

The good, the bad and the neutral: affective profile in dialog system-user communication

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Abstract. We describe the use of affective profiles in a dialog system and its effect on participants' perception of conversational partners and experienced emotional changes in an experimental setting, as well as the mechanisms for realising three different affective profiles and for steering task-oriented follow-up dialogs. Experimental results show that the system's affective profile determines the rating of chatting enjoyment and user-system emotional connection to a large extent. Self-reported emotional changes experienced by participants during an interaction with the system are also strongly correlated with the type of applied profile. Perception of core capabilities of the system, realism and coherence of dialog, are only influenced to a limited extent.

Keywords: affective dialog system, affective profile, conversational agent, affective computing, HCI

1 Introduction

Collective emotions play a pivotal role in creating, forming and breaking-up of online-communities. Recently, the study of these phenomena became an active interest for policy-makers, business professionals and multi-disciplinary research teams. One approach for studying collective emotions on the Internet focus on analysis of online discussions, such as blogs, newsgroups and Twitter-like posts⁴ to understand the role of sentiment and other emotional factors for active Internet users. Using a complementary approach, we develop affective dialog systems to extend these analyses quantitatively, by engaging less active users, and qualitatively, by extending the interaction scope and engaging users in follow-up dialogs about introduced topics. The developed systems serve as testbed for studying affective human-computer interaction and for evaluating affective components in robust real-world interactions with a diverse set of users.

⁴ <http://www.cyberemotions.eu/>

Previous experiments [20], focused on the evaluation of a precursor of the presented dialog system in a VR environment [9]. There, the system was responsible for managing verbal communication of a virtual agent, the Affect Bartender. Results demonstrated that the system was capable of establishing an emotional connection, and further of conducting a realistic and enjoyable dialog. Obtained ratings did not differ from a Wizard-of-Oz (WOZ) setting. The experiments described below focuses on the role of a dialog system’s affective profile and its effect on the communication with users and on their perception of the system capabilities. We aimed at evaluating the system in a setting typical for online, text-based communication platforms, i.e., web chat rooms. In this paper, we present the system architecture and the mechanisms used for affective profiles and character traits. We introduce the components for conducting task-oriented follow-up dialogs, i.e., dialogs about introduced “hot-topics” aiming at acquisition of data on users’ affective responses and attitudes regarding these issues. After describing the interaction setting, we present the experimental procedure, characteristics of participants and discuss the system evaluation results.

2 Relevant Work

In interactions between humans and artificial agents, the capability to detect signs of human emotions and suitably react to them can enrich communication. For example, display of empathic emotional expressions enhanced users’ performance [14], led to an increase in users’ satisfaction [16] and improved the perception and assessment of virtual agents [11]. However, an agent with emotional facial expressions incongruous to the dialog situation is perceived more negatively compared to an agent that expresses no emotion [11]. In [4, 10] applications of aspects of emotion detection and generation of personality traits were proposed for spoken and multi-modal dialog systems and ECA prototypes. Mello et al. [6] describe an intelligent tutoring system that integrates affect-sensing in order to classify emotions using facial expressions, body movements and conversational cues (i.e., correctness of an answer, verbosity, reaction and response time). Bee et al. [2] presents a Virtual Agent that senses affect from users’ voice and applies affective, non-verbal cues for generating emotional mimicry and displaying envelope feedback and empathy.

In our approach, we focus predominantly on the text modality and on the fusion of results from natural language processing and affective dialog management. Further, we examine the effect of a dialog system’s affective profile on users’ perception of the system and its effect on users’ communication style and their expressions of affective states. The developed system is applied to robust, online interactions with a variety of users and provides data that extends the scope of analysis of users’ emotion driven responses to online and offline events. Relevant prior work for acquiring information from users through artificial conversational entities was mostly focused on extending a base of conversational systems’ response candidates [17] or accumulating knowledge useful for the addition to the massive repository of common-sense, real-world knowledge [22].

