

Commented Bibliography on Dynamic Constraint Solving

G erard Verfaillie
LAAS-CNRS, Toulouse, France
gverfail@laas.fr

Narendra Jussien
EMN, Nantes, France
jussien@emn.fr

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Abstract

This document is a commented bibliography on *Dynamic Constraint Solving* and some related topics. It is associated with a tutorial about the same topic that has been given by the authors at CP 2003 (Ninth International Conference on Principles and Practice of Constraint Programming), in Cork, Ireland. These authors are the only responsible for the commentaries that are associated with each reference. Any misunderstanding or omission may be pointed out to them.

Introduction to the dynamic constraint solving setting

- [1] R. DECHTER and A. DECHTER. Belief Maintenance in Dynamic Constraint Networks. In *Proc. of the 7th National Conference on Artificial Intelligence (AAAI-88)*, pages 37–42, St. Paul, MN, USA, 1988. **Introduction to the so-called "Dynamic Constraint Satisfaction Problem". A Dynamic CSP is defined as a sequence of CSPs, each one resulting from some change in the previous one.**
- [2] S. MITTAL and B. FALKENHAINER. Dynamic Constraint Satisfaction Problems. In *Proc. of the 8th National Conference on Artificial Intelligence (AAAI-90)*, pages 25–32, Boston, MA, USA, 1990. **Introduction to the so-called "Dynamic Constraint Satisfaction Prob-**

lem”, different from the previous one. In this definition, the solutions do not have all the same structure. Constraints are of two types: usual ”Compatibility” constraints and ”Activity” constraints which may activate or deactivate variables, depending on the assignment of other variables. Maybe the term ”Conditional” would be more appropriate.

- [3] B. FALTINGS and S. MACHO-GONZALEZ. Open Constraint Satisfaction. In *Proc. of the 8th International Conference on Principles and Practice of Constraint Programming (CP-02)*, pages 356–370, Ithaca, New York, USA, 2002. **Introduction to the so-called ”Open Constraint Satisfaction Problem”. In an Open CSP, variable domains are not completely defined when starting solving. Variable values can be acquired when necessary during solving.**
- [4] E. LAMMA, P. MELLO, M. MILANO, R. CUCCHIARA, M. GAVANELLI, and M. PICCARDI. Constraint Propagation and Value Acquisition: Why we should do it Interactively. In *Proc. of the 16th International Joint Conference on Artificial Intelligence (IJCAI-99)*, Stockholm, Sweden, 1999. **Introduction to the so-called ”Interactive Constraint Satisfaction Problem”, similar to the Open one. Variable domains are not completely defined when starting solving. Variable values can be acquired when necessary during solving.**
- [5] I. MIGUEL and Q. SHEN. Hard, Flexible and Dynamic Constraint Satisfaction. *Knowledge Engineering Review*, 14(3):199–220, 1999. **Presentation of the soft and dynamic constraint satisfaction problem. Problem introduction without solving method.**
- [6] U. MONTANARI and F. ROSSI. Constraint Solving and Programming: What Next? *Constraints : An International Journal*, 2(1):87–91, 1997. **Description of the most important challenges beyond currently available constraint reasoning tools, including dynamic constraint solving.**
- [7] A. DAVENPORT and C. BECK. A Survey of Techniques for Scheduling with Uncertainty. **Unpublished. See <http://4c.ucc.ie/~jcb/publications.html>. A survey focused on a related domain: scheduling.**

