Adaptive Persuasive Scripts

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Abstract. In the context of the HANDS project [13], we argue that cognitive support systems designed for mobile devices may benefit from classical AI techniques as well as from Persuasive Technology. We investigate a system of stepwise instruction, called a Simple Safe Success Instructor, first in terms of *scripts*, and later in terms of *Hierarchical Task Networks.* The system under development is crafted for the benefit of young people with an autism-diagnosis, and the purpose is to support these in desired changes in attitude and behavior in dynamically changing environments.

1 INTRODUCTION

In the pursuit of designing persuasive technology we find it fruitful to look into the findings of AI; since when combined with the theories of persuasive technology (PT) it will be possible to design persuasive technologies that are a lot more adaptive and therefore also potentially more persuasive than conventional PT. An example of a persuasive technology that will gain from an outlook to research in AI is the Simple Safe Success Instructor (SSSI), which is a part of the HANDS project. The HANDS project aims at helping young people with an autism-diagnosis navigate and develop socially through persuasive technology. The general idea is to design a computer program that allows teachers and key caretakers to build cognitive support systems of various kinds. These support systems are then uploaded to the student's PDA. The project is in nature highly interdisciplinary, and the consortium conducting the research consists of experts in pedagogical design for children with autism from LSBU in London; experts in autism-spectrum disorders from the point of view of cognitive psychology from ELTE University in Budapest; and experts in persuasive design from Aalborg University, Denmark.

The actual prototypes are being developed based on input from the three universities in close cooperation with teachers and students from four schools in Budapest, Meopham, Kent, Stockholm, and Aalborg. The target group for the HANDS system consists of teenagers of normal intelligence, but with issues often related to diagnoses within the autism spectrum. This means that the students typically are high-functioning in many respects, but may also experience problems with handling situations outside a strict regime of routines [14].

In the early stages of the project, and leading all the way up to the software specifications, user scenarios have played an important role. In this paper, we will focus on one such scenario, and we will consider various properties of cognitive support systems from a PT point of view. In section 2, we suggest to draw on the AI tradition of scripts and frames in order to formalize the problem. In section 3, we suggest to model a user scenario in terms of hierarchical task networks.

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In section 4, we relate these structures to known principles in Persuasive Technology. Finally, in section 5, we investigate the possibilities of extending the case scenario with location-aware capabilities.

2 SOCIAL STORIES AS SCRIPTS

The software requirements for the HANDS toolset is written in use case format, in which scenarios and user stories play an important role [3, 15]. The user stories enable experts in non-technical domains to specify success criteria for the software. In many cases this consists of a process where different persuasive needs are clarified. The needs may differ from child to child and from school to school, but the scenarios are still deemed typical beyond the domain of one child and one school. A scenario often considered in the development of the HANDS toolset is the case in which a student has to travel on his own using public transportation. This situation is realistic in the sense that it is a task many people in the target group wants to be able to do, and also finds difficult because of the number of things that might happen, and can possibly go wrong. Even small things that do normally not pose problems for neuro-typical teens, may here cause severe frustration and failure to complete the tasks in question. In many schools for autism-diagnosed children and youths, it is customary to use *social stories* to assist the user in keeping track of step-wise instructions as they unfold. In addition, social stories are also used for rehearsing difficult situations [6].

Social stories are not necessarily stories in the sense that they embody narrative qualities, but rather they are step-wise accounts of what typically happens in certain situations, or they contain heuristics for desired behavior in given situations. In this sense, we might say that the narratives embody meaning central to acting in the domain of the users, and also as an important instrument for the software developers [10]. Specifically, the software must support the teachers in writing cognitive support systems that are tailored to the needs of individual children, aesthetically pleasing, and which embody effective means of dealing with situations, that the child in question finds difficult.

While collecting the use cases and user stories, we have found that a number of scenarios appear repeatedly, and we consider these stories to be powerful instruments in shaping expectations among and between future users of the system. At the same time, teachers and other caretakers insist on the importance of being able to customize cognitive support systems directly to an individual user. In fact, we have repeatedly heard practitioners say that the support systems must be manufactured precisely to one child, and that the software designed for the teachers therefore must facilitate this extreme level of customization. Although social stories are highly adapted to individual users, we argue that these cognitive support systems can be said to have a logical core in two respects. In the first place, many teachers do in fact report that they deal with many of the same

situations, typically situations such as morning routines, going on a bus, meeting people, buying groceries and similar everyday practices. So even though the actualized story has to be highly individualized in order to fit the student's needs, the stories, at the same, time refer to essentially typical situations, and are recognizable as such. In the second place, the stories themselves are in many cases structured around a logical core with a rigid, formalizable structure. In artificial intelligence research we have a long tradition for talking about such structures as scripts. In the words of Schank and Abelson: "Some episodes are reminiscent of others. As an economy measure in the storage of episodes, when enough of them are alike they are remembered in terms of a standardized generalized episode which we will call a script" [11].