Extending databases of contextual and episodic information is a potentially infinite task. As time progresses, external circumstances change and knowledge accumulates. However, other conversational components such as human emotions are comparatively stable and, at least to some degree, universal [5, 7]. Because of their constant influence on human communication [12], they are immensely valuable for designing conversational systems. For instance, it has recently been demonstrated that affective mood influences the disclosure of personal information, both in real and virtual setups [8]. Such disclosure is an essential part of human relationship formation [1]. Conversational systems able to detect and respond to human affect therefore have the potential to improve HCI more than by accumulating knowledge bases—though both approaches are complementary.

3 Dialog System Architecture

The dialog system used in the experiments is equipped with three distinct affective profiles (positive, negative, neutral). The system is responsible for the management of text-based communication between an agent (the virtual bartender) and a user in an online web chat environment. The main objectives for the system in this interaction scenario are:

1. Realistic and coherent dialogs,
2. Conducive setting for communication (i.e. acquisition of large data sets),
3. Introducing and conducting task-oriented dialogs related to “hot topics” in order to acquire users’ affective states and their stance towards the issues,
4. Maintaining a consistent affective profile (positive, negative, or neutral) throughout the whole communication with users.

The characteristic of online, real-time and unrestricted interactions with a wide range of users influenced the selection of methods and design decisions. We aimed at: (i) robustness regarding erroneous natural language input, (ii) responsiveness, (iii) extensibility regarding modification of used components and application scenarios. Below we provide an overview of the main system components and present mechanisms used for simulating affective profiles. For a detailed description of the system architecture refer to [18, 20]. Changes, compared with our previous experiments [20], included the introduction of the Affective Profile Control Component (APCC) and extensions of the core system mechanisms for generating response candidates: Affect Listeners Dialog Scripting (ALDS) [18] and Affect Bartender AIML set (AB-AIML) [20]. We introduced a new component for modifying system responses to conform to a specific affective profile: Post-processing of System Responses. Fig.1 presents the top-level layers of the system architecture (communication, perception, control) and the interaction loop with the environment. Fig.2 shows an excerpt of the Perception Layer annotation for example inputs⁵.

⁵ The Perception Layer, cf. [19], annotates both, user utterances and system response candidates. DA- dialog act classes, SC- sentiment class (-1,0,1), NS/PS- neg./pos.

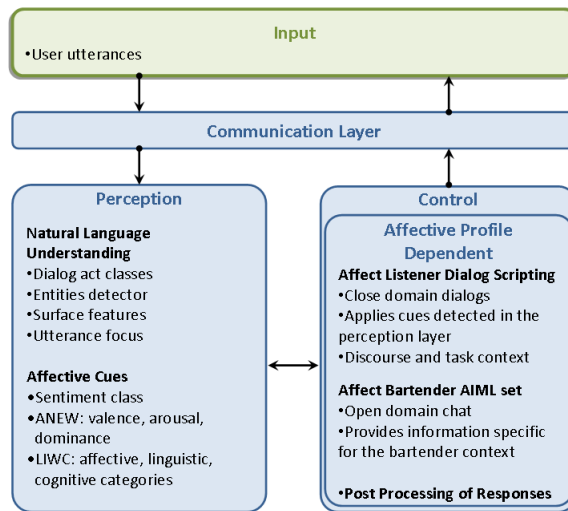


Fig. 1. Interaction loop and dialog system layers

Input	Perception Layer Output (excerpt)
You must be kidding!	DA-Statement SC- -1 NS- -3 PS-1 DR-pina colada EM-1
No more pina colada?	LC-Social:Discrep:Certain AV-6.91 AA-5.27 AD-5.07
I really like being here! :=)	DA-Statement SC-1 NS- -1 PS-5 EE-smile
	LC-Affect:Posemo:CogMech AV-0.0 AV-0.0 AD-0.0
Didn't you forget to pay the bill last time??	DA-ynQuestion SC- -1 NS-3 PS-3
	LC-Money:Work:Past:Negate AV-5.31 AA-4.64 AD-4.63

Fig. 2. Perception Layer – annotation example.

