About the algorithm for construction of coordinated university timetables

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Abstract. The factual description of the task and an algorithm for drawing up a coordinated timetable of academic work of the faculty and students at the level of department (local timetable) is presented, as well as the procedure for integrating private schedules, i.e. the formation of a university-wide timetable. Coordination of the latter has not only spatio-temporal in nature, but also takes into account the preferences (interests) of agents (users and performers of works).

1. Introduction

A complete mathematical model of the elements of academic work and university timetable, is not given here due to its cumbersome nature. It can be found in [1]. The most important elements of the department timetable are:

a) the disciplines taught at the department $\overline{DS^d}$;

b) faculty of the department $\overline{F^d}$;

d) groups of students $\overline{G^d}$ taught by the faculty;

e) classrooms $\overline{Cl}$, laboratories $\overline{La}$ and other resources assigned to the department.

Preferences of the performers (teachers and groups of students) can be formally represented by the corresponding matrices $Mr[d,t]$, $Mr[d,t,(cl\,|\,la)]$ where d – the day, t – the time slot (or "class"), cl – classroom, la – laboratory.

The essence of the problem is formed as follows. Agents of the department – faculty and groups of students; resources of the department – laboratories (la), classrooms (cl) and other collective workplaces; types of academic work – lectures, practical classes, laboratory classes, etc., are given. The requirements for specific performers of works (teachers and groups of students) are defined. The department's assets are linked by relationships, which are well illustrated by a typical academic workload form, see below (figure 1).

Drawing up of curricula and preparation of teachers academic workloads is a number of related tasks that are indirectly present in the task of constructing the academic work timetable. In order to avoid collisions when merging local (departmental) timetables, it is desirable that the elements $\overline{DS^d}, \overline{F^d}, \overline{G^d}, \overline{Cl^d}$ from different departments do not overlap with each other.

Academic secretaries of different departments who form local timetables and academic workload should mainly use only their own assets when planning educational works and the range of timeslots allocated to them. Such requirements can be met in practice. For example, the prerequisites for a simple merging of departmental timetables into the university-wide one without collisions can be formulated in a semantic statement: “if the academic secretary of a graduate department N is using only its own assets {groups, faculty, subjects and classrooms} and the timeslots allocated by the administration, then there will be no collisions when merging the local departmental timetables into the university timetable”.

