Dreaming of Adaptive Interface Agents

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Abstract
This interactive project uses the metaphor of human sleep and dreaming to present a novel paradigm that helps address problems in adaptive user interface design. Two significant problems in adaptive interfaces are: interfaces that adapt when a user does not want them to do so, and interfaces where it is hard to understand how it changed during the process of adaptation. In the project described here, the system only adapts when the user allows it to go to sleep long enough to have a dream. In addition, the dream itself is a visualization of the transformation of the interface, so that a person may see what changes have occurred. This project presents an interim stage of this system, in which an autonomous agent collects knowledge about its environment, falls asleep, has dreams, and reconfigures its internal representation of the world while it dreams. People may alter the agent's environment, may prevent it from sleeping by making noise into a microphone, and may observe the dream process that ensues when it is allowed to fall asleep. By drawing on the universal human experience of sleep and dreaming, this project seeks to make adaptive interfaces more effective and comprehensible.

Keywords
Adaptive interfaces, autonomous agents, dreams

ACM Classification Keywords
H5.2. Information interfaces and presentation (e.g., HCI): User Interfaces; I.3.7. Three Dimensional Graphics and Realism: Animation.

Introduction

A significant problem in human-computer interaction involves enabling people to interact continuously with an adaptive interface. While adaptive interfaces may result in more effective performance in the long run, they often suffer from one or more periods of confusion or reduced efficiency as the interface changes and the user needs to learn how to work with the new configuration. For example, if the interface moves a certain function to a new location, the user must find and remember the new location. The process of interface adaptation can be annoying for the user and represents a significant challenge in the design and implementation of adaptive interfaces.

The purpose of the system described here is to demonstrate a paradigm by which people might interact with an adaptive interface using the metaphor of human sleep and dreaming. The goal is to help people understand the process of adaptation and work with interactive systems more effectively. In particular, this paradigm helps people work with a system in at least three ways:

a) It helps people become aware of when and how the system desires to revise the interface.

b) It provides people with a natural mechanism for preventing or allowing the revision to occur.

c) It enables people to learn how the interface is being revised, and thereby to adopt the changes more readily and easily.

In this dreaming paradigm, the adaptive system maintains a constant configuration as long as it is awake, and only changes while it is asleep. Using a graphically-embodied agent-based approach, the interface agent becomes more tired and prone to sleeping when it believes that the interface could be improved significantly. However, the user can prevent the interface agent from sleeping, and thereby preserve consistent interface configuration. When the agent is finally permitted to sleep, a visualization of the interface's process of transformation is presented so that the user can see the proposed changes. By using a metaphor that is a significant part of all humans' lives, the notion of an adaptive interface may be made more comprehensible to both novice and expert users.

Related Work

Adaptive interfaces

A variety of work has been done in an effort to develop methods for creating adaptive interfaces. Some previous experiments explored the usefulness and desirability of dynamic menus that re-order the items they contain based on frequency of use [7]. Static menu setups were much more effectively and efficiently used than dynamic menus. Later projects experimented with the idea of using computer knowledge models to predict user interface features that would be desirable [11]. The computer would try to predict which extra features would be desirable, prompting the user with the option of either changing the current interface to a possibly more appealing one

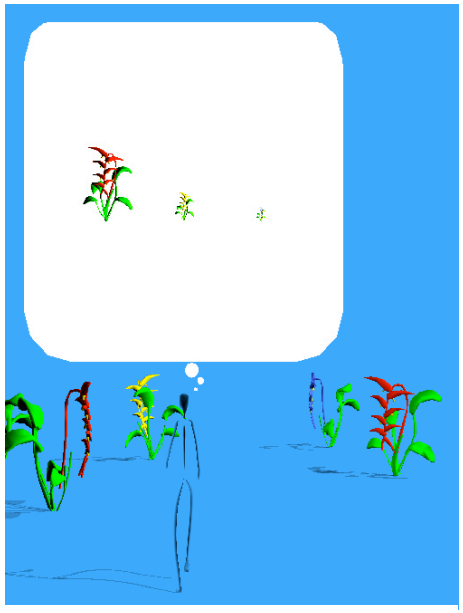

Figure 1: An agent creates mental representations of the plants in its world.

or discarding the change and continuing to use the current interface.

