

A Computer-Based Decision Support System for Employee Timetabling Problems

High degree of job satisfaction is an essential factor for the success of a company. Company's objectives, labour conditions and workers' preferences have to be optimized in a complex space of solutions. OPTIHPER is a computer-aided system able to efficiently assign employees to tasks verifying a wide set of constraints and optimizing organizational objectives and employee's preferences. The system is currently used by leader commercial companies with very good results.

Employee Timetabling Problems (ETPs) involve an organization with a set of tasks to be assigned to a set of employees, with their own qualifications, constraints and preferences. This problem arises in many institutions (hospitals, supermarkets, etc.) where employee's assignment usually is performed manually. However, the use of computer-based tools is essential in companies with a large number of workers and working centres, making compatible organizational objectives and worker's 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 (men x hours) to complete them. Workers have different degree 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, Evening and Night). Once assigned, shifts are maintained during a period of time and follow rotation patterns.

Several constraints arise in ETPs. Hard constraints must be satisfied in a solution to be feasible. For instance, task constraints enforce each task to be assigned only to the most capacitated and available workers. Workers constraints, for instance require that the timetable assigned to each worker has to belong to its feasible timetables and is kept for a given period of time. Meal breaks have to be assigned to workers within the limits allowed by company requirements, but guaranteeing task requirements. Soft constraints have to be met as much as possible, but never affecting the quality of the final solution. Some examples are: (i) Timetables with starting/finishing times as late/soon as possible in morning/evening shifts are preferred, (ii) Workers prefer to alternate morning and evening shifts instead of repeating shifts, (iii) Assignments of 'no preferred' timetables should be equilibrated over a period of time, etc.

A solution of the problem is an assignment that fulfils the set of hard and soft constraints and optimizes an objective function. This is a 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 considering a wide range of constraints and optimizing organizational objectives and worker's preferences. OPTIHPER is able to deal with different typology of tasks, workforce, qualification and preferences of workers, shifts, organizational constraints and objectives, etc.

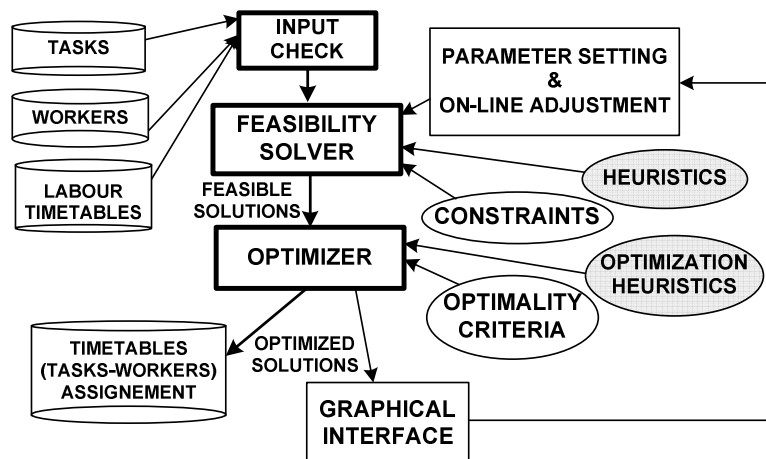


Figure 1. Flow Chart of OPTIHPER

Solving Process: A Multi-Start Randomized algorithm

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

- The **Standard** mode computes optimized task assignments considering all available workers.
- The **Opti-Staff** mode computes optimized task assignments for a limited number of workers, which allows 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 (Figure 1). After its execution, OPTIHPER generates several statistical and graphical reports (Figure 2 and Figure 3).

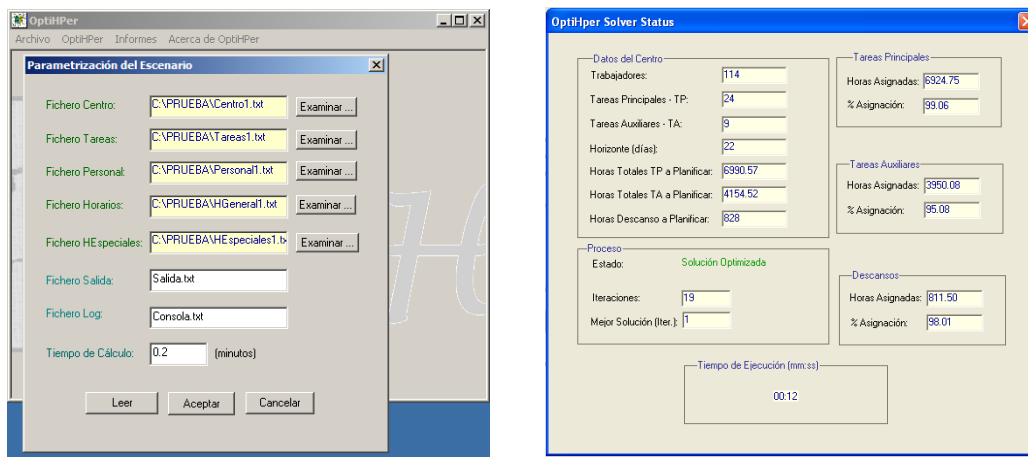


Figure 2. Some windows of OPTIHPER: Input Data and Solver Status Windows

Benefits

OPTIHPER integrates AI/OR techniques able to cope with complex ETPs arising in real world. It obtains optimized assignments either considering all the staff 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 European leader distribution companies. Standard scenarios involve assignments of more than 100 workers, 50 types of tasks and 60 labour timetables. Assuming a planning horizon of 4 weeks, it implies personnel assignments of more than 15,000 hours. The optimized solution is obtained in a few seconds. The performance of the system, flexibility and efficiency turns OPTIHPER into an essential tool for staff allocation in many contexts, allowing to increase companies' competitiveness and to optimize workers' skills and their preferences.

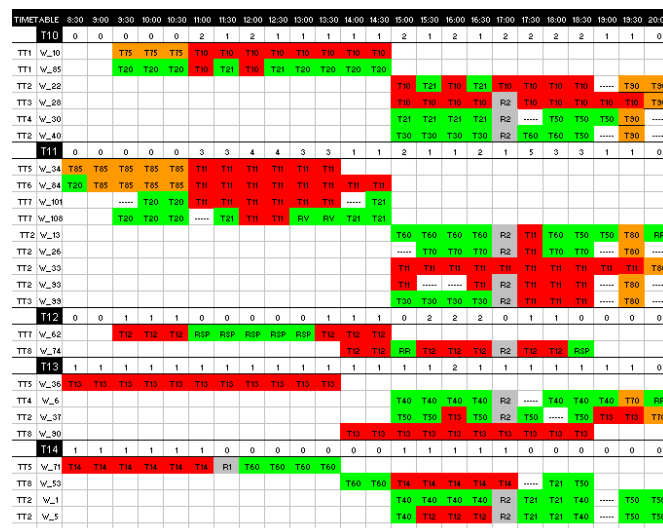


Figure 3. Task assignments (Partial view of a solution).