Reactive methods – Search for a minimum change

- [8] A. BELLICHA. Maintenance of Solution in a Dynamic Constraint Satisfaction Problem. In *Proc. of Applications of Artificial Intelligence in Engineering VIII*, pages 261–274, Toulouse, France, 1993. **Search for a solution at a minimum distance from the previous solution in dynamic binary constraint satisfaction problems. Distance measured in terms of number of differently assigned variables.**
- [9] Y. RAN, N. ROOS, and J. van den HERIK. Approaches to Find a Near-minimal Change Solution for Dynamic CSPs. In *Proc. of the 4th International Workshop on Integration of Artificial Intelligence and Operations Research Techniques in Constraint Programming for Combinatorial Optimization Problems (CP-AI-OR-02)*, Le Croisic, France, 2002. **Search for a solution at a minimum distance from the previous solution in dynamic constraint satisfaction problems. Distance measured in terms of number of differently assigned variables. Algorithm inspired from HR (Heuristic Repair) and LDS (Limited Discrepancy Search).**
- [10] R. BARTÁK, T. MÜLLER, and H. RUDOVÁ. Minimal Perturbation Problem - A Formal View. In *Proc. of the Joint Workshop of the ERCIM Working Group on Constraints and of the CologNet area on Constraint and Logic Programming*, Budapest, Hungary, 2003. **Search for a solution at a minimum distance from the previous solution in dynamic constraint satisfaction problems. Distance measured in terms of number of differently assigned variables. Problem description without solving method.**
- [11] H. El SAKKOUT and M. WALLACE. Probe Backtrack Search for Minimal Perturbation in Dynamic Scheduling. *Constraints : An International Journal*, 5(4), 2000. **Search for a solution at a minimum distance from the previous solution in dynamic scheduling problems. Distance measured in terms of sum of the shifts in the temporal variables (start and end times of the activities). Use of a solving approach called "Unimodular Probing", combining constraint and linear programming.**

Reactive methods – Solution reuse

- [12] B. FREEMAN-BENSON, J. MALONEY, and A. BORNING. An Incremental Constraint Solver. *Communications of the ACM*, 33(1):54–63, 1990. **Maintenance of solutions in dynamic constraint satisfaction problems, where changes are limited to changes of values for some variables. DeltaBlue algorithm. Limited to acyclic constraint networks involving only functional (also called "Dataflow") constraints.**
- [13] M. SANNELLA, J. MALONEY, B. FREEMAN-BENSON, and A. BORNING. Multi-way versus One-way Constraints in User Interfaces: Experience with the DeltaBlue Algorithm. *Software: Practice and Experience*, 23(5):529–566, 1993. **Extension of the DeltaBlue algorithm to the management of multi-way constraints: functional (dataflow) n-ary constraints with multiple output variables.**
- [14] M. SANNELLA. The SkyBlue Constraint Solver and Its Applications. In *Proc. of the 1993 Workshop on Principles and Practice of Constraint Programming (PPCP-93)*, Newport, RI, USA, 1993. **From DeltaBlue to SkyBlue: management of cycles in the constraint graph.**
- [15] A. BORNING and B. FREEMAN-BENSON. Ultraviolet: A Constraint Satisfaction Algorithm for Interactive Graphics. *Constraints : An International Journal*, 3(1):9–32, 1998. **From DeltaBlue and SkyBlue to Ultraviolet: management of cycles in the constraint graph and of non functional constraints.**
- [16] G. TROMBETTONI. A Polynomial Time Local Propagation Algorithm for General Dataflow Constraint Problems. In *Proc. of the 4th International Conference on Principles and Practice of Constraint Programming (CP-98)*, pages 432–446, Pisa, Italia, 1998. **Maintenance of solutions in dynamic constraint satisfaction problems in the context of functional (dataflow) constraints: how to deal with cycles in the constraint graph.**
- [17] G. TROMBETTONI and B. NEVEU. Links for Boosting Predictable Interactive Constraint Systems. In *Proc. of the CP-01 Workshop on "User Interaction in Constraint Satisfaction"*, Paphos, Cyprus, 2001. **Maintenance of solutions in dynamic constraint satisfaction problems in the context of functional (dataflow) constraints: how**

to specify the way of repairing a constraint among several possible ways.