A script, e.g., for taking the bus, will vary according to cultural and local differences, but most people will as a minimum recognize that the script includes buying a ticket, locating the right bus at location A, entering the bus at location A, riding the bus, and exiting the bus at location B.

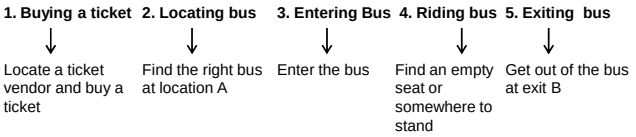

Figure 1. Script for taking the bus

For the teachers working with autism-diagnosed youths, writing such scripts is a complicated task that involves a very deep understanding of the individual person. This process normally involves detailed information stemming from a long-term relationship between a teacher and a child. The question becomes to deeply understand how the individual construes a given situation, for instance figuring out exactly which part of an everyday situation that may cause problems. A fundamental design idea underpinning the HANDS toolset is therefore a desire to build interfaces that not only allow the teacher to compose files containing SSSIs or social stories in an appropriate and aesthetically pleasing manner, but the teachers should also have tools that allow them to evaluate the persuasive effect of the HANDS enabled PDAs. We are, in other words, interested in supporting existing practices by means of ICT; and also to fertilize existing practices by means of advanced conceptual modeling and advanced feedback systems.

In terms of persuasion this means that the HANDS toolset has a double scope of intention. We are, in the first place, hoping to give teachers tools that will aid them in monitoring the use of the cognitive support systems they produce in novel ways, thus creating a room for reflection on practice. The more direct persuasive objective is of course to support the children and youths in navigating more freely in, what appears as very complicated settings for them. Other efforts as well as pilot-studies indicate that persuasive technology may be a significant contributor to this.

3 FORMALIZING SCRIPTS IN HTN

We propose to further formalize the scripts by means of a Hierarchical Task Network (HTN). There are two reasons for this choice. In the first place, the AI tradition dating back to [9, 12] of dividing a task into sub-tasks has proven to be a very efficient tool for automated planning, see also [7]. Specifically, we follow the tradition of using AND-OR graphs to represent several sub-routines that must all be satisfied in order to solve a given problem [8]. Seeing the situation as a script provides us with a good understanding of the subtasks in question. In the second place, HTNs have in recent years proven useful in modeling dynamic contexts [2], and furthermore, HTNs have been proven to function as a central component in interactive systems with a high degree of user influence [1].

Figure 2 shows a HTN structured as an AND-OR graph where the overall goal is to use public transportation to get from location A to location B. In this example the public transportation is in form of a bus ride and the sub goals that the overall goal is divided into are listed at the level below. This level consists of tasks that must be fulfilled in order to accomplish the overall goal. The tasks may vary according to cultural and local settings, and must therefore be adjusted to match those differences. The arcs are read as "AND" and represent the tasks necessary to complete the overall task. The edges with no arcs are read "OR", and represent situations where the task has more than one possible solution. It is, e.g., possible to either take a seat or remain standing during a bus ride.

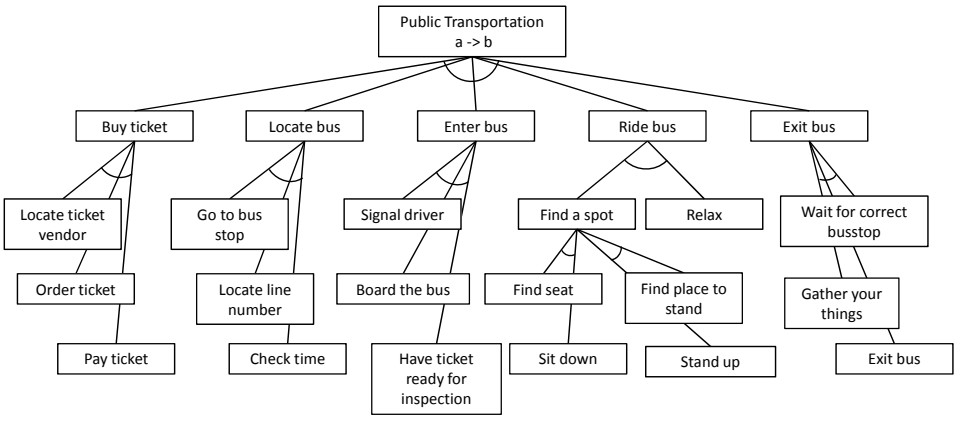

Figure 2. HTN for public transportation

The student should do one or the other – not both. The whole series of events can also be presented using branching time to illustrate the possible future courses of events [14]. This is however beyond the scope of this paper.

4 EMPLOYING PERSUASIVE PRINCIPLES

The AI principles of scripts and HTN are not necessarily persuasive in themselves, but if they are combined with persuasive principles, we believe that they can prove very helpful as extensions or improvements of some of the persuasive strategies put forward by B.J Fogg [4].