The question of adaptive versus adaptable interfaces has also been explored. Adaptive interfaces are interfaces that seek to predict what sorts of features would be desirable. Adaptable interfaces are interfaces that are customizable by the user. McGrenere, Baecker, and Booth [6] set up an experiment to test whether users would prefer having an interface which they could customize entirely, or an interface which would adapt without user intervention and without notifying the user. Their study showed that solely computer-controlled interface changes are entirely undesirable, and that their implementation of an adaptable interface was much better than their implementation of an adaptive interface. Bunt, Conati, and McGrenere [1] also performed experiments with multiple user interface designs. They used up-front, as-you-go, and non-customizable interfaces, where the first two were an interface that had the user configure it before use, and during use respectively. They concluded that their up-front design allowed users to work more efficiently, and that customizing interfaces was very much worth the effort when it was "done right," but stated that a major goal was to teach users how to customize interfaces to their advantage. Findlater and McGrenere [2] did an experiment to determine which kinds of user interfaces (static, adaptive, and adaptable) were most effective in aiding users, and which were perceived as more effective in aiding users. They concluded that their adaptive menu was less efficient than their adaptable menu, and that their static menu was the most effective. Changing menus seemed to hinder the interaction in many cases. However, users tended to prefer the adaptable menus to the static menus. From these examples, it becomes clear that adaptive interfaces have great potential but present significant challenges for usability.

Dreams

To help address these challenges, this research project draws on the human behaviors of sleep and dreaming. All humans are believed to dream, although only a subset of people remember their dreams. [4] People dream during REM (or paradoxical) sleep, a period of sleep that occurs periodically during a given sleep session. Psychotherapists, psychics, priests, neurologists, and many others have offered explanations for dreams; nevertheless, there is still little consensus for why and how dreams happen. Various possibilities include that dreams help to consolidate memories, dreams cull "left over" daily experiences from short term memory, or that dreams are an artifact of other neurobiological activities during sleep. This research project is built on a model of dreaming in which dreams are closely connected to direct experience and the learning process.

Experience

When the interaction begins, the user is presented with with an animated grove of ethereal flowering plants, with flowers colored red, yellow, blue. (See Figure 1.) A solitary animated humanoid, the Dreamer, lives in this world. He is tall and slender, and wanders around the world inspecting the flora. Occasionally the Dreamer lies down to sleep amongst the plants. Upon waking, he sighs calmly, stands up, and returns to his rounds.

Visitors view this world on a large monitor located at chest-height and may interact with the plants and the

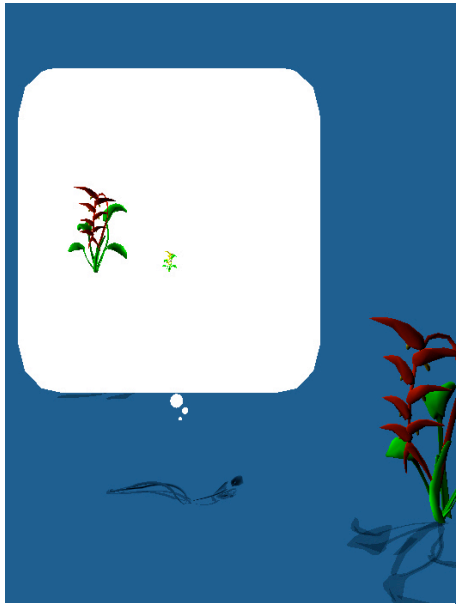

Figure 2: The agent dreams about the flowers in its world, combining the red flowers into a large archetypal flower.

Dreamer through a mouse and a microphone. When a visitor clicks on the Dreamer, a visualization of the Dreamer's mental representation of his world appears above his head. The representation is a graphical "thought bubble" containing several "plant-ideas" (mental representations of plants). In the center is a large "archetypal" plant-idea, which reflects the appearance of the plants in the agent's world. When the Dreamer visits a plant that is of a different color or size, he adds an additional plant-idea to his mental representation. Visitors can also click on any of the plants to cycle through possible colors for the plant's flower.

