# Can't I get no Satisfaction?
## Optimizing Workers' Satisfaction in Small Organizations

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**Abstract.** This paper describes the *S4AMT* (for "SPONSOR for Activity Matching and Timetabling") problem, arisen within the SPONSOR AAL project, whose aim is to allocate workers to a set of scheduled activities proposed by an organization. In order to maximize the outcome of the services offered by the organization, the assignment should be made so as to assign to the workers the "best task" for them. Since both the workers and the activities are finite resources, however, the optimality of the assignment of a single worker can clash with the collective well-being of the organization. In this regard, *S4AMT* aims at generating solutions which take into account, at the same time, *all* the possible assignments. This paper introduces the formalization of the problem as a generic optimization problem.

## 1 Introduction

Optimizing satisfaction in working environments directly results in the improvement of people's working life. Workers carrying out those tasks which are most congenial to them are, indeed, both happier and more productive at the same time. Assigning people the "right task", however, might represent a challenging problem both regarding the choice of the appropriate tools for assessing satisfaction as well as regarding combinatorial complexity of the assignment. The *S4AMT* (for "SPONSOR for Activity Matching and Timetabling") problem, arisen within the SPONSOR AAL project (wee [3]), aims at allocating workers to a set of scheduled activities proposed by an organization while taking into account workers' expectations.

The SPONSOR project, indeed, aims at developing, testing and implementing an ICT platform that facilitates the posting, browsing and exchange of key information between competence-offering elderlies and search-based requests, from competence-demanding organizations both in the public, private and volunteering sectors. Within the project, our team focused on the understanding of the situation of the Italian older adults who either lose their jobs or retire. In particular, we discovered how realities which help elderlies in finding again a job are few and, in most of the cases, the older adult is left alone to face a very frustrating problem. Volunteering organizations, however, seem to play an important role in retaining elderlies occupied. Thanks to these associations, indeed, elderlies feel more useful to the society and less abandoned, resulting in a better attitude

in searching new activities on a regular basis. One of the major problems of volunteering work, however, is the high level of abandonment. Hence, the main objective of these organizations is to allocate tasks to volunteers in a way that spurs them in giving continuity to their collaboration over time. Keeping persons motivated is a challenging aspect that also depends on the level of satisfaction that the volunteers have while performing the assigned activities. In this light, a feature of this problem is that doing a volunteer is not only a question of skills (hard and soft) but also of the adequacy of the activities to the predisposition of those who have to do them.

Among the different organizations we came across, Televita[1] is a volunteering association whose main tasks consist in tele-assistance services (tele-friendship) and a 24h active helpline devoted to lonely elderlies who need support. Beside these, Televita carries on several laboratories that involve elderlies both as attendees and conductors as a computer lab, a tailoring lab, an Italian language teaching for foreign people, etc. Furthermore, even if not very often, the association organizes cultural events as concerts, museum visiting, theater, etc. The overall objective is to maintain the elderlies active and motivated, leveraging upon individual aptitudes and/or competencies. Televita's volunteers, in fact, are, themselves, elderlies who want to keep active by offering their abilities and competences to the organization.

A peculiar aspect of Televita, compared to other volunteering organizations, consists in the evaluation of their volunteers which, rather than just considering their skills, takes into account, also, their attitude and their adequacy in performing specific tasks. In other words, the idea pursued by Televita is to select the volunteers according to their own inclinations and to assign them the "most suitable" activities, thus increasing the level of satisfaction and accomplishment of the volunteers and, hence, the likelihood of avoiding drop out. Specifically, the screening is performed through the periodic filling of customized questionnaires (see Figure 1) that assess the volunteers' psychological aspects so as to recognize the best suited activities for them. Such questionnaires are construed so as to extract behavioral and emotional aspects characterized by the following relevant features: (**P**) **President**, coordinates common efforts so as to achieve the ultimate goals; (**S**) **Structurer**, represents the leader of the working group; (**B**) **Brilliant**, is the source of original ideas, suggestions and proposals for the team; (**Ev**) **Evaluator**, contributes at producing precise and unbiased evaluations; **C**) **Concrete**, (is the practical organizer (**Ex**) **Explorer**, is the member of the team who goes outside of the organization so as to capture information and ideas, developing them for the common interest; (**W**) **Worker**, is the most sensitive of the team and (**O**) **Objectivist**, worries about what might end up badly.

