Design of Interactive Systems (DIS)

Lecture 19: Agents and avatars

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Part III Contexts for designing interactive systems

- **Chapter 14**: Designing Websites
- **Chapter 15**: Social media
- **Chapter 16**: Collaborative environments
- **Chapter 17**: Agents and avatars

Introduction

- Agents are autonomous, active computer processes that possess some ability to communicate with people and/or other agents and to adapt their behaviour
- Agents are small artificial intelligence (Al) computer programs
- Agents have some impact on the interaction of people with interactive systems

Aims

- Describe the key features of interface agents
- Understand the conceptual model of agents
- Understand the key idea of user modelling
- Describe some agent-based systems.

Agents

- Agents are autonomous, active computer processes that possess some ability to communicate with people and/or other agents and to adapt their behaviour.
- There is a ‘strong view’ of agents: they have beliefs, desires and intentions and can plan, learn, adapt and communicate
- In human-computer interaction and the design of interactive systems, the move towards utilizing intelligence at the interface through the use of artificial agents was popularized in the 1990s.
- The fundamental difficulty is that computers have access to a very limited view of what people are doing. They can detect mouse movements, typing, the selection of menu items and that is just about all.

Agents

Agents can be seen in a number of different ways:

- As guides they would explain the structure and features of an information space.
- As reminder agents they would help us keep appointments and keep us up to date with new developments.
- As monitors they would watch over mailing lists and announcements for relevant information.
- As collaborators they would work with us on problems.
- As surrogates they would stand in for us at meetings.

Agents

Generally there are two main types of agent:

- Some act on behalf of and know about an individual person. This, then, allows for personalization and adapting systems to an individual's preferences, habits and knowledge.
- Others know about particular types of work such as indexing, scheduling, spellchecking and so on. They have **more domain knowledge**, but **less knowledge of individuals**. Predictive technologies such as the T3 text system and the systems on Web browsers that try to anticipate long URLs are examples

Agents

- Robots are examples of agent-based interaction and industrial and domestic robots are becoming more common. Industrial robots include pre-programmed systems, such as are used in car manufacturing, and mobile robots, used in applications such as security monitoring.
- Domestic robots include lawnmowers and devices for undertaking other menial tasks, such as vacuum cleaners. Figure 17.1 shows a robot vacuum cleaner.

Robot vacuum cleaner

The Nursebot ‘Pearl’

Metaphors for thinking about agents

- Travel agents – the user specifies some fairly high-level goal that they have and some broad constraints. The agent tries to come up with an option that satisfies.
- Estate agents work independently on behalf of their clients, scanning the available options for real estate and picking likely-looking properties.
- The secret agent goes out to find out what is going on, working with and against others to discover important information.
- The agent as friend or companion suggests someone who gets to know your likes and dislikes and who shares your interests – someone who can pick out interesting things when they see them.
- The film star's or basketball player's agent is someone who works on their behalf negotiating the best deals or the best scripts or teams.
- The slave does the jobs for you that you do not want to do.

Adaptive systems

- Agents are adaptive systems.
- Systems contain subsystems and are contained within supersystems
- Systems interact with other systems. Systems interact with their environments, with their subsystems and with other systems at the same level of abstraction
- A seed interacts with the earth and so obtains necessary nutrients for its growth. A traveller listens to an announcement at Munich airport. A hammer interacts with a nail and drives the nail into a piece of wood.

Adaptive systems

- In order to interact with another system at all, every system requires some representation, or model, of the other system
- The interaction of the traveller and the airport announcement can be described at the following levels:
  - *Physical.* The announcement must be clear and loud enough for the traveller to hear it.
  - *Conceptual.* The traveller must be able to interpret what is heard in terms of airports, travel and the German language.
  - *Intentional.* The announcement will relate more or less to some purpose of the traveller.

