# Modification of employees' timetables

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**Abstract.** Workforce scheduling problems have been studied for years. The first approaches (Shift Scheduling Problem, Days-Off Scheduling Problem and Tour Scheduling Problem) had for objective to schedule workers in order to minimize total costs. Recently, another approach that takes the preferences of the employees into account in addition to costs has been developed: the Employee Timetabling Problem.
The problem that faces us is the modification of the expected planning of the employees in case of hazard. Our objective is then to change employees' assignments in order to respond to workload, while minimizing the number of modified employees' planning. We call this problem Modification of Employees Timetables (MET).

## 1 Introduction

Workforce scheduling problems have been studied for decades. However, with the appearance of new employee work legislation (particularly with the French law reducing the number of weekly working hours), these problems receive more and more interest.

Organizations must manage their employees as well as possible to stay competitive while respecting labour legislation or agreements signed with the trade unions. A better management of their workforce does not only provide direct economical interests but it also improves the employees' perception of the company which often makes them more productive, reduces their absenteeism...

[2] decomposed the workforce scheduling problems into several steps:

- **Demand forecasting**
- **Determination of the minimal Workforce size**.
- **Determination of the adequate number of employees assigned to each candidate shift**.
- **Positioning employees days off**.
- **Determination of each employee planning**.

Wren mentioned in ([3]) that these classical approaches only consider a minimal cost assignment without dealing with employees' preferences. In addition these problems usually consider only one activity to assign to employees.

Unlike the previous approaches, Timetabling problems consider several activities to perform. More recently, a special type of Timetabling Problem (the Employee Timetabling Problem) has been developed to solve workforce scheduling problem while taking employees' preferences into account.

Unfortunately, it is never possible to exactly apply the expected planning for the employees due to the absenteeism of the employees or the unpredictable emergency of a command for example. Consequently, it is necessary to distinguish another level in workforce scheduling: **modification of employees timetables (MET)**.

The next section presents MET and then two methods to solve or to model the MET are detailed.

## 2 Definition of the Modification of Employees Timetables Problem

MET problem consists in modifying the timetables of the employees (the assignment of each employee to one activity on each time period) to still respond to workload, while respecting working legislation. These modifications must be done carefully to preserve equality between employees.

We now introduce a particular MET problem that we studied in the context of service industries. The timetables of the employees must respect the constraints of French work legislation (bounds on working day duration and amplitude) and two different workload types. The first one corresponds to the classical requirements (the number of employees that need to be assigned to each activity during each time period). The second workload type is dictated by maintenance contract (the number of employees able to do a specific activity needed to be present during each time period). The problem also considers additional constraints on the maximal number of activities changes an employee can do.

## 3 Different Approaches of Modelisation

We have first tested our mathematical program using Cplex. Unfortunately the average size of the problem prevents its efficient resolution. Consequently, we propose two procedures based on generalized network flow models.

The first one is a greedy approach in which each time period is considered separately. The second one is a procedure developed to find a feasible solution for the problem, without considering the number of activity changes for each employee. These two approaches used generalized network flow models with minimal and maximal capacity and cost on each edge.

### 3.1 Greedy Heuristic.

This heuristic is based on the iterative resolution of the network flow shown in Fig. 1 on each time period of the planning horizon.

In Fig. 1, for each edge u, $b_u$ and $c_u$ represent the minimal and the maximal capacity of u; $\gamma_u$ is the cost associated to u; $\phi_u$ is the flow on u and $m_u$ is the multiplier associated to u.

A second order edge v=($Emp_i$,$Emp_iAct_j$) is created if the employee i can perform activity j in the time period considered (called t). v has the following attributes:

- $\gamma_v$=0 if $Emp_i$'s planning has already been changed during previous time periods, or if $Emp_i$ was assigned to $Act_j$ during t in the initial planning. It can also represent the cost for an employee to do a specific activity or to work during a certain time period.
- $\phi_v$=0 if $Emp_i$ was not assigned to $Act_j$ during t in the initial planning, 1 otherwise.
- $m_v$=0 if j is a rest activity, $m_v$=$K_i$ otherwise. It means that each employee assigned to a presence activity will be also counted for each activity he can be assigned to.

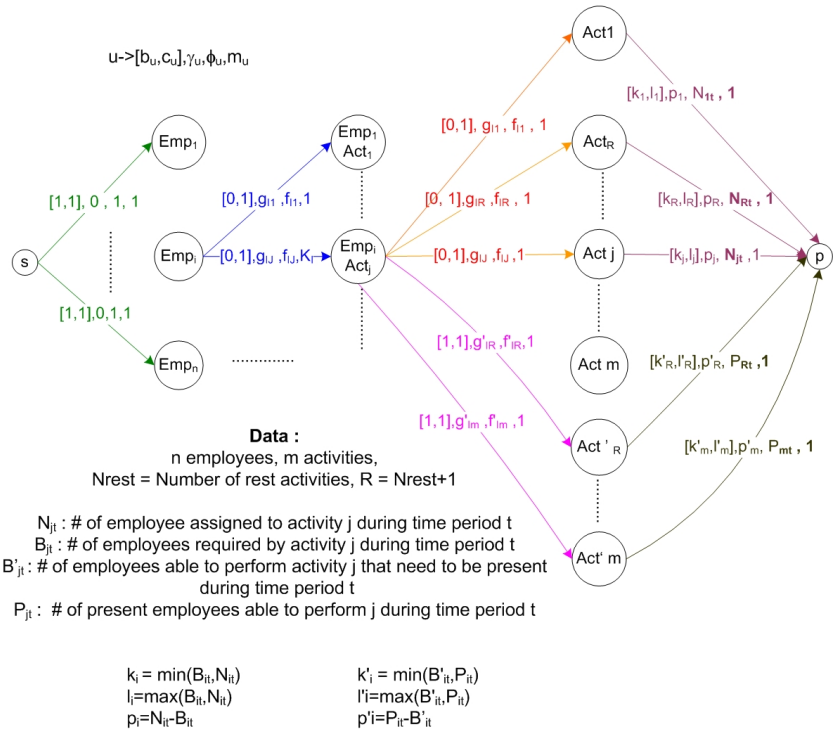


**Fig. 1.** First heuristic Network Flow Model

Edge v is not created if $Emp_i$ can not be assigned to $Act_j$ during t due to his skills or due to constraints on his maximal daily amplitude, on his maximal number of activities changes or on his maximal number of working periods per day. If edge v is created and if j is a presence activity, an edge $(Emp_i Actj, Act'_k)$ is created for each activity k $Emp_i$ is able to do.

This model is inspired by the model of the machine loading problem mentioned in [1].

### 3.2 Second Heuristic.

This approach consists in solving a network flow problem for all the periods, without taking constraint on the maximal number of changes of activities in a day into account. After solving only one network flow problem, another procedure must be used in order to obtain a solution that respects the problem constraints on the number of activities changes.

## 4 Conclusion and Future Work

The MET is a practical problem and it is particularly met in companies of services. The heuristics we present allow us to better know the complexity of our problem, but they are both limited because of the integrity of the flow that can not be guaranteed in a generalized network. Our next work will now consist in testing these heuristics performances and in developing a local search algorithm to solve this problem.

## References


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