After the answers construing process, for each volunteer, a value is associated to each of the above features. By observing these values and, in particular, the highest ones, it is possible, for a Televita manager, recognize some peculiar characteristics of the volunteer which make him/her adequate at performing some
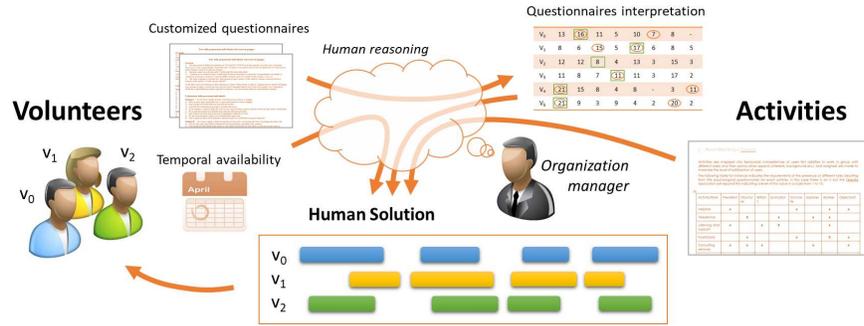
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[1] http://www.televita.org

**Fig. 1.** The Televita current modalities in managing the organization. Volunteers answer a customized questionnaire and managers, by interpreting the results of the questionnaires, assign activities to them.

specific tasks. The vector $\langle P = 21, S = 5, B = 11, Ev = 12, C = 5, Ex = 8, W = 7, O = 1 \rangle$ describes, for example, a person with a dominant *president* trait. This characterizes the person as suitable to carry out decision-making tasks. The same person is, nevertheless, evaluated as *brilliant* and as an *evaluator*, hence, suitable (albeit with less relevance) in performing other tasks.

At the same time, the organization has a set of activities, distributed over a quarterly planning horizon, to be carried out. These activities are characterized by a temporal span and by a set of required skills. An "Animation" activity, for example, might require that the "animator" volunteer is a structurer, brilliant, explorer and objectivist person. The task of the organization manager becomes, therefore, to find the most appropriate person, among the available volunteers, to carry out this task, seeking for the right compromise between people's availability, as well as their abilities and desires. It is worth noting that a volunteer who caters to a volunteering association, does so in order to feel useful and to help the society. It is, therefore, responsibility of the organization not to leave him/her without any activity to be carried out. On the other hand, the organization has some activities that must be carried out by someone and volunteers, with their skills, constitute a "limited resource", hence the idea of exploiting AI techniques so as to optimize the matching process.

## 2 The *S4AMT* Problem

The *S4AMT* problem consists in assigning a set of *activities* $A$ to a set of *volunteers* $V$ while taking into account behavioral and emotional aspects. Each activity $a \in A$ has its own *execution interval* $t_a = [lb^a, ub^a]$ representing the span of time within which the activity is carried on (e.g. $[8:30, 10:30]$). In addition, each activity $a$ has associated a *skill vector* $\mathcal{S}_a = \langle q_0^a, \ldots, q_7^a \rangle$ of boolean values representing the relevant skills needed to perform the activity (e.g. $\langle P = 0, S = 1, B = 0, Ev = 1, \; C = 0, Ex = 1, W = 1, O = 0 \rangle$). At the

same time, each volunteer $v \in V$ has his/her own *temporal availability* $\mathbb{T}_v = \{[lb_1^v, ub_1^v], \ldots, [lb_i^v, ub_i^v]\}$ representing the temporal intervals within which the volunteer has provided willingness in performing activities (e.g. $\{[8:00, 11:00], [13:00, 15:00], [32:00, 35:00]\}$). Furthermore, each volunteer $v$ has associated a *psychological profile vector* $\mathcal{P}_v = \langle p_0^v, \ldots, p_7^v \rangle$ representing the 8 values resulting from the interpretation of his/her questionnaire (e.g. $\langle P = 15, S = 5, B = 8, Ev = 14, C = 5, Ex = 8, W = 10, O = 5 \rangle$).

