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Towards Intelligent Personal Task and Time Management: Requirements and Opportunities for Advanced To-do Lists

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Abstract: Today's working world can be characterized by an increase in flexibility, complexity and speed. For employees, it is challenging to keep pace to dynamic professional requirements and to constantly collect and prioritize necessary tasks in order to stay well-organized. While there is a plethora of IT-supported to-do lists that help to remember important or necessary tasks, these lists are predominantly rather simple and provide only little support for managing work and life. Hence in our paper, we focus on advanced approaches for personal task and time management via improved IT-supported to-do lists. Such lists could proactively support the user by (i) collecting and prioritizing tasks, (ii) providing context-sensitive reminders and (iii) tracking activities in order to provide insights regarding progress, productivity and health-related aspects that in sum could be considered as "intelligent". Towards the IT-supported realization of such lists, we collect initial requirements by analyzing existing and upcoming tools as well interviews we conducted about work organization with professionals in the IT-domain. Based on this, we provide an integrated requirements catalogue and comment on opportunities for further research.

Keywords: Task and Time Management, To-do Lists, Assistance Systems.

1 Motivation

The digital transformation has rapidly changed and continues to change the world of work tremendously. On the bright side, improved work flexibility [SCT12] in terms of content, time and location provides employees with additional autonomy with regard to how they do their jobs. On the dark side, work can be characterized by high complexity, time-pressure, constant interruptions and multi-tasking as well as work-intensification that is ongoing over decades [GM01]. In sum, employees face growing challenges upon managing their work and keeping track of relevant tasks as well as managing progress, productivity and health. Therefore, it is of vital importance to equip employees with powerful tools in order to tackle these challenges and be successful. In this regard, it can be observed that in daily work, many activities or projects typically involve a series of tasks, people, deadlines and locations. No matter how big or small these projects are, success is always largely dependent on the organizing skills of the people involved. This is still a big challenge that

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often is mastered with the help of simple means such as paper-based to-do lists, or notepads, despite the many technical possibilities. However, these methods are time-consuming and also not always effective, since e.g. reminders are missing. In spite of a plethora of applications on the market that are designed to provide better time and task management, most of them are rather a digitalized version of paper-based to-do lists or notebooks and lack intelligent features such as context-sensitive reminders. Context-sensitive means that, for example, reminders of important tasks such as project planning do not appear when the user is attending a meeting or that reminders appear only on pre-determined locations or situations. While some to-do lists already provide such features, a more sophisticated approach should consider the task context as well. With this, using an email or calendar application could trigger another task context and thus different reminders than e.g. working with an Integrated Programming Environment (IDE). State-of-the-art tools are largely unable to learn or draw logical conclusions that would be needed for such behaviors. A further example illustrating this deficiency is booking a conference trip that takes place for several days abroad. This usually includes booking a hotel and means of transport. However, state-of-the-art to-do list tools usually cannot infer this even if such a behavior occurred frequently in the past sequences of user actions. In sum, intelligent to-do lists would relieve the user by automatically collecting and resubmitting tasks, while recognizing priorities, scopes of tasks, and deadlines. Beyond that, they could additionally assist the user in tracking activities in order to provide insights regarding progress, productivity and health-related aspects. In this regard, they could e.g. suggest tasks implying concentrated and complex work when the user is at its daily performance peak or could remind the user to take a break. Finally, an intelligent to-do list should provide integration with established software like Outlook and fitness trackers. To sum up, support for personal task and time management with intelligent to-do lists is highly relevant still today. Despite this relevance, requirements for intelligent to-do lists are still an under-researched topic which we address with our preliminary contribution. To do so, we elicit requirements from literature, existing tools and interviews and compile them into a preliminary requirements catalogue.

