Evaluating Consistency Algorithms for Temporal Metric Constraints

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Focus: Networks of temporal metric constraints

Task: Evaluating the performance of algorithms for
- Determining the consistency of the Simple Temporal Problem (STP).
- Finding the minimal network of the Temporal Constraint Satisfaction Problem (TCSP).

Future: Enhance triangulation-based algorithms with incrementality.

Temporal constraint network: a graph G = (V, E, l), where
- V: set of vertices representing time points
- E: set of directed edges representing constraints between two time points i & j
- l: set of constraint labels for the edges. A label is a set of intervals and an interval [a, b] denotes a constraint of bounded differences [a, b]

Single Temporal Problem (STP)
- Temporal Consistency (TCONS)
- Consistency Checks for selected STP solvers

Directional Path Consistency (DPC)
- A unique global constraint:
- Constraint density
- Does not affect number of nodes visited in BT

O- STP results in the minimal network &

Improving the performance of BT-STP:
- A new algorithm for filtering STP
- Removes inconsistent intervals from the domain of the variables of the meta-STP to reduce the size of the meta-STP.
- In a pre-processing step (implemented)
- In a look-ahead strategy (to be tested)

Properties & advantages of dSTP
- dSTP considers the temporal graph as composed of triangles instead of edges
- A finer version of PPC
- Cheaper than PPC all-pairs shortest paths
- Incremental version of Belman-Ford (incBF)

Algortihms for the STP

Determining consistency
- Directional Path Consistency (DPC)
- Belman-Ford (BP), single-source shortest paths
- Incremental version of Belman-Ford (incBF)

Determine consistency & finding minimal network
- Floyd-Warshall (FW), all-pairs shortest paths
- Partial Path Consistency (PPC)
- APT: an improvement of PPC

Properties
- Single Temporal Problem (STP)
- Temporal Consistency (TCONS)
- Consistency Checks for selected STP solvers

Determining the consistency of the Simple Temporal Problem (STP)
- It is effective, especially under high density.

Determining the consistency & finding minimal network

Determining the consistency & finding minimal network

Temporal constraints

Improving the performance of BT-STP

Experiments

Random generators of STP & TCSP:
- Generation of data:
  1. Number of time points of the STP
  2. Constraint density
  3. Number of intervals per edge
- Percentage of problems guaranteed consistent
- Note that size of meta-STP is exponential in the number of time points

Results of Empirical Evaluations

For STP: STP outperforms all others
For TCSP:
- incBF outperforms STP
- EdgeOrd & NewCyc always beneficial

References

Dechter, Meiri, & Pearl. Temporal Constraint Networks. AIJ 91.