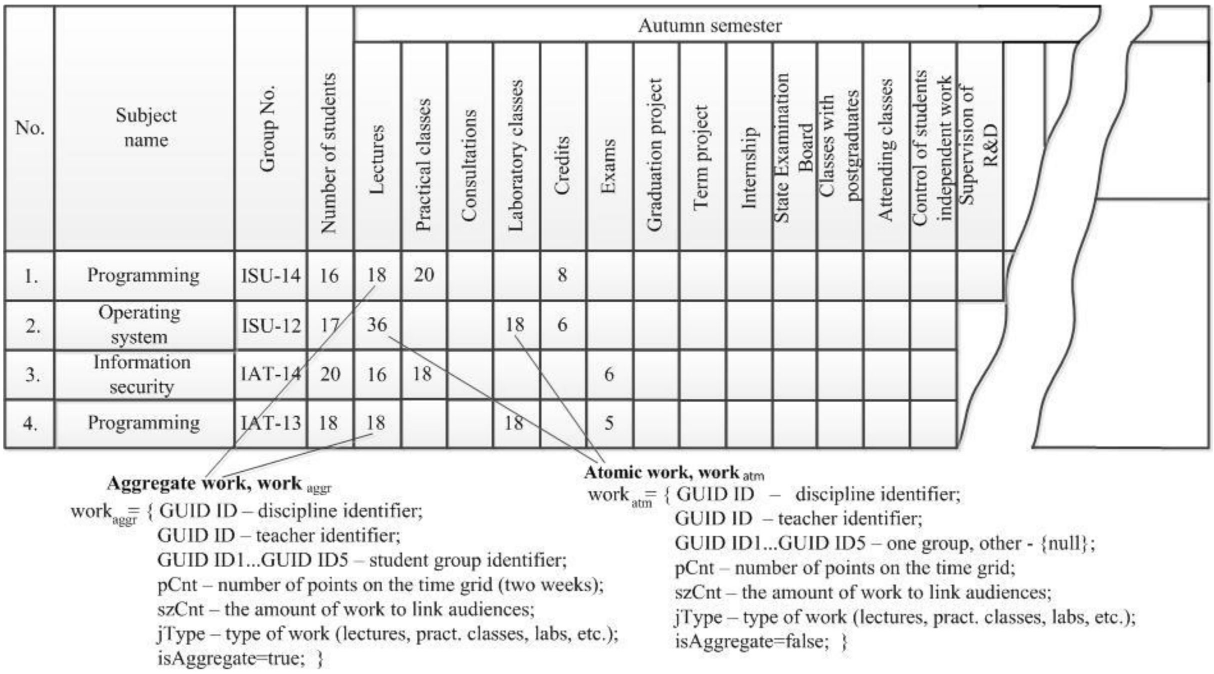

Figure 1. Structure of the teacher’s academic workload.

1) On the basis of faculty academic workload of the department to form academic works (indicating for each of them the following information: subject, teacher, location, desired time) with certain properties that can be distributed on the time grid. The work must correspond to one type of activities (lecture, practical class, laboratory work, etc.), as well as one or more groups of students.

2) To form a cluster of restrictions, to which the impossibility of using a certain asset (teacher, classroom, student group, subject) several times, within the same time slot (“classes”) [d,t] belongs to.

3) To distribute the works on the time grid so that all work time counters (or time-slot counters) would turn into zero values, and often contradictory requirements of the performers would be taken into account with regard to “hard and soft” restrictions on the final timetable.

Despite the “simple” factual description, the formulated problem is complex, both from the position of algorithmic machine realization, and from the point of view of computational growth (in other words, it is NP-difficult). However, the relatively low dimensionality for a separate department allows us to obtain a coordinated solution.

2. Algorithm for priority distribution of training activities

The authors propose a general algorithm (figure 2) for the priority distribution of academic activities, which can be used to synthesize timetable agreed with performers of timetables. In fact, a human-machine procedure is proposed, which consists of three main stages:

1) Formation and actualization of information for the preparation of the classes timetable, including a list of all departmental assets and a list of requirements (wishes) of performers (agents);

2) Machine synthesis of the departmental timetable, according to the criteria of minimizing the “gaps” and maximizing the requirements of agents.