Adaptive systems

- The hammer has been carefully designed in order to achieve its purpose of banging nails into wood; its physical model must capture the conceptual level (that it is strong enough) which must be suitable for its purpose.
- Browne *et al.* (1990) identify a number of types of adaptive system in their consideration of adaptivity in natural and computer-based systems:

1. At the simplest level, some agents are characterized by their ability to produce a **change in output in response to a change in input**. These systems must have some receptor and transmitter functions and some rudimentary, rule-based adaptive mechanism. Example: a thermostat: the temperature rises so the thermostat turns the heating off, the temperature falls so it turns the heating on.
2. The simple agent can be enhanced if it maintains a record of the interaction that allows it to respond to sequences of inputs rather than just individual signals. Predictive text systems fall into this category.

Adaptive systems

3. A more complex system will monitor the effects of the adaptation on the subsequent interaction and evaluate this through trial and error. This evaluation mechanism then selects from a range of possible outputs for any given input (e.g. chess games, noughts and crosses games, etc.)
4. Type 3 agents have to wait to observe the outcome of any adaptation on the resultant dialogue. In the case of game-playing agents, this might mean that they lose the game.
5. Yet another level of complexity is in systems which are capable of changing these representations: they can reason about the interaction.

Adaptive systems

Dietrich *et al.* (1993) consider the interaction between two systems and various stages at which adaptations can be suggested and implemented. In any system-system interaction we can consider

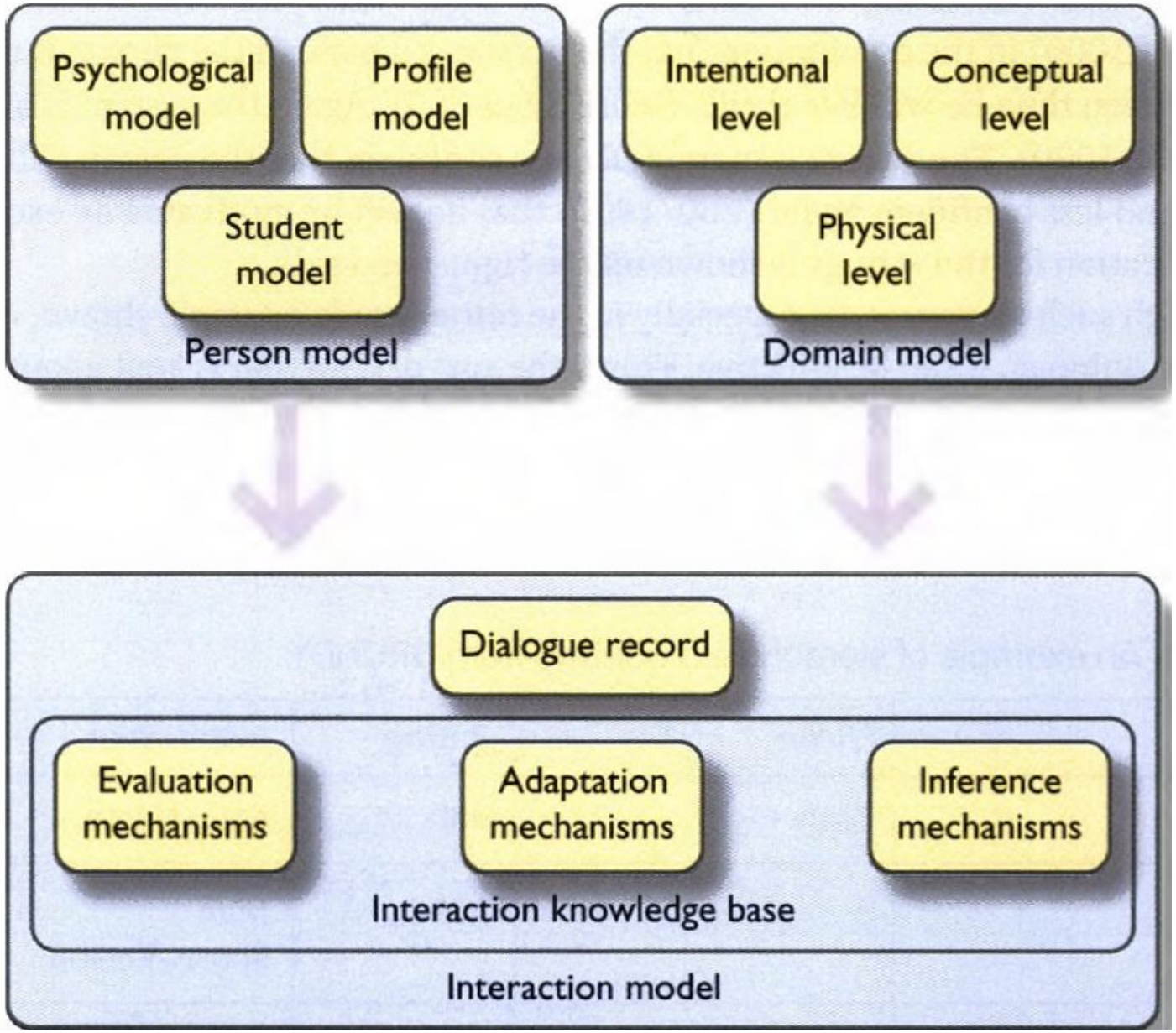
- *Initiative.* Which system starts the process off?
- *Proposal.* Which system makes the proposal for a particular adaptation?
- *Decision.* Which system decides whether to go ahead with the adaptation?
- *Execution.* Which system is responsible for carrying out the adaptation?
- *Evaluation.* Which system evaluates the success of the change?

