as part of the standard distribution. Conversion software has been developed to convert museums' collection databases, thesauri and other sources of domain knowledge to RDF, and to create meaningful links between the sources. For CWI, the main research challenges are the design and evaluation of new search functionality that is made possible by the linked data, and the design and evaluation of the associated web interfaces.

The project's approach payed off immediately: eight months later, in August 2006, the second release of the platform was submitted to the International Semantic Web Challenge, a submission that turned out to be a winning one during the International Semantic Web Conference in November 2006. To project's impact goes, however, well beyond the computer science research world. Less than five months after the ISWC award ceremony, the project was presented before the international cultural heritage community, which was gathered in San Francisco in April 2007 for the Museums and the Web conference. There it turned out that the project had made the right decision to base its strategy on open and linked data. Museums and archives all over the world start to realize the serious limitations of vendor lock-in and closed proprietary solutions. While we researchers think about ways to provide a wide audience better access to the museum collections over the public Web, on the other side of the firewall, many museums fight to get access to their very own data, as it is locked inside proprietary software without public APIs.

Project leader Guus Schreiber (right) demonstrating the project to Tim Berners-Lee, Director of the World Wide Web Consortium, at ISWC 2006.

In this context, it is clear that a future in which data is open may scare off many in the museum world. It takes time to get used to the idea that your own website is no longer the only way to access 'your' data. But without a doubt, sooner or later both the museum itself, unknown users and third parties will develop a wide range of new web services, mash-ups, widgets, social tagging applications, and much more based on the museum's data. This is simply because what the curators call 'their data represents 'our' heritage, and there are just too many of us users interested in these rich information resources. Providing a wider public access to data in a commonly agreed upon, open and linkable format is definitely the way to go. It may even be the only way to get the large amounts of valuable data back that is now locked up inside proprietary formats.

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OPTIHPER: A Computer-Based Decision Support System for Employee Timetabling Problems

by Antonio Lova, Pilar Tormos and Federico Barber

A high degree of job satisfaction is an essential factor in the success of a company. A company's objectives, labour conditions and worker preferences must be optimized in a complex space of solutions. OPTIHPER (Optimización de Horarios de Personal - Employee Timetabling Optimization) is a computer-aided system able to efficiently assign employees to tasks while verifying a wide set of constraints and optimizing organizational objectives and employee preferences. The system is currently in use by leading commercial companies with very good results

Employee Timetabling Problems (ETPs) arise in any organization with a set of tasks that must be assigned to a set of employees, each with their own qualifications, constraints and preferences. This problem arises in many institutions (hospitals, supermarkets etc) where the assignment of employees is usually performed manually. However, in companies with a large number of workers and working centres, the use of computer-based tools is essential for making organizational objectives compatible with worker preferences.

ETPs can be formulated as a constraint network, where the main entities that define the problem are tasks, workers and timetables. Tasks can be sporadic or can be repeated along one shift. They can have either a fixed duration or require a certain amount of work (man-hours) to complete. Workers may have different degrees of qualification for each task and can be assigned to different timetables.

Timetables are defined by the start/finish time and the shift (usually morning, afternoon, evening and night).

Once assigned, shifts are maintained during a period of time and follow rotation patterns.

A number of constraints arise in ETPs. Hard constraints must be satisfied for a solution to be feasible. For instance, task constraints require that each task be assigned only to the most skilled available workers. Worker constraints may require that the timetable assigned to each worker belongs to its feasible set of timetables (working hours according to their contract) and is kept for a given period of time. Meal breaks must be assigned to workers within the limits allowed by company requirements, but while guaranteeing task requirements.

Soft constraints should be met as far as possible, but without affecting the quality of the final solution. Some examples are:

- timetables with start/finish times as late/early as possible in morning/evening shifts are preferred
- workers prefer to alternate morning and evening shifts instead of repeating shifts
- assignments of uncomfortable timetables should be equilibrated over a period of time.

A solution of the problem is an assignment that fulfils the set of hard and soft constraints and optimizes an objective function. This is an NP-hard problem that requires the use of efficient heuristics.

OPTIHPER: A Software System to Solve Employee Timetabling Problems

OPTIHPER is a software system developed at the Polytechnic University of Valencia to efficiently assign employees to tasks while taking into consideration a wide range of constraints, and optimizing organizational objectives and worker preferences. OPTIHPER is able to deal with a variety of tasks, workforces, worker preferences and qualifications, shifts, and organizational constraints and objectives.

