

The Seventeenth International Conference on Automated Planning and Scheduling (ICAPS-07)

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■ *The Seventeenth International Conference on Automated Planning and Scheduling (ICAPS-07) was held in Providence, Rhode Island, in September 2007. It covered the latest theoretical and practical advances in planning and scheduling. The conference was collocated with the Thirteenth International Conference on Principles and Practice of Constraint Programming (CP-07). The program consisted of tutorials, workshops, system demonstrations, a doctoral consortium, and three days of technical presentations mostly in parallel sessions. ICAPS-07 also hosted the second edition of the International Competition on Knowledge Engineering for Planning and Scheduling. This report describes the conference in more detail.*

The International Conference on Automated Planning and Scheduling (ICAPS) is well established as the premier forum for researchers and practitioners in the area. The annual conference series was formed in 2003 through the merger of the International Conference on AI Planning Systems (AIPS) and the European Conference on Planning (ECP), two biennial conferences. ICAPS covers the latest advances, ranging in scope from theoretical analyses of planning and scheduling problems and processes, to new algorithms for planning and scheduling under various constraints and assumptions, to empirical evaluation of planning and scheduling techniques in practical applications.

ICAPS-07 was held September 22-26, 2007, in Providence, Rhode Island (USA). This departure from its traditional June timing was in order to facilitate, for the first time, collocation with the Thirteenth International Conference on Principles and Practice of Constraint Programming (CP-07). The intention behind this collocation was to encourage communication between the two communities, build on existing collaborations, and encourage the development of new opportunities for cross-fertilization of ideas. The conferences were held concurrently, with all sessions open to registrants of either conference. The first two days of the conference program consisted of tutorials and workshops and took place at Brown University, while the three main

conference days were held downtown at the Rhode Island Convention Center, allowing the 212 ICAPS registrants to discover more than one facet of a sunny Providence.

ICAPS-07 received a record 136 submissions, reviewed by a committee of 72 international experts. To account for the increase in the number of submissions while leaving space in the program for other activities than just paper presentations, a third of the 45 accepted submissions were presented as posters with the addition of a five-minute oral summary in one of the technical sessions. This year, the distinction between plenary and poster presentation was based not on the quality of the submission but on whether it was considered to be of broad, or more focused, interest. Additionally, ICAPS-07 experimented for the first time with parallel sessions, with, according to a participant poll, positive but also negative effects to be remedied in future conferences. Another new, very welcome, feature of the program was the introduction of 10-minute commentaries by senior members of the community at the end of each session. Commentators gave their perspective on the topic of the session and their own reaction to the work presented.

The main sessions covered planning with time and resources (including a joint session with CP-07 on constraint-based reasoning), planning under uncertainty, online planning and execution, exploitation of the

structure of planning problems, planning formalisms, search and learning, and systems and applications. Several themes emerged rather strongly during the conference. One of them was the systematic study of the relationship between classical planning and more complex problems such as temporal planning, planning under incomplete information (conformant planning), or probabilistic planning, and the conditions under which the more complex problems can be compiled and efficiently solved by classical planners. This was motivated by the success of planners such as SGPlan, t0, and FF-replan in recent planning competitions. At ICAPS-07, it also became apparent that the bridge with communities such as ICML, NIPS, and UAI is starting to solidify. In particular, there was a much more widespread use of techniques such as linear value approximation, linear programming, policy gradient, and harmonic analysis for planning under uncertainty, which are more typically found in the mentioned conferences. Finally, there were a striking number of papers attempting to identify and exploit problem structure that leads to tractability or better heuristics. In particular, abstraction-based structure and heuristics played a prominent role.

Three papers were selected by the program committee for an award. "Flexible Abstraction Heuristics for Optimal Sequential Planning" by Malte Helmert (University of Freiburg), Patrik Haslum (NICTA and ANU), and Jörg Hoffmann (DERI) received the best research paper award. "From Conformant into Classical Planning: Efficient Translations That May Be Complete Too" by Hector Palacios and Hector Geffner (Universitat Pompeu Fabra) was granted the best student paper award. "An Innovative Product for Space Mission Planning: An a posteriori Evaluation" by Amedeo Cesta, Gabriella Cortellessa, Simone Fratini, Angelo Oddi (CNR), and Nicola Policella (ESA) won the best application paper award.