3.1 Affective Profiles for a Dialog System

We define an *artificial affective profile* as a coarse-grained simulation of affective characteristics of an individual, corresponding to dominant, observable affective traits, that can be consistently demonstrated by a system during the course of its interactions with users. In this round of experiments, three distinct affective profiles were provided to the dialog system: positive, negative and neutral, limiting variations to baseline levels of positive and negative affectivity in personality [21]. Each affective profile aims at a consistent demonstration of character traits of the “Affect Bartender” system that could be described as, respectively:

sentiment (-5...-1, 1...5) [13], DR- drink instance, EM- exclamation mark, LC- categories in LIWC dictionary [15]. The ANEW classifier assigns valence (AV), arousal (AA), dominance (AD) between 1 and 9 [3].

- cooperative, emphatic, supporting, positively enhancing, focusing on similarities with a user,
- conflicting, confronting, focusing on differences with a user,
- professional, focused on job, not responding to expressions of affect.

Affective Profiles in Affect Listeners Dialog Scripting (ALDS). ALDS is an information state based dialog management component that uses a set of information cues provided by a perception layer to control dialog progression, cf. [18,19] for details on concept and implementation. The ALDS set used in previous experiments [20] was extended to offer the required, profile-dependent, variety of system response candidates and dialog scenarios. In particular, the following extensions were introduced:

- **affective variety:** new interaction scenarios and template-based response instructions that match the whole spectrum of the affective profiles,
- **affective responsiveness:** ALDS-based mechanism to select responses according to affective profiles and affective expressions detected in user utterances. E.g., positive - prefer similarity with users' expressions; negative - prefer dissimilarity.
- **dialog context:** analysis of local dialog context for initiating the task-oriented scenarios.

Further, new ALDS-based interaction scenarios were provided for conducting task-oriented dialogs with users, i.e., querying about users' initial responses and current stance towards selected topics of interest. The list of topics introduced to the discussion was selected based on their importance at the time of conducting the experiments (December 2010) for the participants (people of Polish nationality): (i) announcement of a tax increase for the year 2011, (ii) accusations about alleged bribery related to the Polish-Ukrainian winning bid for the organisation of 2012 European Soccer Championships, (iii) introduction of a smoking prohibition in public places.

For managing dialogs, ALDS scenarios depend on the discovery of particular cues in user utterances such as e.g., specific Dialog Act classes (Agreement, Rejection, yAnswer, whQuestion, etc.), LIWC categories or a positive or negative sentiment value. These influence dialog progression and enable the system to generate responses that match its affective profile. E.g., in the "hot-topics" part of a dialog, the positive affective profile relies on the assessment of the sentiment value (PS/NS from a Lexicon-Based Sentiment Classifier[13]) of a user response to a question "What was your first reaction when you heard about this?", when deciding on the suitable response, e.g. for $(PS+NS < 0)$ - "You don't seem to be happy about this too. Can you tell me why does this news affect you?".

The initiation of a particular ALDS-based interaction scenario depends on dialog progression (i.e., number and type of message exchanges so far) and the local dialog context. The analysis of dialog context enables the system to avoid e.g., sudden changes of topic when there is sufficient evidence that such a change would break the dialog progression. In particular, new scenarios cannot be initiated when the system is already conducting other, task-oriented scenarios.

Further, a new scenario cannot be started when the Dialog Act classes assigned to the last user’s utterance includes categories such as: DA-ynQuestion, DA-whQuestion, DA-Order. Fig.3 presents an excerpt of an interaction log illustrating the change between task-specific parts of the dialog (here, ordering drinks and acquisition of current stance, initial response and affective states regarding tax increases).