Solving Process: A Multi-Start Randomized Algorithm

OPTIHPER performs an anytime heuristically guided multi-start process to search for the best solution with two phases. The construction phase builds a feasible solution, whose neighbourhood is explored until a local optimum solu-

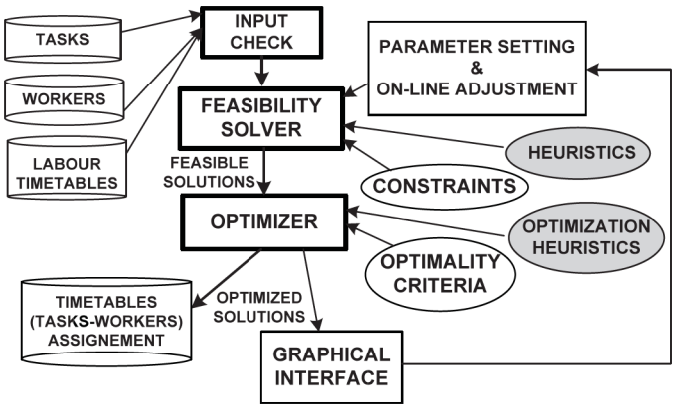

Figure 1: Flow Chart of OPTIHPER.

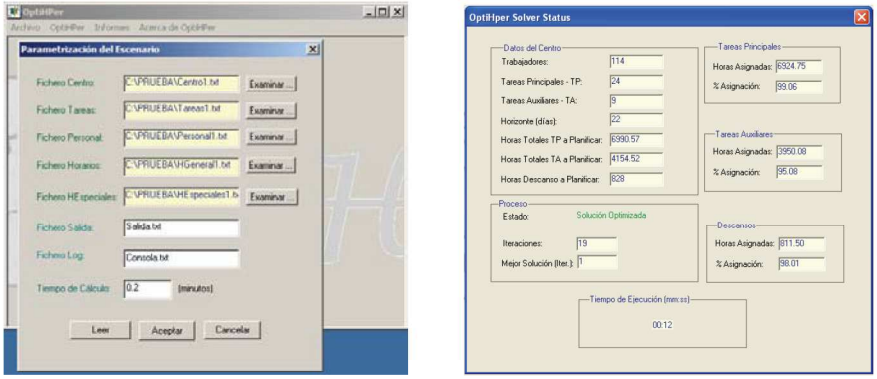

Figure 2: Input data and solver status windows.

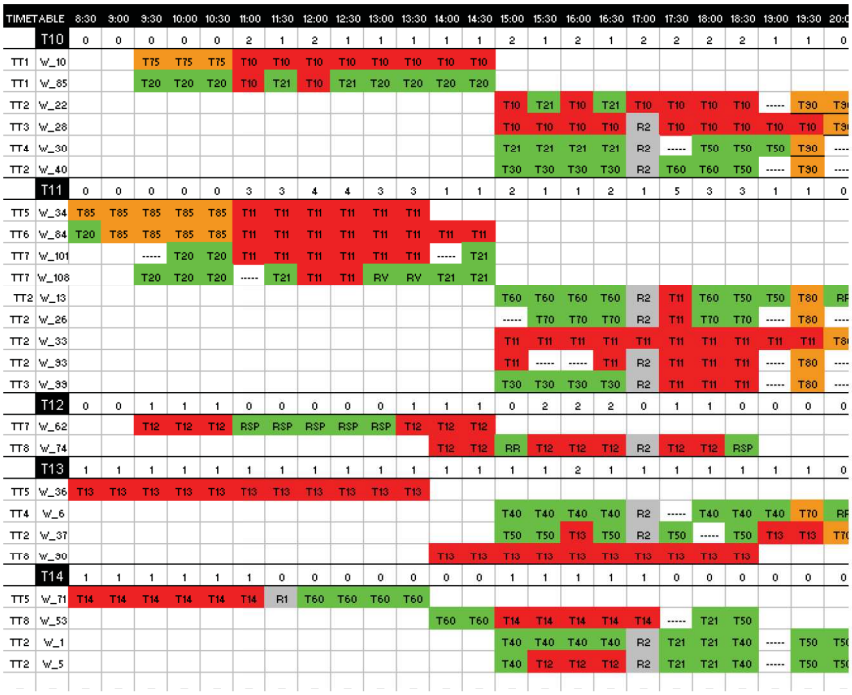

Figure 3: Partial view of task assignment (solution).

tion is found in the local search phase. OPTIHPER has two execution modes:

- 'Standard mode' computes optimized task assignments considering all available workers,
- 'Opti-Staff mode' does so for a limited number of workers, thereby allowing us to determine the optimum size/qualification of the staff.