- [18] G. VERFAILLIE and T. SCHIEX. Solution Reuse in Dynamic Constraint Satisfaction Problems. In *Proc. of the 12th National Conference on Artificial Intelligence (AAAI-94)*, pages 307–312, Seattle, WA, USA, 1994. **Description of a complete algorithm (Local Changes) dedicated to the maintenance of solutions in dynamic constraint satisfaction problems.**
- [19] I. MIGUEL and Q. SHEN. Dynamic Flexible Constraint Satisfaction. *Applied Intelligence*, 13(3):231–245, 2000. **Soft and dynamic constraint satisfaction problem solving. Extension of the LC algorithm (Local Changes) to the management of fuzzy constraints (max aggregation operator), resulting in the FLC algorithm (Flexible Local Changes). Combination of this extension with fuzzy constraint propagation.**
- [20] I. MIGUEL, Q. SHEN, and P. JARVIS. Efficient Flexible Planning via Dynamic Flexible Constraint Satisfaction. *Engineering Applications of Artificial Intelligence*, 14(3):301–327, 2001. **Application of the techniques developed for solving soft and dynamic constraint satisfaction problems to the classical planning problem (Strips modelling). Use of the FLC algorithm to search for a plan in the graph created by the preprocessing phase of a Graphplan-like method.**
- [21] I. MIGUEL and Q. SHEN. Fuzzy rrDFCSP and Planning. *Artificial Intelligence*, 148(1-2):11–52, 2003. **Extension and synthesis of the work presented in the previous paper.**
- [22] S. MINTON, M. JOHNSTON, A. PHILIPS, and P. LAIRD. Solving Large-Scale Constraint Satisfaction and Scheduling Problems Using a Heuristic Repair Method. In *Proc. of the 8th National Conference on Artificial Intelligence (AAAI-90)*, pages 17–24, Boston, MA, USA, 1990. **How to solve a scheduling problem or, more generally, a constraint satisfaction problem, either static or dynamic, via either a complete or an incomplete search based on conflict repair.**
- [23] S. SMITH. Reactive Scheduling Systems. In D. BROWN and W. SHERER, eds., *Intelligent Scheduling Systems*. Kluwer, 1995. **View of scheduling as a dynamic reactive process whose objective is to main-**

tain a feasible and optimal schedule when changes in the external world add or remove constraints. Scheduler based on a set of repair operators which allow any schedule to be modified until a feasible and near-optimal schedule is reached.

- [24] M. ZWEDEN, B. DAUN, E. DAVIS, and M. DEALE. Scheduling and Rescheduling with Iterative Repair. In M. ZWEDEN and M. FOX, eds., *Intelligent Scheduling*, pages 241–256. Morgan Kaufmann, 1994. **Similar view of scheduling as an iterative repair process.**
- [25] S. CHIEN, R. KNIGHT, A. STECHERT, R.SHERWOOD, and G. RABIDEAU. Using Iterative Repair to Improve the Responsiveness of Planning and Scheduling. In *Proc. of the Fifth International Conference on Artificial Intelligence Planning and Scheduling (AIPS-00)*, Breckenridge, CO, USA, 2000. **Presentation of the CASPER tool which is dedicated to continuous planning/scheduling with interleaving between planning/scheduling and execution and uses an iterative repair approach.**

Reactive methods – Reasoning reuse

- [26] C. BESSIÈRE. Arc-Consistency in Dynamic Constraint Satisfaction Problems. In *Proc. of the 9th National Conference on Artificial Intelligence (AAAI-91)*, pages 221–226, Anaheim, CA, USA, 1991. **Maintenance of the arc-consistency property in dynamic binary constraint satisfaction problems. DnAC4 algorithm based on AC4 and on the recording of value removal justifications.**
- [27] C. BESSIÈRE. Arc-Consistency for Non-Binary Dynamic CSPs. In *Proc. of the 10th European Conference on Artificial Intelligence (ECAI-92)*, pages 23–27, Vienna, Austria, 1992. **Extension of the AAAI-91 paper to the general case of dynamic n-ary constraint satisfaction problems.**
- [28] P. PROSSER. A Reactive Scheduling Agent. In *Proc. of the 11th International Joint Conference on Artificial Intelligence (IJCAI-89)*, pages 1004–1009, Detroit, MI, USA, 1989. **View of a scheduling problem as a constraint satisfaction problem. Use of a constraint propagation mechanism equipped with a justification recording and handling mechanism, to cut the search when solving either static or dynamic problems.**

