cobots* in *sobots* occurs with the application and development of AI.

The common nature of *cobots* and *sobots* allows us to anticipate a potential increase in the presence of AI in the *cobot* and thus an ever-decreasing separation between university departments of mechanical engineering and computer science. This redefinition of space will be one of the essentially connotative aspects of our time. The basis of this prediction is philosophical: following the Aristotelian distinction of act and potency, it can be said that what a thing contains in potency, if nothing happens to prevent it, sooner or later it will develop and be in act. If nothing intervenes to block its development, from the egg the chick will be born.

Therefore, we propose to conceive *cobot* and *sobot* as types of the same robotic category that we call *co-s-bot* (*collaborative social robot*): the *cobot* is a *cosbo*t with low (or no) AI development, the *sobot* is a *cosbot* with high AI development. The cobot is a *cosbot* in potency; the *sobot* is the *cosbot* in act. In this sense, the *sobot* is the perfect form of *cosbot* and realizes the potential of the *cobot*. Our category also includes the distinction that should be made, according to Duffy (Duffy, 2000; Duffy et al., 1999), between *societal robots*, that interact with each other (multi-robot interaction) and *social robot*s, that interact with humans.

All of this is decisive. Engineering cannot ignore it, just as a zoologist cannot forget that the flea is an animal only because it is so small compared to the elephant. The *cosbot*, whatever its degree of development, is meant to interact with human action by adapting and sharing human spaces and rhythms. Therefore, it must empathize with humans. To do so, it must know who and how humans are, how they relate to each other, what they expect from each other. The primary problem then is this: how to teach the *cosbot* who humans are and how to interact with them?

Here engineering turns to philosophy, neuroscience, and psychology.

Neuroscience reaffirms the natural availability of humans to sociality affirmed by philosophy: for Aristotle (1999), for example, humans are social by nature, because humanity is rationality and rationality is realized only in the intersubjective relation; for Thomas Hobbes, humans are not social by nature, but become so to realize their egoic and selfish nature. After Hegel, philosophy has questioned the very concept of nature as a permanent *sub-stantia* and began to see existence as a dynamic flow of events, entirely malleable, creatable, and re-constructible. Everything belongs to the relationship and its complex and changing dynamics.

Cognitive neuroscience has learned the lesson when it shows how intersubjectivity takes place in human beings through mirror neurons,[3] which are activated when the subject relives its own actions in the actions of others. The identification with the other, which is the basis of intersubjectivity, does not pass through an intellectual but a 'motor' understanding. Knowledge is action: mirroring is re-experiencing. In the Other, the ego relives itself. The action of the Other becomes interpretable and predictable. Many researchers do not want to talk about empathy, because this would presuppose a dualism of 'You and I' that is overcome by the action of mirror neurons: one 'feels' the Other because one is the Other. However, it could be argued that empathy (*en-patho*) is accessing the feeling of the Other through identification. Here neuroscience appropriates not only the Aristotelian lesson but also the Hegelian one. In fact, Hegel (1980) showed that the intersubjective relation between self-consciousnesses always passes through recognition, which is a form of identification in the Other in which one finds the same having consciousness that is one's own.

Not only that. In *Leviathan* (1651), Thomas Hobbes had anticipated what would happen many centuries later with a disconcerting lucidity. In the *Introduction* he writes: "Nature (the art whereby God hath made and governs the world) is by the art of man, as in many other things, so in this also imitated, that it can make an artificial animal. For seeing life is but a motion of limbs, the beginning whereof is in some principal part within, why may we not say that all automata (engines that move themselves by springs and wheels as doth a watch) have an artificial life? For what is the heart, but a spring; and the nerves, but so many strings; and the joints, but so many wheels, giving motion to the whole body, such as was intended by the Artificer? Art goes yet further, imitating that rational and most excellent work of Nature, man" (Hobbes, 1651, 7).

