Chapter XI

Mathematics in Virtual Knowledge Spaces: User Adaptation by Intelligent Assistants

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Abstract

The workplace of scientists and engineers is about to change: even though numerical software and computer algebra systems remove the burden of routine calculation, it becomes more important than ever to get familiar with new concepts and methods quickly. Given the rapid growth of knowledge in today’s sciences, traditional “learning on supply” (i.e., defining the learning goal as the accumulation of knowledge) is no longer applicable; instead, adequate learning and teaching methods have to be established to guide learners towards efficient self-controlled learning.
Traditional methods of teaching can only satisfy this demand partially: lectures provide elementary base knowledge, but do not encourage active independent deliberation in the matter. Classical hands-on training in laboratories on the other hand requires additional human resources and is often constrained by the financial possibilities of the involved institutions.

We do not aim to replace the mentioned classical forms of teaching; rather, we want to show how the application of New Media and New Technology presents a turning point in the educational system by providing tools that close the gap between passive document retrieval systems on the one hand and practical courses in laboratories on the other hand.

The value added by the New Technology is the ability to enrich traditional methods of education—teacher centered teaching, literature research, homework training, and laboratory experiments—by some limited form of “intelligence” and by suitable interfaces to allow closer integration of these areas to improve the learning process. Thus, tools are proposed that are not only able to adapt to the learning process of the student, but are also smart enough to point towards additional background information and thus actively support the learner beyond what has been possible before.

Four areas of the application of New Media are presented: the presentation of mathematical content, intelligent lexicon toolkits that are able to learn from natural language texts, homework training courses that are able to break up assignments into elementary subproblems as needed by the learner, and Virtual Laboratories that are able to provide courses that adapt to the errors of the learner, but are still rich enough to be used in research problems.

Introduction: Why Intelligent Assistants?

Mathematics is the key technology of the 21st century: besides being a research field of its own, it is the key ingredient for studies in engineering sciences, physics, computer science and many other fields. Teaching mathematics therefore means teaching a very broad, heterogeneous audience with varying fields of interest; teaching at the Berlin University of Technology in particular means having to handle increasing student numbers with decreasing funding. Luckily, mathematics is a highly structured field using a very precise, formalized language. Its internal structure is built on well-developed entities, for example, fields, vector spaces, linear mappings,
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