

CSCE 976, Spring 2002
Lecture Notes for 03/11/2002
Second lecture on Golumbic's paper on Temporal Reasoning
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Paper: "Reasoning About Time," Martin Ch. Golumbic. *Mathematical Aspects of Artificial Intelligence, Proc. Symp. On Applied Math.*, Vol 55, pages 19—53, 1998.

Golumbic notices from Allen's A_{13} that there are $2^{13} - 1$ combinations of possible temporal relations.

Villain & Kautz already proved that satisfiability in A_{13} is NP-complete. They also show that satisfiability in P_3 (point algebra with 3 relations) can be done in $O(n^3)$, and is thus tractable.

Golumbic then defines A_3 algebra (consisting of the relations: before, after and overlap) and proves that satisfiability for this restricted algebra remains NP-complete.

He identifies the following four important computational problems on interval algebra:

I Satisfiability Problem (ISAT)

II Minimal Labeling Problem (MLP)

Where every value in every 'vector' is present in at least one solution, in other words, if one removes one value, one solution is eliminated.

III All Consistent Solutions Problem (ACSP)

Tries to represent all the solutions in a structure such that:

1. the size of the structure is polynomial,
2. the time to build the structure is polynomial.

IV Endpoint Sequence Problems (ESP)

Which enumerates all distinct interval realizations that are consistent with the given data.

Kautz and Villain proved that MLP is NP-complete for A_{13} and that the path consistency algorithm is incomplete for MLP.

Golumbic shows that the above four problems are likely intractable (i.e., they are NP-complete or NP-hard) also for other algebras, such as A_3, A_6, A_7, A_{13} .

Golumbic simplifies A_{13} algebra in two different ways:

- Keeps intervals as intervals, and takes subsets of relations, yielding A_3, A_6, A_7
- Relaxes intervals, and uses time points, yielding P_3

Furthermore, he simplifies $A_3 \{<, >, \cap\}$ by taking away the combination \diamond (disjunction), thus making satisfiability linear.

Chapters 4 and 5 were briefly discussed as they deal with temporal logic and autonomous agents.

Student Questions and Comments:

- Rob finds the paper somewhat confusing
- Praveen points out that in the construction site problem, a construction site could be a variable, not just an interval, thereby allowing for a more direct CSP approach.
- Shabbir points to page 10, example 7 and asks how did Golumbic come up with that intersection? The answer is that it is canonical, and it seems to be a conjunction of interval intersections.
- Shabbir also likes the application of the theory to practice, since most of the work being done on temporal reasoning has so far been theoretical.
- Xu Lin is disappointed that there is no future work section, and wonders about application of iterative repair strategies in temporal reasoning.
- Corey adds that he likes the simplification of the original A_{13} algebra into A_3 and others.
- Dan thinks that Golumbic could be more descriptive with problems such as archeology, and bathroom problems (there is no representation given, and no solution).
- Amy is also disappointed that there is no answer to the boy-girl problem discussed in the text.