- [29] P. PROSSER, C. CONWAY, and C. MULLER. A Distributed Constraint Maintenance System. In *Proc. of the 12th International Conference on Artificial Intelligence, Expert Systems and Natural Language (Avignon-92)*, pages 221–231, Avignon, France, 1992. **Maintenance of the arc-consistency property in dynamic and distributed binary constraint satisfaction problems. Based on AC3 and on the recording of value removal justifications.**
- [30] R. DEBRUYNE. Arc-Consistency in Dynamic CSPs is no more Prohibitive. In *Proc. of the 8th IEEE International Conference on Tools with Artificial Intelligence (ICTAI-96)*, pages 239–267, Toulouse, France, 1996. **Maintenance of the arc-consistency property in dynamic binary constraint satisfaction problems. DnAC6 algorithm based on AC6 and on the recording of value removal justifications.**
- [31] P. BERLANDIER and B. NEVEU. Arc-Consistency for Dynamic Constraint Satisfaction Problems: a RMS free approach. In *Proc. of the ECAI-94 Workshop on "Constraint Satisfaction Issues Raised by Practical Applications"*, Amsterdam, The Netherlands, 1994. **Maintenance of the arc-consistency property in dynamic binary constraint satisfaction problems. AC—DC algorithm based on AC3, using no value removal justifications.**
- [32] R. DEBRUYNE. Les algorithmes d’arc-consistance dans les CSP dynamiques. *Revue d’Intelligence Artificielle*, 9(3):239–267, 1995. **Synthesis of the different ways of maintaining the arc-consistency property in dynamic constraint satisfaction problems. Comparison of the DnAC4, DnAC6, and AC—DC algorithms. In French.**
- [33] T. SCHIEX and G. VERFAILLIE. Nogood Recording for Static and Dynamic Constraint Satisfaction Problems. *International Journal of Artificial Intelligence Tools*, 3(2):187–207, 1994. **Method based on the production, recording and reuse of nogoods to boost the solving of either static or dynamic constraint satisfaction problems.**
- [34] F. FAGES, J. FOWLER, and T. SOLA. Experiments in Reactive Constraint Logic Programming. *Journal of Logic Programming*, 37(1-3):185–212, 1998. **Design of a reactive constraint logic programming system, which supports both constraint addition and**

removal. Approach based on the recording and maintenance of justifications.

- [35] Y. GEORGET, P. CODOGNET, and F. ROSSI. Constraint Retraction in CLP(FD): Formal Framework and Performance Results. *Constraints : An International Journal*, 4(1), 1999. **How to maintain the arc-consistency property in case of constraint removal in the context of Constraint Logic Programming, by using no value removal justifications, but only information about the constraint graph.**
- [36] A. WOLF, T. GRUENHAGEN, and U. GESKE. On Incremental Adaptation of Constraint Handling Rule Derivations after Constraint Deletions. In *Proc. of the Joint Workshop of the ERCIM Working Group on Constraints and of the CompulogNet area on Constraint Programming*, Amsterdam, The Netherlands, 1998. **Adaptation of the "Constraint Handling Rules" system (CHR) to a dynamic setting where constraint deletions are possible as well as constraint additions.**
- [37] N. JUSSIEN and P. BOIZUMAULT. Best-first Search for Property Maintenance in Reactive Constraint Systems. In *Proc. of the International Logic Programming Symposium*, pages 339–353, Port Jefferson, NY, USA, 1997. **Justification-based approach for dealing with dynamic over-constrained constraint satisfaction problems.**
- [38] N. JUSSIEN, R. DEBRUYNE, and P. BOIZUMAULT. Maintaining Arc-Consistency within Dynamic Backtracking. In *Proc. of the 6th International Conference on Principles and Practice of Constraint Programming (CP-00)*, pages 249–261, Singapore, 2000. **How to improve the DBT algorithm (Dynamic Backtracking) with the use of arc-consistency, although this algorithm is no more a tree search, but a kind of local search in the space of incomplete assignments.**
- [39] N. JUSSIEN and O. LHOMME. Local Search with Constraint Propagation and Conflict-based Heuristics. *Artificial Intelligence*, 139:21–45, 2002. **Combination between local search and constraint propagation in the context of a local search in the space of incomplete assignments. View of this local search as a dynamic constraint satisfaction problem.**