Participants may also interact with the system through a microphone. Harsh, loud noises will keep him from going to sleep, or will wake him up if he is already asleep. The longer the Dreamer goes without sleep the more haggard and fatigued he becomes. When the Dreamer lies down to sleep (see Figure 2), all of the plant-ideas represented in his head are expanded based on the number of plants that they represent. The plant-ideas spread rapidly to fill the thought bubble, settling into a random configuration. During the course of the dream, groups of similar plant-ideas merge into a single larger element. Noises that are too loud will wake the Dreamer, preventing from him from reorganizing his mental representation. Any moderate noise that does not wake the Dreamer will cause the plant-ideas to jitter, making them harder to sort. After a short time the Dreamer awakes, either refreshed if his mental representation has been arranged efficiently, or exhausted if his thoughts are still jumbled.

Occasionally, a new plant will sprout in the grove. Thus, as he wanders the grove, the Dream constantly updates his mental model to reflect the nature of his ever-changing environment.

Implementation

World Model

This project is built in a code base for constructing virtual worlds that was used previously in the Virtual Raft Project shown in the Interactivity program at CHI 2005 [12]. The world contains graphical plants, with shadows that lie on the ground plane. The Dreamer agent can navigate around the world, randomly selecting plants to visit, making them his object of attention. The cinematography system follows him from a distance, smoothly transitioning to a new perspective whenever the Dreamer changes his object of attention.

Dreams

In creating a computational model of dreaming, this project looks to computational data compression for inspiration. An agent has the ability to form archetypal representations of the phenomena that it encounter in its world. These archetypes serve as a means of compressing and archiving its experiences. In order to test the effectiveness of an archetype, an agent attempt to use it to compress a corpus of experience. Experiences that match an archetype closely are archived as instances of that archetype; experiences that do not match are archived as "exceptions." This testing of archetypes happens during dreams. In each dream, archived experiences are uncompressed, combined with stored exceptions, and tested against different archetypes. If a new archetype more efficiently stores the experiential information, it becomes the default archetype for those experiences.

The subjective experience of the agent's dreaming is the visualization of this process.

Discussion

This demonstration presents an argument that the metaphor of dreams can be a useful conceptual approach in helping users to understand and gain better control over adaptive interfaces. Sterling recently argued [10] that creating anthropomorphic interfaces by giving them human-like qualities is actually harmful (rather than simply non-beneficial), as it leads the user to believe that the device is far more capable than it actually is. However, people will often attribute human-like qualities to media and computational devices, even when given no specific encouragement to do so [8]. The goal of the current system is not to make the interface appear to have human-level intelligence by giving it a computational simulation of dreaming. Rather, the goal is to make the adaptations performed by the interface more comprehensible through the metaphor of dreaming.

The metaphor of dreams may help to explain an interface that reconfigures itself. Often times in dreams, as in the Mirror of Galadriel, we may see things as they are or as they were, but we may also see things as they might be. Similarly, a UI that dreams about alternate possible configurations presents the user with a vision of how the interface might be. Like the King Zipperupus in Lem's tale [5], the user has the ability to foresee, through the lens of a dream, various possible configurations the interface might adopt. And, like the King, the user may decide that the envisioned interface is "not bad, of course, but nowhere near as beautiful" as might have been expected, and thus reject the possible modifications.