Architecture of OPTIHPER

OPTIHPER is a multi-platform system implemented in standard ANSI C. It takes the required data either from standard databases or input files (see Figure 1). After its execution, OPTIHPER generates several statistical and graphical reports (see Figures 2 and 3).

Conclusions

OPTIHPER integrates AI/OR techniques able to cope with complex ETPs arising in the real world. It can obtain optimized assignments for when the entire staff is available or when the number of workers is fixed below the total available. Means technological transference agreements, customized versions of this system, are in operation with excellent results in leading European distribution companies. Standard scenarios involve the assignment of over one hundred workers, fifty types of task and sixty labour timetables. Assuming a planning horizon of four weeks, this implies personnel assignments of more than 15,000 hours. The optimized solution is obtained in a few seconds. The performance of the system, along with its flexibility and efficiency, make OPTIHPER an essential tool for staff allocation in many contexts, allowing companies to increase their competitiveness and to optimize their workers' skills and preferences.

Link:
http://www.dsic.upv.es/users/ia/gps/optihper/

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First EchoGRID-EUChinaGRID International Conference

The First International Conference on European Union and Chinese Grid Experiences, held in Beijing on 24-25 April, provided an outstanding platform for European and Chinese state-of-the-art Grid technologies and projects, showcasing results, new application areas and future advancements. The conference attracted some 150 experts and professionals from large enterprises, SMEs, academic and research organisations, government and public administration, international standardisation bodies, scientific and business associations from Europe, China and beyond. The event was organised by EchoGRID and EUChinaGRID, two projects funded by the European Commission, and hosted by the Institute of Computing Technology, Chinese Academy of Science.

The first day of the conference set the scene for ensuing discussions on themes of mutual interest and common challenges.

Dr Xiaohan Liao, Deputy Director, High & New Technology Department, of the Chinese Ministry of Science and Technology (MOST) addressed over 150 attendants from research, business, government and scientific organisations. Alison Birkett, European Delegation to China, was delivering a welcome address highlighting the delegation's mission to extend and intensify the dialogue and co-operation in all the EU's areas of competence, particularly in ICT research and the EU-China Information Society Project.

Keynote addresses were delivered by Chuncheng Wang, Division of Information, MOST, offering insight into Grid Research in China's High-Tech R&D Programme. The participants then heared from four key industrial actors: Wenbo Mao (HP Lab China); Xintai Wang (eStarCom Inc), Wayne Wang (Intervision Software), and Donpu Fu (TongTech).

Thematic Session 1 'Enterprise Challenges with Grids' was led by key business experts. Professor Jun-Seok Hwang, Seoul National University and head of several industrial associations, reported on the major challenges for Open Grid Services. Pawel Plaszczak, president of GridwiseTech (Poland), presented a series of fascinating Grid Technology case studies highlighting benefits for businesses. Dr Wei Zhou, CNIC, CAS, focused his presentation on the new context for innovative interdisciplinary research offering added value to R&D activities.

The afternoon session of the first day opened with a key theme 'Interoperability'. Yongjian Wang, Beihang University, evaluated the challenging and multi-faceted issues related to interoperability, such as job management, data management, workflow and security. The mission of EUChinaGRID is to implement interoperability between CHGrid GOS and EGEE gLite. This talk presented the gatway-based solution proposed by EUChinaGRID aimed at implementing batch level job interoperability and providing a prototype to test it.

The presentation by Jianxin Li, also from Beihang University, revolved around the security architecture for CROWN (China Research & Development Environment over wide-area Network). The talk discussed the planned extensible framework enabling distributed access control & dynamic trust establishment between service providers and consumers in a Grid environment. CROWN Grid research into policy negotiation & virtual organisation security management was also discussed.

Dr. Gang Chen, IHEP, offered insight into LCG, a Grid project aiming to provide HEP computing infrastructure for Large Hadron Collider (LHD) experi-