Algorithms – Definition of algorithm and algorithmic system

Many people are familiar with algorithms, especially in mathematics and logic. But we also constantly encounter algorithms in everyday life. An algorithm is simply a procedure that helps solve a particular problem. The procedure that precisely describes the sequence of actions for brushing one's teeth solves the problem of "dirty teeth," for example. An algorithm always receives input at the beginning. In our example, the input would include one's own toothbrush and a tube of toothpaste. Frequently, certain conditions must be met for the algorithm to start at all: For example, people who want to brush their teeth must have teeth. When the conditions have been met and the input has been received, the algorithm starts with the first established rule. Every algorithm ends with output, thus a result. In this example, the output can be either brushed teeth or unbrushed teeth. Every algorithm has the following properties:

- **General validity:**
  The algorithm solves a large number of identical problems within a class of problems or tasks.
  For instance, in the case of brushing one's teeth, the procedure is valid not only for a particular person, but for any person who wants to brush their teeth.
- **Repeatability:**
  If the same conditions are ensured, an algorithm always delivers the same result. In other words, the same input always leads to the same output. So, if someone wants to brush their teeth and follows the procedure, the result is always the same at the end.
- **Definiteness:**
  At every point of the algorithm, the subsequent step is always clearly defined. Accordingly, it is not possible to change the sequence of the steps, thus preventing misunderstandings. In the case of our example, this sequence means that it is not possible to apply the toothpaste to the toothbrush before opening the tube of toothpaste.
- **Finiteness:**
  The algorithm consists of a finite number of steps and always terminates.
  People who have decided to brush their teeth following the algorithm will always come to an end and thus to the result of brushed teeth. In other words, they do not have to keep brushing their teeth forever.
- **Executability:**
  The instructions must be formulated such that they are understandable and executable.
  For instance, if the algorithm were to include the step to do a handstand and then to brush one's teeth while in a handstand, the algorithm could not be performed.

We often associate computers and the Internet with algorithms. We make this association because we encounter algorithms on the Internet, such as when we use search engines or when an application outputs the fastest route from home to the movie theater. The procedures are translated into programming language and integrated into software; they are used in this form in numerous digital applications. Multiple algorithms operating in software are then referred to as algorithmic systems. These systems must also meet the conditions listed above. They usually have a much more complex design than is the case with the algorithm in our example of brushing teeth. Algorithmic systems can process large volumes of data. (The "Big data" media package on the Siemens Stiftung Media Portal contains many media on this topic.)

Algorithmic systems can be divided into nonlearning and learning systems. In the media and in everyday life, we frequently refer to learning systems as artificial intelligence (the “Artificial intelligence” media package on this topic is available on the Media Portal). These systems work with data that people specify at the beginning. The systems recognize patterns in these data and develop algorithms that they adapt again and again.
Thus, we constantly encounter algorithms in the sense of procedures. If these algorithms are to meet the aforementioned criteria, they often become quite extensive and contain many rules and steps.