PLANET Technology Information Day

Prague (Czech Republic), May 26, 2003

Welcome to Prague Technology Information Day, the next event from the series of Technology Information Days organized by the PLANET Network of Excellence (http://www.planet-noe.org). The goal of these information days is to show practical applicability of the planning and scheduling technology and to promote the transfer of the technology with some emphasis to local community. The Prague event will not differ from this tradition. Speakers both from industry and academia have been invited; all of them have deep experience with solving real-life projects all over the world.

The Prague PLANET Technology Information Day is co-sponsored by PLANET and ITI (Institute for Theoretical Computer Science) and participation to the event is free for registered participants. More information can be found at the Prague InfoDay web site at http://kti.mff.cuni.cz/~bartak/iday2003.

I wish to express many thanks to the speakers for their contribution and I hope that we will spend a pleasant and a valuable day.

Dr. Roman Barták
Prague InfoDay organizer
Charles University

Program

9:00 - 9:30	*Registration*
9:30 - 9:40	**Welcome from the PLANET Network** Ruth Aylett (University of Salford, United Kingdom)
9:40 - 10:30	**Constraint-Based Scheduling: Principles and Application** Claude Le Pape (ILOG S.A., France)
10:30 - 11:20	**Scheduling in the real world what makes it a hard problem?** Brian Drabble (On Target Systems, United States of America)
	Coffee Break
11:40 - 12:30	**Applications of Dynamic Re-scheduling Methodologies** Gerry Kelleher (John Moores University, United Kingdom)
12:30 - 13:20	**Dynamic Scheduling in Mobile Workforce Management** Ralf Keuthen (a.p.solve ltd., United Kingdom)
	Lunch Break
14:30 - 15:20	**Departure Management** Henk Hesselink (National Aerospace Laboratory, The Netherlands)
15:20 - 16:10	**Agent-Based Production Planning** Michal Pěchouček (Czech Technical University, Czech Republic)
16:10 - 17:00	**Planning and Scheduling - Two Worlds in One System** Roman Barták (Charles University, Czech Republic)

Constraint-Based Scheduling: Principles and Application

Claude Le Pape (ILOG S.A., France)
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Abstract

Constraint Programming is a problem-solving paradigm which establishes a neat distinction between, on one hand, a precise definition of the constraints that define the problem to be solved and, on the other hand, the algorithms and heuristics enabling the selection and cancellation of decisions to solve the problem. These principles have been widely applied in the area of scheduling, enabling the implementation of flexible and extensible scheduling systems. Indeed, with Constraint Programming all the specific constraints of a given problem can be represented and actually used as a guide toward a solution. The presentation will provide a non-exhaustive overview of the most widely used Constraint-Based Scheduling techniques, and present an application of Constraint-Based Scheduling to a specific scheduling problem. The problem consists of scheduling batches of molded parts in a three-machine shop according to a wide variety of constraints including machine capabilities, cast-iron availability, minimal and maximal batch sizes, as well as constraints on operation preemption. It illustrates the usefulness of a scheduling library and the importance of its "extensibility", i.e., of the possibility for the user of the library to develop specific types of constraints and specific problem-solving procedures.

Biography

Dr. Claude Le Pape is Director of R&D on Manufacturing Scheduling at ILOG S.A. His main research interests are constraint programming, hybrid problem-solving methods, and their application to complex scheduling problems. He received a PhD in Computer Science from University Paris XI and a Management Degree from "College des Ingénieurs" in 1988. From 1989 to 2001, he was successively postdoctoral student at Stanford University, consultant and software developer at ILOG S.A., senior researcher at BOUYGUES S.A., and research director at BOUYGUES TELECOM, heading a team of 30 researchers in various domains, i.e., telecommunication networks, multimedia technologies, computer science, combinatorial optimization, and social sciences. He designed and developed the first versions of the ILOG SCHEDULER library, as well as CLAIRE SCHEDULE, the first constraint programming library for "preemptive" and "elastic" scheduling. He participated to several European research projects (including the CHIC-2 project on the application of hybrid problem-solving methods to large-scale combinatorial optimization problems) and to the development of many industrial applications in different domains, including mixture design, inventory management, long-term personnel planning, construction site scheduling, and manufacturing scheduling. One of his PhD student, Philippe Baptiste, received both the Robert Faure price from the French Operations Research and Decision Analysis Society (ROADEF) and the Cor Baayen price from the European Research Consortium for Informatics and Mathematics (ERCIM), for his outstanding work at the frontier of operations research and constraint programming.

