Assistive planning for people with cognitive impairments

Maxime La Placa[(1)], **Hélène Pigot**[(2)], **Froduald Kabanza**[(3)]
Department of Computer Science
University of Sherbrooke
Sherbrooke, Québec, Canada J1K 2R1
[(1)]maxime.la.placa@usherbrooke.ca
[(2)]helene.pigot@usherbrooke.ca
[(3)]froduald.kabanza@usherbrooke.ca

Abstract

People with cognitive impairments, be it psychological conditions such as schizophrenia, trauma induced impairments, intellectual disabilities or aging related conditions, often have difficulties in planning their daily living activities. They are in fact often assisted and/or monitored by a clinical caregiver. In this paper we discuss a planning aid that we have developed to support clinical caregivers in the planning of daily living activities for patients with cognitive impairments. The tool also monitors the execution of a plan by the patient to generate reminders for forthcoming activities, alarms for anticipated failures, guidance and remedy in the ongoing activity. The tool is expected to reduce the workload of the caregiver while at the same time providing the patient with more flexible, personalized assistance.

1 Introduction

A wide variety of conditions or traumas may afflict an individual with some form of cognitive impairment. Such individuals may be unable to live independently, since their impairment may prevent them from correctly planning their daily activities, such as preparing and consuming food and performing hygiene related tasks. Activities of a social nature, such as attending appointments or even leisure activities (which may prove to be a part of the rehabilitation process) may become difficult to plan for. An individual in this state has lost some autonomy, and requires some form of assistance if they are to retain a degree of independence [Pigot *et al*., 2005].

One current practice is to assign a clinical professional to such an individual. The professional will provide a schedule of activities for the individual, who will in turn be able to perform them without actually having had to plan for them. This practice is often encountered when dealing with populations afflicted with schizophrenia, Alzheimer's disease or intellectual disabilities, as it is generally desirable to find ways of letting such individuals retain as much independence as possible [Lussier-Desrochers *et al*., 2007].

The patient

An individual with some form of cognitive impairment is defined as a *patient*. The patient is in the process of rehabilitation or long term monitoring, and his impairment warrants specific considerations when planning their schedule. Different patients afflicted by the same impairment may not necessarily experience the same planning difficulties. For instance, one schizophrenic patient may have difficulties preparing his meals but be perfectly able to make his way to his clinic, while another may have no problem with cooking, but be unable to reach his clinic without assistance.

The caregiver

A clinical professional assigned to a patient is defined as a *caregiver*. The caregiver has the responsibility to assist his patient in the planning of his daily living activities, but must avoid providing assistance in a way that would make the patient become entirely dependent on it. The caregiver accomplishes this by being aware of the exact nature of his patient's impairment and only providing a schedule for activities known to cause problems. A caregiver is usually assigned to many patients simultaneously and normally these are patients with the same type of impairment. However, since each patient has very specific needs, assistance must be provided on an individual basis.

The caregiver and the patient need a way of communicating with each other, so the former can provide assistance and the latter receive it.

The cognitive orthotic

A *cognitive orthotic* is a tool assigned to the patient and potentially configured by the caregiver that serves as link between the two, relaying the caregiver's assistance to the patient and providing feedback to the caregiver about the activities completed (or neglected) by the patient. Although not strictly necessary, it is better for the orthotic to be available as a mobile system that the patient may carry with him. In this particular practice, this allows assistance to be provided in or out of the patient's usual environment.

In the next section we examine the caregiver's responsibilities and existing orthotics which can be or are already being used in this practice, and articulate the goal of our research in that regard. We then describe of our approach on embedding an automated planner into such an orthotic and discuss preliminary results of this application.

2 Problem statement

In the above described practice, the caregiver must plan schedules for a potentially large number of patients. Furthermore, many patients require a schedule of very similar activities, but as we have seen, the caregiver typically cannot use the same schedule for different patients, as each will have different impairment related needs to consider.