2 Background

Increasing the degree of automation for to-do lists is a great challenge. Although they are a popular tool for managing personal information, unfortunately they do not yet act according to user behavior. Furthermore, entries are currently only written in free text, from which the system cannot derive any useful information [GR08]. In this way, GIL and RATNAKAR emphasize the capability of to-do list systems to extract details from the user's free text and create a task [GR08]. An early approach in this direction is the concept of RHAICAL [FM05]. Moreover, once a task (e.g. visiting a conference) has been recognized, advanced approaches try to create action plans for tasks (e.g. book hotel, book transportation) [Ko13]. One important problem here is that systems would need to have "common sense" or domain knowledge. An example for the former would be that the systems knows how long a project status meeting usually lasts. An example for the latter would be that it should know when people usually have dinner or how long a dinner usually lasts. It could even imply to draw logical conclusions, such as not inviting a vegetarian to a dinner in a steakhouse. The need of learning "common sense" knowledge and acting accordingly to save the user time when inputting data has already been put forth by [Mu00]. However, in order to provide an effective support in personal task and time management, also user preferences are important and could complement "common sense" knowledge. This has already been acknowledged by Berry et al. [Be06] and is explored more recently by GEETHA et al. [GAK18]. In this context, it is stated that the biggest time management problem is purely personal. Every person, especially very busy workers, have different background preferences regarding the calendar. This includes e.g. priorities and times of tasks, but also to what extent these tasks are shared with others. In this direction, PTIME was developed as one of the first applications that memorized and learned the preferences of the user [Be06]. More recently, the INTELLIGENT DAILY SCHEDULER was developed which automatically generates free time slots for upcoming tasks from the free time of the personal calendar and learns by repetitions [GAK18]. While it is important to recognize to-dos and make plans, it is equally important to remind the user if he or she is unaware of upcoming tasks or appointments. However, already two decades ago, studies have shown that many users have a problem with their reminders because they appear at inappropriate times. This led to the observation that context-information is needed for the generation of adequate reminders [DA00]. Regarding timing for reminders, much can be learned from the stream of research concerned with timing for work interruptions, see e.g. [Ri17] for a literature review. Regarding location-aware reminders, current approaches try to additionally infer the correct location for task reminders [SMO18]. To summarize, there are ongoing developments in regard to to-do list item creation, task planning and context-sensitive reminders. In spite of this, statements about requirements are scattered among these works and also do not consider two important aspects. First, they do not investigate what current tools developed outside scientific research offer the user in response to (presumed) market demands. Second, they do not contain empirical statements about what employees consider as important features. Our contribution hence lies in addressing this gap by summarizing requirements found in literature and derived from state-of-the-art tools and interviews with employees. Our requirements are then compiled into a preliminary requirements catalogue.

3 Requirement Elicitation

3.1 Sources for Requirement Derivation and Procedures

Requirements were collected using two different methods. First, *literature and tools* were studied. Since some tools have not yet been described in scientific papers, we opted against separating requirements from scientific papers and those identified by inspecting tool descriptions. Searching for literature and tools was accomplished using various web search engines with combinations of keywords such as "artificial intelligence", "time management", "task management", "calendar tool", and "time tracking". For the identification of state-of-the-art tools, we used one major product weblog where innovative products are announced, namely on PRODUCTHUNT. Second, we conducted *semi-structured in-depth interviews*. An interview guideline was prepared in advance and followed during the interview. In the first part of the interview, partners were asked questions about their current methods for time and task management. They were then asked whether they could imagine using applications that solve such tasks in an intelligent way and what functions these applications should have (the term "intelligent" was clarified beforehand). Since the interviewees should also consider visionary future technologies and not only focus on the state-of-the-art, the next part asked for functions of such systems that could be developed in the next 20 to 30 years. At the end of the interview, the interviewed persons prioritized the functions collected in part 2. A total of four people with a background in IT-industry took part. A fifth participant served as a pretest. However, since the results of this pre-test were also helpful for the evaluation, it was also included in the overall evaluation of the interviews. The evaluation of the interviews was based on MAYRING [MF14] using the software MAXQDA to support the interpretation and coding process. Finally, a consolidated requirements model was created (see Section 3.2).

3.2 Consolidated Preliminary Requirements Model

The consolidated requirements catalogue has been developed based on all requirements identified using the sources and procedures described in the section before. This involved a process of consolidation, clustering and ordering of the requirements. The final catalogue is presented in the form of a mind map (cf. Fig. 1). It moreover indicates the source as well as the frequency range of elicited requirements per category.