Scheduling in the real world what makes it a hard problem?

Brian Drabble (On Target Systems, United States of America)
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Abstract

The focus of the presentation will be a survey of several state of the art constraint based scheduling and optimization techniques that are being applied to real world applications in manufacturing, shipbuilding and military mission planning. These techniques are able to significantly reduce scheduling time, significantly increase solution quality and significantly increase the size of the problems that can be handled. The survey will describe the basic algorithms underlying the techniques, their advantages and disadvantages and the types of problems for which they are most applicable. In addition to the technical descriptions several small demonstrations will also be provided. The presentation will conclude with details of future research directions and potential new application areas.

Biography

Brian Drabble is Chief Technical Office of On Target Systems (OTS), a research and development company specializing in mission planning, optimization and effects based operations. Prior to forming OTS Brian Drabble was a senior research associate and former Director of the Computational Intelligence Research Laboratory at the University of Oregon. From 1988 to 1997 he was a senior member of technical staff in the Artificial Intelligence Applications Institute at the University of Edinburgh. Brian Drabble has an extensive background in both basic research and its application to real world problems and applications. He has lead several large scale research projects in planning, scheduling and optimization for groups including DARPA, the Office Naval Research and the US Air force Rome Laboratory. Currently, he is leading several projects in the areas of mission planning, optimization and scheduling for clients including the US Air force, Navy and their allied research labs.

Applications of Dynamic Re-scheduling Methodologies

Gerry Kelleher (John Moores University, United Kingdom)
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Abstract

In most practical environments scheduling is an ongoing reactive process within which evolving and changing circumstances continually force reconsideration and revision of existing decisions. In other words, in the real world there is a profound need for the support of rescheduling. Current computer-based scheduling systems often deal poorly (if at all) with this need. Consider a typical scheduling situation - say a job shop - the detailed work plans rarely last for long in the face of the reality of resource deletion, delays, changes in orders or the revision of priorities. The original schedule, and its modified descendants, is often a poor approximation to what is needed to deal with a volatile world.

The talk discusses the use of AI technology for the management of schedules that attempts to realise this aim in real world environment, supporting users in managing mutable schedules that respond to the changing needs of their environment. The talk will explore some of the issues involved in dynamic rescheduling and, using an example from the management of complex logistics chains, describe how these issues can be successfully addressed to achieve significant improvements in performance.

Biography

Professor Kelleher started life as an economist, gaining his BSc from the London School of Economics in 1980. After several years in the software industry working on a variety of projects, including advanced planning and scheduling systems, he gained his PhD in Computer Science from Leeds University. Since that time he has taught and researched in both the UK and the Netherlands on various topics in

Computer Science, Artificial Intelligence and the Knowledge Economy. He has published over 100 refereed papers and books on these subjects. Most recently his research has focussed on AI techniques for rapid rescheduling in dynamic and uncertain conditions applied in complex real world environments. These environments include both manufacturing and logistics. Professor Kelleher has been at John Moores University in Liverpool since 1993 where he is currently Pro Vice-Chancellor and member of the university executive. He is an advisor to the NW Regional assembly on Knowledge Economy, has advised the UK government on University/Industry links and Research management and is a non-executive director of several companies.

Dynamic Scheduling in Mobile Workforce Management

Ralf Keuthen (a.p.solve ltd., United Kingdom)
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Abstract

High quality customer relations and the provision of fault free service represent an important issue for leading telecommunications, cable and utility companies. In order to achieve this, companies employ a large field workforce to provide services to residential and business customers and carry out fault repairs and maintenance work. For example, British Telecom supports a mobile workforce of more than 20.000 technicians that perform in excess of 100.000 tasks each day across the United Kingdom. For a workforce of this scale high quality workforce management solutions are crucial to achieve a high standard of service while maintaining low operational costs.

