JADE: Implementation and Visualization of a BDD Package in JAVA

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Abstract

Decision Diagrams (DDs) are often used in VLSI CAD systems for efficient representation and manipulation of Boolean functions. The most popular data structure *are reduced ordered Binary Decision Diagrams* (BDDs) [Bry86,DB98], also called ROBDDs. They are part of almost all courses on function representation in VLSI CAD education. BDDs are very sensitive to the variable ordering, i.e. the size of a BDD (measured in the number of nodes) may vary from linear to exponential. Finding the optimal variable ordering is an NP-hard problem and the best known algorithm has runtime exponential in the number of variables. This is the reason why many authors presented heuristics for finding good variable orderings from circuit descriptions in the last few years. The most promising methods for BDD minimization are based on dynamic variable ordering.
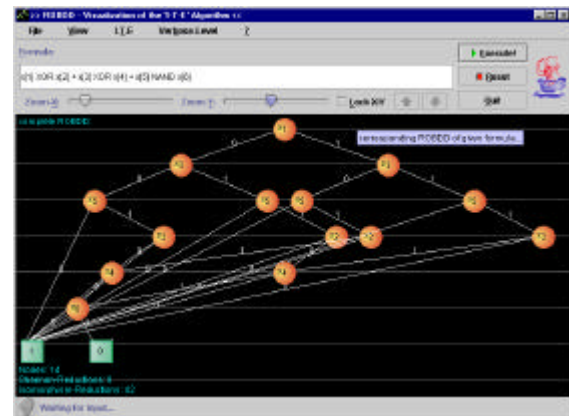
We describe the JAVA implementation of the BDD package JADE (=*JA*VA *DE*cision diagram package). The BDD package has an interactive interface that allows to display the construction and minimization process and by this gives further insight in the data structure. Almost every formula can be entered and immediately translated into a corresponding BDD. Users can easily change the global variable ordering in a given BDD simply by selecting a certain variable with the mouse and exchange its position with adjacent variables. The effects on the BDD can be seen immediately. This allows the user to manually optimize the BDD if the automatic minimization algorithm returns unsatisfying results. The view area can also be changed using the mouse in order to zoom into very large structures. New minimization algorithms can easily be evaluated and their performance can be analyzed. The tool can be directly applied in on-line learning and tele-education. The user gets "hands-on" experience while working with the software.

GUI - Graphical User Interface

The visualization of BDDs is an important topic, since this gives some feedback how well the minimization techniques, like sifting, are doing. For this, most BDD packages presented so far have an output option to display the graph already build. But none of them allow any user interaction or visualization of the BDD manipulation, i.e. minimization and graph construction.

The key advantage of this BDD package implementation is the ability to change the global variable ordering. This can be achieved in different ways. Another important improvement is the visualization during automatic minimization using sifting heuristic and during BDD construction.

In the following we briefly mention some features of the *Graphical User Interface* (GUI) of our JAVA based BDD package (see figure below and [DR02] for more details): trace mode, automatic minimization, setting the variable ordering, interactively changing variable ordering, verbose mode, simple input format, resizing the BDD, swap high/low edges, and keeping of configuration.

Acknowledgment

References

[Bry86] R.E. Bryant. Graph - based algorithms for Boolean function manipulation. *IEEE Trans. on Comp*., 35(8):677-691, 1986.

[DB98] R. Drechsler and B. Becker. *Binary Decision Diagrams - Theory and Implementation*. Kluwer Academic Publishers, 1998.

[DR02] R. Drechsler and J. Römmler. Implementation and Visualization of a BDD Package in JAVA, GI/ITG/GMM Workshop "Methoden und Beschreibungssprachen zur Modellierung und Verifikation von Schaltungen und Systemen", 2002.