This year, the ICAPS council introduced an awards committee and two new awards: the ICAPS Influential Paper Award, which honors a signifi-

cant and influential paper published at least 10 years earlier in a planning and scheduling conference, and the ICAPS Best Dissertation Award, which honors an outstanding Ph.D. thesis in any area of automated planning and scheduling. The ICAPS awards committee selected the following winners for 2007. The ICAPS Influential Paper Award was granted to Mark Peot (Teledyne Scientific and Imaging) and David Smith (NASA Ames Research Center) for their paper "Conditional Nonlinear Planning," published in the *Proceedings of the International Conference on Artificial Intelligence Planning Systems (AIPS)* in 1992. An honorable mention was awarded to Fahiem Bacchus and Froduald Kabanza for their paper "Using Temporal Logic to Control Search in a Forward Chaining Planner," published in the *Proceedings of the European Conference on Planning (ECP)* in 1995.

The ICAPS Best Dissertation Award for 2007 was granted to Håkan Younes (Ph.D. CMU) for his thesis "Verification and Planning for Stochastic Processes with Asynchronous Events." The awards committee noted his creative research on formal verification of discrete event systems and planning with concurrent actions with uncertain duration, in particular his development of an original representation based on semi-Markov decision processes as well as a highly innovative algorithmic approach for solving this class of planning problems. The honorable mention of Outstanding Dissertation in Automated Planning and Scheduling for 2007 was additionally awarded to Daniel Bernstein (Ph.D. University of Massachusetts) for his highly innovative research on planning under uncertainty for multiple agents introducing and characterizing a new framework of decentralized MDPs, Patrik Haslum (Ph.D. University of Linköping) for his marked contribution to the development of a family of admissible heuristics for optimal planning in the sequential and temporal settings, and Malte Helmert (Ph.D. University of Freiburg) for his extensive work on the analysis and characterization of the structure of classical planning domains and his highly effective

heuristics using abstraction hierarchies derived from causal graphs. All four awardees gave a short presentation about their thesis work.

The program featured three invited plenary presentations, the latter two of which were joint with CP-07. Markus Fromherz (Palo Alto Research Center) spoke about the work done at PARC on real-time planning and control for highly reconfigurable printers manufactured by Xerox in front of an audience delighted to hear about a very interesting application of online planning and scheduling. Matt Ginsberg (On-Time Systems) spoke about his experience as a leader of a group that sells optimization techniques. The talk focused on their dealing with the U.S. Navy and the scheduling of shipyard operations, where what is to be optimized is not what one would expect. Finally, Sheila McIlraith (University of Toronto) used the task of web service composition to motivate a set of challenges to AI planning (some well-known challenges such as handling incomplete information, and some newer ones such as dealing with preferences) and to present recent progress in addressing some of these challenges.

ICAPS-07 held the second ICAPS Festivus, an opportunity for the conference participants to air their grievances and grudges in an open and entertaining way. In common with the first Festivus, held at ICAPS-05, a small number of well-known members of the community were chosen to start the proceedings by making controversial observations that would get discussion going. In contrast to the first Festivus, these observations were made on a single theme: "Where Have All Our Hard Problems Gone?" Using this theme, the speakers were invited to comment on the benchmark problems used in the International Planning Competition and the perceived weaknesses of these benchmarks. The speakers were Rao Khambampati (Arizona State University), Jeremy Frank (NASA Ames Research Center), Hector Geffner (Universitat Pompeu Fabra), and Fahiem Bacchus (University of Toronto). Khambampati proposed the introduction of tough nuts and a move towards model-lite planning



Photo courtesy Alexandre Albore.

Figure 1. ICAPS at the Rhode Island Convention Center in Providence.

(plan creation on the basis of approximate domain models). Geffner observed that the community does not tend to focus on solving problems well, and the existence of poor-quality solutions to a collection of problems in a certain class should not be taken to mean that that class of problems is solved. Frank bemoaned the gulf between the PDDL family of languages and real problems and also the gulf between planning as interpreted by the research community and the kind of planning that a busy professional has to do in real life. Bacchus emphasized the (usually neglected) importance of capturing domain expertise in building a realistic model of a complex problem.

A series of demonstrations, selected by Rune Jensen (IT University of Copenhagen) and Froduald Kabanza (University of Sherbrooke), took place in parallel with the main poster session on the last morning on the con-

ference. These demonstrations showcased seven deployed systems and research prototypes for different application domains: automated servicing of satellites, mobile robot applications, course timetabling, web-based personal calendar, and pickup and delivery transport problems.

Following tradition, ICAPS-07 included a doctoral consortium for Ph.D. students in planning and scheduling, chaired by Jörg Hoffmann (DERI) and Jean-Paul Watson (Sandia National Labs). This year, the Doctoral Consortium (DC) was attended by 33 students from Australian, European, North American, and Middle-Eastern institutions. Each received a scholarship that covered the registration fees and a variable part of their expenses. The DC featured a workshop where students were allocated time to present their work orally, a poster presentation of their work to ICAPS attendees as part of the main conference

poster session, and a mentoring program that connected students to senior researchers with similar interests. Two DC papers were distinguished by the DC program committee: "Monitoring the Execution of Optimal Plans" by Christian Fritz (University of Toronto) was awarded the prize of best DC paper, and "Using Decision Procedures Efficiently for Optimization" by Matthew Streeter (CMU) was the runner-up.