In some cases (especially in schizophrenic populations), social reinsertion of the patient is also a goal, and complicates the planning process further. The rehabilitation goal is to gradually decrease the amount of assistance to a patient in the hope that he will progressively become less dependent on said assistance, regaining more autonomy. For instance, the caregiver may initially provide his patient with a very detailed schedule for the activity of visiting his clinic from his residence as follows: get dressed, go to bus stop, take the bus, disembark in front of clinic, enter clinic, reach caregiver's office. In many cases, the plan also must include time interval during which activity are accomplished or time stamps at which they began, such as: get dressed at 9:30 AM, go to bus stop at 9:45 AM, take the bus at 9:50 AM. On the long run, the same activity would be planned with fewer details, for example, as follows: take the bus, disembark in front of the clinic. Eventually the schedule would simply collapse to the goal: go to the clinic.

Thus we can have schedules with a varying degree of *granularity* depending on the patient profile and other circumstances. Assistance is often repeatedly provided for the same activity; however a unique schedule cannot be cached and reused even if it concerns the same patient, given that patient profile evolution and other circumstances may dictate different ways of detailing and carrying on an activity.

Profile information taken into account by the planning process relate to the patient's impairment, personality trait or other external factors which may influence the execution of the activity. For instance, in some individuals with intellectual disabilities, mental fatigue may become an issue as the day progresses. It is therefore better to schedule a cognitively intense activity at the beginning of the day, when the patient is well rested. Then again, one patient may experience this type of fatigue while another does not, in which case the same activity can be scheduled at any time. While planning for their patients, the caregiver must manage all of these *preferences* on a patient per patient basis.

These factors make the caregiver's task a tedious and time consuming one, and limit the attention and time they might spend on providing other forms of assistance to their patients, or take on new ones.

2.1 Current plan-based cognitive orthotics

Several cognitive orthotics are already being used, such as MEMOS [Schulze, 2005], PEAT [Levinson, 1997] or Autominder [Pollack *et al*., 2003].

MEMOS is a client-server based application. The client runs on a *Smartphone* issued to the patient. The caregiver defines activities for his patient using an *Extensible Markup Language (XML)* scheme. Feedback upon activity completion and reminders to be provided to the patient may also be defined. The patient confirms activity completion using his client, and may reschedule an activity at a later time.

PEAT is an activity management application designed to run on *Pocket PCs* and provides an automated planning functionality. A list of activities to be planned for must be specified as *scripts*, together with constraints on the activity length and positioning (for instance, will last 45 minutes and must be done between 8:00 AM and 9:00 AM). Scripts can be specified by caregiver or the patient. Once scripts are properly defined, the system generates a daily schedule for the patient satisfying the given constraints. PEAT also offers visual and auditory assistance to the patient and monitors activity completion, replanning the daily schedule if required.

Autominder is another orthotic with a somewhat different philosophy. Its aim is not to provide an agenda-like schedule to the patient. Rather it is to monitor the execution of a plan by a patient and provide him with reminders and incentives to perform activities for which Autominder has detected a possibility of non completion or other problematic situation, with regard to scheduled daily activities and the patient's cognitive impairments. Autominder was first designed to be deployed on a mobile robot, as part of the Nursebot project [Pollack *et al*., 2002], but it is clear it could be adapted to other platforms, such as portable devices.

2.2 Research goals

The focus in these previous is on planning for the patient, but much less on supporting the caregiver in a mixed-initiative elaboration of a plan. Another limitation is that, although PEAT and Autominder are able to handle contextual preferences over activities to plan for, they do not properly integrate the patient profile so to manage the preferences on patient per patient basis. In fact these approaches do not generally take into account the fact that a professional caregiver will be assigned a potentially large number of patients for which he must plan individually. The notion of a plan with different levels of granularity is not either properly addressed in these plan-based orthotics. .

Our objective is to provide the caregiver with a plan-based orthotic featuring services accounting for the above limitations; that is, plans with different levels of granularity, preference and patient profile handling, and mix-initiative planning for the caregiver taking into account the management of several patients. To describe our approach we begin first by present in the next section the orthotic platform aboard which our planner runs.

