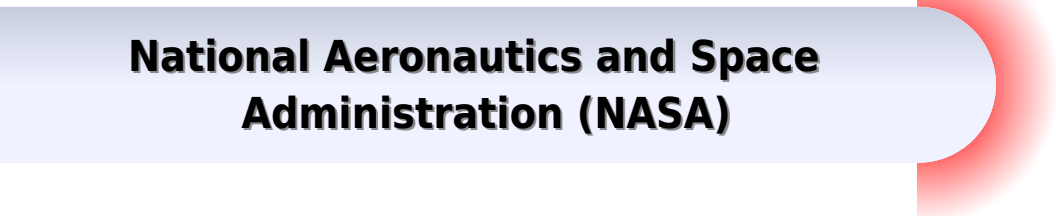


Introduction

- **Constraint-Based Scheduling = Scheduling + Constraint Programming**
- **Scheduling problems arise in situations where**
 - **A set of *activities* has to be processed**
 - **By a *limited* number of *resources***
 - **In a *limited* amount of *time***

Constraint Based Scheduling

**National Aeronautics and Space
Administration (NASA)**



Constraint Based Scheduling:

Constraint-Based Scheduling Philippe Baptiste, Claude Le Pape, Wim Nuijten, 2012-12-06 Constraint Programming is a problem solving paradigm that establishes a clear distinction between two pivotal aspects of a problem 1 a precise definition of the constraints that define the problem to be solved and 2 the algorithms and heuristics enabling the selection of decisions to solve the problem It is because of these capabilities that Constraint Programming is increasingly being employed as a problem solving tool to solve scheduling problems Hence the development of Constraint Based Scheduling as a field of study The aim of this book is to provide an overview of the most widely used Constraint Based Scheduling techniques Following the principles of Constraint Programming the book consists of three distinct parts The first chapter introduces the basic principles of Constraint Programming and provides a model of the constraints that are the most often encountered in scheduling problems Chapters 2 3 4 and 5 are focused on the propagation of resource constraints which usually are responsible for the hardness of the scheduling problem Chapters 6 7 and 8 are dedicated to the resolution of several scheduling problems These examples illustrate the use and the practical efficiency of the constraint propagation methods of the previous chapters They also show that besides constraint propagation the exploration of the search space must be carefully designed taking into account specific properties of the considered problem e g dominance relations symmetries possible use of decomposition rules Chapter 9 mentions various extensions of the model and presents promising research directions

Constraint-Based Scheduling National Aeronautics and Space Administration (NASA), 2018-08-16 The GERRY scheduling system developed by NASA Ames with assistance from the Lockheed Space Operations Company and the Lockheed Artificial Intelligence Center uses a method called constraint based iterative repair Using this technique one encodes both hard rules and preference criteria into data structures called constraints GERRY repeatedly attempts to improve schedules by seeking repairs for violated constraints The system provides a general scheduling framework which is being tested on two NASA applications The larger of the two is the Space Shuttle Ground Processing problem which entails the scheduling of all inspection repair and maintenance tasks required to prepare the orbiter for flight The other application involves power allocations for the NASA Ames wind tunnels Here the system will be used to schedule wind tunnel tests with the goal of minimizing power costs In this paper we describe the GERRY system and its applications to the Space Shuttle problem We also speculate as to how the system would be used for manufacturing transportation and military problems Zweben Monte Ames Research Center NASA TM 107873 FIA 91 27 NAS 1 15 107873

Handbook of Constraint Programming Francesca Rossi, Peter van Beek, Toby Walsh, 2006-08-18 Constraint programming is a powerful paradigm for solving combinatorial search problems that draws on a wide range of techniques from artificial intelligence computer science databases programming languages and operations research Constraint programming is currently applied with success to many domains such as scheduling planning vehicle routing configuration networks and bioinformatics The aim of this

