



## II. Related fields

In addition to AI, there are several other closely related topics that are good to know at least by name. These include machine learning, data science, and deep learning.

**Machine learning** can be said to be a subfield of AI, which itself is a subfield of **computer science** (such categories are often somewhat imprecise and some parts of machine learning could be equally well or better belong to statistics). Machine learning enables AI solutions that are adaptive. A concise definition can be given as follows:

Key terminology

### Machine learning

Systems that improve their performance in a given task with more and more experience or data.

**Deep learning** is a subfield of machine learning, which itself is a subfield of AI, which itself is a subfield of computer science. We will meet deep learning in some more detail in Chapter 5, but for now let us just note that the “depth” of deep learning refers to the complexity of a mathematical model, and that the increased computing power of modern computers has allowed researchers to increase this complexity to reach levels that appear not only quantitatively but also qualitatively different from before. As you notice, science often involves a number of progressively more special subfields, subfields of subfields, and so on. This enables researchers to zoom into a particular topic so that it is possible to catch up with the ever increasing amount of knowledge accrued over the years, and produce new knowledge on the topic — or sometimes, correct earlier knowledge to be more accurate.

**Data science** is a recent umbrella term (term that covers several subdisciplines) that includes machine learning and statistics, certain aspects of computer science including algorithms, data storage, and web application development. Data science is also a practical discipline that requires understanding of the domain in which it is applied in, for example, business or science: its purpose (what "added value" means), basic assumptions, and constraints. Data science solutions often involve at least a pinch of AI (but usually not as much as one would expect from the headlines).

**Robotics** means building and programming robots so that they can operate in complex, real-world scenarios. In a way, robotics is the ultimate challenge of AI since it requires a combination of virtually all areas of AI. For example:

- Computer vision and speech recognition for sensing the environment
- Natural language processing, information retrieval, and reasoning under uncertainty for processing instructions and predicting consequences of potential actions
- Cognitive modeling and affective computing (systems that respond to expressions of human feelings or that mimic feelings) for interacting and working together with humans

Many of the robotics-related AI problems are best approached by machine learning, which makes machine learning a central branch of AI for robotics.

Note

### What is a robot?

In brief, a robot is a machine comprising sensors (which sense the environment) and actuators (which act on the environment) that can be programmed to perform sequences of actions. People used to science-fictional depictions of robots will usually think of humanoid machines walking with an awkward gait and speaking in a metallic monotone. Most real-world robots currently in use look very different as they are designed according to the application. Most applications would not benefit from the robot having human shape, just like we don't have humanoid robots to do our dishwashing but machines in which we place the dishes to be washed by jets of water.

It may not be obvious at first sight, but any kind of vehicles that have at least some level of autonomy and include sensors and actuators are also counted as robotics. On the other hand, software-based solutions such as a customer service chatbot, even if they are sometimes called “software robots”, aren't counted as (real) robotics.

 **Unanswered**

### Exercise 2: Taxonomy of AI

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### Exercise 3: Examples of tasks

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III. Philosophy of AI