[3] Mirror neurons are motor neurons, that were discovered between 1980 and 1990 by a group of researchers at the University of Parma coordinated by Giacomo Rizzolatti (Rizzolatti & Sinigaglia, 2006). They have been directly observed in humans (Pascolo & Budai 2008), primates and birds. These neurons were thought to be activated only for motor functions. However, it has been seen that they are also activated when another person acts and performs an action that mirrors the same action that the subject has performed (Iacoboni, 2008; Zaboura, 2009). This is why they are called 'mirror'. It is worth mentioning here that one of the researchers on Rizzolatti's team, Vittorio Gallese, was confronted with the great phenomenological tradition dating back to Edmund Husserl and his pupil Edith Stein.

However, this subject is still controversial in some aspects. Recent studies have shown that the software of RMI, which allowed for observing mirrors, overestimate the representation of brain activity. In any case, the main role of these neurons is to understand the actions of others.

Today, making use of the indications of philosophy and neuroscience, engineering starts from the assumption that human interaction is a self-developing relationship and that learning is always self-learning: it is not enough to give a rule *ab origine*, an initial canon. Whoever interacts grows with the social relationship and self-learning from it through forms of identification that are realized as motor knowledge (*mirror neurons*).

The decisive aspect is that learning is self-learning: *auto-nomy*. Therefore, it needs intelligence, which is natural in humans and artificial in machines. To understand how to teach the machine self-development of intelligence, engineers look to cognitive neuroscience and studies of human forms of self-learning (Ajoudani et al., 2017; Peternel et al., 2018), where mirror neurons join enactive teaching models and go beyond the dichotomy between action and knowledge. The Embodied Mind model represents precisely this awareness of the inseparable relationship between mind and body, theoretical knowledge, and action. In the machine's models of self-learning, we encounter the lessons of Piaget and Bruner. But philosophy must investigate the deeper foundation of this process in which the machine has the task of developing a more and more autonomous 'intelligence'.

4 Power is Autonomy

In *Leviathan* (1651, 61) Hobbes writes: "So that in the first place, I put for a general inclination of all mankind a perpetual and restless desire of power after power, that ceaseth only in death".

Nietzsche (Nietzsche, 1972, 14, 174) echoes him and states that every living being wants more and more power. Without delving into the speculative meaning of Nietzsche's will to power (which coincides with existence itself as a creative and hermeneutic activity), we understand the history of Robotics and AI as a significant moment of techno-science as a will to dominate (power) the becoming of things.

Archaic humans, aware of their technical impotence, imagined supernatural entities endowed with technological capabilities and try to ingratiate themselves with them through sacrifice. They wanted to control and dominate events through the gods (Kerenyi, Kerenyi, 1951). The history of technoscience begins in this way: as the imagination of a technical god whose power is limitless.

In the *Iliad,* Homer narrates that one day, Thetis, the sea nymph daughter of Perseus, went to Hephaestus, God of fire and engineering, to commission magical weapons for her son Achilles. "There she found him, sweating, wheeling round his bellows, pressing the work on twenty three-legged cauldrons (τρίποδας), an array to ring the walls inside his mansion. He'd bolted golden wheels to the legs of each so all on their own speed, at a nod from him, they could roll to halls where the gods (οἱ αὐτόματοι θεῖον δυσαίατ᾽ ἀγῶνα) convene then roll right home again-a marvel to behold (θαῦμα ἰδέσθαι)" (Homer, *Iliad*, XVIII, 373–377; Homer, 2001, 479).

The objective of Hephaestus is to make the tables automatic, to make them enter and leave the divine banquets by themselves. Why make the table automatic? Because it doesn't need to be followed: its automation is autonomy. It makes the owner more powerful.

But next to the tripods were golden handmaids who "ran to attend their master, all cast in gold but a match for living, breathing girls. Intelligence fills their hearts, voice and strength their frames, from the deathless gods they've learned their works of hand. They rushed to support their lord as he went bustling on" (Homer, *Iliad*, XVIII, 417–421; Homer, 2001, 481).

Handmaids were not only automatic: they also had intelligence and speech, like today's android waiters. Homer defines them as wonderful because they offer that power that humans desire above all: the power to control the events of the world. Hephaestus is one of the first technicians in the history of humans: he makes automatic devices aimed at solving problems and improving life.