- [40] R. DEBRUYNE, G. FERRAND, N. JUSSIEN, W. LESAIN, S. OUIS, and A. TESSIER. Correctness of Constraint Retraction Algorithms. In *Proc. of the 16th International Florida Artificial Intelligence Research Society Conference (FLAIRS-03)*, St. Augustine, FL, USA, 2003. **General scheme for constraint retraction algorithms using explanations. Necessary conditions for algorithm correctness.**
- [41] A. ELKHYARI, C. GUÉRET, and N. JUSSIEN. Conflict-based Repair Techniques for Solving Dynamic Scheduling Problems. In *Proc. of the 8th International Conference on Principles and Practice of Constraint Programming (CP-02)*, Ithaca, New York, USA, 2002. **Application of the justification-based techniques used for dealing with dynamic constraint satisfaction problems to the solving of dynamic scheduling problems.**

Reactive methods – Solution and reasoning reuse

- [42] P. Van HENTENRYCK and T. Le PROVOST. Incremental Search in Constraint Logic Programming. *New Generation Computing*, 9:257–275, 1991. **Solution and reasoning reuse for solving a sequence of constraint satisfaction problems. When solving a problem, recording of the first solution found and of the fact that no solution exists before it in the search tree.**
- [43] G. VERFAILLIE and T. SCHIEX. Dynamic Backtracking for Dynamic Constraint Satisfaction Problems. In *Proc. of the ECAI-94 Workshop on "Constraint Satisfaction Issues Raised by Practical Applications"*, Amsterdam, The Netherlands, 1994. **Description of an extension of the DBT algorithm (Dynamic Backtracking) for the maintenance of solutions in dynamic constraint satisfaction problems. Combination of solution and reasoning reuse.**
- [44] G. VERFAILLIE and T. SCHIEX. Maintien de solution dans les problèmes dynamiques de satisfaction de contraintes: bilan de quelques approches. *Revue d'Intelligence Artificielle*, 9(3):269–309, 1995. **Synthesis of several algorithms based on either solution or reasoning reuse for the maintenance of solutions in dynamic constraint satisfaction problems. Algorithm descriptions. Experiment results. In French.**

- [45] L. PURVIS. Dynamic Constraint Satisfaction using Case-Based Reasoning Techniques. In *Proc. of the CP-97 Workshop on "Theory and Practice of Dynamic Constraint Satisfaction"*, Schloss Hagenberg, Austria, 1997. **Discussion about the possible use of case-based reasoning techniques for solving dynamic constraint satisfaction problems.**

Proactive methods – Search for robust solutions

- [46] H. FARGIER and J. LANG. Uncertainty in Constraint Satisfaction Problems: A Probabilistic Approach. In *Proc. of the European Conference on Symbolic and Quantitative Approaches of Reasoning under Uncertainty (ECSQARU-93)*, pages 97–104, Grenade, Spain, 1993. **Introduction to the so-called "Probabilistic Constraint Satisfaction Problem". In a Probabilistic CSP, constraints are not certain. A probability of presence in the real world is associated with each of them.**
- [47] T. SCHIEX, H. FARGIER, and G. VERFAILLIE. Valued Constraint Satisfaction Problems : Hard and Easy Problems. In *Proc. of the 14th International Joint Conference on Artificial Intelligence (IJCAI-95)*, pages 631–637, Montréal, Canada, 1995. **The probabilistic constraint satisfaction problem as a special case of "Valued Constraint Satisfaction Problem" (VCSP).**
- [48] H. FARGIER, J. LANG, and T. SCHIEX. Mixed Constraint Satisfaction: a Framework for Decision Problems under Incomplete Knowledge. In *Proc. of the 13th National Conference on Artificial Intelligence (AAAI-96)*, pages 175–180, Portland, OR, USA, 1996. **Introduction to the so-called "Mixed Constraint Satisfaction Problem". In a Mixed CSP, variables are of two types: decision and non-decision variables. The first ones are controllable by the decision system. The second ones are uncontrollable or, in other words, controllable by the "external world" (environment, user, other decision systems ...).**
- [49] R. WALLACE and E. FREUDER. Stable Solutions for Dynamic Constraint Satisfaction Problems. In *Proc. of the 4th International Conference on Principles and Practice of Constraint Programming (CP-98)*,

