Paper Summary
Dechter *et al.*, 1991
"Temporal constraint networks"

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The paper presents a formalism (TCSP) that enables representation of time constraints between activities or events so that they can be effectively solved. The formalism is based on CSPs (Constraint Satisfaction Problems) and uses variables to represent the actual time of an event, unary constraints on the variables representing the possible time interval when an event may occur, and binary constraints representing time dependencies between events. A possible simplification of the formalism can be done by removing all unary constraints, and turning them into a binary constraint with respect to a variable that contains the time of the "beginning of the world." The paper presents also a restricted version of the problem: Simple Temporal problem (STP), in which each binary constraint between two variables contains only one time interval.

The original, formalism presented (TCSP) is related to other formalisms for temporal reasoning like Allen's interval algebra and Villains and Kautz's point algebra.

The paper discusses several methods that can be used to solve the TCSPs. The most restricted version of TCSP – STP can be solved either using simplex method (exponential; all constraints can be formulated as a set of inequalities) or it can be recast as a graph problem (by creating a distance graph), which can be then solved using shortest paths algorithms. (The shortest distance between any node and node X_0, representing the "beginning of the world.")

Other methods presented in the paper relate to the general version of the problem, which is NP-hard. The first method divides a TCSP problem into many (potentially exponentially many!) STP problems, solves them using the previously mentioned technique, and then tries to merge the solutions for the subproblems. In order to enumerate all the subproblems and merge the solutions this method uses backtracking.

Yet another class of methods for TCSPs is based on the notion of path consistency (or k-consistency in general) known from "traditional" CSPs. The paper presents three such algorithms (PC-1, PC-2 and DPC – Directional Path Consistency). Unfortunately, only the first algorithm can solve a TCSP in polynomial time, and only for a specific set of constraints (i.e., the ones that have "distributivity property").

The final class of methods presented are network methods. These method try to take advantage of particular topologies of networks imposed by binary constraints (e.g., "series parallel-networks" or networks that can be decomposed into "non-separable components")