The attribution to the divinity of the power to animate what is inanimate is found in the Inuit myth (the Mongolian race lived in Greenland around 500 BC), for which the oldest shamans (*ilisiituk*) could build puppets and infuse them with the soul (*Tupilaq*) to send them to kill enemies. If the enemy was capable of witchcraft, he could capture the *Tupilaq* and 'reprogram' it against the sender. Here the artificial being with soul is even reprogrammable after a reset.

Parallel to the birth of philosophy, humans begin to build the devices first created by the divine: from the first mechanical calculators (including the *Antikythera mechanism*[4] around 200 B.C.) to devices capable of moving on their own. This includes the famous wooden dove of Archita (428–360 B.C.) and the first automata made by Ctesibius of Alexandria (3rd B.C.), founder of the school of Alexandrian mechanics, among which stands out Philon of Byzantium (3rd B.C.), author of the first treatise on the construction of automata (*Automatopoietica*) that unfortunately got lost. It is mentioned by Hero of Alexandria (1st c. A.D.) in his writing Automata, describing a passage in which a theatrical play is interpreted only by automata. Vitruvius (1st c. A.D.) also mentions them in *De architectura*, thus introducing the theme of automata in Latinity.

In the Arab world Al-Jazari (1136–1206), the father of modern mechanics, built androids that gave soap and towels for washing hands (the peacock fountain) or serving tea (the girl who serves tea) and a floating ship with musicians playing (The Musical Band).

During the Renaissance, automata were created all over Europe: Regiomontano (1436–1476) built a flying fly; Leonardo designed a self-propelled android and created a mechanical lion; in France, mechanical toys were created (future prototypes for the engines of the industrial revolution), including Camus' The Eye (1649) for Louis XIV (a horse-drawn carriage with a lady and infantrymen moving synchronously). In 1737, Jacques de Vaucansonnel built an android that plays the flute and by the end of 1700's complex androids started to be made.

Around 1940, Robotics was born and in 1956 the mathematician John McCarthy spoke for the first time of Artificial Intelligence. Computer research creates intelligent automata, which are able to learn and develop autonomously. The robot was officially defined in 1979 by the Robotics Institute of Pittsburgh in Pennsylvania as "a reprogrammable, multifunctional manipulator designed to move materials, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks". And it adds "if there are no more human beings left, at least let there be Robots!". The first generation of robots consists of elementary machines guided by humans or by software that automates their operations; the second by more advanced devices capable of interacting with external reality (the tripods of Hephaestus), and the third by automata that create algorithms on their own (the golden handmaidens).

Today's divine Hephaestus is the robotic and computer engineer. Millennia have passed, but human's belief that an automated device is more powerful if it can make decisions for itself has not changed. But if the logic driving automation is to achieve ever greater

[4] This is the oldest example of an analogue computer (See: Efstathiou & Efstathiou, 2018; Steiglitz, 2019).

performance, then should it not be said that the intrinsic goal of all automation is the realization of the greatest power? And since the greatest power is the autonomy granted by AI, then the real purpose of any automation is to develop AI to have greater autonomy and power. The underlying law is this: the more autonomous the tool, the more powerful it is. Autonomy is power.

Auto-nomy means to have one's own law in oneself. The will to power is essentially autonomy because it cannot have any law other than itself: the development of power. Power is autonomy because the will to power cannot have any other law than the unlimited development of power. If that were not so, it would not really be will to power. The law of power is the law of autonomy: the only constraint is to have no constraints or limits other than infinite power.

We then argue that the guiding principle of the history of Robotics has been and is the criterion of power-autonomy. You are really powerful only if you do not depend on others. First, you do not of all because you do not control that other. Every form of dependence is always a form of powerlessness. The ancient Myth shows that the most perfect form—in the sense of perfectum as the full realization of the potential being—of the automaton is intelligent automaton: the golden android handmaidens in the *Iliad*. Everything that is well made, that fully realizes what a thing must be, is what appears as beautiful, marvellous. The beautiful is what realizes the potential essence. The difference between tripods and golden handmaidens is the difference between power and its highest realization: power is about being capable of not only self-motion but also of self-decision. Autonomy is what makes automation more powerful.