Adaptive systems

- As a very simple example of a human-agent interaction, consider the spellchecker on a word processor.
- It is up to the person to decide whether to take the initiative (turn on the spellchecker), the system makes proposals for incorrecdy spelled words, the person decides whether to accept the proposal, the system usually executes the change (but sometimes the person may type in a particular word) and it is the person who evaluates the effects.

An architecture for agents

- The simple model of adaptive systems provides a framework model for thinking about agent-based interaction.
- Agents are adaptive systems - systems that adapt to people.
- Fig. 17.5: Overall architecture for an agent



Person model

- The person model is also known as a ‘user model’, but the term ‘user’ here seems particularly inappropriate for human-agent interaction where people are not using agents, but are interacting with them.
- The person model describes what the system ‘knows’ about people
- Some systems concentrate on developing models of habits, inferred by monitoring interactions over time
- Other profile data can often be most easily obtained by asking people to provide it.
- Other systems try to infer people’s goals, although it is very difficult to infer what someone is trying to do from the data typically available to a computer system (mouse clicks and a sequence of commands).

Domain model

- The domain model describes the agent's representation of the domain.
- It may do so at all or any of three levels of description: physical, conceptual and intentional.
- Physical characteristics of the domain would include things such as colours of a display, and whether data was displayed as a menu or as a list of radio buttons.
- Conceptually a domain is described in terms of the objects and attributes of the things in that domain
- The intentional description is to do with purpose. For example, an e-mail filtering agent might have a domain model which describes e-mails in terms of the main concepts - header, subject, who it is from, and so on.

Interaction model

- This consists of two main parts: an abstraction of the interaction (called the dialogue record) and a knowledge base that performs the ‘intelligence’.
- The knowledge base consists of mechanisms for making inferences from the other models, for specifying adaptations and, possibly, for evaluating the effectiveness of the system’s performance.
- This knowledge base consists of‘IF-THEN’ rules, statistical models, genetic algorithms or any of a host of other mechanisms

Interaction model

The dialogue record may contain details such as:

- Sequence of keystrokes made
- Mouse clicks and mouse movements
- Facial expressions of people using the system
- Timing information such as the time between commands or the total time to complete a task
- Eye movement, pupil size and direction of gaze
- Characteristics of speech such as speed, tone and loudness
- Words spoken as recognized by an automatic speech recognizer (ASR)
- System messages and other system behaviour
- Command names used
- Physiological characteristics of people such as skin conductivity, pressure of grip and so on.

