Chapter Four:
Supported and Supporting Technologies

Multiple technologies are influenced by AI or sometimes other technologies are required to enable or support AI applications. Below is a partial list of prominent supported and supporting technologies:

Robotics

The field of robotics has existed since the 1960s. Over the years, and thanks to technological developments, developers have perfected the capabilities of robots, so that fourth generation robots, belonging to the 21st century, are able to analyze new situations, examine their environment, and act accordingly. Some are even able to relate to human emotions. AI is an important component in the development of robotics, since it is the "brain" that controls the physical body of the robot, and with the progress of AI, the functioning and activities of the robots have also improved. Robots now are able to perform a wide range of missions, including autonomous driving, transporting goods, manufacturing products, cleaning, and many other tasks in different fields.

Robots help perform tasks that are characterized by "the 4 Ds": dull, dirty, dangerous, and dear (expensive).[70] In the past two decades, many robots have been used for security purposes in the air, at sea, and on land. As these robotic systems become increasingly autonomous, their potential grows, as does the complexity of legal and ethical issues.

Swarms

Swarms intelligence is a field of AI that imitates animals operating in groups, such as bees and ants. Members of a swarm share a common intelligence that transcends that of the individual member of the group. Developments in the field of processing, networking, and interface design have enabled

software and hardware to imitate the swarm's decision-making process. These AI systems receive information from all connected parts, each providing unique information, enabling it to make the best decision for the entire group.[71] DARPA, for example, has been developing swarms for a long time and recently has focused on the cooperation between a swarm and a person.[72] One of DARPA's experiments is the action of a swarm that has the ability to recover, meaning it can successfully execute a task, even if some swarm members are injured or disabled. In such a case, a computer restarts its activity and performs the task based on the new data, and this is the advantage that swarms have over actions based on individual tools.[73]

Human–Machine Interaction

This field includes various subfields of AI that enable easy and effective interaction between machines and people, including natural language analysis, bot chat, analysis of human emotions, and personal assistants, such as Siri and Alexa.[74] The interaction between people and machines occurs by connecting teams of people and robots, by connecting people and AI programs as a means of increasing human abilities; and as an action as one entity that has been cognitively and physically enhanced by machine capabilities. In the security context, militaries seek ways to streamline the human–machine interaction and to create integrated teams that will change planning and fighting and reinforce the defensive strength.[75] In this field, like in others, the ability of a single person to control a large number of tools in the most intuitive and simple manner, or to cooperate with them to enable short response times, is extremely important. In this way, various interfaces are also developed, including the brain–machine interface.

Brain–Machine Interaction

Brain–machine interface is a comprehensive name for devices that communicate with computers through brain activity alone; they translate neurological information into commands in order to control software or hardware. Advanced developments of the interface should enable people to communicate through brainwaves and "read each other's thoughts."[76] Most of the existing interfaces were developed for medical applications, including cochlear implants (hearing devices) and robotic limbs. In 2018, the entrepreneur Elon Musk announced an investment of 27 million dollars

in Neuralink—a company that seeks to develop a brain–machine interface that will improve human communications by connecting electrodes to the brain and connecting the brain to computing capabilities.[77] Musk sees the brain–machine interface as a means of improving human abilities and coping with the increasing threat to humanity, which AI presents. This development also has potential for the field of security. DARPA, for example, is working to improve the cognitive abilities of soldiers through the appropriate brain–machine interfaces.[78] This technology greatly relies on AI systems to identify patterns, learn from the environment, and adjust the response to all of these.[79]

Big Data

Development in the field of technology and different types of digital components, including components of IoT, has led to the creation of enormous quantities of "digital signatures," which are expressed as location data (GPS), images, text, and other forms. According to data from 2018, every day, 2.5 quintillion (equivalent to 2.5 billion billions) bytes of information are created, and this rate continues to grow.[80]

Although the concept of big data refers to enormous amounts of data, some relate to big data as a particularly large and complex database, whose management and manipulation involves logistic challenges, since it cannot be done using traditional data processing methods and applications.[81] Others consider big data as a group of statistical techniques capable of identifying patterns in huge arrays of data.[82] Big data is used to train AI, because significant and valuable patterns can be learned from its analysis, and in many cases its size has become a bottleneck in developing certain applications.