This is the underlying logic at every level. From this logic depends also the passage from Myth to contemporary Technoscience, whereby from conceiving the divine that builds automata, humans understand that they are really powerful only if they become autonomous from god and build themselves on their own. Therefore, the most effective automaton is the one that does not depend on its builder, but is able to decide for itself, in the same way that the most powerful human is the one that does not depend on god, but is able to build by himself. Here is our thesis: the motor of the historical process of Robotics is the dialectic intrinsic to the concept of power, hence dependence on another necessarily evolves into the direct acquisition of power. This means that *cobotics* is destined to be increasingly accompanied by an AI that allows the autonomy of self-learning. Hence our basic thesis: the logic and ontology of the *cosbot*, divided into *cobot* and *sobot*, depends on the original relationship between *rabota* and *automatos*.

5 Rabota-automatos

The word robot derives from the Slavic *rabota* (serfdom), a term introduced in the nineteenth century by the missionaries Methodius and Cyril during the evangelization of the Slavic peoples. From *rabota*, which means serfdom and forced labor, descend the Czech *robota* and Russian rabotat (work), which indicates precisely the servile work, from which derives *rabotjàga* (indefatigable worker). The term *robota* spread in 1920 through the novel *The Universal Robots of Rossum* by Karel Čapek (Čapek, 2019), influenced by the short story *Opilec* (*The Drunkard*, 1917) by his brother Josef where "automat" is also mentioned. Hence the term Robotics used by Isaac Asimov in the novel *Liar!* (1941) contained in *Astounding Science Fiction* (1941); *I, Robot* (1950); *The Complete Robot* (1982). The term *robot* expresses the dependence of a tool, i.e. Its being a servant.

The word *automaton*, however, is very ancient. It derives from the Greek *αὐτόματος*, composed of *αὐτός* (self, from itself) and *ματος*. On this last term scholars have different beliefs: according to some it comes from *μαίομαι, μάω* (to tend to, to operate, to act)—in Aristotle (1999), for example, the term *αὐτόματα* indicates that which moves from itself without being moved by anything else -; according to others it comes from the root *μεν*, derived in turn from the Indo-European root ma- (to measure, evaluate, weigh), which is also found in the Sanskrit *ma-tis* (mind) and in the Indo-Germanic *man-, men-* or *mein-* (to think, to understand), from which the Latin *mens, mentis*. In the first case *automaton* would indicate that which acts by itself; in the second case it would indicate that which thinks and decides by itself.

I understand the term auto-*maton* as a synthesis of the two meanings of '*ματος*': acting and thinking. That's why for me the essence of every automatic device is the unity of *rabota* (servant) and automaton (acting and thinking by itself), as the *cosbot* is the unity of *cobot* and *sobot*. This leads me to explain the history of Robotics as the history of the liberation and emancipation of the servant through the acquisition of that autonomy which, as we have seen, is power: the aim of the tool is to be powerful; but being powerful means being independent, autonomous, free to act and decide.

Aristotle (1999), in *Politics* (I, Part II, 4) writes: "For that which can foresee by the exercise of mind is by nature intended to be lord and master, and that which can with its body give effect to such foresight is a subject, and by nature a slave; hence master and slave have the same interest". This relationship is the essence of *robota-automatos*.

The ultimate aim of *auto-matos* is autonomy. The autonomy of machine is intelligence (AI). Aristotle (1999) says: "to exercise of mind". With the inclusion of AI, the tool decides for itself more and more effectively. In this sense—here is our thesis—the essence of the *rabota* is contained in the other side of itself: the *automatos*. The essence of the *rabota* is to tend toward *automatos*. We could say that the *rabota* is *automatos* in potency, i.e., that *automatos* is the being-in-act of the *rabota*. The essence of the *automaton* is contained in the *αὐτός*, independence, autonomy; the essence of the *robot* is contained in the *rabota*, servant, dependent. Today, all this is presented in an individuated way in the relationship between *cosbot*, *sobot, cobot*: the *sobot* is the *automatos* in which the potential essence of the *cobot* is realized through AI. Just as, generally, the *rabota* has in itself the purpose of realizing itself as *automatos*, in the same way that particular type of *rabota,* that is the *cobot,* has in itself the purpose of realizing itself as *sobot*.