pages 447–461, Pisa, Italia, 1998. **Search for so-called "Stable Solutions", i.e. solutions which resist as best as possible temporary changes which may appear in dynamic "Recurrent Constraint Satisfaction Problems": temporary loss of either values or combination of values. Non probabilistic approach. Penalization of the least robust values or combinations of values.**

- [50] D. FOWLER and K. BROWN. Branching Constraint Satisfaction Problems for Solutions Robust under Likely Changes. In *Proc. of the 6th International Conference on Principles and Practice of Constraint Programming (CP-00)*, Singapore, 2000. **Introduction to the so-called "Branching Constraint Satisfaction Problem". In a Branching CSP, variables may be added according to some probability. The objective is to make the most robust decisions, by taking into account the possible variable additions. The objective function is the sum of the utilities of the assigned variables.**
- [51] D. FOWLER and K. BROWN. Branching Constraint Satisfaction Problems and Markov Decision Problems Compared. *Annals of Operations Research*, 118(1-4):85–100, 2003. **Comparison between a CSP approach and an MDP one (Markov Decision Processes) for solving branching constraint satisfaction problems.**
- [52] A. DAVENPORT, C. GEFFLOT, and C. BECK. Slack-based Techniques for Robust Schedules. In *Proc. of the Sixth European Conference on Planning (ECP-01)*, Toledo, Spain, 2001. **Search for robust solutions in scheduling problems with uncertainty on actual activity durations. Addition of a sensible extra time to each activity in order to be able to absorb increases in activity durations without rescheduling.**
- [53] J. BRANKE and D. MATTFELD. Anticipatory Scheduling for Dynamic Job Shop Problems. In *Proc. of the AIPS-02 Workshop on "Online Planning and Scheduling"*, Toulouse, France, 2002. **How to anticipate future changes when building a schedule by modifying the optimization criterion.**
- [54] M. LITTMAN, S. MAJERCIK, and T. PITASSI. Stochastic Boolean Satisfiability. *Journal of Automated Reasoning*, 27(3):251–296, 2001. **Study of the so-called "Stochastic Boolean Satisfiability Problem" (SSAT), which involves three types of variables: existential,**

universal, and randomized. Links with planning under uncertainty. Complexity results. Presentation of two kinds of algorithms: a complete DP-like tree search (Davis & Putman) involving unit resolution, purification, and thresholding, and an incomplete stochastic sampling search.

- [55] T. WALSH. Stochastic Constraint Programming. In *Proc. of the 15th European Conference on Artificial Intelligence (ECAI-02)*, Lyon, France, 2002. **Introduction of the so-called "Stochastic Constraint Satisfaction Problem". In a Stochastic CSP, variables are of two types: decision and stochastic variables. Problem complexity. Description of a tree search algorithm with forward checking.**
- [56] S. MANANDHAR, A. TARIM, and T. WALSH. Scenario-based Stochastic Constraint Programming. In *Proc. of the 18th International Joint Conference on Artificial Intelligence (IJCAI-03)*, Acapulco, Mexico, 2003. **Scenario-based approach for solving stochastic constraint satisfaction problems.**
- [57] N. YORKE-SMITH and C. GERVET. Certainty Closure: A Framework for Reliable Constraint Reasoning with Uncertainty. In *Proc. of the 9th International Conference on Principles and Practice of Constraint Programming (CP-03)*, Cork, Ireland, 2003. **Given a CSP which involves a set of uncertain parameters, either to define or to bound the so-called "Certainty Closure" i.e., the set of all the possible solutions, which are solutions for at least one combination of values of the uncertain parameters. Note the difference with robust solutions, which must be solutions for all the possible combinations of the uncertain parameters or at least most of them.**

