Extended Task Representation Model in Personal Task Managers and New Methods of Task Processing for User Advanced Interaction Organization

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Abstract. On the basis of analysis of modern planners, their main drawbacks and ways to overcome them were identified. The notion of event with an uncertain timings is defined and algorithms of the dynamic planning with regard to events of this kind are proposed. K-diagram ontology of task managers with elements of artificial intelligence is submitted.

Key words: algorithm, data, event, planning, uncertainty, ontology.

In modern world people are always forced to handle large amount of diverse information. And then make decisions and schedule their time based on it. Task preplanning helps to increase efficiency in any sphere of activity as personal or professional one. Today the most popular tool of personal planning is task manager software that have replaced their paper analogues [7].

Based on made modern task managers analysis [4] it identifies its main disadvantages and methods of how to fix it.

Mainly electronic organizers deals with tasks that has start time only. In table 1 it shows task classification depends on its time conditions.

<table>
<thead>
<tr>
<th>Kind</th>
<th>Task start time</th>
<th>Task end time</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>II</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>III</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Mainly modern task managers can operate with kind I tasks. Such kind of tasks support is completely made in any task manager today. Graphic model of kind I tasks is shown at figure 1. Examples of such kind of events may be a phone call or eating.
Figure 1. Graphic model of kind I tasks

Kind II tasks indirectly determine the duration $\Delta t_i$ of time period during one task is made. This assumes that $\Delta t_i \leq t_{\text{fin}} - t_{\text{start}}$, where $t_{\text{start}}$ — task planned start time; $t_{\text{fin}}$ — time not later one task should be finished. Such kind of tasks widely available in modern task managers but it can’t be handled because of lack of methods for its processing. So only few task managers allows user to use kind II tasks. Graphic model of kind II tasks is shown at fig. 2. Examples of such kind of events may be book reading or article writing.

Figure 2. Graphic model of kind II tasks

Kind III tasks have no defined time borders. Normally all task managers have ability to represent it but no one can remind user about it because there is no basis for making notify. There is no task start time. In case of time borders lack the determining factor becomes situation context. It’s task location, task category and task priority as well. Based on this data it can be defined time borders for such kind of task automatically during making user schedule. Graphic model of kind III tasks is shown at figure 3. Examples of such kind of events may be one of lamp’s light bulb replacement or noncritical car fixing.
It should be noticed that there is a case when task requires only end time defining. That kind of tasks can be described as kind II tasks there task start time is current time moment.

Location property often is very important in task definition. However only few modern task managers somehow support location representation by interacting with user. This process requires to be automatic that allows to make completely new notify system. Today we have everything that is required for making user continuous location tracking. All needed data can be collected from widespread GPS and GLONASS modules or local location tracking gears that use ultrasound and infrared radiation.

In most modern task managers task linking implemented very erratically or simplified. Meanwhile this feature requires well-organized data structure and convenient representation at user interface. E.g. it may be graph — a network with priority relations. Ordered set of works allows to make automatic planning of optimal schedule for end user.

Normally modern task managers have two task classes: task itself and to-do item there each class has its own properties. To improve task representation it should be reorganized all task classes in one unified class. It may improve and simplify schedule making process as well.

First step for implementing of proposed ideas is to make knowledge representation system for task manager with artificial intelligent elements.

Comparing research work of different knowledge representation models was done [6], [2]. Specialization of data representation in personal scheduling is simple enough to refuse of using neural networks [9] and frame–based models [8] in it. Changing task properties with time makes doubtfully to use fuzzy logic [5]. Thereby it was decided to take ontology model for data representation [5]. It has one of the most efficient model structures for our specialization and can be easily implemented as software as well. K-diagram of designed ontology is shown at fig. 4.

Most important things of defined representation becomes classes «Location», «Time», «User», «Task» and «History». To improve interaction efficiency between user and task manager task location coordinates should be used as one of major parameter automatic making of user schedule. Logically user should have location properties as well.
Thereby user location relatively to forward task locations gives task manager additional important information. To represent all described task kinds time condition class has 3 slots: start time, time duration and end time. To collect data about current situation context and to plans kind III tasks task manager uses history of completed tasks. In conclusion of ontology special features describing it should be noticed about low prevalence of embedded task representation in modern personal planning software. This is serious disadvantage because splitting one big task to chain of linked small tasks may increase the convenience of making scheduled tasks [1], [3]. Thereby it offers to use dependent on each other tasks scheme based on the nesting.

