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How Artificial Intelligence is  
Transforming our World

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Aachen, Germany

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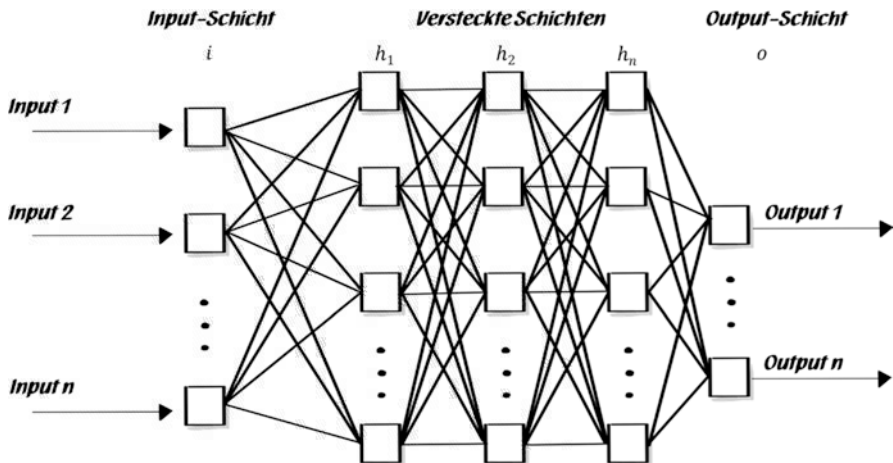
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# Preface

During my studies 50 years ago, I had already learned something about *neural* networks. At that time, it was a very exciting discovery for me to be able to reproduce the basic functions of a nerve cell of a living being using a computer program. Such a neural network is shown in simplified form in Fig. 1. It contains many parallel inputs, all of which act on a first hidden layer. This layer consists of nodes and each node receives information from all the available inputs.



**Fig. 1** Representation of the structure of a neural network ([https://en.wikipedia.org/wiki/Artificial\\_neural\\_network](https://en.wikipedia.org/wiki/Artificial_neural_network), accessed in April 2020)

Each node processes and weighs this information, passing it on to every node in the following layer. In the end, you end up at an output layer.

This output layer is now ready to be used as an additional input layer. Through these feedback loops, the neuronal network learns from its own results.

These networks of nodes were mirrored by the structures of the nerve cells I had learned about as a student. Each individual node is structured like a nerve cell (Fig. 2).

I remember being impressed by the incredible diversity and ability of nature to deal with information. Every piece of external information is processed with different weightings in each nerve cell and leads to a message, the so-called activation function, which is then forwarded to all nodes of the next layer.

50 years ago, it was clear to us that this was a pretty clever construction with a lot of potential for application. Some renowned scientists predicted a great future for advances following this theoretical framework. However, this proved to be wrong in the following decades. The time had not yet come. It was far too complex technically and therefore seemed unlikely to have any significant effect on ongoing technical development, at least for the foreseeable future.

The reality turned out to be different.

Back then, it gained respect for nature's enormous achievement and its wasteful effort. I learned that the hamstring reflex of the frog's leg alone

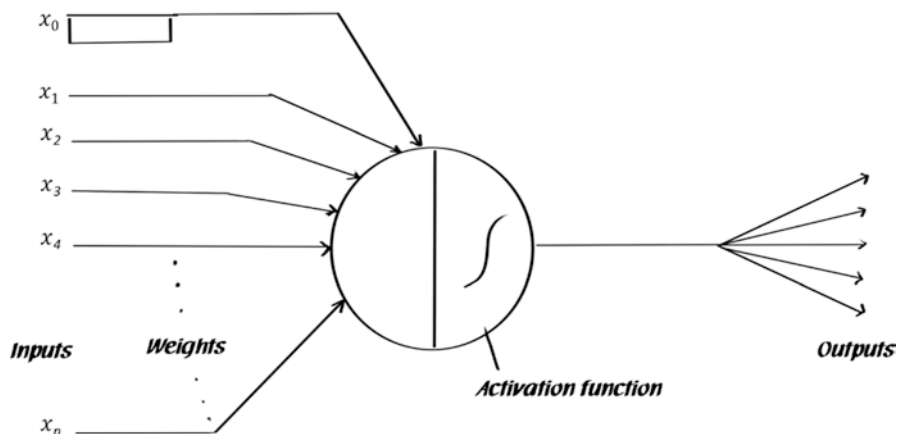


Fig. 2 Structure of the replica of a nerve cell ([https://en.wikipedia.org/wiki/Artificial\\_neural\\_network](https://en.wikipedia.org/wiki/Artificial_neural_network), accessed in April 2020)