ICAPS-07 also hosted the second edition of the International Competition on Knowledge Engineering for Planning and Scheduling (ICKEPS). The event was organized by Stefan Edelkamp (University of Dortmund) and Jeremy Frank (NASA Ames Research Center). The objectives of ICKEPS are to present and evaluate tools for knowledge acquisition and domain modeling, to accelerate knowledge engineering research in AI,

and to encourage the development of software platforms that promise more rapid, accessible, and effective ways to construct reliable and efficient systems. The ICKEPS organizers created a client-based software infrastructure and solicited five simulated domains for competitors to interact with: a cyber-security domain, an online manufacturing plant control domain, a telescope scheduling domain, a power-supply restoration domain, and a graph transition system domain. Participants were provided with a description of the simulator's behavior, which at root was a description of the plans they accepted, and the responses they would provide after being provided with a plan. Participants had to create domain descriptions, planners, and their associated heuristics in order to generate the plans for the simulators. Four KE systems participated in the competition: GIPO IV from the University of Huddersfield; a system derived from OWL (web ontology language) from IBM's T. J. Watson Laboratory; iSimple 2.0 from the University of São Paulo; and a constraint modeling system called MiniZinc from NICTA. The competition emphasized the importance of model visualization, specification of entity relationships and hierarchies, visualization of intermediate plan steps, and tight integration of planners into the knowledge engineering framework. The organizers felt it was premature to award prizes at this stage given the preliminary advances that have so far been made in these areas.

A set of eight workshops was selected by workshop chairs Philippe Laborie (ILOG) and Dan Weld (University of Washington) and took place over September 22 and 23: "AI Planning and Learning," "Heuristics for Domain-independent Planning: Progress, Ideas, Limitations, Challenges," "Planning and Plan Execution for Real-World Systems: Principles and Practices for Planning in Execution," "Scheduling a Scheduling Competition," "Constraint Satisfaction Techniques for Planning and Scheduling Problems" (this was a joint workshop with CP), "International Planning Competition: Past, Present and Future," "Moving Planning and Scheduling Systems into

the Real World," and "Planning and Games." The workshops were well attended, and the audience commented on the very high quality of many of the contributions.

The tutorial program, put together by John Bresina (NASA Ames Research Center) and Brent Venable (University of Padova), included five half-day tutorials, running concurrently with the workshops. Rina Dechter, Radu Marinescu (University of California at Irvine), and Robert Mateescu (Caltech) detailed the principles underlying recent progress in the field of combinatorial optimization with graphical models such as constraint networks and probabilistic networks. The tutorial "Learning Techniques in Planning" by Sungwook Yoon and Subbarao Kambhampati (Arizona State University) gave a comprehensive picture of new and older work on learning in planning, from learning search control to learning domain models. Mausam (University of Washington), David Smith (NASA Ames Research Center), and Sylvie Thiébaux (ANU and NICTA), presented a tutorial on "Probabilistic Temporal Planning," that is, planning in stochastic domains involving concurrency and actions with uncertain durations. Son Cao Tran (New Mexico State University) talked about reasoning about actions and change under incomplete information and, in particular, about approximate reasoning and its application to conformant planning. The last tutorial—on Fuzzy Temporal Reasoning by Marco Falda (University of Padova) and Massimiliano Giacomini (University of Brescia)—unfortunately had to be cancelled after the presenters' plane was significantly delayed.

ICAPS-07 would not have been as successful without the dedication of local arrangement chair Meinolf Sellmann (Brown University), the support of the Association for the Advancement of Artificial Intelligence (AAAI), the outstanding work of our publicity chairs Adi Botea (NICTA and ANU), Berthe Choueiry (University of Nebraska), and Alessandro Cimatti (IRST), the effectiveness of our sponsorship chairs Mark Drummond (SRI), Barry Fox (Boeing), and Toby Walsh

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ICAPS-08 will take place September 14–18 in Sydney, Australia, collocated with a number of other international conferences such as the International Conference on Principles and Practice of Constraint Programming (CP) and the International Conference on Principles of Knowledge Representation and Reasoning (KR). Additional information about the ICAPS conference series and the electronic proceedings of the recent conferences are available at www.icaps-conference.org. The printed proceedings are available from AAAI Press.

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