System: here you are! enjoy! [order served]
 User: thank you
assessment of a dialog context: ability to start a new task oriented dialog
 System: Have you heard that they want to raise the taxes in the next year?
 Do you think this decision was really necessary?
 User: its annoying but i think its necessary
 System: What was your first reaction when you heard about this?
 User: angry
perception layer annotation (excerpt):LC-Affect:Negemo:Anger
SC- -1 NS- -3 PS-1 AV-2.85 AA-7.17 AD-5.55
 System: You don’t seem to be happy about this too. Can you tell me why does this news affect you?
 User: because they promised not to rise it up
 LC-CogMech:Cause:Social:They:Affect:CogMech:Negate **SC- -1 NS- -2 PS-1**
 System: I feel very similar about it! It is a pleasure to talk with you.
 The next drink is on me :-)

Fig. 3. Dialog excerpt (positive profile) related to a hot-topic of discussion.

Besides the “hot-topic” discussion part of a dialog, the profile-dependent, ALDS-based scenarios were also provided for “drinks and snacks ordering” and “hobby” scenarios, as well as for the ALDS-based system comments related to the user’s affective states (based on LIWC categories and sentiment classification), each in three different versions matching the profiles.

Affective Profiles in AIML sets (AB-AIML). The AB-AIML set used in the previous round of experiments and described in more detail in [20] was extended to contain a variety of response templates suitable for the affective profiles. Based on an analysis of data from previous experiments, a sub-set of most frequently used templates was identified. This set included e.g., questions and comments about the user, messages used at the beginning and at the end of a dialog and confusion statements. In total, for the above presented categories, 133 response templates were provided: 40 positive, 55 negative and 38 neutral.

Affective Profile-Dependent Post-processing of System Responses. To achieve a consistent affective characteristic for all the responses generated by the system with a particular affective profile, we introduced profile-dependent post-processing of system responses. System response candidates are modified aiming at a specific affective profile. This is a crucial functionality that influences a majority of system-generated responses, for which no specific profile-dependent

interaction scenarios or templates are present beforehand. The mechanism processes a response candidates and modifies (by adding or removing words) discovered positive or negative expressions, words and/or emoticons. For example, for the negative profile, the component removes text chunks that contain words, classified as “positive” (e.g., glad, happy, welcome, great, sir, please) from response candidates.

4 Experimental Method

For conducting experiments, a browser-based communication interface, resembling a typical web chat-room environment was developed: a user input field at the bottom of the screen and a log of communication above. Participants interacted with all three affective profiles in turn, once with each. To avoid ordering effects in the evaluation of systems, the actual sequence was randomly and evenly assigned and the list of evaluation statements was displayed to users before the start of the first interaction so that they could familiarize themselves with the statements to be rated. These statements were:

1. I enjoyed chatting with the conversational partner during the just completed interaction.
2. I found a kind of “emotional connection” between myself and the conversational partner.
3. I found the dialog with the conversational partner to be realistic.
4. I found the dialog to be coherent. In other words, the sequence of responses of the conversational partner made sense.
5. I noticed a positive emotional change in myself during the interaction.
6. I noticed a negative emotional change in myself during the interaction.
7. I would like to chat again with this particular conversational partner in the future.

During the experiments, after each experimental condition corresponding to a single affective profile, participants were asked to express their agreement or disagreement with the above presented statements on a five-point Likert scale (i.e., from 1 = *strongly disagree* to 5 = *strongly agree*). Participants interacted with the dialog system in an unsupervised manner and were aware that they talk with an artificial system. Interactions were always initiated by the system, i.e. the system provided the first utterance, and stopped after 7 minutes, with a suitable closing response followed by the display of the questionnaire. To further increase the number of system-user message exchanges compared to previous experiments [20], no artificial delays (e.g., a simulation of thinking or typing) were used in this experiment.

91 participants (33 female, 58 male), aged between 18 and 52, completed interactions in all three experimental settings resulting in 273 interaction logs. English, the language in which the experiments were conducted, was not their native language, but all participants who completed the set of interactions had at least average communication skills in this language.

