The Revolution of Robotics

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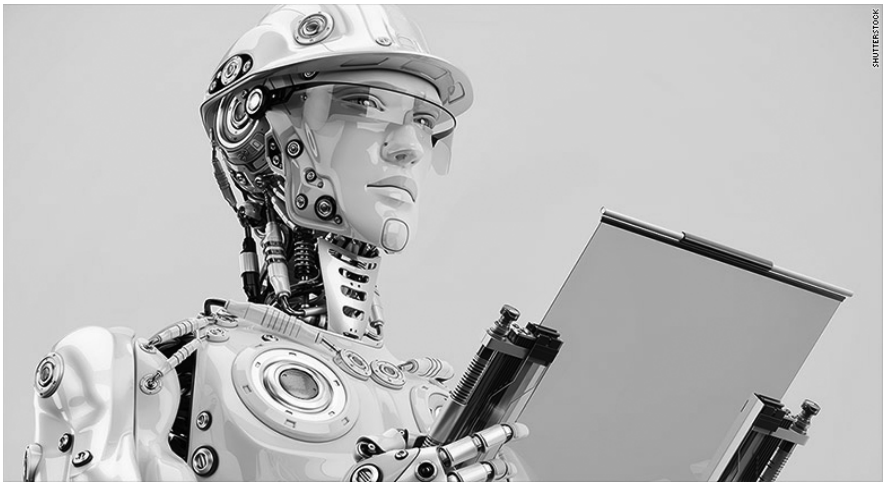
Robots are typically defined as physical agents that perform a variety of tasks by manipulating the physical world. The first use of the word "Robot" dates back in 1921 and it was introduced by Karel Capek in his play Rossum's Universal Robots. The play describes mechanical men that are built to work on the factory assembly lines and that rebel against their human masters. The etymological origin of the word Robot is from the Czech word 'robota', which means servitude or forced labor.

The term 'Robotics' was first mentioned by the Russian-born American science-fiction writer Isaac Asimov in 1942 in his short story Runabout. Asimov had a much brighter and more optimistic opinion of the robot's role in human society compared to the view of Capek. In his short stories, he characterized the robots as helpful servants of man. Asimov defined robotics as the science that study robots.



Robotics, like many other technologies, suffered from an inflated set of expectations, which resulted in a decrease of the developments and results during the 1990s. Robots have been slower in coming than science fiction books had predicted, but they are starting to leave the factories and the most innovative laboratories with the aim of revolutionizing mankind´s daily life. From defense to interpersonal relationships, from the services sector to the space exploration industry, robotics has already provided some examples of machines involved in people´s work and leisure activities: they are not the future, they are the present.

Robots are actively being introduced in many disciplines. With the growing popularity of such systems, we observe a transition that goes from mass manufacturing to a mass customization, particularly for industrial robots. Increasingly, personal (e.g. cleaning robots) and professional robots (e.g. service robots) are also demanding such customizations. We are also observing creation of modular robots whose components could be easily exchanged or replaced meeting the growing needs for customization.

Robotics today brings together several concepts from Artificial Intelligence (AI) and Machine Learning like probabilistic state estimation, perception, unsupervised learning and reinforcement learning, among others. The success of robots depends quite a bit on the design of sensors and effectors that are appropriate for the task for which the robot is being deployed. Here are some projections about the future of robotics :

* A significant percentage of commercial robotic applications will be in the form of 'robot-as-a-service' (RaaS). This will help to significantly lower the cost for robot deployment.

* A significant percentage of all robotic deployments will be smart collaborative robots that will operate three times faster than many robots being used today and will be safe for work around humans.

* Over 50 percent of robots will depend on cloud-based software to define new skills, cognitive abilities and application programs, leading to the formation of a robotics cloud marketplace.

* In the very near future, 50 percent of the 200 leading global ecommerce and Omni-channel commerce companies will deploy robotic systems in their order fulfillment, warehousing and delivery operations.

* By 2020, over 40 percent of commercial robots will become connected to a mesh of shared intelligence, resulting in 200 percent improvement in overall robotic operational efficiency.

In 2017, researchers from the Computer Science and Artificial Intelligence Laboratory (CSAIL) of the Massachusetts Institute of Technology (MIT) made a breakthrough: robots that can learn from each other. PhD student Claudia Pérez-D'Arpino, a specialist in robotics and computer science at CSAIL, developed a system called C-LEARN that adopts a two-pronged learning approach.

First, a robot is programmed with a knowledge base that allows it to interact with different objects. This knowledge base helps it navigate through the limitations of its environment, such as the need to turn a knob to open a door. And once the robot knows how to physically interact with objects, it can begin to learn more complex tasks. For this, a human programmer uses the C-LEARN software to move the extremities of a virtual representation of the robot and thus demonstrate to its real equivalent how to execute each task. ▸

In the future we will live together with all kinds of robots, drones, autonomous cars and other electronic entities. But how long until this science fiction is truly part of our daily lives? From which tedious or dangerous tasks will the robots liberate us first? To answer these questions, let us review some of the latest creations from the leading laboratories and universities worldwide.