Super-Computing

The term supercomputer is not one-dimensional but rather refers to computers that have powerful calculation capabilities and are considered the leading computers when they are built. While the first supercomputer had processing capability of several kiloFLOPS (Floating point operations per second) powerful computers today reach 34 petaFLOPS (10^{15} X 34 FLOPS). Most of the current super-computers use parallel processing—a large number of cores connected together on a fast network. Most super-computers are designed to solve a single problem by way of a specific calculation. Super-computers are also useful for theoretical calculations needed to develop

nuclear weapons; as a result, the international arena restricts their production and distribution.[83] It is claimed that the next generation of AI will face the supercomputer problem: The digital world multiplies its volume every two years, and to cope with massive amounts of data while performing various tasks and creating a variety of training methods, tremendous computing power is necessary. Super-computing, which is characterized by an extendable architecture and prevents waste, may meet this need for AI and could enable additional leaps in the field.[84]

Quantum Computerization

Some AI systems require processing and computing capabilities that can support automation processes and cope with huge arrays of data.[85] For this purpose, extremely powerful hardware—sometimes beyond that of the existing computer systems—is needed, rendering certain ideas in the field of AI as merely theoretical calculations. Problems that exceed a particular threshold of complexity and size require more powerful computing power to resolve them, and quantum computing was created to cope with these challenges, which cannot be processed by means of classic computing systems.

Quantum computers use the unique phenomena of quantum mechanics, including quantum superposition and entanglement, and create high-level computing abilities.[86] While "classic" computers perform calculations using binary bits, quantum computers use qubits, which exist in multiple states (superposition); that is, it can be both 0 and 1 at the same time, enabling quantum computers an exponential advantage in their computing capabilities.[87] Quantum technologies can create new paradigms in the way information is collected, stored, and processed, and they can offer improved tools for security, computation, and measurement.[88] The quantum computing revolution has not only improved computing, but it also has the potential to "disrupt" all conventional encryption, thereby causing the collapse of the systems currently in use.[89]

Cloud Computing

Cloud computing allows on-demand access from anywhere to a shared pool of computing resources, including networks, servers, storage, applications, and services.[90] These services allow remote computer connected to the network to access resources. Users of cloud computing do not need to acquire and

manage their own resources and systems; instead they rent cloud services, which they can adapt to their needs at a relatively low cost.[91] The types of services include infrastructure as a service (users receive computing resources, such as storage and processing to use), platform (users receive computer resources and tools supported by the provider), and software (instead of purchasing and installing software, the user obtains the provider's software services through a communications network via the provider's website).[92]

Cloud computing can store large amounts of data, which AI systems can access for training or decision making. In addition, the improvement in the capabilities of AI could produce new data to be entered into the cloud, which could help other AI systems learn. In fact, the cloud allows calculation power and capabilities to cope with large arrays of data for AI.[93] The internet infrastructure, however, limits its accessibility, and therefore cloud services cannot be used in every case, because the rate of transfer of information may be partial compared to the needs of the system.

5G—Fifth-Generation Networks

The increasing use of mobile devices and connecting them to the network demand fast data streaming and reliable services that can handle significant traffic on the network. 5G mobile networks should meet this need, considerably expand the bandwidth, and generate a new record high of 20 gigabytes per second for downloading speed, compared to the single gigabyte per second with the 4G networks.[94] 5G networks are expected to allow vendors to extend services provided to consumers (for example, streaming of video or virtual reality applications), to support the growing number of devices connected to networks (e.g., multiple objects in the domain of IoT), to support new industrial uses (such as industrial sensors), to perform advanced data analysis, and to enable the use of advanced technologies such as autonomous vehicles.[95] 5G networks can enable and improve the performance of AI systems by providing the infrastructure for transferring huge amounts of data while AI can reciprocate by understanding the complexity of 5G networks and the information they produce.[96]