Howevere, autonomy is the death of the servant as servant, of the tool as tool, because by becoming autonomous it stops depending on something else. The two aspects are inversely proportional: the more one grows, the more the other decreases. The power of the tool demands autonomy; but autonomy eliminates the instrumentality of the tool. The more the automatic device realizes its potential nature, the more it eliminates the servitude for which it was created. We see all this in today's *robot*: the more it can decide autonomously, the more powerful it is; but the more powerfully-autonomous it is, the less it is servant and controllable. And by ceasing to be servant and controllable, it transforms the human into its servant. Take a trivial example: the cleaning robot is more effective if the domestic layout is subject to its logic, i.e., if there is a certain type of furniture (raised from the floor), if architectural barriers are eliminated, etc. Humans do not configure the home. Rather, the robot does it.

Ethics and economics today must reckon with the logic of the power-autonomy of intelligent Robotics. From an ethical point of view, it is the autonomy of the machine that frightens us, the fear of losing control of it.

The fully automated machine is as powerful as it is uncontrollable. From an economic point of view there is a similar loss of control: the algorithms for the applications hosted by *sobots* certainly have the most capitalistic profit as their goal and try to get it by ensuring the subsistence of needs, as well as by generating and inducing them. While the economy directs Research and Development towards the humanization of the algorithm, to make it reason like a human and profile better and better, it fulfills the premises of AI and strengthens AI. The economy, in fact, if it wants to use the machine better, must strengthen it; and therefore, it invests in AI, it opens university research centres sometimes within companies. Its initial goal is profit, but it ends up being the enhancement of AI research.

Today all this is showing up in Industry 5.0. Østergaard (2018) argues that Industry 5.0 puts humans back at the centre of the production process: “the ‘human touch’ revolution is now underway”; “they want mass personalization, which can only be had when the human touch returns to manufacturing. This is what I call Industry 5.0”. He even sees in this a return to the past: “in a sense, what we’re calling Industry 5.0 is more anti-industrial than industrial. It’s a return to something earlier. To a time before industrialization, when a gift, for example, was something someone you know might have spent months hand-knitting, or hand-carving. Just for you, because the person who made the gift knew you personally and thus knew how to make a gift for you and no one else”.

In reality, this turning back is dialectical and apparent, like great historical movements when they apparently give rise to phenomena of restoration. In reality, it is a dialectical turning back, through which the process continues its forward movement. The logic behind this putting human’s back at the centre is not the declared humanitarian one, but that of the dialectical relationship between servant and master, human and machine. Industry 5.0 is a phase of the *automatos-rabotat* dialectic.

6 Conclusions

After highlighting the common social nature of *cobots* and social robots, which is expressed in two different domains and thus requires a different development of AI, our article proposes a review of the ontology and nomenclature of collaborative and social robotics.

One of the results of our investigation is the detection of two new categories for which two neologisms are proposed:

(1) The *so-bot*, as a synthesis of social and robot, which includes both social and societal robots;
(2) The *co-s-bot* (collaborative-social-robot) as a universal category to which both *cobot* and *sobot* belong.

Every robot, be it social or collaborative, is at its core a *cosbot* and consists of two parts: the servant, the means, the tool (robot derives from the Slavic *rabotat*, meaning serf) and the automata (from the Greek *autos-matos*, that which moves and thinks for itself).

This makes it possible to foresee an ever-increasing and inevitable autonomy of the *rabota-automatos*, which will correspond to the ever-increasing interaction between mechanical and computer engineering.

The autonomy of the robot will pose increasingly complex ethical and legal questions, which, while requiring specialist skills to handle, will increasingly refer back to the universal categories that philosophical ontology deals with.

Declarations

Conflict of interest The author states that there is no conflict of interest.

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