Creating efficient work schedules for a mobile workforce is a highly complex task due to a dynamic and uncertain environment. Changes to the scheduling environment may be introduced by various sources such as the company itself, the customers and the technicians. While the schedule is executed new tasks are introduced following a company or customer request; existing activities may change due to cancellations, amendments or reviews of business objectives. Furthermore, technician availability is subject to uncertainty because of traffic, variations in task duration or vehicle breakdowns. Technological advances in the management of mobile workers via Personal Digital Assistants and mobile telephony have enabled companies to automate workforce management operations and react to these environmental changes in real-time.

To enable quick reaction times in this dynamic environment and ensure high quality service to its customers British Telecom developed the fully automated workforce management application TASKFORCE that is now marketed by a.p.solve. Among other operations, TASKFORCE automates the allocation of tasks to

technicians, the task despatching process and monitors the progress of tasks in the system. The implementation of TASKFORCE has increased productivity at BT by about 15 per cent and enabled BT to introduce new service offerings on the speed of provision and repair to both business and residential customers.

Biography

Ralf Keuthen holds a MSc degree in Numerical Analysis and gained his PhD at the Automated Scheduling, Optimisation and Planning Group of the University of Nottingham, UK. After the completion of his PhD studies in 2001 he joined a.p.solve ltd, a recent spin-off of the British Telecom Research Laboratories BTexact, as a research scientist. At a.p.solve he explores new scheduling technologies for mobile workforce management. Among other projects he is currently involved in the design and development of the Next Generation Dynamic Scheduler, a mobile workforce scheduling system currently developed by the BTexact Intelligent Systems Lab in collaboration with a.p.solve.

Departure Management

Henk Hesselink (National Aerospace Laboratory, The Netherlands)
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Abstract

Current day airport traffic is constrained by many rules and regulations. It is the task of the airport traffic controller to optimise the traffic flow, whilst ensuring safety. Departure management is the complex task of optimising departure traffic at airports involving many actors, such as controllers, pilots, handlers, push-back, catering, fueling, and of course passengers. A departure management function supports all actors and takes preferences of all actors involved into account.

We used constraint reasoning for solving the departure scheduling problem. Where aircraft are represented by the flight object, the airports regulations are represented in constraints. The most important constraints concern speed and time separation. Aircraft following each other are constrained by their relative speeds and by the wake vortex, which requires a larger separation for a small aircraft following a large one. Other constraints are the air route that aircraft follow (i.e. optimal use of airspace through separating following aircraft on different routes) and the acceptance rate of the air traffic controller of the next control sector. Over-constrained problems are solved by constraint relaxation.

The departure scheduling management function is a decision support aid for the airport traffic controller. Especially during peak periods and in changing meteorological conditions (e.g. changing a runway configuration), the function has proven its use. Furthermore, environmental rules often impose a strong constraint on the routes for aircraft to fly and controllers cannot always oversee the consequences of certain choices, especially when these contradict the optimisation

criterion. Trials have been performed at Prague, Hamburg, Paris Orly, and Rome airports.

Biography

Henk Hesselink is employed at the National Aerospace Laboratory in the Netherlands since 1991. He is currently group leader "Airport Decision Support Systems". Henk has been working in the field of air traffic control since his employment at NLR and is involved in airport ground movement and planning since the early days of the "Advanced Surface Movement Guidance and Control Systems" (A-SMGCS) in 1996. He was project leader for several projects on airport traffic controller support in planning air traffic, mainly for planning of departing traffic from the gate, over the airport, to the first air sector. He was also project leader for constructing the first international airport simulator that was equipped with an A SMGCS. Currently, he is working on the project Triple-I: Intelligence Instead of Infrastructure, a proof-of-concept project for demonstrating new airport functions in the NLR Tower Research Simulator.

Agent-Based Production Planning

Michal Pěchouček (Czech Technical University, Czech Republic)
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Abstract

The field of distributed artificial intelligence and multi-agent systems provides production planning and intelligent manufacturing systems in general with three distinctive pieces of technology: (i) architectures and design methodology for development of integrated enterprise resource planning systems (ii) technologies for distributed decision making algorithms and planning in particular and (iii) technologies for incorporeality, agentification, and legacy systems integration. There were several different approaches how to implement planning and balanced resource allocation in complex distributed systems (e.g. auctioning and advanced methods of negotiation, reactive agents and stigmergic approach, etc). Within the presentation I intend to deliver a balanced overview between theoretical achievement and practical applications of the distributed planning technology in the Gerstner Laboratory, Czech Technical University. I will focus primarily to the concept of social knowledge and acquaintance models and show their potentials in planning application. The use of acquaintance-model-based interaction will be illustrated on the ExPlanTech multi-agent system. ExPlanTech has been implemented in order to support planning of patterns and forms manufacturing in an important Czech car industry supplier.