3 The MOBUS assistant

Our planner runs on *MOBUS* (MOBility at University of Sherbrooke) orthotic, which was designed at DOMUS (Domotic at the University of Sherbrooke) lab [Pigot *et al*., 2007]. This orthotic is built on the assumption that a caregiver will be providing assistance to many patients, and the necessary infrastructures required to manage this are already in place.

3.1 MOBUS architecture

MOBUS is a client-server application. The server side is meant to run on desktop PC type hardware. The client side may also run on desktop hardware, but is also meant to run on Internet enabled portable devices, such as a *Portable Data Assistant (PDA)* or a Smartphone. The client comes in two versions. The *caregiver version* allows a caregiver to connect to the MOBUS server and manage their patients, i.e. construct an activity schedule for their patients, upload it to the server and later obtain information on which activities were completed. The *patient version* allows a patient to connect to the MOBUS server and retrieve the schedule provided for them, then access it in an agenda form. The patient can then follow their schedule and validate that they have completed their activities. This data is sent back to the MOBUS server and then made available to the caregiver.

Both caregiver and patient are issued a portable device. However, the caregiver will usually use a desktop client, due to the lack of interface limitations of this platform and the fact that they will likely be using the MOBUS system from their workspace, where a desktop is readily available. The patient is meant to use the portable device exclusively.

MOBUS incorporates other functionalities, such as patient symptoms logging, assistance request, contextual aid and GPS localization. A more complete description of MOBUS may be found in.

3.2 Planning in MOBUS

MOBUS provides a proven infrastructure for maintaining a two way communication between a caregiver and his patients. The original design handles schedules daily living activity schedule that are provided manually by the caregivers. No automated planning functionality is supported.

Figure~1 shows the new design integrating an automated planning aid. Now we have a planner component which holds data about patient conditions and daily activities, and provides an automatically generated schedule for a patient based on this data. Once patient data has been properly defined, the caregiver may then configure the planner to generate a schedule for some desired activities which will accommodate patient specific needs and maintain a specified degree of granularity. The generated schedule is then reviewed by the caregiver and may be edited if desired. Finally the scheduled is then exported to the MOBUS system by the planner, and from now on it will be handled exactly like a schedule that would have been entered manually by the caregiver.

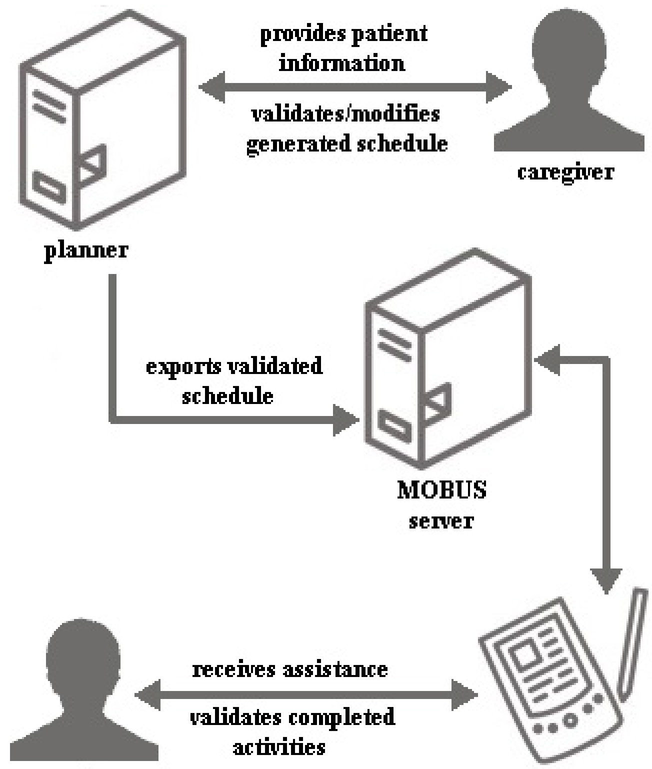

Figure 1
The planner within the MOBUS architecture

Due to the rather high computational requirements of automated planning in general, the planner is meant to run on desktop hardware, similar to that of the MOBUS server. The caregiver accesses the planner's functionalities via an extended version of the previously described client. Note that existing MOBUS services on both caregiver and patient side remain completely unaffected by this new component, and continue to function as they did prior to the introduction of the planner. The caregiver may view or modify exported schedules by using the previously described client. The patient continues to access their activities schedule in the same method and format whether it has been generated by the planner or manually entered by the caregiver.