Proactive methods – Search for flexible solutions

- [58] P. JÉGOU. A Logical Approach to Solve Dynamic CSPs: Preliminary Report. In *Proc. of the ECAI94 Workshop on "Constraint Satisfaction Issues Raised by Practical Applications"*, Amsterdam, The Netherlands, 1994. **Use of a BDD-like representation (Binary Decision Diagrams) to represent compactly all the solutions of a dynamic constraint satisfaction problem.**

- [59] J. AMILHASTRE, H. FARGIER, and P. MARQUIS. Consistency Restoration and Explanations in Dynamic CSP: Application to Configuration. *Artificial Intelligence*, 135(1):199–234, 2002. **Use of an ATMS approach (Assumption-based Truth Maintenance System) to deal with the dynamic CSP which results from the interactive solving of a configuration problem. Use of an automaton to represent compactly all its solutions offline.**
- [60] D. LESAINT. Maximal Sets of Solutions for Constraint Satisfaction Problems. In *Proc. of the 11th European Conference on Artificial Intelligence (ECAI-94)*, pages 110,114, Amsterdam, The Netherlands, 1994. **Computation of sets of solutions which can be represented as a cartesian product of subdomains of all the variable domains.**
- [61] M. GINSBERG, A. PARKES, and A. ROY. Supermodels and Robustness. In *Proc. of the 15th National Conference on Artificial Intelligence (AAAI-98)*, pages 334–339, Madison, WI, USA, 1998. **Search for so-called "Supermodels" i.e., solutions which, in case of a limited change (change of value for a limited number of variables), can recover consistency by performing a limited change too (change of value for a limited number of variables, different from the first). Study in the context of the SAT problem.**
- [62] E. HEBRARD, B. HNICH, and T. WALSH. Super CSPs. In *Proc. of the CP-03 Workshop on "Handling Change and Uncertainty"*, Cork, Ireland, 2003. **Extension of the notion of supermodel to the CSP framework. Introduction of the notion of superconsistency. Algorithms for producing supersolutions.**
- [63] M. DRUMMOND, J. BRESINA, and K. SWANSON. Just-In-Case Scheduling. In *Proc. of the 12th National Conference on Artificial Intelligence (AAAI-94)*, pages 1098–1104, Seattle, WA, USA, 1994. **Off-line anytime computing of contingent schedules to take into account the most probable schedule breaks due to uncertainty about actual action duration.**
- [64] T. VIDAL and H. FARGIER. Handling Contingency in Temporal Constraint Networks: From Consistency to Controllabilities. *Journal of Experimental and Theoretical Artificial Intelligence*, 11(1):23–45, 1999. **Introduction to the so-called "Simple Temporal Problem with Uncertainty" (STPU), an extension of the "Simple Temporal**

Problem” (STP), where some constraints may be uncontrollable (or contingent). In such a setting, the classical consistency property must be redefined in terms of controllability. Definition of three levels of controllability: weak, strong, and dynamic. Associated checking algorithms. Complexity results.

- [65] P. MORRIS and N. MUSCETTOLA. Managing Temporal Uncertainty Through Waypoint Controllability. In *Proc. of the 16th International Joint Conference on Artificial Intelligence (IJCAI-99)*, pages 1253–1258, Stockholm, Sweden, 1999. **In the STPU framework, introduction of the waypoint controllability which generalizes weak and strong controllabilities.**
- [66] T. VIDAL. Controllability Characterization and Checking in Contingent Temporal Constraint Networks. In *Proc. of the 7th International Conference on the Principles of Knowledge Representation and Reasoning (KR-00)*, Breckenridge, CO, USA, 2000. **Extension of the previous works on STPUs. Modelling of a STPU as a ”Timed Game Automaton”.**
- [67] T. VIDAL. A Unified Dynamic Approach for Dealing with Temporal Uncertainty and Conditional Planning. In *Proc. of the Fifth International Conference on Artificial Intelligence Planning and Scheduling (AIPS-00)*, Breckenridge, CO, USA, 2000. **Extension of the previous works on STPUs. Applicability in the context of conditional and reactive planning.**
- [68] P. MORRIS, N. MUSCETTOLA, and T. VIDAL. Dynamic Control of Plans with Temporal Uncertainty. In *Proc. of the 17th International Joint Conference on Artificial Intelligence (IJCAI-01)*, pages 494–499, Seattle, WA, USA, 2001. **In the STPU framework, proof that the most practically interesting controllability property, the dynamic one, can be checked in polynomial time. Description of the associated algorithm.**
- [69] T. VIDAL and J. BIDOT. Dynamic Sequencing of Tasks in Simple Temporal Networks with Uncertainty. In *Proc. of the CP-01 Workshop on ”Constraints and Uncertainty”*, Paphos, Cyprus, 2001. **Extension of the schedule flexibility to sequencing decisions.**
- [70] N. MUSCETTOLA, P. MORRIS, and I. TSAMARDINOS. Reformulating Temporal Plans for Efficient Execution. In *Proc. of the 6th Interna-*