Agent based system is a collection of autonomous computational elements (independent programs) that perform collective behaviour in order to meet either their individual goals (self-interested agents) or an in-community shared goal (collaborative agents). An agent's acquaintance model is a computational model of agents awareness of the other existing agents, their properties, services, free resources, models of past and future behaviour, etc. In complex agent-based systems the collective decision making may involve excessive amount of agents' interaction. We claim that agents may make a reasonably good decision, that is based on imprecise information stored in their acquaintance models and they can adapt minor discrepancy and solve possible conflicts by classical negotiation techniques, rather than searching the entire space of possible collaboration patterns.

Biography

Dr. Michal Pěchouček works as assistant professor in Artificial Intelligence at the Department of Cybernetics, CTU FEE. He graduated in Technical Cybernetics from FEE-CTU in 1995, got his M.Sc. degree in IT: Knowledge Based Systems from University of Edinburgh and completed his Ph.D. in Artificial intelligence and biocybernetics at CTU in Prague in 1998. He is the Head of the Agent Technology Research Group at the Gerstner Laboratory for Intelligent Decision Making and Control. His research focuses on problems related to social knowledge, acquaintance models, forming coalitions, monitoring, meta-reasoning and reflection in multi-agent systems while at the same time he is interested in industrial applications of agent technologies. Dr. Pěchouček participated in and coordinated several international projects (EC funded) and acted as a principal investigator of direct research contracts (Rockwell Automation, US Air Force, Office of Naval Research, NASA). He is an author or co-author of about 50 publications in proceedings of international conferences and journal papers. In addition, he is the co-chair of the International Workshop on Industrial Applications of Holonic and Multi-Agent Systems (HOLOMAS 2000, 2001, 2002) and CEEMAS2003 - Central and Eastern European Conference on Multi-Agent Systems. Besides, he is a PC member of several workshops and conferences related to multi-agent system research. Michal Pěchouček consults to Rockwell Research Center in Prague and is a senior research consultant in CertiCon, corp.

Planning and Scheduling - Two Worlds in One System

Roman Barták (Charles University, Czech Republic)
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Abstract

Planning and scheduling are notions used in different meanings by different communities which might be confusing. In the talk, we explain the difference between these notions: traditional planning deals with the problem of finding activities to satisfy a given goal while traditional scheduling solves the problem of allocating known activities to limited resources and to limited time. In many real-life problems both tasks should be accomplished together. Then the typical solving method is to separate planning and scheduling into two modules: the planning problem is solved first, i.e., the set of activities is generated, and the scheduling problem is solved next, i.e., the activities are allocated to resources and to time. In the talk we argue that such separation is not appropriate for some real-life problems and we give several examples where planning and scheduling should be performed together. Then we present a technology based on constraint satisfaction to resolve such integrated planning and scheduling problems. In particular, we show how to model complex resources with transition schemes and how to model dependencies between the resources. The presented technology is currently used by Visopt ShopFloor system for solving production scheduling problems in complex industries like chemical, pharmaceutical, or food industries.

Biography

Roman Barták got his Ph.D. in Computer Science at Charles University, Prague in 1997. Since then he works as an assistant professor and a researcher there. He leads the Constraint & Logic Programming Research Group that is involved in activities of the ERCIM Working Group on Constraints and PLANET II. Since 1999 he leads research activities of Visopt BV, a multinational company located in The Netherlands, Israel, Germany, and Czech Republic. He is the main architect of the scheduling engine being developed by this company. His work focuses on techniques of constraint satisfaction and their application to planning and scheduling. Dr. Barták is teaching a course on Constraint Programming at Charles University since 1998 and he had several tutorial-like invited talks over Europe. He is the author of the On-line Guide to Constraint Programming; he also published several journal surveys on Constraint Programming.