4 The planner

Several well documented algorithms may be used to perform automated task planning with an agenda type schedule in mind, such as a simple *State Space Search* [Russell and Norvig, 2006], *Temporal Logic Planning* [Bacchus and Kabanza, 1998;2000], *Constraint Satisfaction Techniques* [Ghallab *et al*., 2004a] or hybrid techniques [Refanidis and Alediadis, 2008].

Our planning algorithm inspired by *Hierarchical Task Network (HTN) Planning* [Ghallab *et al*., 2004a]. HTN planning has the interesting feature of expressing its planning operators as a series of methods which may be applied to a task requiring planning. In the planning process, such a method will be applied to a task, generating subtasks to be planned for, and in turn other methods will be applied to those tasks, and so forth until no more tasks require further planning, and a plan is found.

4.1 HTN characteristics

We found the HTN approach of decomposing tasks into subtasks remarkably close to the way caregivers approaching planning for their patients. To illustrate let's consider a set of informally defined task-decomposition methods for the activity of making a trip to the clinic:

Method: PlanClinicTrip
AppliedToTask: GoToClinic
GeneratedSubtasks: Prepare, TravelToClinic, Arrive
Constraints: Prepare before TravelToClinic,
TravelToClinic before Arrive

Method: PrepareForTrip
AppliedToTask: Prepare
GeneratedSubtasks: Dress
Constraints: -

Method: MakeTrip
AppliedToTask: TravelToClinic
GeneratedSubtasks: ReachBusStop, TakeBus,
DisembarkAtClinic
Constraints: ReachBusStop before TakeBus,
TakeBus before DisembarkAtClinic

Method: ArriveAtClinic
AppliedToTask: Arrive
GeneratedSubtasks: ReachCaregiverOffice
Constraints: -

Method: GetDressed
AppliedToTask: Dress
GeneratedSubtasks: PutUnderwareOn, PutPantsOn,
PutShirtOn, PutShoesOn
Constraints: PutUnderwareOn before PutPantsOn,
PutUnderwareOn before PutShirtOn,
PutPantsOn before PutShoesOn

Additional methods may be defined for subtasks ReachBusStop, TakeBus, *etc*.

A cognitive work analysis on the planning activity by caregivers confirmed that they typically consider their patient activities in a similar "top-down" fashion. When caregivers were asked to provide examples of the assistance they would plan for their patient, they would often offer responses such as: "My patient must attend his appointment at the clinic. First, he'll need to prepare, then make his way to the clinic, then reach my office. It's in the morning, so he will be getting up and will need to get dressed first. To reach the clinic, he will need to take the bus. So he will need to go wait for the bus at the corner stop." and so on. Thus there is a strong correlation between the caregiver cognitive reasoning process and the HTN planning process.

Interestingly, the HTN planning approach provides with a natural mechanism to generate plans at different levels of granularity. During the planning process, when a method is applied to a task, the generated subtasks can be tagged with the task that led to their creation. This is repeated as the process goes on, so that in the end, the resulting plan will contain primitive tasks which can be associated to the higher level task that led to their insertion in the plan. Once this information is available, it is then possible to present the plan to the patient with a configurable degree of granularity, essentially reusing the same plan for different scenarios.