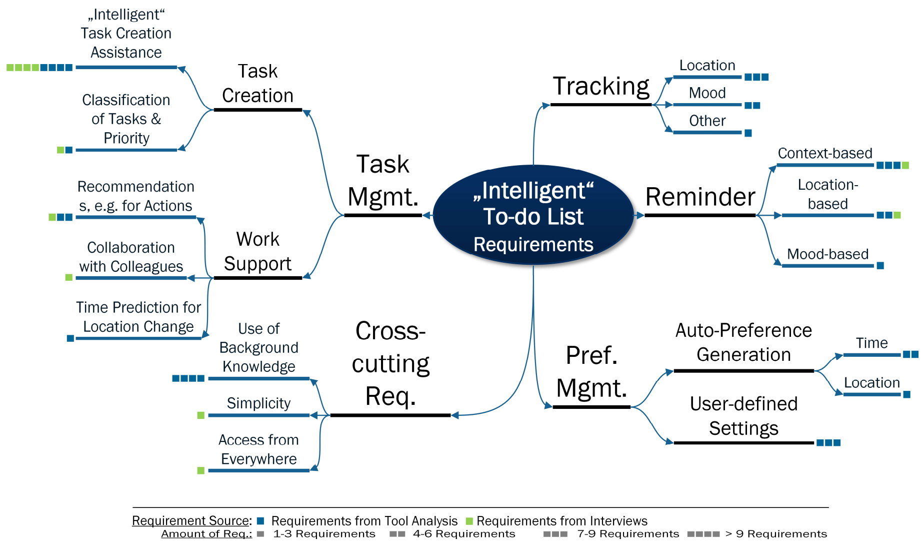

Fig. 1: Requirements catalogue for IT-supported "intelligent" to-do lists

Requirements fall into five broad categories: *Task Management*, *Tracking*, *Reminder*, *Preference Management* and *Cross-cutting Requirements*. In more detail, *Task Management* contains requirements regarding the creation of tasks and work support. The former mainly comprises "intelligent" assistance for the creation of tasks based on textual descriptions, e-mails or from voice messages as well as classification of tasks according to pre-defined categories and prioritization. The latter comprises requirements for working with the to-do list such as recommendations for the next best action, sharing to-dos with colleagues and receiving predictions for the time needed to physically change the location that e.g. depends on the transportation means and traffic, which some of the advanced tools already provide. Since the to-do list should adapt to the context, *Tracking* is required. Here, location, mood and other tracking data (e.g. time-use or physiological data) have been elicited. Tracking such data can be used for more adequate *Reminders* that could be context-based, location-based or mood-based. While location- and mood-based reminders simply take the users' GPS position and emotional state into account, context-based reminders could be adaptive to the current situation in complex ways, e.g. considering what the user has done before, what the user could do now and what the goals of the user are. In regard to *Preference Management*, the system should be able to learn preferred timeslots or locations for engaging in to-dos based on previous data (e.g. no appointments on early Monday morning) as well as provide the possibility for various user-defined settings. Finally, in regard to *Cross-cutting Requirements*, the system should be capable to leverage background knowledge such as preferences of co-workers (e.g. working times, diet preferences for meetings) or common-sense knowledge (e.g. public holidays, average speed of transportation means) and should be simple to use and accessible from everywhere, which could be accomplished via cloud-based access.

3.3 Discussion

Regarding requirements elicitation from literature, despite the large amount of popular guidebook literature, surprisingly little works are available on the precise topic of IT-supported personal task und time management, and even more so in regard to to-do lists. In addition, found literature mainly offered descriptions of developed tools from which requirements had to be derived since they were not explicitly mentioned. As a further limitation of our research, we focused on functional requirements and some cross-cutting aspects, leaving non-functional requirements largely open for future research. Regarding tool analysis, PRODUCTHUNT was useful to get an overview of current tools on the market. Most of the functions however had to be derived from user comments or by downloading and testing the tools, since often no in-depth documentation was available. Finally, regarding requirements elicitation with interviews, it was helpful that participants were invited to actively think about requirements of advanced future tools. A major limitation of the research in this direction is the number of five interviewees with IT-background which creates potentials for future research.