handbook is to capture the full breadth and depth of the constraint programming field and to be encyclopedic in its scope and coverage. While there are several excellent books on constraint programming, such books necessarily focus on the main notions and techniques and cannot cover also extensions, applications, and languages. The handbook gives a reasonably complete coverage of all these lines of work based on constraint programming so that a reader can have a rather precise idea of the whole field and its potential. Of course, each line of work is dealt with in a survey-like style where some details may be neglected in favor of coverage. However, the extensive bibliography of each chapter will help the interested readers to find suitable sources for the missing details. Each chapter of the handbook is intended to be a self-contained survey of a topic and is written by one or more authors who are leading researchers in the area. The intended audience of the handbook is researchers, graduate students, higher year undergraduates, and practitioners who wish to learn about the state of the art in constraint programming. No prior knowledge about the field is necessary to be able to read the chapters and gather useful knowledge. Researchers from other fields should find in this handbook an effective way to learn about constraint programming and to possibly use some of the constraint programming concepts and techniques in their work, thus providing a means for a fruitful cross-fertilization among different research areas. The handbook is organized in two parts. The first part covers the basic foundations of constraint programming, including the history, the notion of constraint propagation, basic search methods, global constraints, tractability, and computational complexity, and important issues in modeling a problem as a constraint problem. The second part covers constraint languages and solvers, several useful extensions to the basic framework, such as interval constraints, structured domains, and distributed CSPs, and successful application areas for constraint programming. Covers the whole field of constraint programming. Survey style chapters. Five chapters on applications.

Constraint-based Scheduling, 1991 **Constraint-based Reasoning** Eugene C. Freuder, Alan K. Mackworth, 1994

Constraint-based reasoning is an important area of automated reasoning in artificial intelligence with many applications. These include configuration and design problems, planning and scheduling, temporal and spatial reasoning, defeasible and causal reasoning, machine vision, and language understanding, qualitative and diagnostic reasoning, and expert systems. Constraint-based Reasoning presents current work in the field at several levels: theory, algorithms, languages, applications, and hardware. Constraint-based reasoning has connections to a wide variety of fields, including formal logic, graph theory, relational databases, combinatorial algorithms, operations research, neural networks, truth maintenance, and logic programming. The ideal of describing a problem domain in natural declarative terms and then letting general deductive mechanisms synthesize individual solutions has to some extent been realized and even embodied in programming languages. Contents: Introduction. E. C. Freuder, A. K. Mackworth. The Logic of Constraint Satisfaction. A. K. Mackworth. Partial Constraint Satisfaction. E. C. Freuder, R. J. Wallace. Constraint Reasoning Based on Interval Arithmetic. The Tolerance Propagation Approach. E. Hyvonen. Constraint Satisfaction Using Constraint Logic Programming. P. Van Hentenryck, H. Simonis, M. Dincbas.

Minimizing Conflicts A Heuristic Repair Method for Constraint Satisfaction and Scheduling Problems S Minton M D Johnston
 A B Philips and P Laird Arc Consistency Parallelism and Domain Dependence P R Cooper M J Swain Structure Identification
 in Relational Data R Dechter J Pearl Learning to Improve Constraint Based Scheduling M Zweben E Davis B Daun E Drascher
 M Deale M Eskey Reasoning about Qualitative Temporal Information P van Beek A Geometric Constraint Engine G A Kramer
 A Theory of Conflict Resolution in Planning Q Yang A Bradford Book **Constraint-Based Scheduling in an Intelligent
 Logistics Support System: An Artificial Intelligence Approach** M. S. Fox, S. F. Smith, CARNEGIE-MELLON UNIV
 PITTSBURGH PA ROBOTICS INST., 1985 This report summarizes the progress of research performed under AFOSR contract
 Number F49620 82 K 0017 titled Constraint Based Scheduling in an Intelligent Logistics Support System An Artificial
 Intelligence Approach During the contract renewal period from March 1984 to March 1985 the continued development of a
 theory of hierarchical opportunistic constraint directed reasoning for job shop scheduling has been the focus of our research
 Specifically we have conducted work in the areas of opportunistic exploitation of constraints and constraint directed
 diagnosis The former has led us to the use of multiple problem decompositions during schedule generation while the latter
 has evolved toward development of a more broad based framework for reactive scheduling An experimental software system
 call ISIS has continued its evolution and additional testing with simulated plant data has been performed The design of a
 successor system called PHOENIX has been initiated Author **Using a constraint-based scheduling library to solve a
 specific scheduling problem** Claude Le Pape, 1994 *Constraint-Based Agents* Alexander Nareyek, 2001-05-30
 Autonomous agents have become a vibrant research and development topic in recent years attracting activity and attention
 from various areas The basic agent concept incorporates proactive autonomous units with goal directed behaviour and
 communication capabilities The book focuses on autonomous agents that can act in a goal directed manner under real time
 constraints and incomplete knowledge being situated in a dynamic environment where resources may be restricted To satisfy
 such complex requirements the author improves combines and applies results from areas like planning constraint
 programming and local search The formal framework developed is evaluated by application to the field of computer games
 which fit the problem context very well since most of them are played in real time and provide a highly interactive
 environment where environmental situations are changing rapidly *Planning, Scheduling and Constraint Satisfaction* Luis
 Castillo, 2005 Bringing artificial intelligence planning and scheduling applications into the real world is a hard task that is
 receiving more attention every day by researchers and practitioners from many fields In many cases it requires the
 integration of several underlying techniques like planning scheduling constraint satisfaction mixed initiative planning and
 scheduling temporal reasoning knowledge representation formal models and languages and technological issues Most papers
 included in this book are clear examples on how to integrate several of these techniques Furthermore the book also covers
 many interesting approaches in application areas ranging from industrial job shop to electronic tourism environmental