Applications of agent-based interaction

Natural language processing

- Natural language processing - in terms of speech input and speech output, but also in terms of typed input - has been the dream of computing since it was invented
- Natural language systems adapt by generating text appropriate to the particular query and characteristics of individual people or by recognizing natural language statements.
- To do this they have to infer the person's needs and focus of attention from the (ambiguous) use of natural language
- Chatbot or Chatterbot systems take typed input and try to respond to keep the conversation going

Applications of agent-based interaction

Intelligent help, tutoring and advice-giving systems

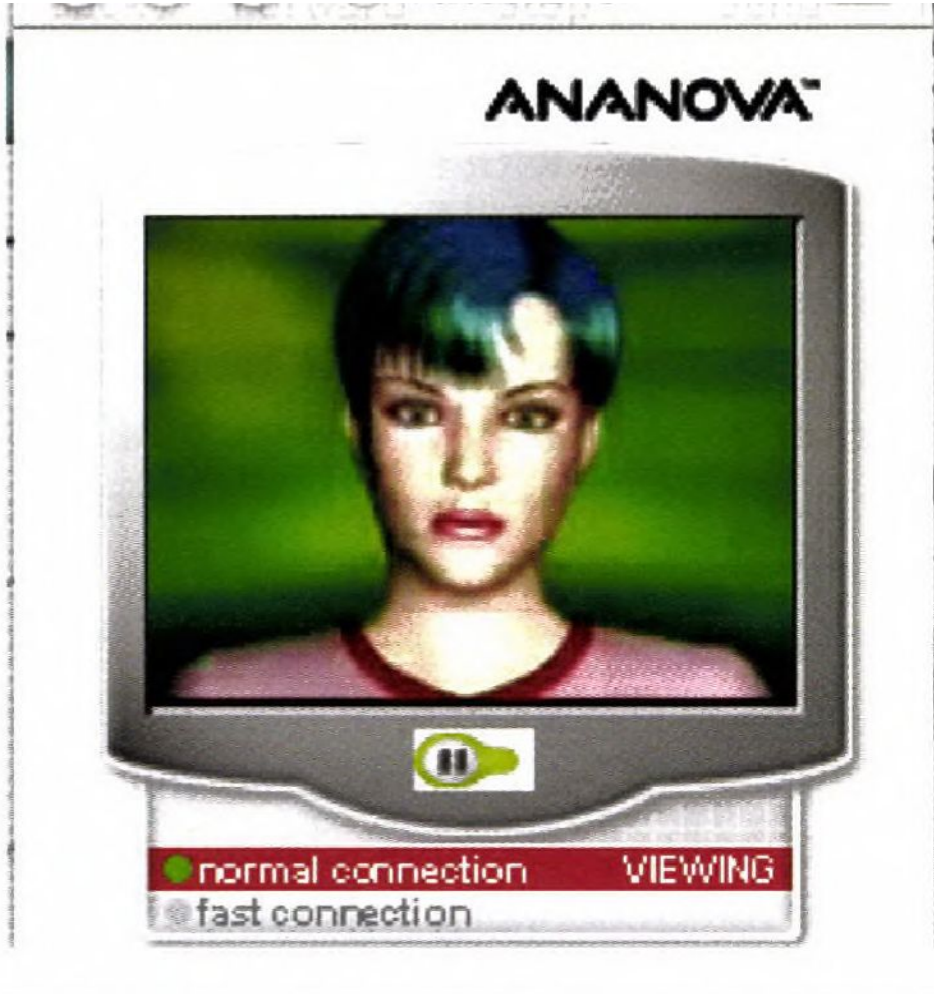
- Help, advice and teaching are natural applications for agent-based interaction.
- The rationale of intelligent tutoring systems (ITSs) is that, for given students and topics, an intelligent system can alleviate the variance of human-based teaching skills
- ITSs need to be able to recognize errors and misconceptions, to monitor and intervene when necessary at different levels
- A ‘student model’ of the student using an ITS stores information on how much the student ‘knows’ about concepts and relationships which are to be learnt and about the student’s level and achievements.

