Using Computeralgebra for Rapid Development of ITS Components in Engineering

Burkhard Alpers

Aalen University of Technology and Business,
Department of Mechanical Engineering, D-73428 Aalen, Germany
balper@fh-aalen.de

Implementing an Intelligent Tutoring System (ITS) is a costly and time-consuming activity requiring qualifications from many fields like Artificial Intelligence, Instructional Theory, and application expert knowledge. Therefore, ITS are rare and often rather test systems in academic research than wide-spread tools in practical use.

We show how computer algebra systems (CAS) like Maple (TM) or Mathematica (TM) can be used to reduce the development effort for parts of an ITS in engineering considerably. The built-in intelligence of CAS wrt. symbolic computation is exploited for implementing parts of the expert module and diagnostic capabilities for certain assignment types in engineering. This way, a tutored assignment environment can be easily written. As opposed to other approaches which implement so-called "intelligent CAS" with explanatory components from scratch (cf. [Nisheva]), we use an existing CAS and enhance it didactically by implementing tutorial procedures.

Note that we do not claim to provide a "full-fledged" ITS including a student model. Since our learning material is not the only offering but just one part of the overall curriculum (including lectures), this restriction is not problematic. It is the main advantage of our approach, that a tutoring environment for periods of self-study can be implemented with low effort by an instructor in engineering, i.e. by the person who is responsible for making students use it. In order to facilitate this, we set up a sequence of guidelines on how to proceed when writing tutored assignment worksheets for certain classes of engineering problems (cf. [Alpers] for examples on stress analysis) and we implemented generic diagnostic procedures for one of the most frequently occurring underlying mathematical models, i.e. linear systems. These procedures can be used to find faults in linear systems of equations like missing or wrong equations which, for example, occur when students set up equations for equilibrium conditions in mechanics. Moreover, they also give information on certain kinds of errors like wrong symbols, sign errors, wrong terms, or missing terms which (according to [Gertner]) show up frequently. Future work will provide more generic procedures in order to further facilitate the implementation work of an instructor.

Alpers, B.: *Combining hypertext and computer algebra to interconnect engineering subjects and mathematics*, Proc. of the 4th Int. Conference on Technology in Math. Teaching, Plymouth 1999

Gertner, A.S.: *Providing feedback to equation entries in an intelligent tutoring system for Physics*, in: Goettl, B.P. et al..: Intelligent Tutoring Systems, Proc. of 4th Int. Conf. ITS '98, Springer, Berlin 1998 (=LNCS 1452), pp. 254-263

Nisheva-Pavlova, M.M.: *An Intelligent Computer Algebra System and its Applicability in Mathematics Education*, The International Journal of Computer Algebra in Mathematics Education, Vol. 6, No.1, 1999, pp. 3-16