To illustrate, consider the following plan:

Dress (tags: GoToClinic, Prepare)
ReachBusStop (tags: GoToClinic, TravelToClinic)
TakeBus (tags: GoToClinic, TravelToClinic)
DisembarkAtClinic (tags: GoToClinic, TravelToClinic)
ReachCaregiverOffice (tags: GoToClinic, Arrive)

The caregiver may configure the planner to offer the full plan to the patient, or group them according to a particular task. For instance, he could choose to group the tasks tagged as accomplishing TravelToClinic if consider his patient to be able to perform this task without further assistance, yielding the following presentation to the patient:

Dress (tags: GoToClinic, Prepare)
TravelToClinic (tags: GoToClinic)
ReachCaregiverOffice (tags: GoToClinic, Arrive)

The same mechanism may be applied to other tasks (such as GoToClinic in this case).

The basic HTN planning algorithm [Ghallab *et al*., 2004a]. is also easily extended to handle time constraints [Beaudry *et al*., 2005]. In the current practice, planning in time is facilitated by the fact that time windows are already considered discrete. A caregiver will plan a weekly schedule for their patient based on a time grid view of the upcoming week, allocating time block lengths to tasks and filling out available slots with tasks that they wish their patient to perform. The planner proceeds much in the same way, scheduling primitive tasks into a time grid matching the one available to the patient as the planning process progresses.

The HTN can be further extended to handle preferences as priorities in decomposition of tasks. More precisely, we mark subtasks with preference markers so that planner will decompose them only if it can. Let us again consider the clinic trip example:

Method: PrepareForTrip
AppliedToTask: Prepare
GeneratedSubtasks: Dress, [preference level] Breakfast
Constraints: [preference level] Breakfast before Dress

In the planning process, the planner first considers the Breakfast task and Breakfast before Dress constraint to be mandatory for a successful plan. Should the planning later fail, the planner backtracks and reattempts the process with the Breakfast before Dress constraint lifted (which will yield a plan where the Breakfast task will be scheduled before the Dress task). Should this process also fail, backtrack again occurs and this time lifts the Breakfast task, which will yield a plan without the Breakfast task. In other terms, the planner examines all possible ways to incorporate a preference into the plan, and if it cannot do so, finally lifts the preference. This handling of preferences is basic, but sufficient for initial experimentation with caregivers. Preferences are lifted in the order of their given priorities.

4.2 Algorithm

Let us define the following concepts:

- A *primitive task* is a task which requires no further planning.
- An *open task* is a task which needs to be planned for.
- A *time grid* is a discrete representation of the available time windows for planning.
- A *plan* is a representation of primitive tasks and their location in a time grid.
- A *world* is a representation of the current state of the planning problem. It contains the actual representation of the state, the list of open tasks and the current partial plan.
- The *method pool* is a representation of available methods as defined in the planning problem. The method pool is considered globally available throughout the entire process.

The planner then implements the following abstract algorithm:

```
AbstractMobusPlanner(world)
  if world has no more open tasks
    return empty plan

  choose T an open task from world [1]

  if T is a primitive task
    choose S an available time slot in current world's plan [1]
    nextWorld ← world with T applied and scheduled at slot S
    plan ← AbstractMobusPlanner(nextWorld)
    return T added to plan

  if T is a non-primitive task
    applicable ← all methods from method pool
                 which may be applied to T
    if applicable is empty
      return failed plan

    choose M a method from applicable [1]
    nextWorld ← world with M applied to T
    plan ← AbstractMobusPlanner(nextWorld)

    if plan is a failed plan
      choose P a preference from M [1]
      liftedM ← M with preference P lifted
      nextWorld ← world with liftedM applied to T
      return AbstractMobusPlanner(nextWorld)
    else
      return plan
```

[1] denotes a *backtrack point*, i.e. should the next plan generated using this selection be a failure, another selection will be made and the process launched again from this point. Preferences in M are ordered in the order of their priorities.

An implementation of this abstract algorithm has been developed and integrated into the MOBUS system. Selection on open tasks, methods, available time slots and preferences to be lifted are normally done nondeterministically, but the planner may also be configured to perform these selections deterministically.

5 Preliminary results

MOBUS system without the planner had already been validated on experiments involving patients and caregivers. The new version with planner has not yet gone through a similar validation. However, we performed experiments based upon the data collected from tests with the previous version of MOBUS for which the schedules were generated manually by the caregivers. The scenarios are for schizophrenic patients.