For each of the $\langle v, a \rangle$ couples we introduce a binary integer variable $d_{v,a} \in [0, 1]$ and give it the following semantic: $d_{v,a} = 1$ if and only if the volunteer $v$ performs the activity $a$. The task of the solver will be to assign values to such variables while guaranteeing that (i) each volunteer performs at least one activity (we recall that volunteers should feel useful), (ii) each of the activities should be performed by someone (more specifically, by exactly one volunteer), (iii) volunteers' temporal availability should be compatible with the assigned activities temporal span and (iv) each volunteer can perform at most one activity at a time. Additionally, in order to consider the volunteers' attitudes and preferences, we introduce the concept of *adequacy* $w_{v,a} = \mathcal{P}_v \times \mathcal{S}_a^T$, representing how much a volunteer $v$ is "adequate" in performing the activity $a$ (e.g. $15 \times 0 + 5 \times 1 + 8 \times 0 + 14 \times 1 + 5 \times 0 + 8 \times 1 + 10 \times 1 + 5 \times 0 = 37$). We can thus introduce the objective function of the optimization problem: $\sum_{v \in V, a \in A} w_{v,a} d_{v,a}$. Maximizing this expression, given the premises, guarantees an optimal assignment, in terms of the *adequacy*, of the activities to the volunteers.

*General constraints.* Once the decision variables have been introduced, it is possible to enforce constraints among them. Specifically, guaranteeing that each volunteer performs at least one activity, can be expressed by means of the expressions $\sum_{a \in A} d_{v,a} \geq 1 \quad \forall v \in V$. Analogously, guaranteeing that each activity is performed by exactly one volunteer can be expressed as $\sum_{v \in V} d_{v,a} = 1 \quad \forall a \in A$. The expression $[\neg \exists t_k \in \mathbb{T}_v : t_k \subseteq t_a] \Rightarrow d_{v,a} = 0 \quad \forall v \in V, a \in A$, where $t_k \in \mathbb{T}_v$ represents the temporal availability of the volunteer $v$, $t_a$ the temporal span of the activity $a$ and $t_k \subseteq t_a$ is true if the interval $t_k$ *contains* the interval $t_a$ (i.e. $[lb(t_k) \leq lb(t_a)] \wedge [ub(t_a) \leq ub(t_k)]$), guarantees that the temporal availabilities are met. Finally, the constraints $\sum_{a \in O} d_{v,a} \leq 1 \quad \forall v \in V, O \in Overlaps$, where $O$ represents the $i$-th set of all the temporally overlapping activities $Overlaps$ within the foreseen plan's horizon, forbid the assignment of more than one activity at a time to the volunteers. Notice that a viable strategy for computing the $O$ sets consists in adapting the "collecting peaks" procedure described in [4].

*Additional constraints for a more realistic modeling.* From the interaction with the volunteering organization, further constraints have emerged for guaranteeing the generation of solutions that can be feasibly enacted by both the organization and the volunteers. These additional constraints are intended to refine the produced solutions, taking into account further factors which are not considered by the previous modeling. A first constraint, for example, is aimed at limiting the working hours of people in order to improve the fairness. Furthermore, the organization aims at reducing the job demand on public holidays (e.g. Sundays) implementing a simple turnover strategy. Additionally, further

constraints deal with managing particular cases. Some activities, indeed, can only be carried out by some people having some specific skill or authorization. A visit to a museum, for example, requires the use of a bus that can be driven only by a volunteer with the appropriate driving license.

## 3 Conclusion and Future Work

This paper introduces the *S4AMT* problem as an optimization problem. The *adequacy* concept plays a crucial role within the objective function guiding the optimization process towards the assignment of the right activities to those volunteers which are most likely to carry them out. The pursued overall aim is to find the best match that respects the tasks' constraints while maximizing the level of satisfaction of elderly users, thus contributing to increase their level of motivation in performing volunteering work.

By relying on some pre-packaged solvers (namely, Choco[2] and Z3[3]), a complete system, aiming at serving small organizations with similar structures, has been developed [1]. As the problem size increased, however, it quickly resulted as intractable forcing us to use more sophisticated techniques [2]. At current state, the system can help the human users to find better solutions with respect to an hand-made current practice. In the near future we would like to perform some additional exploration of different optimization procedures ranging, for example, from those based on Large Neighborhood Search to those based of Genetic Algorithms. Improving the search techniques, indeed, would allow us to scale towards larger organizations.

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[2] http://www.choco-solver.org/
[3] https://github.com/Z3Prover/z3