tional Conference on the Principles of Knowledge Representation and Reasoning (KR-98), pages 444–452, Trento, Italy, 1998. **Link between planning and execution. Introduction of the notion of "Dispatchability": a simple temporal network (STP) is dispatchable if it can be executed by the execution module, which is equipped with specified propagation algorithms, without violating any constraint.**

- [71] P. MORRIS and N. MUSCETTOLA. Execution of Temporal Plans with Uncertainty. In *Proc. of the 17th National Conference on Artificial Intelligence (AAAI-00)*, pages 491–496, Austin, TX, USA, 2000. **Extension of previous works on dispatchability to the STPU framework.**
- [72] R. WALLACE and E. FREUDER. Dispatchability Conditions for Schedules with Consumable Resources. In *Proc. of the 14th European Conference on Artificial Intelligence (ECAI-00)*, pages 526–539, Berlin, Germany, 2000. **Extension of previous works on dispatchability to take into account limited consumable resources in addition to temporal constraints.**
- [73] N. MUSCETTOLA. Computing the Envelope for Stepwise-Constant Resource Allocation. In *Proc. of the 8th International Conference on Principles and Practice of Constraint Programming (CP-02)*, pages 139–154, Ithaca, New York, USA, 2002. **How to compute bounds on the consumption of resources in the setting of a flexible schedule.**
- [74] F. ROSSI, B. VENABLE, and N. YORKE-SMITH. Preferences and Uncertainty in Simple Temporal Networks. In *Proc. of the CP-03 Workshop on "Handling Change and Uncertainty"*, Cork, Ireland, 2003. **Combination between two extensions of the STP framework for dealing with preferences as well as with uncertainty, resulting in the STPPU framework.**
- [75] N. POLICELLA, S. SMITH, A. CESTA, and A. ODDI. Steps toward Computing Flexible Schedules. In *Proc. of the CP-03 Workshop on "Handling Change and Uncertainty"*, Cork, Ireland, 2003. **Objective: to maintain temporal flexibility as much as possible when planning, in the presence of time and resource constraints. Introduction of two measures of flexibility: fluidity and disruptability. Comparison between a resource envelope approach and a early start time one.**

Applications

- [76] C. CHIU, C. CHOU, J. LEE, H. LEUNG, and Y. LEUNG. A Constraint-Based Interactive Train Rescheduling Tool. In *Proc. of the 2nd International Conference on Principles and Practice of Constraint Programming (CP-96, LNCS 1118)*, pages 104–118, Cambridge, MA, USA, 1996. **Dynamic scheduling with two objectives: to minimize the passenger delays and the number of station visit modifications in case of rescheduling.**
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- [78] K. MARRIOTT, P. MOULDER, P. STUCKEY, and A. BORNING. Solving Disjunctive Constraints for Interactive Graphical Applications. In *Proc. of the 7th International Conference on Principles and Practice of Constraint Programming (CP-01)*, Paphos, Cyprus, 2001. **Dynamic management of the disjunctions of linear inequalities which are associated with the non-overlap constraints in the context of interactive graphical applications.**
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