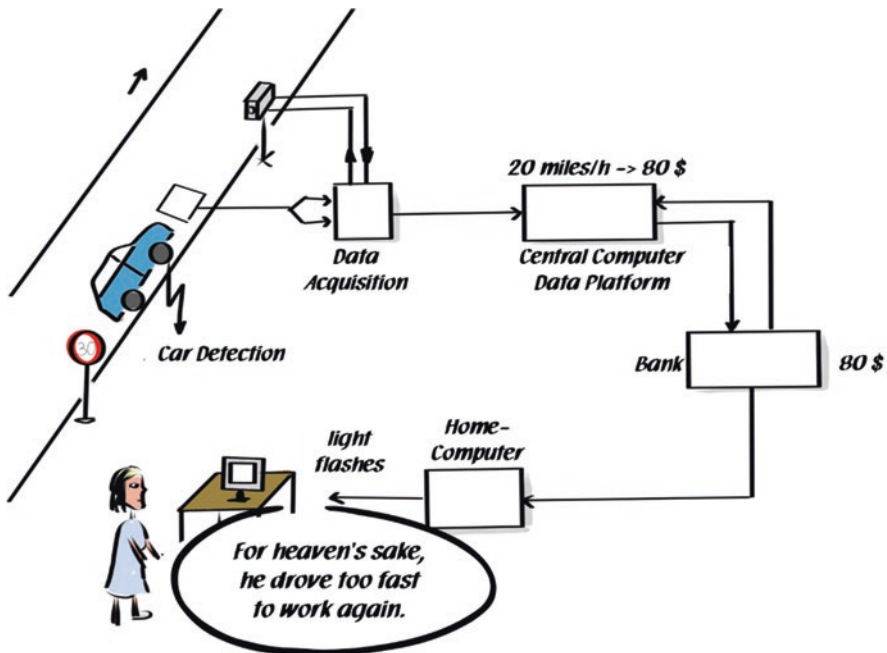
contains over a dozen highly complex parallel control loops, each full of neuronal pathways consisting of countless layers of neuronal networks.

I came to the following conclusion: With technology, we can make things easier. You don't have to make it so complicated to just stabilize the hamstring reflex in a frog's leg.

Again, reality turned out to be different.

Of course, in my cybernetics lectures 40 years ago, I often told my students about all manner of possibilities. For example, I recently found this sketch in my records, detailing a possibility for the automatic settlement of traffic fines (Fig. 3).

I was of the opinion at the time that this would come very quickly. And although it has been technically feasible for 40 years, to my knowledge there is still no system in which direct deposits of fines are coupled with the devices in one's own home. This would allow all family members to have complete transparency and to get notified immediately which family member drove too fast where.



**Fig. 3** The automatic fine machine, a vision from 1985 [Henning, Klaus: Kybernetische Verfahren der Ingenieurwissenschaften (Cybernetic Procedures in Engineering Sciences). Mainz, Aachen 1986]

But enough about the past. Artificial intelligence today is a powerful tool whose basic mathematical construction has existed for two generations. Only now does it lead to dramatic changes in the reality of our lives and work.

The continuing increase in computer capacity has made it possible to exchange and process almost unlimited amounts of data worldwide. At the same time, the computers are getting smaller and smaller and here too the end is not yet in sight.

On the other hand, there is always the phenomenon that technical developments are possible but do not prevail and spread. In this respect, any prediction as to when which form of artificial intelligence will penetrate which part of our lives has an enormous degree of uncertainty.

Here is what we can say based on the development so far: When artificial intelligence systems spread, they do so extremely quickly and worldwide. We can observe that in several areas. But when artificial intelligence has to do with the real things of this world, it often takes much longer than expected.

With these preliminary remarks, I now invite you to begin a journey with me. In addition to theoretical facts, I have also written down my personal experiences and assessments in this non-fiction book. The positive attitude towards digital transformation with artificial intelligence corresponds to my conviction. A great deal is written and discussed about the negative and risky aspects. That is why we will not deepen these aspects but focus on the opportunities. On this journey, we will see how this world has been and will be changed by the gamechanger artificial intelligence. The challenge of the coming decades will be to ensure that this change succeeds for the good of mankind.

Aachen, Germany  
May 2020

Klaus Henning



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# 1

## It's All About Us

### Contents

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Welcome to an excursion into the age of digital transformation and the gamechanger artificial intelligence (AI).

I sit in the middle of a snowstorm in a cozy chalet in the Swiss mountains and look banned at my birdhouse, which I have just filled with fresh food. The thermometer is showing 10 degrees Fahrenheit. However, it doesn't take 10 min for the first bird to fly in and discover the food. It then takes another 10 min until about 20 more birds fly around the feeding all at once.

