The Third Competition on Knowledge Engineering for Planning and Scheduling

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■ *We report on the staging of the third competition on knowledge engineering for AI planning and scheduling systems, held during ICAPS-09 at Thessaloniki, Greece, in September 2009. We give an overview of how the competition has developed since its first run in 2005 and its relationship with the AI planning field. This run of the competition focused on translators that, when input with some formal description in an application-area-specific language, output solver-ready domain models. Despite a fairly narrow focus within knowledge engineering, seven teams took part in what turned out to be a very interesting and successful competition.*

Knowledge engineering for planning and scheduling systems is the process that deals with the acquisition, formulation, validation, and maintenance of application knowledge and the fusion of this knowledge with appropriate solver machinery to create a working system. The International Competition on Knowledge Engineering for Planning and Scheduling (ICKEPS) has been running since 2005 as a biannual event promoting the development and importance of the use of knowledge engineering methods and techniques within planning and scheduling. Past events include ICKEPS-05 held during ICAPS at Monterey, California, in June 2005, and ICKEPS-07 held during ICAPS at Providence, Rhode Island, in September 2007. We report here on the third running of the competition, ICKEPS-09, held during ICAPS at Thessaloniki, Greece, in September 2009.

Clearly, the main focus in planning and scheduling is centered on solver engines that accept a domain and task model as input and that output solutions to planning and scheduling problems. This focus needs to be complemented with research on the construction, validation, and optimization of the domain models and the domain model languages. The ICKEPS competition series was founded in order to encourage complementary research into the knowledge engineering aspects of planning and scheduling. ICKEPS has promoted the development and sharing of tools and platforms that promise more rapid, accessible, and effective ways to construct reliable and efficient planning and scheduling systems. This includes domain

modeling, heuristic acquisition, planner-domain matching, domain knowledge validation, and so forth. ICKEPS promotes the knowledge-intensive aspects of planning and scheduling by evaluating knowledge engineering tools within a competitive forum.

The first two competitions focused on the more general aspects of knowledge engineering for planning, spanning knowledge acquisition, validation, and refinement. For the third competition, we decided to focus on a particular aspect of knowledge engineering, as follows. It is important for the field of domain-independent planning and scheduling that general solver engines can be accessed and used by non-AI experts, much in the way that constraint-programming technology has been packaged and is available to the wider community. Considerable advances have been made in the last decade on the generality and efficiency of planning engines: we were concerned that knowledge engineering issues would limit their use outside of the community. One way to increase access is to consider application areas where a planning function would be potentially useful and where there is already use of formal description languages. Experts in that area may be familiar with their own description languages, but not with planning and scheduling description languages such as PDDL. The task would then be to create a translator from the application language to a planning and scheduling solver input language, so that planning and scheduling solvers could be embedded into tool support in the application without the need for a planning expert. Another translator might also be needed—one that translates output from the solver (plans) back to the application. While being of obvious potential benefit to the application domain, this also promotes the visibility, usability, and exploitation of current planning and scheduling solvers, leading to further development of the technology as their use in new applications uncovers new directions and challenges.

Hence for the third competition we focused on tools, translators, and techniques that, when input with a model described in an application-area-specific language, output solver-ready domain models. We were targeting application areas such as web services, workflow, business modeling, e-learning, games, narrative generation, and so forth, as there had already been some progress in using embedded planning and scheduling engines in these areas. As well as being useful tools in their own right, we postulate that the study of the translation process may highlight fundamental research problems in planning and scheduling, particularly in the use of domain-independent solvers. Many users in application areas of planning and scheduling would be tempted to implement their own solver, and embed specific heuristics. Rather, with ICKEPS-09 we sought to promote the use of existing domain-independent solvers and highlight the research challenges, such as the expressiveness of their input and output languages.

Judging Criteria

The mechanism used to judge the competitors in ICKEPS cannot be based on a set of truly objective measures, given the nature of the subject, and the variability of input-output of competing tools. Instead, we decided to appoint three judges: two researchers well known in the planning and scheduling community (Piergiorgio Bertoli and Adi Botea), and one of the organizers (Simone Fratini). They were to have the sole responsibility for developing the original criteria formed by the organizers, for detailing and publishing them, and then for evaluating the entered systems and deciding on the final awards.

The judges decided to take into account (1) *user-related issues,* such as spread of use of the translator by application experts, perceived added value or impact to the application area, robustness, usability, originality and ingenuity of the translator, comprehensiveness of the translation process, including translation of output plan or schedule back into the application domain; (2) *planning- and scheduling-related issues,* such as the challenges involved in the translation process (differences in the input-output languages, translation of output plan or schedule back into the application domain), the availability of solvers to input the translated domain model, the performances of the planner and scheduler (when available) with the translated domains, the quality of the solutions produced, the comprehensiveness of the translation process; (3) *software engineering issues,* such as portability, meant as a measurement of the "difficulty of using the tool out of the laptop of the competitor"; robustness, meant as a measurement of how much the value quality of the translation is input dependent; usability, meant as a measurement of how usable the tool is either by AI experts or target domain experts; and flexibility, meaning how easy it would be to use the tool for domains out of those foreseen by the authors, and how demanding it is to extend the set of problems that it is possible to translate; and (4) *general scientific issues,* such as the originality, ingenuity, and significance of the approach.