4 Conclusion and Research Opportunities

Despite the fact that personal time and task management is one of the most important topics in work life, surprisingly little research is available so far regarding the requirements for intelligent task and time management tools that could be embodied in "intelligent" to-do lists. Therefore, our work makes a contribution in this field, although our results are very preliminary. However, we provide a preliminary overview of key requirements of intelligent task and time management systems that support the user in the creation of to-dos and provide context-sensitive reminders or suggestions for relevant tasks. Future research opportunities lie in the interrelation of these requirements, e.g. context-sensitive reminders require in some form tracking the user. Further research opportunities lie in the selection, adjustment or adaptation, application and finally evaluation of research results of various sub-fields of Computer Science, Business Information Systems and Organizational Psychology. In regard to task management, the question is *how natural language processing for extraction of information from texts could be combined with other data* (e.g. previous tasks performed on the day) to increase the accuracy of do-do item generation. Moreover, psychological models could be used to explore the question *how the ordering of daily tasks may impact the individual*, e.g. in terms of perceived progress or fatigue at the end of the work day. This could be relevant to optimize the ordering of to-dos. Likewise, the utility of physiological models of cognitive performance in relation to the time of day for task ordering could be studied. Regarding tracking, further questions would be to *analyse the prospects and limitations of integrating work-related time tracking data with more physiological tracking data into a combined approach*. For example, heart rate variability (HRV) allows to detect stress, but the question is whether such data could be applied in task scheduling to avoid stressful working conditions. Regarding reminders, the challenge is *how to predict the acceptability and utility of a reminder that might interrupt the user*. Extensive prior research on work interruptions can be leveraged on this aspect as well as machine learning techniques. Finally, regarding the user model, the question is *how to combine different approaches for knowledge representation* such as rules, ontologies, or general common sense knowledge catalogues like [Ko13] with machine learning techniques. All in all, intelligent personal task and time management offers a plethora of interesting research questions. They are worthwhile to explore not only for the sake of improved "mechanization" of planning and scheduling activities, but also for ensuring long-term productivity, well-being and health.

Bibliography

[Be06] Berry, P. et al.: Deploying a personalized time management agent. In: Proc. of the 5th int.l conf. on Autonomous agents and multiagent systems. ACM, NY, 2006; p. 1564.

[DA00] Dey, A. K.; Abowd, G. D.: CybreMinder: A Context-Aware System for Supporting Reminders. In: Proceedings of the 2nd international symposium on Handheld and Ubiquitous Computing. Springer-Verlag, London, UK, 2000; pp. 172–186.

[FM05] Faulring, A.; Myers, B. A.: Enabling rich human-agent interaction for a calendar scheduling agent. In: CHI '05 Extended Abstracts. ACM, 2005; p. 1367.

[GAK18] Geetha, J.; Akanksh, B. S.; Koushik, A. S.: Intelligent Daily Scheduler. In: 2018 ICACCI. 19-22 Sept. 2018. IEEE, Piscataway, NJ, 2018; pp. 2308–2312.

[GM01] Green, F.; McIntosh, S.: The intensification of work in Europe. In Labour Economics, 2001, 8; pp. 291–308.

[GR08] Gil, Y.; Ratnakar, V.: Automating To-Do Lists for Users: Interpretation of To-Dos for Selecting and Tasking Agents: Proceedings of AAAI, 2008; pp. 765–771.

[Ko13] Kokkalis, N. et al.: TaskGenies. In ACM Transactions on Computer-Human Interaction, 2013, 20; pp. 1–25.

[MF14] Mayring, P.; Fenzl, T.: Qualitative Inhaltsanalyse. In: Handbuch Methoden der empirischen Sozialforschung. Springer VS, Wiesbaden, 2014; pp. 543–556.

[Mu00] Mueller, E. T.: A calendar with common sense. In: IUI 2000. ACM, New York, N.Y., 2000; pp. 198–201.

[Ri17] Rissler, R. et al.: Towards an integrative theoretical framework of it-mediated interruptions. In: Proceedings of the 25th ECIS, 2017; pp. 1950–1967.

[SCT12] Shore, L. M.; Coyle-Shapiro, J. A.-M.; Tetrick, L. E.: The employee–organization relationship: Applications for the 21st century. Taylor & Francis Group, NY, 2012.

[SMO18] Suzumura, R.; Matsuno, S.; Ohyama, M.: Where Can we Accomplish our To-Do?: Estimating the Target Location by Analyzing the Task. In: IEEE AINA 2018, Krakow, Poland. IEEE, Piscataway, NJ, 2018; pp. 457–463.