Another reason that dreams may be a useful metaphor in the context of adaptive interfaces is that the process of dreaming is not fully understood. Dreams may be seen to recombine elements from our daily activities in new and often unpredictable ways. Similarly, the technique described here could be used to recombine elements from the daily use of an interface to explore new possible configurations. Like dreams, these alternate interface configurations may give users a chance to explore the possibilities afforded to them by a reconfigurable interface. While the neurobiological aspects of dreaming may aid in the task of learning, dreams are also often a valuable resource for reflecting upon our lives and experiences, offering new approaches or alternate conceptions. Similarly, a dreamt interface may offer the user occasion for reflecting on the nature of the tasks he or she performs. For example, an interface reconfiguring to allow automatically emailing various groups of contacts could serve as an occasion for the user to reflect on the relationships between the various social networks of which he or she is a part. Such reflection can serve a number of useful functions, for instance, as a part of reflective practice. [9]

Future Work

The majority of this paper has focused on adaptive interfaces as the key area within HCI where dreams could be the most useful. Presenting a metaphorical relationship between the activity of dreaming and an adaptive interface's reconfiguration process may allow adaptive interfaces to be more comprehensible by their users, give users a better grasp of what the implications of possible reconfigurations might be, and allow users more control over the possible reconfigurations.

Another possible application of these techniques would be in the creation of synthetic dreams. Projects such as MyLifeBits [3] attempt to digitally archive the daily activities of an individual. While the intended purpose of such technologies is to create a readily accessible archive of the individual's life to aid in tasks such as information retrieval, it may also be possible to harness the data collected in such a manner to produce synthetic dreams. Using methods similar to those in the project presented here, a computational system could be presented with the data gathered from an individual's day, recombine parts of those experiences in novel and potentially provocative ways, and present the results as the system's dreams about the user. Not only could synthetic dreams be a method of evoking reflection on one's day, it may allow one to see connections between seemingly disparate experiences.

Conclusion

This demonstration helps people think about a new way in which we could interact with adaptive interfaces. Using a metaphor of human sleep and dreaming, this project allows participants to control the timing of a system's adaptation, and to view a visualization, in the form of a dream, of how the system adapted. Drawing on this familiar paradigm from human behavior can help to make adaptive interfaces more understandable and their use more efficient.

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References

[1] Bunt, A., Conati, C. and McGrenere, J., What role can adaptive support play in an adaptable system? in *international conference on Intelligent user interface*, (Funchal, Madeira, Portugal, 2004), 117-124.

[2] Findlater, L. and McGrenere, J., A comparison of static, adaptive, and adaptable menus. in *SIGCHI conference on Human factors in computing systems*, (Vienna, Austria, 2004), 89-96.

[3] Gemmell, J., Bell, G. and Lueder, R. MyLifeBits: a personal database for everything. *Communications of the ACM*, *49* (1). 88-95.

[4] Jouvet, M. *The Paradox of Sleep*. MIT Press, 1999.

[5] Lem, S. The Princess Ineffabelle. in Hofstadter, D.R. and Dennett, D.C. eds. *The Mind's I*, Basic Books, New York, 1981, 96-99.

[6] McGrenere, J., Baecker, R.M. and Booth, K.S., An evaluation of a multiple interface design solution for bloated software. in *SIGCHI conference on Human factors in computing systems*, (Minneapolis, Minnesota, USA, 2002), ACM Press, 164-170.

[7] Mitchell, J. and Shneiderman, B. Dynamic versus static menus: an exploratory comparison. *ACM SIGCHI Bulletin*, *29* (4). 33-37.

[8] Reeves, B. and Nass, C. *The Media Equation*. Cambridge University Press, Cambridge, 1996.

[9] Schön, D. *The Reflective Prectitioner: How Professionals Think in Action*. Basic Books, New York, 1983.

[10] Sterling, B., Keynote Talk: Spime Meme Map. in *UBICOMP 2006*, (Orange County, CA, 2006).

[11] Sukaviriya, P.N. and Foley, J.D., Supporting adaptive interfaces in a knowledge-based user interface environment. in *1st international conference on Intelligent user interfaces*, (orlando, Florida, United States, 1993), ACM Press, 107-113.

[12] Tomlinson, B., Yau, M.L., O'Connell, J., Williams, K. and Yamaoka, S., The Virtual Raft Project: A Mobile Interface for Interacting with Communities of Autonomous Characters. in *Conference Abstracts and Applications, ACM Conference On Human Factors In Computing Systems (CHI 2005)*, (Portland, OR, 2005).