Preliminary results show that the currently implemented planner accommodates planning domains derived from these scenarios and generates schedules which match the requirements provided by caregivers.

Reusability of partial planning domains has also become evident. As previously discussed, many patients share similar daily activities, and the specification of these activities within the planner can easily be transferred from one patient to another. Use of medication is a good example of this feature. A method hierarchy is defined for a certain type of medication, and this hierarchy may then be used in the planning domain of any patient using this particular medication. Method hierarchies for common daily activates such as cooking, cleaning or hygiene tasks also show a high degree of reusability.

Preferences as previously defined provide sufficient flexibility to account for all the special cases provided by the caregivers; as currently implemented, the planner can take several types of constraints into account, such as ordering relations, hard time constraints (task must begin at a particular time), time zone constraints (task must be scheduled within a particular time zone, AM, PM, Monday, etc.), agglomeration constraints (this set of tasks must be scheduled next to one and other) or spacing relations (this task must be scheduled a certain amount of time before or after another). Should future scenarios require more than the currently implemented constraints, extending the planner to support them would be an easy task.

The planner performs adequately with regard to granularity, but some user interface issues arise when exporting schedules into the MOBUS system. These are a more a consequence of the interface limitations of the portable device used by the patient, and as such are not directly related to the planner itself. We are currently experimenting with ways to improve the current MOBUS system interface.

It has also become apparent that the specification of method hierarchies and planning domains is a time consuming process in its current form, especially for an individual with little technical know-how, such as the caregiver. This has led us to consider the development of tools to assist planning domain specification.

6 Discussion

Outside of field experimentation, the introduction of automated planning in the MOBUS architecture naturally leads to the consideration of automated replanning. Since the MOBUS system maintains data on which tasks have been completed (or neglected) by the patient, such data could be validated against the original schedule, and replanning could be performed based on this comparison, possibly without the intervention of the caregiver. This would provide the patient with much more flexible assistance. However, some important factors arise when considering replanning.

Firstly, great care must be taken when providing schedules to patients without direct validation from their caregiver. As we have seen, their impairment may warrant specific considerations, which may be invalidated through replanning.

Secondly, some form of false negative detection on task completion data must be implemented. Since we are dealing with individuals with cognitive difficulties, and that task completion data is essentially gathered from their own acknowledgement, it is reasonable to assume that some completed activities will be marked as incomplete, or vice versa. A replanning process which would not detect at least a minimal set of false negatives would only continually provide the patient with a misleading schedule, which would contribute to their existing difficulties rather than alleviate them. The planner (and the MOBUS system which utilizes it) must be integrated into an environment that is capable of providing the appropriate patient monitoring required to perform this false negative detection.

Finally, we must consider the platform on which the replanning process will take place. It would be interesting to perform replanning on the portable device carried by the patient, as this would ensure some degree of autonomy should the link to the MOBUS server be unavailable for some reason. Unfortunately, in its current implementation, it is impractical to run the planner on portable hardware due to computational and memory requirements. Some optimization work would be required to achieve this.

7 Conclusion

In this paper we have described the relationship between a patient and their caregiver, their use of the MOBUS system, and how introducing automated planning into the existing system reduces the workload of the caregiver and increases the quality of the assistance the patient receives.

Early results indicate that in the typical scenarios obtained from previous experimentations, the implemented planner does indeed provide viable and customizable schedules, which meet the caregiver's requirements with regard to granularity, preferences and planning in time, which will in turn facilitate their work, and therefore allow them to provide improved assistance to their patients.

Although these scenarios were obtained from schizophrenic populations, we are confident that the techniques employed will also prove useful in populations with other types of cognitive impairments, such as Alzheimer's disease or intellectual disabilities.

However, early results have also shown that the initial setup of the planner on the caregiver's side may be difficult as proper impairment and schedule specific data will need to be supplied to the planner on patient per patient basis. During the integration process, it will be capital to stress the one-time nature of this initial setup, and emphasize the mid to long term workload reduction the caregiver will experience.