![Figure 4. Ontology K-diagram of task manager with artificial intelligent elements.](image-url)
The next step is to make planning algorithms for creating user schedule. The most simple and importance at same time becomes handling of kind I tasks because they are solid and defined by time borders. Thereby that kind of events originally included in user schedule so task manager no needs to calculate notify time, controls task breakdown and resolves conflicts itself. Only user can directly change task I time properties. The most important parameter in this case becomes current time that task manager compares with kind I task time properties. Such kind of algorithms already was well implemented and used in all modern task managers and allows to successfully operate with kind I task.

The singularity of kind II task is that its duration can be less than planned time borders. Because of that this task category has twofold characteristics. From the one hand user defines task time borders. And from the other hand task manager should controls task execution part by part. The strategy of kind II task planning bases on tracking how many time left before task end time. In the beginning task manager send task start notify to user as in kind I task case. When user interrupts (but not ends) task execution (e. g. for resting or executing other task) task manager notifies user at certain time intervals about to back to current kind II task. User can interrupt and back again to kind II task several times. When task duration time left will be equal to residual between task end time and current time task manager will notify user about it and then will ask about changing task end time. Because of kind II task can divided to several parts that overlap with kind I tasks is allowed during scheduling.

Kind III tasks are most problematic category today. Because modern task managers have no methods to handle it.

Task manager should make decision of including to schedule kind III tasks itself based on situation context:

- free space in schedule — space between end time of previous task and start time of next one kind I or II task. If task location is defined then time needed to reach it shouldn’t exceed free schedule space plus time needed to arrive in next kind I or II task;
- location \((s)\) — if user define task location then in other equal conditions the task with lower location distance should be included into schedule;
- category \((c)\) — based on completed tasks history task manager should make decision of user preferences. That is task of what category user more prefers to make in current time period. Of cause preference for including in schedule should be given to task with most similar categories;
- priority \((p)\) — in spite of time borders lack user can specifically define importance level for task. In other equal conditions It should give preference to task with most higher priority.

To calculate quantitative indicator of most suitable task for current situation the special index of suitability was invented. To calculate this index each context task parameter (except time) should be normalized and multiplied by user coefficient of importance:

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i_j = k_s \frac{s_j}{s_{\text{max}}} + k_c \frac{c_j}{c_{\text{max}}} + k_p \frac{p_j}{p_{\text{max}}},
\]
There \( s_i \) — current task distance; \( s_{\text{max}} \) — maximum distance among all viewing tasks; 
\( c_i \) — current task counter of matches current task’s tags with tags of previously completed in same time tasks; \( c_{\text{max}} \) — maximum of tag match counter among all viewing tasks; 
\( p_i \) — current task priority; \( p_{\text{max}} \) — maximum priority among all viewing tasks; 
\( k_s \) — coefficient of importance for task distance; \( k_c \) — coefficient of importance for tag match counter of task; \( k_p \) — coefficient of importance for task priority.

The algorithm of choosing most suitable task for plan including can be described in follow words. At first step free time space is calculated and based on that kind II tasks is selected by index described above. If task has no defined location it is included in list. Then index of suitability calculates for each task of selected ones. And if task has no location then normalized value becomes one and if task has no categories or priority then normalized value becomes zero. Onward tasks are ordered by descending index and user notifies about task with greatest index.

Kind III tasks can fill almost all unplanned time space in user schedule. Thereby using such kind of tasks we have maximized amount of time that will be spend for task executing. Undoubtedly it improves user working efficiency, increases amount of completed tasks and decreases user idle time. After all it saves user from necessity to carefully design task schedule every day and to dynamically correct it during execution.

Thereby described ontology of knowledge representation and methods of making user schedule for task manager with artificial intelligence have all features that need to fix disadvantages of modern organizers. Based on new ontology and planning methods new data structures, algorithms and logical rules can be done to bring artificial intelligence behavior to scheduling software. A well it definitely makes task manager capabilities closer to human secretaries. Therefore it increases user convenience of planning.

References


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Модель расширенного представления событий в персональном планировщике и новые методы их обработки для организации интеллектуального взаимодействия с пользователем

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Аннотация. На основе анализа современных планировщиков выявлены их основные недостатки и определены пути их устранения. Определено понятие события с неопределенными временными характеристиками, предложены алгоритмы динамического планирования с учетом событий такого рода. Предложена К-диаграмма онтологии планировщика с элементами искусственного интеллекта.

Ключевые слова: алгоритм, данные, событие, планирование, неопределенность, онтология.

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