

# Real-Time Robot Personality Adaptation based on Reinforcement Learning and Social Signals

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## ABSTRACT

Recent findings in Human-Robot Interaction (HRI) indicate that the adaptation of a robot's behaviors to the human's personality profile makes interaction more engaging, but also that it depends on the task context whether a similar or opposing robot personality is preferred. This late breaking report presents our ongoing work on an approach using Reinforcement Learning and social signals for figuring out and adapting to the human preferences, i.e. desired personality profile. Our scenario involves a "Reeti" robot in the role of a story teller talking about the main characters in the novel "Alice's Adventures in Wonderland" by generating descriptions with varying degree of introversion/extraversion. The learning process is running in real-time during the interaction and allows for simultaneous adaptation without explicitly asking the user about its preferences.

## Keywords

Adaptation; Reinforcement Learning; Personality; introversion/extraversion; Social Robotics; Dialog; Social Signals

## 1. BACKGROUND AND PROTOTYPE

In HRI, implementing compelling personality in a social robot makes interaction more interesting, desirable and encourages the establishment of a relationship between user and robot [3]. Moreover, recent research points out that humans prefer robots with similar personality to their own and that the adaptation of a robot's personality to the human's profile makes interaction more engaging [1]. Other results indicate that it depends on the task context whether a similar or opposing personality is preferred [4]. In any case the existence of an adaptation process is important to address the user's needs and preferences, to customize and keep interaction engaging [7].

When implementing a new HRI application, we don't know which type of personality the robot should express. Therefore, we aim to develop an approach for figuring out and

adapting to the user's personality preferences automatically without sticking to the similarity or complementary attraction principle. In our human-robot dialog prototype a "Reeti" robot describes and presents facts about the main characters in the novel "Alice's Adventures in Wonderland". Reeti's personality is expressed via linguistic style: utterances are not predefined, but generated automatically with varying amount of introversion/extraversion (one of the "Big Five" personality dimensions [6]). An adaptation process based on RL and social signals controls and optimizes the robot's personality to keep the user engaged.

## 2. ADAPTATION PROCESS

Implementing adaptation in an HRI scenario requires to get information about the user's actual needs or preferences. We do not want to explicitly ask the user and thus cannot get this data directly. Moreover, depending on the task, we do not know whether the robot's personality should match these preferences or not. Therefore, our approach relies on social signals which are available during interaction anyway: we use the Social Signals Interpretation (SSI) framework [8] for estimating the user's current level of engagement based on the operationalization in [2]. Engagement serves us as an indication of whether Reeti's personality engages the user or not. Based on this estimation, RL is our algorithmic method of choice for manipulating the robot's personality and learning about the user's needs and preferences in a given scenario.

Figure 1 illustrates the interaction and adaptation process. SSI estimates the current level of user engagement  $E_t$  at time  $t$  based on the user's gestures, posture, video and audio. This value is discretized in an integer interval  $[-2; +2]$  ("not engaged at all" to "very engaged").

The RL process uses this information for learning about the relationship between the robot's expressed personality and the user's engagement. Therefore, it manipulates the robot's current extraversion level  $X$ , which is in the integer interval  $[-2; +2]$  ("very introverted" to "very extraverted"). Three actions allow to increase or decrease  $X$  by 1 as well as to leave  $X$  unchanged.

The state space includes the robot's current  $X$  value as well as the last sensed level of user engagement  $E_{t-1}$ . This allows to learn how to maximize engagement by increasing or decreasing  $X$ . In order to find the optimal value, the RL process uses the change of engagement  $\Delta E_t = E_t - E_{t-1}$  between two sequent points in time  $t-1$  and  $t$  as reward signal. For  $\Delta E_t = 0$ , the robot gets a small reward  $+0.5$  for preventing a decrease of engagement.