The experiments were on data collected from a previous experiment with real patients but no involving the present planner. A live experimentation of the planner with patients is a next step.

References

[Bacchus and Kabanza, 1998] F. Bacchus and F. Kabanza. Planning for temporally extended goals. *Annals of Mathematics and Artificial Intelligence*, Vol. 22, pages 5-27, 1998

[Bacchus and Kabanza, 2000] F. Bacchus and F. Kabanza. Using temporal logic to express search control knowledge for planning. *Artificial Intelligence*, Vol. 116, pages 123-191, 2000

[Beaudry *et al.*, 2005] E. Beaudry, F. Kabanza, F. Michaud. Planning for a Mobile Robot to Attend a Conference. In *Proceedings of 18th Canadian Conference on Artificial Intelligence*. Lecture Notes in *Artificial Intelligence*, Vol. 3501, pages 48-52, 2005

[Ghallab *et al.*, 2004a] M. Ghallab, D. Nau, P. Traversi. *Automated Planning theory and practice*, Chapter 8 Constraints Satisfaction Techniques, pages 167-197, 2004

[Ghallab *et al.*, 2004b] M. Ghallab, D. Nau, P. Traversi. *Automated Planning theory and practice*, Chapter 11 Hierarchical Task Network Planning pages 229-280, 2004

[Levinson, 1997] R. Levinson. PEAT - The Planning and Execution Assistant and Trainer. *Journal of Head Trauma Rehabilitation*, April 1997

[Lussier-Desrochers *et al*., 2007] D. Lussier-Desrochers, Y. Lachapelle, H. Pigot, J. Bauchet. Des habitats intelligents pour promouvoir l'autodétermination et l'inclusion sociale. *Revue Francophone de Déficience Intellectuelle*, Vol. 18, 2007

[Pigot *et al*., 2005] H. Pigot, J.-P. Savary, J.-L. Metzger, A. Rochon, M. Beaulieu. Advanced Technology Guidelines to Fullfill the Needs of the Cognitively Impaired Population. In *Proceedings of the 3rd International Conference On Smart Homes and Health Telematic (ICOST 2005)*, pages 27-32, 2005

[Pigot *et al*., 2007] H. Pigot, D. Pache, B. Paccoud, S. Giroux, J.-P. Savary, E. Stip, J. Sablier. MOBUS : Agenda d'aide aux déplacements. In *Proceedings of the Festival of International Conferences on Caregiving, Disability, Aging and Technology (FICCDAT 2007)*, Toronto, June 2007

[Pollack *et al*., 2002] M. E. Pollack, S. Engberg, J. T. Matthews, S. Thrun, L. Brown, D. Colbry, C. Orosz, B. Peintner, S. Ramakrishnan, J. Dunbar-Jacob, C. McCarthy, M. Montemerlo, J. Pineau, N. Roy. Pearl: A Mobile Robotic Assistant for the Elderly. *AAAI Workshop on Automation as Eldercare*, 2002

[Pollack *et al*., 2003] M. E. Pollack, L. Brown, D. Colbry, C. E. McCarthy, C. Orosz, B. Peintner, S. Ramakrishnan, I. Tsamardinos. Autominder: An Intelligent Cognitive Orthotic System for People with Memory Impairment. *Robotics and Autonomous Systems*, Vol. 44, pages 273-282, 2003

[Schulze, 2005] H. Schulze. Memos: an interactive assistive system for prospective memory deficit compensation-architecture and functionality. In *Proceedings of the 6th international ACM SIGACCESS conference on Computers and accessibility*, pages 79-82, New York, 2004

[Refanidis and Alediadis, 2008] I. Refanidis and A. Alediadis. SelfPlanner: Planning your time! *ICAPS 2008 Workshop on Scheduling and Planning Applications*. Sydney, 2008

[Russell and Norvig, 2006] S. Russell and P. Norvig. *Intelligence Artificielle 2ème édition*, Chapitre 11 Planification, pages 421-466, 2006