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## Introduction

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The imagination of machines replacing human teachers – maybe not as a whole but at least part-wise – has inspired philosophers educational and computer scientists for many decades. One of the first steps was Skinner’s and Pressey’s teaching machines – at that time purely mechanical instructional devices [78, 79, 92, 93]. Since then the desire accrued to create machines that are capable of empathizing with human beings. Empathy is what empowers a teacher to adopt the perspective of a student. Perspective adoption is the key ability that we need to explain things and to create individual instructions and recommendations.

In the case of human beings, Jean Piaget gave us a detailed description of the development of this particular skill. He observed children aged between three and 6 years developing the ability of adopting another person’s perspective. From him, we know that the prerequisite that constitutes this ability is what we call self-consciousness, which means being conscious of oneself in contrast to others and the environment. We can adopt another one’s perspective only if we are aware of our own point of view and the difference to the other ones.

In the field of learning and teaching we have contented ourselves with a concept that appears to be less ambitious than the one we call “consciousness”. We rather use the term “adaptivity” to describe a machine’s capability of adapting itself to the learner’s individual needs. How can we create adaptive machines and algorithms, respectively? Indeed, there is an elegant way to give a universal answer. Alan Turing has bequeathed us the Turing machine – until today the strongest model of a universal state-based machine. If we can make a statement about the Turing machine this is also valid for any kind of machine we know – no matter what technology it is based on.

Turing’s universal machine receives input from outside and transfers it into a particular internal state. Moreover, the Turing machine can output information that it may read again as its input. This way, the Turing machine may feed itself with changes of its internal state. In other words: The Turing

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machine has the capacity of self-back coupling. Indeed, this self-back coupling is the only mechanism we can facilitate to create adaptivity in machines. Consequently, if we intend to create adaptive learning environments, they have to be designed as elaborated in the following. The inner state of the system must comprise a knowledge representation of both the learning content and the student. Driven by outer events – for example certain actions and behaviors of the student – the knowledge representation is modified which equates to the transition to another internal state.

The system feeds itself now with a representation of this new internal state, inferring on it and generating the respective instructions and recommendations for the learner. This process is repeated cyclically with each modification of the knowledge base.

The INTUITEL research project – an acronym for “Intelligent Tutoring Interface for technology Enhanced Learning” aimed to develop a general design for such an adaptive system. In the first place, INTUITEL is a design pattern. In the second place, the research team also developed a prototype system to prove the functionality of the design. The aforementioned knowledge representation is based on ontologies. With these ontologies pedagogical and didactic knowledge of both the learning content and the learner is modeled. Outer events are triggered by the learner’s actions and the periphery of the system. These events form the input that results in a modification of the inner state – more precisely the ontologies modeling the knowledge about the learner and the learning content. A reasoning unit acts as the transfer unit by inferring on the just modified ontologies and generating according learning recommendations for the learner. This adaption is performed cyclically with every change of the knowledge base.

These are the fundamental principles of the INTUITEL concept which we will discuss in this book. Not only will the reader become familiar with the theoretical foundations. We also give an instruction on how to build your own INTUITEL system.