Chapter 7

CONCLUSIONS

An attempt is made to design a new efficient algorithm to compute the prime implicants of a formula. This dissertation reports theoretical arguments and experimental results of the proposed algorithm. Chapter 3 reports the theoretical basis of the algorithm. The implementation details as well as experimental results are presented in Chapter 4. The advantage of the algorithm being suitable for the incremental computation of prime implicants is explored. The proposed algorithm is suitable for parallel computation of prime implicants. The parallel algorithm is given in Chapter 5. Though the prime implicants are of great importance in AI applications, its application in computer vision, for the problem of shape from silhouettes is presented in Chapter 6. A detailed summary of these achievements is presented in this chapter. The limitations and further research plans are also summarized.

Summary

In this dissertation, a study of the relevance of prime implicants in the context of RMS and hypothetical reasoning is carried out. Hence a brief review on RMS and algorithms to compute the prime implicants of a formula is reported. Realizing the need of prime implicants in different areas of AI, and the drawbacks of the existing methods to compute the prime implicants of a formula, a new algorithm is designed. In Chapter 2, the matrix representation of a formula, and the concept of path in a matrix are presented. The drawbacks of three well-known algorithms are also explained using examples.

In Chapter 3, a special scheme to partition a matrix is proposed, and it is theoretically
established that the prime paths of a formula can be obtained by the concatenation of prime paths of subformulæ. The new algorithm based on this concept uses a tree-structure for representation of a formula as well as it’s prime paths. Hence the system is called a Tree-structured Reason Maintenance System.

The implementation details as well as experimental results are presented in Chapter 4. Experiments were performed to compare the number of subsumptions required, the execution time taken, and the number of paths generated by the algorithms (Socher’s algorithm and PIAP). Since subsumption check is the crucial part in any prime implicants algorithm, the number of subsumptions required by both the algorithms are computed and compared. It is observed that the proposed algorithm, PIAP requires considerably less number of subsumption operations compared to that of Socher’s algorithm. Though the execution time is machine dependent, the results obtained substantiate the fact that execution time for PIAP is much less compared to that of Socher’s algorithm. The number of subsumptions as well as the execution time depends on the paths generated by the algorithms. Hence, the number of paths generated by both the algorithms are also compared. In this comparison, PIAP is found to generate fewer paths. Thus, all three aspects of the experimental results affirm that the proposed algorithm is better than the Socher’s algorithm.

The implementation is shown to be suitable for a complete RMS. Hence, certain aspects of RMS are shown in terms of updating the knowledge-base and compiling the knowledge-base in incremental mode. The proposed method is well suited for incremental computation of prime implicants. Apart from being efficient in sequential mode, PIAP is parallelizable since the algorithm hinges on divide-and-conquer paradigm. Three different levels of granularities—coarse-grain, medium-grain and fine-grain are explored and a hybrid architecture suitable for the parallel algorithm PARPIAP is proposed.

Finally, an application of prime implicants is shown in the context of shape from
silhouettes. The problem of shape from silhouettes is rephrased as a problem of computing prime implicants of a formula obtained from different silhouettes of an object. It is shown that all possible minimal reconstructions of the 3D object can be obtained from the prime implicants of this formula.

Shortcomings

Though the present study proposes a design of tree-structured RMS based on a very efficient algorithm for prime implicants, the implementation of RMS is not done completely as it is not appended to a problem-solver. The computational experiments were restricted to the prime implicants algorithm. However, the same conclusion can be derived for RMS also. The proposal for parallel algorithm for prime implicants is not implemented.

The areas in which RMS has been used include qualitative process theory [de Kleer 80a], circuit analysis [de Kleer 87], analog circuit design [de Kleef 80], temporal reasoning [Williams 86] and vision [Herman 86], deductive databases [Ku 94], to name a few. Different ways in which a RMS can be used in the process of solving constraint satisfaction problem are discussed in [Bodington 88]. The ATMS is used in conjunction with forward checking algorithms to reduce search in a constraint satisfaction problem [Smith 88]. Though there are many areas in which the proposed algorithm can be used, its use in only one particular problem in the area of Computer vision is demonstrated.

Future work

More study on RMS can be carried out and a full-fledged RMS can be designed. Parallel implementation of RMS can also be carried out as a future work. The application of the proposed algorithm in different areas such as qualitative process theory, circuit analysis, analog circuit design, temporal reasoning, vision, deductive databases, constraint satisfaction problem, etc. can be investigated.
Finally, not withstanding the existing shortcomings, the proposed system is an efficient and elegant RMS, based on a new algorithm to compute the prime implicants. The algorithm is established both theoretically and experimentally to be better than the presently known algorithm for the same problem. This can be utilized by the researchers of knowledge based systems in several techniques of nonmonotonic reasoning such as hypothetical reasoning, and ATMS.