Issues in Designing Agents for Long Term Behavior Change

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Abstract

We describe our on-going effort to develop a longitudinal health behavior change counseling system, in which counselor intentions and utterance semantics are explicitly represented, and knowledge is encoded in an ontology to promote re-use.

Keywords

Health Behavior Change, Embodied Conversational Agents, Relational Agents, Dialogue Systems

ACM Classification Keywords

H5.2 [Information Interfaces and Presentation]: User Interfaces—Evaluation/methodology, Graphical user interfaces, Interaction styles.

Introduction

Some people are not ready to change their health behavior, such as stopping smoking, or improving exercising or dieting, even though they may know all of the reasons for change. Such individuals will not likely take the first step toward change, even when asked to do so by a counselor or therapist. These individuals, who admit to no plans or willingness to change, are referred to as "precontemplators" within the framework of the transtheoretical (stages of change) model of health behavior change [20]. They represent a

particular challenge for human and automated health counselors alike, and have not received much attention in the literature on automated health behavior change to date.

One counseling technique that has demonstrated results with individuals in precontemplation is motivational interviewing [19]. Motivational interviewing is a brief, directive, client-centered counseling method for enhancing intrinsic motivation to change by helping clients explore and resolve ambivalence. The method includes a number of conversational strategies for eliciting "change talk" from clients in order to increase their motivation to and confidence in changing their behavior. MI was originally developed for use in the treatment of substance abuse disorders [18] but has also been successfully used in physical activity [15] and diet [22] promotion. Motivational interviewing integrates well within the transtheoretical model [8], and has been identified as a particularly effective mechanism for health care providers to adopt in assisting individuals to move from the precontemplation and contemplation stages of change through preparation and into action.

We have been developing an automated counseling system to help individuals in all stages of change, but particularly those in precontemplation, through a 30-day health behavior change intervention. Our basic approach is to model patient-counselor dialogue as a collaboration in which the participants coordinate their actions toward achieving shared goals, such as coordination of the start, end, and maintenance of the interaction, negotiation of topics, taking turns, and other conversational actions [7]. The Shared Plans theory of Grosz and Sidner [13,14], Grosz and Kraus

[12,11], and Lochbaum [16], provides a well-specified computational theory for modeling dialogue as a collaboration, and uses hierarchical task modeling and a runtime focus stack as its model of discourse context. Collaboration is an also especially appropriate theoretical foundation for medical and therapeutic dialog given the recent focus on patient-centered medicine [3], therapeutic alliance [9], and shared decision making between counselors and patients. We are currently using a newly released standard for representing hierarchical task models, CEA 2018[1], along with a publicly available reference implementation for using it as a dialogue engine. We are also attempting to expose as much of the counseling knowledge as possible in a re-usable, OWL-based ontology [2] of health behavior change concepts, so that the counseling system can be more easily ported to new behaviors or protocols.

To achieve these goals, we must model not only the surface form of the counseling dialogues (as is common practice) but the counselor's intentions and some aspects of utterance semantics as well. In the user interface, the counselor is represented as an embodied conversational agent, who speaks utterances using a speech generation system and uses synchronized nonverbal conversational behavior (Figure 1). The client's participation in the conversation is modeled as a series of possible responses, which are presented to the client as a set of possible utterances to respond to the counselor at each turn of the dialogue.

Challenges

In the rest of this paper, we outline some of the most significant and interesting challenges we have confronted in developing this system.
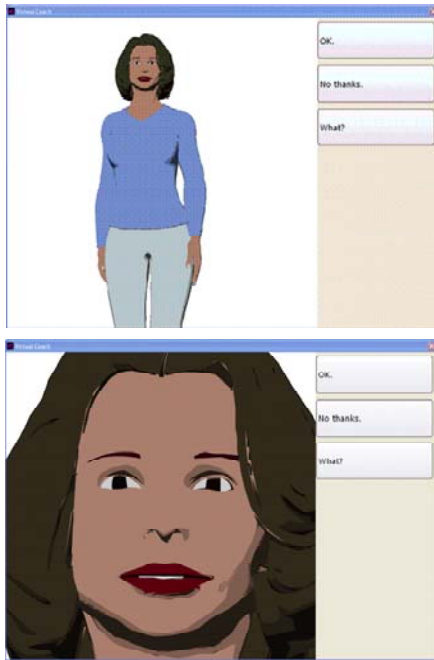