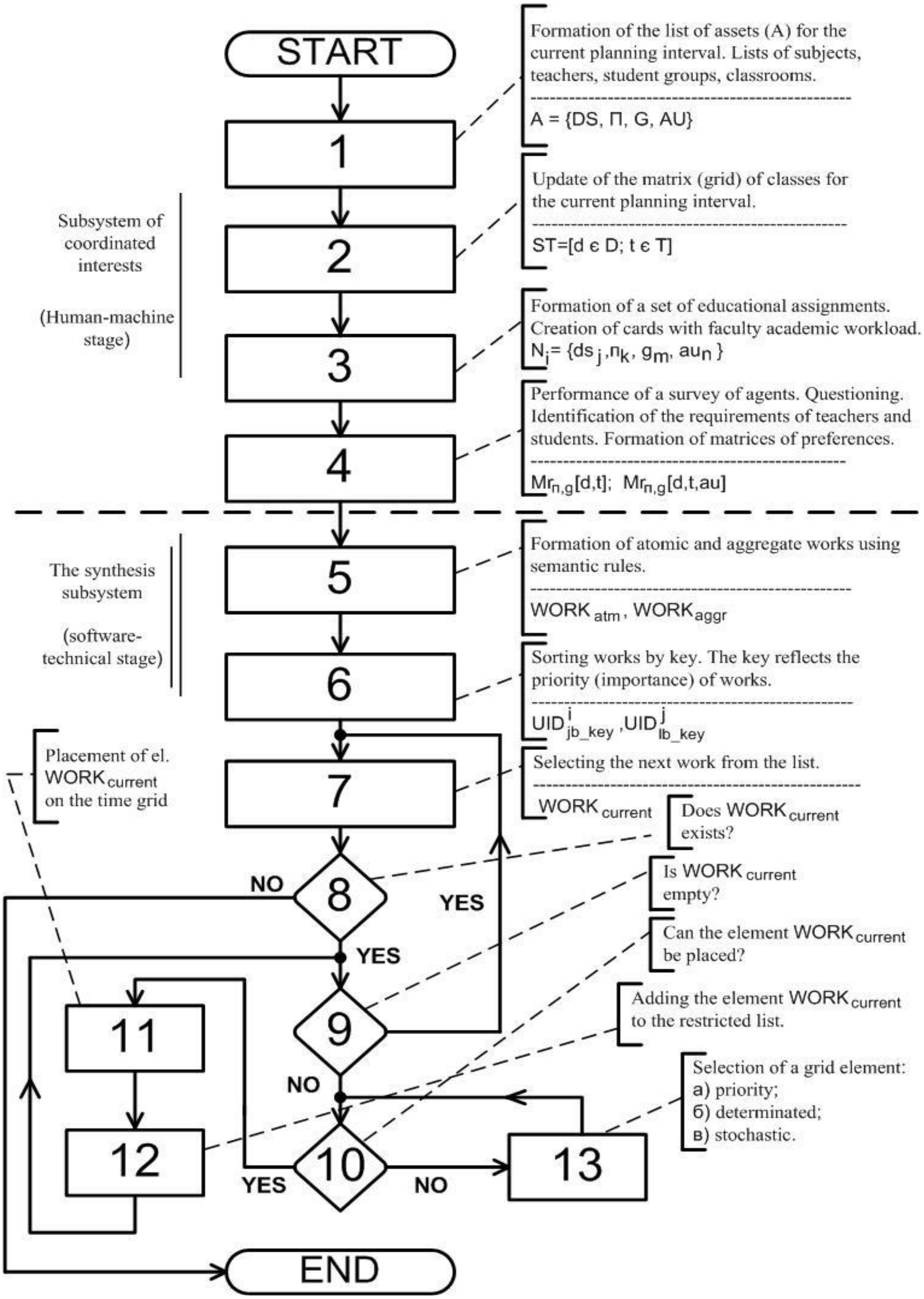

Figure 2. Consolidated procedure for the priority distribution of academic activities.

3) The merging of departmental timetables into a university one is carried out in the absence of collisions of previously formed fragments. If it is impossible to meet important requirements for assets, it is advisable to allocate additional timeslots in the timetable.

One of the most important requirements for the algorithm is the formation of correct, qualitative timetables at each stage of synthesis. This need is caused by a large number of information links, varying preferences of performers and indirect dependencies. The keys of priorities sorting are defined by the expressions (1) (2):

$$UID_{jb\_key} = \sum_{d=1}^{D}\sum_{s=1}^{S} Mr[d,s] \tag{1}$$

where UID_{jb_key} – the key of sorting for the greedy algorithm in the "teacher –group – academic load" space.

$$UID_{lb\_key} = Mr[d,s] \tag{2}$$

3. Conclusion

The article considers the task of synthesizing coordinated departmental timetables [1, 4], taking into account the wishes (requirements) of the performers. Consolidated human-machine procedure can be implemented as a part of large algorithmic complex of timetable construction [2] or within a separate software product. Modifications and processing of individual elements of the algorithm are allowed as it is implemented in software, as well as in the event of technical problems or organizational problems.

References

[1] Dobrynin A S et al 2013 *Scientific Review* **9** 95–101
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[4] Koinov R S et al 2013 *Bulletin of the Development of Science and Education* **6** 23–27