The main challenge for the SSSI is to be able to define the most opportune moment for the system to intervene. In the ancient theories of persuasion, this is framed as Kairos [5]. Fogg refers to this as *suggestion*. If the script is subdivided into tasks that the user has to go through in order to fulfill the overall goal, say, that of taking the bus, it becomes more obvious when the system should intervene. Particularly, this is true of situations where actual circumstances do not match those outlined by the system. If the bus is delayed or does not show up at all, the system cannot proceed and must return to earlier steps that can push information on how to find another bus.

It is a general challenge for PT to keep the user interested in the technology and the actions it suggests. The *tunneling* strategy, suggested by Fogg forms a possible solution to this problem. However, when the technology is used in a real-life situation it becomes even more challenging to keep the user interested since the user is not tied to one specific location, e.g., in front of the computer. It is therefore not enough for the system to simply suggest actions in a predetermined order. The system must also be highly adaptable to possible changes in the situation.

When the system is equipped to gather contextual information, it also becomes possible to present that information in an authoritative manner. This opens the possibility of letting the system take on the form of a *social actor*; yet another strategy proposed by Fogg in order to influence behavior. In fact, the systemic interaction between the SSSI and other parts of the HANDS toolset, gives rise to many other persuasive strategies as well, including giving rewards, and various kinds of monitoring.

5 EXTENDING THE SSSI

Simply having the script present on a mobile device may be of great help in many cases. The advantages of the HANDS toolset here consist in having access to familiar information in a customized form, and in a non-obtrusive format (on the screen of a mobile phone rather than, say, on laminated cardboard pieces). But several extensions may be added to this skeleton version, which may enhance functionalities, user experience, and persuasive potential. Within a framework that can be formalized through HTNs, we envision the following levels that may be added to the basic functionality.

1. *Adding static information about routes and locations.* Firstly, the public transportation SSSI may be extended by integrating timetables for trains and busses.
2. *Adding static information about the user.* Secondly, timetables may be integrated with actual information regarding the user's destinations; be it actual destinations extracted from the user's calendar, or possible destinations, i.e., extracted from the user's list of contacts and locations. Since time planning is essential to any work with autism-diagnosed youths, the HANDS toolset also has strong calendar functions build into it [15]. For example, integration of addresses from a list of contacts is found in the TOMTOM Navigator, which can synchronize addresses with MS Outlook. Integration with calendars and and contact lists help adding routes and times to the cognitive support system.
3. *Adding dynamic information about the context.* Thirdly, the system may be enriched by contextual information at runtime. A typical problem arises when a proposed plan is disturbed, e.g., if the bus is delayed. GPS technology can be used to convey such information to users, possibly hindering a breakdown in this case. Figure 3 shows a mobile interface indicating which busses will arrive next at a given bus stop. The + sign indicates that the first bus to arrive is 1 minute late. For people with autism-diagnosis, even slight delays can be very disturbing. A user waiting for the second bus in figure 3 might benefit from a discreet prompt: "The bus is 3 minutes delayed. You can still make your connecting bus".

Figure 4. Possible extensions

4. *Adding dynamic information about the context of the user.* Fourthly, the user's location can be logged via GPS, allowing the system to detect discrepancies between the plan and actual events. This gives the possibility of considering intervention at the appropriate moment. Let us say, for instance, that a user for some reason misses a bus, corresponding to the facts that the user is at the expected bus stop (cf. 2), but too late (cf. 1), and the bus has already left (cf. 3). For some users, the toolset should now intervene and prevent panic by prompting the user: "The bus already left. Want to look for the next solution?"

Figure 4, below, shows which tasks may gain from being extended by static and dynamic information. The higher the number of the extension the more complex it is. The complexity increases the chances that the system, if it works as intended, will be persuasive and able to intervene at the most appropriate time.

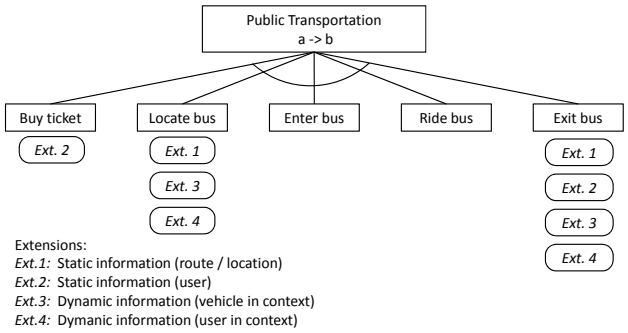

Figure 4. Possible extensions

6 CONCLUSION

In this paper we have suggested to draw on the AI tradition of scripts in order to formalize the social stories that are used in order to help young people with an autism-diagnosis handle difficult situations. The formalization makes it possible to divide the script into subtasks that can be implemented in a HTN. Certain extensions may be added to the SSSI in order to make it more adaptive, namely static and dynamic information about routes, locations, the user, and the context. Furthermore, we have considered the relations between AI modeling and persuasive potential.

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