problems virtual teaching or space missions This book also provides powerful techniques that allow to build fully deployable applications to solve real problems and an updated review of many of the most interesting areas of application of these technologies showing how powerful these technologies are to overcome the expressiveness and efficiency problems of real world problems **Handbook on Project Management and Scheduling Vol.1** Christoph Schwindt,Jürgen

Zimmermann,2015-01-13 Due to the increasing importance of product differentiation and collapsing product life cycles a growing number of value adding activities in the industry and service sector are organized in projects Projects come in many forms often taking considerable time and consuming a large amount of resources The management and scheduling of projects represents a challenging task and project performance may have a considerable impact on an organization's competitiveness This handbook presents state of the art approaches to project management and scheduling More than sixty contributions written by leading experts in the field provide an authoritative survey of recent developments The book serves as a comprehensive reference both for researchers and project management professionals The handbook consists of two volumes Volume 1 is devoted to single modal and multi modal project scheduling Volume 2 presents multi project problems project scheduling under uncertainty and vagueness managerial approaches and a separate part on applications case studies and information systems **Intelligent Decision Systems in Large-Scale Distributed Environments** Pascal

Bouvry,Horacio González-Vélez,Joanna Kołodziej,2011-06-19 One of the most challenging issues for the intelligent decision systems is to effectively manage the large scale complex distributed environments such as computational clouds grids ad hoc and P2P networks under the different types of users their relations and real world uncertainties In this context the IT resources and services usually belong to different owners institutions enterprises or individuals and are managed by different administrators These administrators conform to different sets of rules and configuration directives and can impose different usage policies on the system users Additionally uncertainties are presented in various types of information that are incomplete imprecise fragmentary or overloading which hinders the full and precise determination of the evaluation criteria their subsequent and selection the assignment scores and eventually the final integrated decision result This book presents new ideas analysis implementations and evaluation of the next generation intelligent techniques for solving complex decision problems in large scale distributed systems In 15 chapters several important formulations of the decision problems in heterogeneous environments are identified and a review of the recent approaches from game theoretical models and computational intelligent techniques such as genetic memetic and evolutionary algorithms to intelligent multi agent systems and networking are presented We believe that this volume will serve as a reference for the students researchers and industry practitioners working in or are interested in joining interdisciplinary works in the areas of intelligent decision systems using emergent distributed computing paradigms It will also allow newcomers to grasp key concerns and potential solutions on the selected topics **Metaheuristics for Scheduling in Distributed Computing Environments** Fatos Xhafa,2008-08-19

This volume presents meta heuristics approaches for Grid scheduling problems It brings new ideas analysis implementations and evaluation of meta heuristic techniques for Grid scheduling which make this volume novel in several aspects

Constraint Programming and Large Scale Discrete Optimization Eugene C. Freuder, Richard John

Wallace, 2001-01-01 Constraint programming has become an important general approach for solving hard combinatorial problems that occur in a number of application domains such as scheduling and configuration This volume contains selected papers from the workshop on Constraint Programming and Large Scale Discrete Optimization held at DIMACS It gives a sense of state of the art research in this field touching on many of the important issues that are emerging and giving an idea of the major current trends Topics include new strategies for local search multithreaded constraint programming specialized constraints that enhance consistency processing fuzzy representations hybrid approaches involving both constraint programming and integer programming and applications to scheduling problems in domains such as sports scheduling and satellite scheduling

