

Artificial intelligence

Fact sheet for innovation fields

Artificial intelligence: computing like a machine, deciding like a person

- Computers that can recognize images, diagnose diseases and beat grandmasters in chess or world champions in the strategy game Go – the progress made in the field of artificial intelligence over the last five years is huge. And there are many other examples, including autonomous driving, decisions on lending at banks and detection of suspicious objects in the course of whole-body scans at airports. Everywhere, software is making automated decisions on the basis of artificial intelligence. In the machine learning sub-discipline, training data forms the foundation for algorithms to learn the right outcome in line with specifications outlined by humans.
- Artificial intelligence is based on the perception of information, which can originate from sensors, images, language and text. From this information, the software draws its conclusions, learns, adjusts parameters accordingly and generates hypotheses. In the end, it reaches a decision on its own or makes a recommendation that human partners can use to underpin their own actions.
- But even the boundaries of these broad application areas are being broken through in thought experiments, in research and in the shape of prototypes. If machines can already write simple newspaper articles or cooking articles, why not a musical or a rap song? Trials are already underway.
- For the future, milestones in artificial intelligence are expected to be reached at the same rate as in the past. There are two main reasons for this: on the one hand, technological progress and, on the other hand, the fact that the best algorithms are now available to everyone and everyone can improve them.

Deep learning – when machines learn to learn

- The accuracy of automated image recognition, for example, has leaped from about 70% in 2011 to over 95%, putting it on a par with human beings. This tremendous progress is largely due to deep learning methods. Here, complex algorithms are used in multilayered neural nets that learn, on the basis of huge volumes of data in a training phase, which patterns lead to which propositions and can then apply these new findings to new images. Two of the reasons this works so well are that computing speed continues to evolve exponentially and that GPUs are being used increasingly, i.e. computer chips whose strength lies in the simultaneity of mathematical operations and which are therefore highly suited to deep learning tasks. We must not overlook the fact that large amounts of training data must be available; computers simply need far more input than people in order to recognize similar patterns. Machines are still inferior to people in this respect but research into more efficient algorithms is in full swing.

An optimal field for open innovation

- Another factor accelerating the use of artificial intelligence is that large IT and Internet companies, mostly on the West Coast of the United States, and academia are sharing their knowledge more and more openly. For years now, these major players have been putting a lot of venture capital into young, innovative companies while investing in their own research at the same time. The global community can consequently pick up suggestions from another part of the globe very quickly and can increasingly access distributed systems to draw upon previously unused computing resources for artificial intelligence operations.
- Ever more artificial intelligence labs are being set up in parallel to this – frequently under the control of renowned scientists and academics. In addition to their own ambitions and inventive spirit, they take their duty to educate very seriously and, for example, offer online courses on deep learning and on artificial intelligence systems. In this way, they enable many start-up companies and young researchers to learn the basics of artificial intelligence quickly and to develop their own applications within a very short time.

Hype or trend? What does artificial intelligence mean for Siemens?

- Siemens has always been a pioneer when it comes to developing the right technologies. And that is still the case today when it comes to seizing the opportunities offered by digital trends for industrial application areas and turning them into concrete products. There are two outstanding areas as far as artificial intelligence is concerned:
 - Complex image recognition as used, above all, in interpreting the results of computed tomography (CT) and magnetic resonance imaging (MRI)
 - Autonomously learning, self-optimizing industrial systems such as for gas turbines and wind farms, or accurate forecasts of, for example, copper prices and expected grid capacity utilization.
- In addition, intensive work is being carried out on physical, autonomous systems for use in collaborative, adaptive, flexible manufacturing as part of Industrie 4.0.
- However, the rapid progress made in the recent past raises some questions for Siemens. Where can image recognition systems add value, for instance in quality assurance, in object recognition for autonomous trains and in augmented reality in the context of service scenarios? How will robots capable of flexible decision making interact with humans in production plants? Will people be able to talk to a gas turbine or a traffic control center in the future? Will these systems be able to make proactive suggestions or give intelligent warnings based on what they have learned independently from their interaction with people?
- We know we cannot answer many of these questions on our own but only in the course of an open exchange with creative partners. By setting up next47, we are creating the right framework.