

agent toward users.

Most of empathic virtual agents are based on the OCC model [19]. Consequently, only two types of empathic emotions are considered : *happy-for* and *sorry-for*. However, research in psychology suggests that the type of an empathic emotion toward a person is similar to the type of the emotion of the latter [11]. Indeed, by empathy, someone may, for instance, feel fear for another person. Therefore, there exist as many types of empathic emotion as types of non empathic one. Then, an empathic virtual agent should *feel* an empathic emotion of frustration for the user if it thinks the user is frustrated.

In [7], the *happy-for* (respectively *sorry-for*) emotion is elicited by the empathic agent when a goal of another agent (virtual agent or user) is achieved (respectively failed). The empathic virtual agent has a representation of the other agent's goals. It deduces these goals from their emotional reactions. Consequently, the agent knows the other's goals only if they have been involved in an emotion elicitation. Therefore, the other agent's goals representation might be incomplete. In [28], the virtual agent expresses *happy-for* (respectively *sorry-for*) emotion only if it detects a positive (respectively negative) emotional expression of its interlocutor. The agent's empathic emotions are in this case elicited by the perception of the expression of an emotion of another agent. Indentically, in [25], the virtual agent expresses empathy according to the user's emotions (frustration, calm or joy) recognized through physiological sensors. However, an empathic emotion can be elicited even if this emotion is not felt or expressed by the interlocutor [24].

Another approach consists in observing real interpersonal mediated interactions in order to identify the circumstances under which an individual expresses empathy and how it is displayed. The system *CARE* (*Companion Assisted Reactive Empathizer*) has been constructed to analyze user's empathic behavior during a treasure hunt game in a virtual world [16]. The results of this study are domain-dependent. The conditions of empathic emotion elicitation in the context of a game may not be transposable in another context (as for example the context in which a user interacts with a virtual agent to find out information on a specific domain).

Our method to create empathic virtual agent is based both on a theoretical and empirical approaches. It consists to identify through psychological cognitive theories of emotion and through the study of real human-machine emotional dialogs, the situations that may elicit users' emotions. In the next section, we present our model of empathic emotions.

3. A MODEL OF EMPATHIC EMOTIONS

An empathic virtual dialog agent should express empathic emotions in situations in which the user potentially felt an emotion. The agent should therefore know the conditions of elicitation, the types and intensity of the users' emotions during the dialog.

3.1 Theoretical Foundations.

According to the *cognitive appraisal theories* [31], emotions are triggered by a subjective interpretation of an event. This interpretation corresponds to the evaluation of a set of variables (called *appraisal variables*). When an event occurred (or is anticipated) in the environment, the individual evaluates the latter through a set of variables. The values of these variables determine the type and the intensity of the

elicited emotion. In our work, we focus on the goal-based emotions [19]. We consider the following appraisal variables (extracted from [30]):

- *The consequence of the event on the individual goal*: an event may trigger an emotion only if the person thinks that it affects one of her goals. The consequences of the event on the individual goal determine the elicited emotion. For instance, fear is triggered when a survival goal is threatened or risks to be threatened. Generally, failed or threatened goals elicit negative emotions whereas achieved goals trigger positive ones.
- *The causes of the event*: the causes of an event that lead to emotion elicitation may influence the type of the elicited emotion. For instance, a goal failure caused by another agent may trigger anger.
- *The consistency of consequences with the expectations*: the elicited emotion depends on the consistency between the current situation (*i.e.* the consequences of the occurred event on the individual's goals) and the situation expected by the individual.
- *The potential to cope with consequences*: the coping potential represents the capacity of an individual to deal with a situation that has led to a threat or failed goal. It may influence the elicited emotion.

The interpretation of an event (*i.e.* the evaluation of appraisal variables and then the elicited emotion) depends principally on the individual's goals and beliefs (on the event, its causes, its real and expected consequences, and on her coping potential). That explains the different emotional reactions of distinct individuals in front of a same situation.

In a dialog context, an event corresponds to a communicative act. Consequently, according to the appraisal theory of emotion [31], a communicative act may trigger a user's emotion if it affects one of her goals. To identify more precisely the dialogical situations that may lead a user to feel emotion, we have analyzed real human-machine dialogs that have led a user to express emotions. We present in the next section the results of this study.

3.2 The Analysis of Users' Emotions Elicitation in Human-Machine Interaction.

The analyzed dialogs have been derived from two vocal applications. The users interact orally with a virtual dialog agent to find out information on a specific domain (on stock exchange or on restaurants in Paris). First, the dialogs have been annotated with the label *negative_emotion* by two annotators¹. The annotations have been done based on vocal and semantic cues of user's emotions. Secondly, these dialogs have been annotated with a particular coding scheme in order to highlight the characteristics of the dialogical situations that may elicit emotions in a human-machine context (for more details on the coding scheme see [18]). The analysis of the annotated dialogs has enabled us to identify more precisely the characteristics of a situation that may lead to a *negative* emotion elicitation in human-machine interaction. Concerning the appraisal variable *consequence of the event*,

¹Unfortunately, the dialog corpus did not cover situations that have led users to express positive emotion