Humanoids; Despite the huge advances in autonomy and capabilities in recent years, much remains before we will be seeing a real Terminator walking our streets. Robots designed to move like us or use our tools are much more complicated than those created for specific tasks, such as robots on an assembly line. To stimulate the development of these humanoids, the agency in charge of technological development for US military use (DARPA) launched a competition endowed with $3.5 million in prizes.

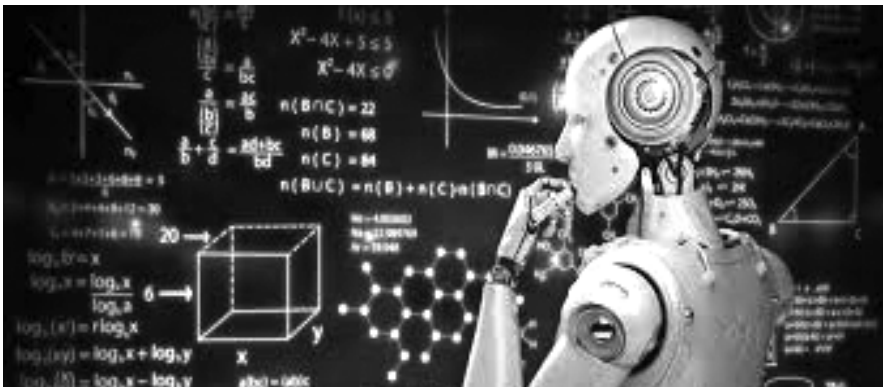
The competition was launched after the disaster at the nuclear plant in Fukushima (Japan) demonstrated the need to develop robots that can be deployed in disaster areas, and was organized as a timed race in which robots must pass a series of tests, such as driving a vehicle designed for humans, walking in areas strewn with rubble, climbing stairs, opening doors and using common tools such as a drill.

The winner was DRC-HUBO, designed by the team from the Korea Advanced Institute of Science and Technology (KAIST). This robot stood out over its competitors by being relatively lightweight, having great manual dexterity and being able to kneel while moving quickly. Its victory confirmed South Korea as an international power in robotics.

Soft Things : Soft robotics is a relatively new discipline that is inspired by biological designs, in this case mimicking soft tissue to carry out more delicate tasks or to access inaccessible areas where rigid robots cannot go. Soft robotics is based on the use of new flexible materials and compressed air or other techniques to make the soft bodies of the robots flex and stretch to perform various tasks such as crawling through cracks in disaster areas or grasping objects with changing properties.

These robots have the advantage of being inexpensive and can be deployed in large quantities to perform specific missions. One of the examples is robotic fish developed by the University of Essex in the UK. Other applications are the tentacles or soft grippers for grasping irregular objects that need an adaptable tip for the robot to be able to interact with them.

Insects, Worms and Flies : If there is something that has inspired robot builders since the beginning of robotics, it is insects. However, in recent times, due to miniaturization and the development of new materials, they not only resemble insects but they also have the same size. An example of this is dragonfly or cockroach developed by the micro-robotics laboratory at Harvard University. Another example is the species of worm, called OmniTread, developed at the University of Michigan. This robot is designed to move through extremely difficult terrain, such as the rubble of ruined buildings. It can also move on sand, gravel or through dense vegetation.



Space Explorers : Space is the final frontier for both humans and robots. In fact, they have already provided many advantages to us as the robotic exploration of the solar system has been underway for several years running. One need only remember that there are currently some robots exploring the surface of Mars. For some time now, NASA has proposed the concept of using robots in their missions, either alone or to support the human teams. Back in March 2012, a "Robonaut" called R2 was sent to the International Space Station and was subjected to various tests. Now the agency is developing the R5, nicknamed "Valkyrie," a more capable robot designed to operate on the ground, probably on planet Mars. R5 has 44 articulations containing a multitude of cameras in the head and the joints, along with sonar to detect obstacles.

Experiments at the Massachusetts Institute of Technology (MIT) illustrate how humans can teach machines to teach other machines. This system of demonstrating tasks to a robot that can then transfer its abilities to other robots with different shapes and capacities could be only the first step towards independent social learning in machines. Is this the beginning of robot culture?

Pérez-D'Arpino clarifies that, at the moment, the social learning of robots still requires the great involvement of human beings, and that the machines cannot deviate from the steps learned. But her team is already working on projects to make robots more adaptable. "I think in the future this type of robotics will go out of factories and help in settings like hospitals and, ultimately, at home, where it can assist people in doing tasks that they cannot do," says the researcher.

'Traditional programming of robots in real-world scenarios is difficult, tedious and requires a lot of domain knowledge," adds Julie Shah, MIT professor and one of the directors of the research. "It would be much more effective if we could train them more like how we train people: by giving them some basic knowledge and a single demonstration," she says. "This is an exciting step towards teaching robots to perform complex multi-arm and multi-step tasks necessary for assembly manufacturing and ship or aircraft maintenance.'

Social learning is, according to experts in different areas, what makes humans complex beings in their entire splendor. Without that ability to learn by observing others and interacting with them, we would not have culture, as evolutionary biologists Kevin Laland and Will Hoppitt argue: "Culture is based on information that is socially learned and transmitted." However, it is not an exclusive characteristic of our species: chimpanzees learn from their fellow chimps how to use plant stems to collect termites, and whales sing in different dialects. Now, technological progress is making it possible for robots to also join this list of beings with social learning capacity ◙