Figure 1. Agent Interface

Minimizing Repetitiveness

One surprising finding from prior longitudinal studies of health counseling agents we have conducted was that, even though dialogue scripts had been authored to provide significant variability in each days' interaction, most participants found the conversations repetitive at some point during the month, and because of this many lost motivation to follow the agent's advice [4,5]. As one participant put it, "It would be great if Laura could just change her clothes sometimes." This repetitiveness was more than an annoyance; some subjects indicated that it negatively impacted their motivation to exercise (e.g., "In the beginning I was extremely motivated to do whatever Laura asked of me, because I thought that every response was a new response."). The amount of behavioral, linguistic and visual variability required to avoid the perception of robotic repetitiveness remains an open research question.

Establishing Therapeutic Alliance

The therapeutic alliance – the strength of the bond between counselor and patient, and their mutual agreement on the goals and tasks of therapy – is a key component of successful change across a wide variety of different counseling methods and strategies [6]. We believe that establishing a strong therapeutic alliance between an agent and its user will, similarly, be a key requirement in maintaining engagement through the course of a long-term behavior change intervention. The patient's assessment of the therapeutic alliance tends to be established early, within the first few sessions; this early assessment is relatively stable over time, and predictive of successful outcomes [17]. The behavior of the agent within the first few interactions with the user must be carefully designed, as a failure to develop a strong alliance may be difficult to correct later. The alliance also tends to develop through a cycle of short-term ruptures and repairs [21]; a successful agent must be able to assess and respond to these variations in its working relationship with users.

Maintaining Persistence Across Counseling Sessions

In order to perform counseling actions that span more than one session, in addition to demonstrating continuity in the working relationship [10], the agent must remember something about its past encounters with users. Many schools of psychotherapy involve giving patients some form of "homework" to do in between counseling sessions, and most behavioral techniques (e.g., shaping and positive reinforcement) require that patients' past behavior and/or goals be remembered for comparison purposes. At a minimum, the fact that the agent has interacted with a given user before, and perhaps the number and/or duration of such interactions must be remembered between sessions. Persistent memory should ultimately be represented as an episodic store recording details of all past interactions with users. A useful middle ground is to record specific facts that can be referenced in future conversations. Examples in the physical activity coaching domain include remembering the name of a user's walking buddy or favorite walking location, as well as purely social (off-task) facts, such as the user's favorite television program and whether they had any big plans for the upcoming weekend. In our system, a user model is loaded from a relational database at the start of each counseling session, and saved back out at the end of the session, in order to provide persistence across sessions.

Authoring Counseling Dialogue

Devising an efficient and effective process for authoring large quantities of dialogue for longitudinal interaction is a significant challenge of this project. We must provide sufficient content for up to 30 conversations per user, encompassing as large a range of user situations as possible. The content should be reviewed by experienced counselors or other domain experts. Finally, the content should be modular and reusable, to ease the implementation effort of future systems. In previous work [5], we have used dialogue systems based on augmented transition networks. This simple formalism has been usable by domain experts with relatively little training. Thus far we have found that our current hierarchical task modeling approach is significantly more difficult to understand and author. Whether these increases in authoring difficulty result in commensurate improvements in reusability remains to be seen.

Eliciting Open-Ended Responses

Open-ended questions and continuation prompts ("tell me more about that") are used extensively in motivational interviewing to get clients talking about their own motivations for change. Eliciting this kind of information through multiple-choice menus represents one of the biggest hurdles to our use of hierarchical task models to emulate this style of counseling. Approaches we have taken include: keeping user responses very abstract; providing "drill down" trees to index desired statements from general categories to specific responses; and using knowledge about users gleaned from other sources (e.g., enrollment web forms) that they can simply endorse during a counseling session. None of these approaches is entirely satisfactory, and this remains an open area of research.

Conclusion

We have described many challenges and open research problems in building a re-usable health counseling system for longitudinal health behavior change interventions. We plan to conduct initial testing of an exercise promotion intervention based on this framework early in 2009 and then proceed to porting the framework for use in a diet intervention (fruit and vegetable promotion) to evaluate the portability of the system.

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