5 Experimental Results

A repeated-measures analysis of variance (ANOVA) revealed the expected main effects of the dialog system’s affective profile (positive, neutral, or negative) on all dependent measures: chatting enjoyment, subjective feeling of emotional connection, perception of dialog realism and coherence, participants self-reported positive or negative emotional change experienced during the interaction, as well as the willingness to chat again with a system that uses a particular type of affective profile (all $F_s(2, 180) > 4.44$, $p_s < .05$). These effects were characterized by significant linear trends for all measures (all $F_s(1, 90) > 6.60$, $p_s < .05$), reflecting the increasingly negative ratings of participants for progressively less positive affective profile of the system.

Pairwise comparisons with Bonferroni correction demonstrate significant differences on all measures between the positive and negative affective profiles (see Fig. 4). Additional differences are found between neutral and non-neutral profiles on some measures, such as enjoyment or desire to chat again.

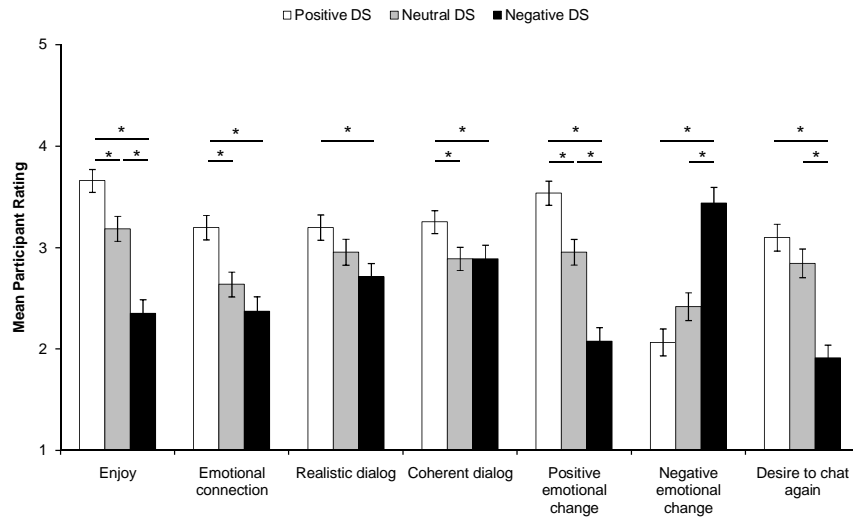


Fig. 4. Participant’s mean ratings on all dependent variables, of their interactions with the dialog systems with three different affective profiles (positive, neutral, negative). An asterisk indicates a significant difference (at $p < .05$) between two types of affective profile used. Error bars represent 1 SE.

The effect sizes (i.e., the proportion of variance in measures (enjoyment, emotional connection, etc.) due to the differences in affective profile) vary. They are the lowest for dialog realism and coherence ($\eta_p^2 = .06$ and $\eta_p^2 = .05$, respectively), and biggest for enjoyment and the feeling of a positive emotional change ($\eta_p^2 = .31$ and $\eta_p^2 = .32$, respectively). In other words, the difference in dialog system

profile does not have a large impact on how real or how coherent participants perceive it to be. However, it has a much bigger impact on the enjoyment of the conversation and on the positive emotional changes felt during the conversation.

6 Conclusions

In this paper, we have presented an implementation of affective profiles in a dialog system and its evaluation in an experiment with 91 participants. The proposed components responsible for the realization of affective variety of system responses were integrated with a previously presented system architecture that has been evaluated in a VR setting, obtaining results on par with a WOZ setting regarding dialog realism, chatting enjoyment and participants' feeling of an emotional connection with the system. In the current experiment, participants conducted tests online, using only textual modality, in a setting typical for casual Internet activities. The presented experiments focused on the assessment of the effect of an affective profile and its influence on communication processes and system perception. The results demonstrate that the implemented affective profiles to a large extent determined the assessment of the users' emotional connection and enjoyment from the interaction with the dialog systems, while the perception of core capabilities of the system, i.e. dialog coherence and dialog realism, were only influenced to a limited extent. Further, the emotional changes experienced by the experiment participants during the online interactions were strongly correlated with the type of applied profile. The affective profile induced changes to various aspects of the conducted dialogs, e.g., communication style and the users' expressions of affective states.

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