Avatars and conversational agents

- Avatars, or virtual humans, bring another degree of interest to agent-based interaction.
- Here the agent is represented by a character - either an on-screen character or a physical object.
- For example, Nabaztag is a plastic rabbit-like object which has flashing lights and rotating ears
- It takes data from the Web, or from e-mail messages, and reads it out using a text to speech (TTS) system

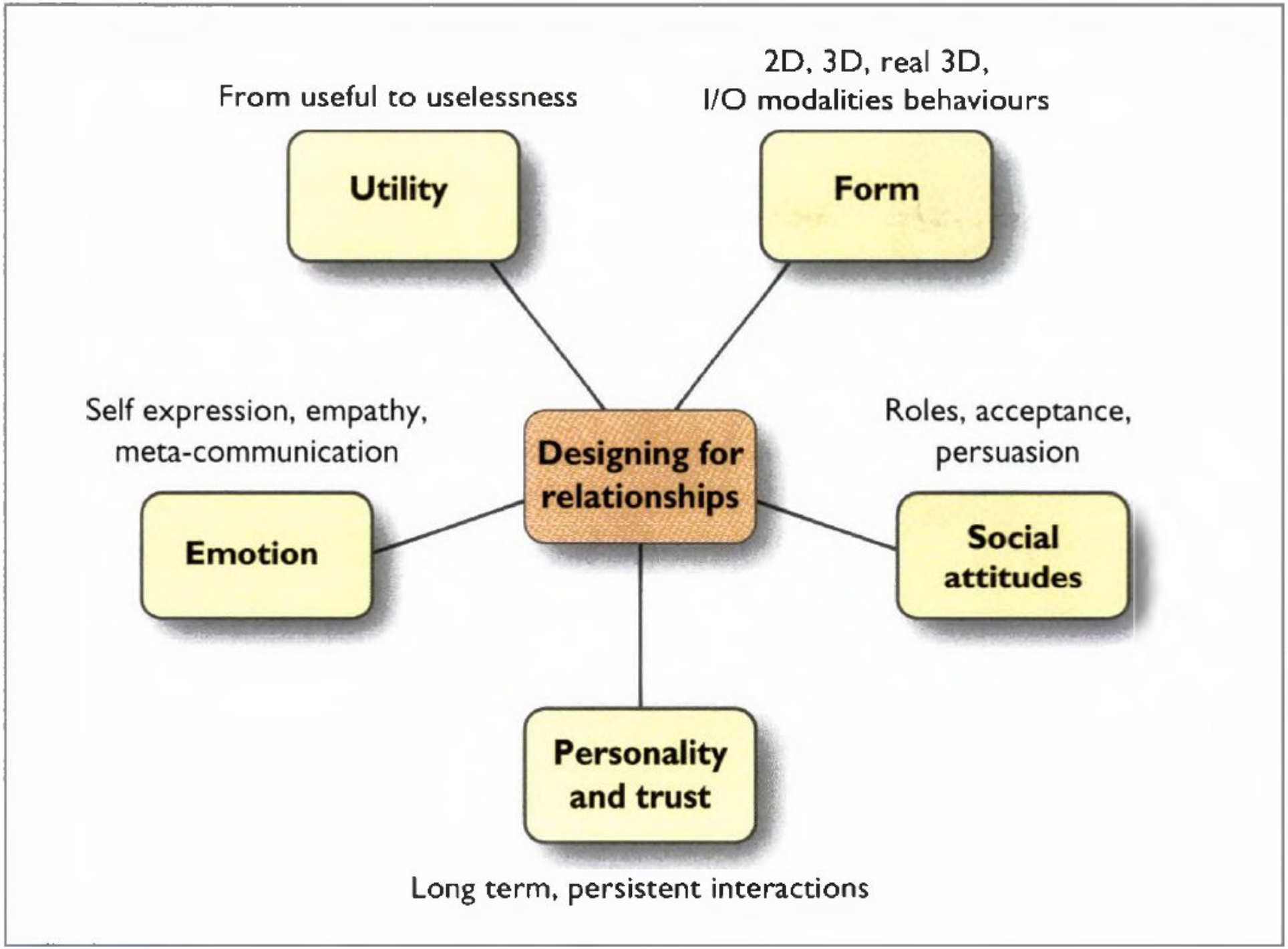
Avatars and conversational agents

- Another conversational agent is Ananova (Figure 17.9). This character reads news stories.
- The synchronization of lips to speech is quite good, but there are still the telltale inflections that do not sound correct



Companions

- Embodied conversational agents (ECA) that aim to provide support and emotional engagement with people. The aim is to ‘change interactions into relationships’
- We shout at our computers and call them ‘stupid’. We stroke our favorite mobile phone and talk to it as if it were a person. Companions aim to develop these relationships, so that people will engage in richer and more fulfilling interactions
- Companions need to engage in conversations with people, conversations that need to be natural and appropriate for the activity being undertaken.


From useful to uselessness
Utility
2D, 3D, real 3D,
I/O modalities behaviours
Form
Self expression, empathy,
meta-communication
Emotion
Designing for relationships
Roles, acceptance,
persuasion
Social attitudes
Personality and trust
Long term, persistent interactions

Utility

- There is a spectrum of usefulness for companions.
- At one end is non-specific purpose (i.e. companions that serve no specific function) while at the other is specific purpose
- A cat has no specific function other than to be a cat, while a care assistant undertakes specific tasks such as distributing medication, monitoring health and supervising exercise, but both may be considered companions.

Shared whiteboards

The Sony AIBO, despite now being discontinued, was one of the most effective robotic ‘pets’ there have been, but it had no real utility

Form

- The form that a companion takes refers to all the issues of interaction such as dialogues, gestures, behaviours and the other operational aspects of the interaction.
- It also refers to the representational aspects such as whether it is 2D, graphical 3D or true 3D, whether it has a humanoid, abstract or animal form, and the modalities that it uses.
- The form and the behaviours of the companion are likely to vary widely between different owners

Emotion

- Designing for pleasure and design for affect are key issues for companions.
- Attractive things make people feel good, which makes them more creative and more able.
- Emotional integration and stability are key aspects of relationships.
- There should be opportunities for each partner to talk about themselves to help self-disclose and to help with self-expression.