Integration of AI and OR Techniques in Constraint Programming for Combinatorial Optimization Problems Nicolas Beldiceanu, Narendra Jussien, Eric Pinson, 2012-05-15 This book constitutes the refereed proceedings of the 9th International Conference on Integration of AI and OR Techniques in Constraint Programming for Combinatorial Optimization Problems CPAIOR 2012 held in Nantes France in May June 2012 The 26 revised full papers presented were carefully reviewed and selected from 64 submissions The papers are focused on both theoretical and practical application oriented issues in combinatorial optimization and feature current research with a special focus on inference and relaxation methods integration methods modeling methods innovative applications of CP AI OR techniques and implementation of CP AI OR techniques and optimization systems

Designing the Framework of a Constraint-based Scheduling Software System for Operations Management Jing Tan, Thayer School of Engineering, 2007

Principles and Practice of Constraint Programming - CP 2004 Mark Wallace, 2005-01-12 The 10th International Conference on the Principles and Practice of Constraint Programming CP 2003 was held in Toronto Canada during September 27 October 1 2004 Information about the conference can be found on the Web at <http://ai.uwaterloo.ca/cp2004> Constraint programming CP is about problem modelling problem solving programming optimization software engineering databases visualization user interfaces and anything to do with satisfying complex constraints It reaches into mathematics operations research artificial intelligence algorithms complexity modelling and programming languages and many aspects of computer science Moreover CP is never far from applications and its successful use in industry and government goes hand in hand with the success of the CP research community

Constraint programming continues to be an exciting and growing research field

As the annual CP conference proceedings amply witness This year from 158 submissions we chose 46 to be published in full in the proceedings Instead of selecting one overall best paper we picked out four distinguished papers though we were tempted to select at least 12 such papers In addition we included 16 short papers in the proceedings these were presented as posters at

CP 2004 This volume includes summaries of the four invited talks of CP 2004 Two speakers from industry were invited However these were no ordinary industrial representatives but two of the leading researchers in the CP community Helmut Simonis of Parc Technologies until its recent takeover by Cisco Systems and Jean Francois Puget Director of Optimization Technology at ILOG The other two invited speakers are also big movers and shakers in the research community

Knowledge-Based Systems, Four-Volume Set Cornelius T. Leondes, 2000-07-11 The design of knowledge systems is finding myriad applications from corporate databases to general decision support in areas as diverse as engineering manufacturing and other industrial processes medicine business and economics In engineering for example knowledge bases can be utilized for reliable electric power system operation In medicine they support complex diagnoses while in business they inform the process of strategic planning Programmed securities trading and the defeat of chess champion Kasparov by IBM's Big Blue are two familiar examples of dedicated knowledge bases in combination with an expert system for decision making With volumes covering Implementation Optimization Computer Techniques and Systems and Applications this comprehensive set constitutes a unique reference source for students practitioners and researchers in computer science engineering and the broad range of applications areas for knowledge based systems *Temporal QOS Management in Scientific Cloud Workflow Systems* Xiao Liu, Jinjun Chen, Yun Yang, 2012-02-23 Chapter 1 Introduction Chapter 2 Literature Review and Problem Analysis Chapter 3 A Scientific Cloud Workflow System Chapter 4 Novel Probabilistic Temporal Framework Chapter 5 Forecasting Scientific Cloud Workflow Activity Duration Intervals Chapter 6 Temporal Constraint Setting Chapter 7 Temporal Checkpoint Selection and Temporal Verification Chapter 8 Temporal Violation Handling Point Selection Chapter 9 Temporal Violation Handling Chapter 10 Conclusions and Contribution Bibliography

Integration of AI and OR Techniques in Constraint Programming for Combinatorial Optimization Problems Pascal Van Hentenryck, Laurence Wolsey, 2007-06-23 This book constitutes the refereed proceedings of the 4th International Conference on Integration of AI and OR Techniques in Constraint Programming for Combinatorial Optimization Problems CPAIOR 2007 held in Brussels Belgium in May 2007 It covers methodological and foundational issues from AI OR and algorithmics as well as applications to the solution of combinatorial optimization problems in various fields via constraint programming

Handbook of Scheduling Joseph Y-T. Leung, 2004-04-27 This handbook provides full coverage of the most recent and advanced topics in scheduling assembling researchers from all relevant disciplines to facilitate new insights Presented in six parts these experts provide introductory material complete with tutorials and algorithms then examine classical scheduling problems Part 3 explores scheduling models that originate in areas such as computer science operations research The following section examines scheduling problems that arise in real time systems Part 5 discusses stochastic scheduling and queueing networks and the final section discusses a range of applications in a variety of areas from airlines to hospitals

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