Competition Operation and Results

ICKEPS-09 ran in two stages in conjunction with the ICAPS-09 conference. First, in the preconference stage, the competitors submitted papers

describing the tools, focusing in particular on the translation processes from their application domains to the chosen planning language (and possibly back). In this phase, a program committee of 15 members reviewed the papers with the main goals of assessing their appropriateness to the competition, evaluating the contributions, and providing feedback to their authors. Then, during the conference, the competitors gave talks about their systems in a workshoplike setting that lasted a morning. In the afternoon of the same day, they presented the systems during a plenary demonstration session, open to all. During this afternoon session, the judges evaluated and tried the tools, interacting directly with the competitors that were running the demonstration. During the talks and demonstrations, the judges continuously evaluated the contributions, trying to assess the value of the proposed tools under the general criteria described previously.

Seven systems participated in this edition of ICKEPS (from the United Kingdom, Spain, Greece, USA, and Brazil). These systems embedded translators from or to a wide range of application area languages, such as PMML and KFML for data mining, IMS-MD and IMS-LIP for e-Learning, BPMN/XPDL for business process modeling, OWL for web service composition, MABLE's interlingua for human-instructable computing, and UML.

In the evaluation process the judges tried to assess the value of the proposed tools according to two main general criteria, which reflect their potential to link planning and scheduling research to applicative areas in the following directions: "What advantages does the use of planning proposed in the tool bring in solving problems in the chosen application domain?" and "What is the added value for the planning community in using planning and scheduling technologies in the chosen application domain?" In the view of our main high-level criteria, the spread of use and the challenges involved in the translation process have been considered as driving factors for the evaluation purposes (while of course taking into account also the remaining criteria). Following these two guidelines, two winners were chosen: the JABBAH system (by Arturo Gonzalez-Ferrer, Juan Fernandez-Olivares, and Luis Castillo), for showing the greatest advantage that the use of planning and scheduling techniques brings to solving problems in a relevant application domain, and the itSIMPLE 3.0 system (by Tiago Stegun Vaquero, Jose Reinaldo Silva, Marcelo Ferreira, Flavio Tonidandel, and J. Christopher Beck), for showing the best added value in helping the planning community in using planning and scheduling techniques in application domains.

The JABBAH system provides a tool for analysts that need to perform resource allocation analysis on business workflows. During the evaluation, the system appeared solid and scored well with respect to usability. It embeds a nontrivial transformation of BPMN-expressed workflows in terms of HTNs allowing the exploitation of the vastly diffused BPMN standard for workflow specification. Henceforth, JABBAH may have a considerable potential impact outside the planning community and may appeal to a very wide and relevant audience.

The itSIMPLE 3.0 system showed as a prominently robust and comprehensive system capable of effectively supporting engineers and scientists in modeling domains, planning on them, and analyzing the outcomes of planning activities. The system allows performance of such activities by means of user-friendly GUI interfaces, and it takes the well-known UML standard as the key representational means. While not focused on a specific application area, the tool has been exploited in several application fields, witnessing the strength of this workbench and its potential to significantly widen the forum of the users of planning techniques.

General Conclusions

The focus of ICKEPS-09 was much narrower than in previous years. Nevertheless, seven tools competed (the same number as in ICKEPS-05), which we see as a success. Moreover, most of these tools were connected to some specific application domain, which highlights the role of the competition—bridging the planning and scheduling systems and real-life problems. This bridging role of ICKEPS might be the driving force for future research in planning and scheduling as there is a continuous demand for applications in the planning and scheduling community, while there are many real-life problems suitable for planning and scheduling technology but not yet exploiting this technology. To build the bridge, it is important to bring real-life problems to the planning and scheduling community, for example, by translating the problem specification in the application domain to the modeling language used in planning and scheduling, and also bringing the results of planning and scheduling back to the real world. ICKEPS-09 showed that there already exist good tools doing exactly this job.

The results of ICKEPS-09 are publicly accessible from the competition web pages.[1] The site includes papers describing all competing tools and a detailed report from judges highlighting the weak and strong points of the systems and justifying the decision about the winners. To further support exploitation of ICKEPS results in the planning and scheduling community we collected some of the domains generated by the competing tools and started an online repository presenting the real-life

problems in the planning formalism. This repository is accessible from the competition web pages. In future, this repository may serve as a source of challenging problems for the now well-established International Planning Competition that served and still serves as a driving force of research in planning and scheduling. Thanks to the results of ICKEPS-09 we believe that the role of future ICKEPS competitions and knowledge engineering techniques in general will further strengthen in the planning and scheduling community.

Note

See kti.mff.cuni.cz/ ~bartak/ICKEPS2009.

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