Personality and trust

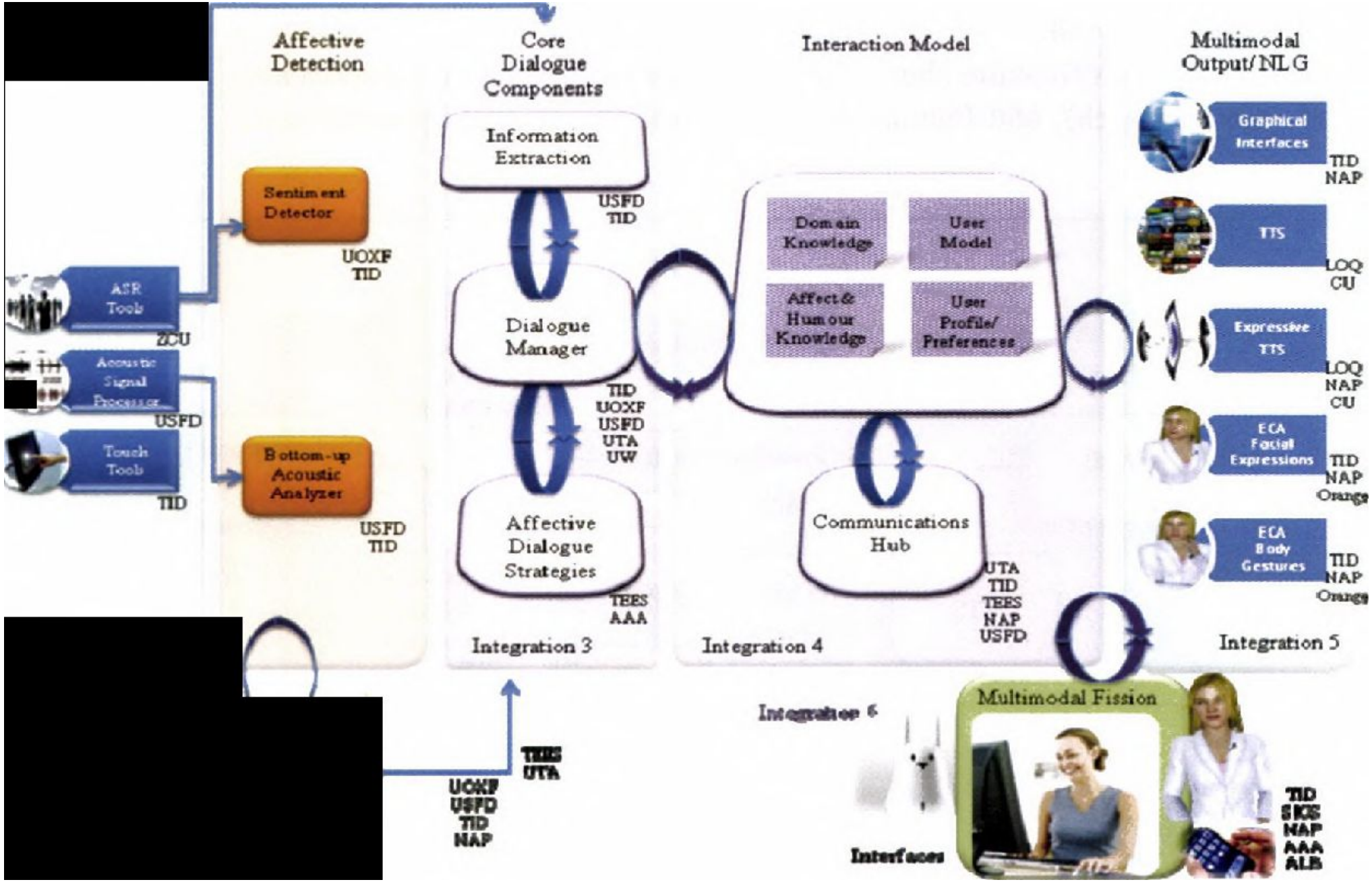
- Personality is treated as a key aspect of the media equation by Reeves and Nass (1996). They undertook a number of studies that showed how assertive people prefer to interact
- with an assertive computer and submissive people prefer interacting with submissive devices. As soon as interaction moves from the utilitarian to the complexity of a relationship, people will want to interact with personalities that they like.
- Trust is a ‘a positive belief about the perceived reliability of, dependability of, and confidence in a person, object or process’

Social attitudes

- Bickmore and Picard (2005) emphasize appraisal support as a key aspect of relationship building and the importance of other social ties such as group belonging, opportunities to nurture, autonomy support and social network support.
- The rather controversial idea of ‘persuasive technologies’ is based on getting people to do things they would not otherwise do.
- A health and fitness companion, for example, should try to persuade its owner to run harder, or train more energetically.

Social attitudes

- Another view of the companion architecture is shown in Figure 17.15.
- This shows the architecture moving from input on the left to output on the right and the order in which components are accessed and information extracted.
- First, the different modalities of input - GUI and touch, automatic speech recognition (ASR) and signal detection - are integrated.
- Emotion is detected through voice detection software and through an analysis of the sentiment expressed in the words of the utterance.
- The dialogue is ‘understood’ based on analysis of the words used, the emotion inferred and the entities that are recognized by the system.
- This accesses domain and user knowledge to determine the best course of action and the best way of presenting this in terms of words spoken, intonation and the behaviours of the avatar.



Another view of the Companion architecture