Suddenly, it shoots through my head: How would 20 small drones, equipped with systems of strong artificial intelligence,<sup>1</sup> try to get the food from the feeder without human intervention? I observe the speed and agility of the birds, their seemingly chaotic strategy of approaching the feeder, and come to the following conclusion:

By the time we have reached the point where all 20 drone systems will empty the feeder, collision-free, in a very small space, without external input, and with the same speed and agility as these birds, it will take quite a while, certainly more than a generation.

As long as these kinds of interactions “only” take place in virtual spaces (like the internet), making them work is still relatively simple. But when it

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<sup>1</sup>[https://en.wikipedia.org/wiki/Strong\\_AI](https://en.wikipedia.org/wiki/Strong_AI), accessed in April 2020.

comes to introducing artificial intelligence systems into “physical reality,” it becomes arduous. The “last mile” to realize complex AI support for mechanical systems is especially difficult and tedious.

Until AI systems in such devices as drones have the intelligence, agility, speed, and dexterity of these birds, a lot of work in research and development is still required.

But the world is working on it. For example, a major aircraft manufacturer is in the process of designing a parcel center equipped to handle 10,000 shipments per day. All shipments are to be carried by drones. This would require about five take-offs and landings per minute. The coordination problem is gigantic from a software design perspective—not even considering that the “small side problem” of loading drones with fully automatic AI-controlled transport robots in such a confined space is not yet solved.

And then there is the problem of air traffic control when so many drones are buzzing through the airspace. Already, a Silicon Valley group of companies is trying to simulate how such an AI-controlled system might work.

My message to the reader is twofold:

**If one goes into detail, the implementation of artificial intelligence systems (AI systems) is extremely difficult and laborious. If it succeeds, however, there will be radical breakthroughs across worldwide applications in an extremely short time.**

Rapid dissemination will be accelerated, when usefulness is proven, and people waive all privacy concerns because of the benefits they receive. You might raise an eyebrow at this but surely, you usually check off those ubiquitous Terms of Use disclaimers very quickly without reading them, don't you?

## AI Is a Gamechanger

When technologies “surprisingly” find a mass application in a very short time and processes, habits, learning processes, and order systems are turned upside down, we speak of a so-called disruptive innovation—a gamechanger.

It is often assumed that disruptive innovations are a new phenomenon only when they occur in connection with the internet, digital transformation, and artificial intelligence.

Yes, the digital transformation of our lives is a dramatic transformation. But is such a revolution so unique in the history of mankind?

Let's travel back in time together.

Around 1750, the first industrial revolution began with the invention of the steam engine, i.e. the systematic use of water and steam power. This became the basis of mechanical production.

The next milestone came at the beginning of the nineteenth century through electrical energy. This allowed energy to be transported to any location. This structure laid the foundation for mass production and division of labor. At the beginning, in a period of only 10 years from 1903 to 1913, this enabled the change from horse-drawn carriage mass transport to car mass transport. In the beginning, the first drivers were fined because they had exceeded the speed limit intended for horse-drawn carriages.

Another 70 years later, the digital revolution began, initially “only” related to computer technology and communication technology.

Only today do we feel the full extent of this digital revolution, because it covers the information revolution, in which everything is connected with everything and the world begins to grow together into one huge “brain.” Autonomous systems and systems of autonomous systems are growing across a worldwide network, in both factories and administrations. And here's the bottom line: What seemed 50 years ago as a strange dream of computer science can suddenly be realized<sup>2</sup>.

**Machines and systems have—at least at a low level—their own consciousness and can independently determine for goals and solutions that nobody has taught them before.**

The special thing about it is that the objects of this world are linked with each other as in the “Internet of Things” (IoT), all around the globe.

Today, there are already vehicles with the so-called autopilots, in which the experiences of the vehicles with road courses and curves are exchanged overnight among all vehicles of this class all over the world. They are already learning valuable lessons from each other through a worldwide network. With the enhanced interconnectivity provided by 5G technology and the power of future quantum computers, these exchanges will be possible in a few minutes.<sup>3</sup>

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<sup>2</sup> For more information on the concept of consciousness see Chap. 4.

<sup>3</sup> Sabina Jeschke: 3 Shades of AI – 5G and Quantum Computing setting the stage for next generation AI. Keynote Wirtschaftspolitik aus erster Hand at Leibniz-Zentrum für Europäische Wirtschaftsforschung (ZEW) (Feb. fifth, 2020), Mannheim. [http://www.sabina-jeschke.de/Talks/2020/2020-02-05\\_ZEW\\_talk.pdf](http://www.sabina-jeschke.de/Talks/2020/2020-02-05_ZEW_talk.pdf), accessed in April 2020.