Designing and implementing an emotion-aware chatbot V2

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The research problem to be tackled by this proposal is revising some foundations of designing autonomous software agents and particularly chatbots with the emergence of the theory of predictive probabilistic processing in the brain (Clark, 2013), which is increasingly considered to be as important for neuroscience as the theory of evolution is for biology. According to the theory of predictive probabilistic processing, a human brain invisibly constructs everything one experiences by matching the given situation with the most similar situation from the past, which is found by very fast predictive simulations in the brain, and by "storing" each new situation. Among everything else, also emotions are constructed in the brain, in concordance with the goals aimed to be achieved (Barrett, 2017a). For example, if the goal is romantic love, the emotions *Passionate*, *Longing* and *Lustful* might be constructed which make this goal more attainable. Differently, if the goal to be attained is tough love or brotherly love, respective instances of the emotions *Disciplined* and *Bonded* might be constructed (Barrett, 2017b).

The theory of predictive probabilistic processing can fundamentally change the way software agents and chatbots are designed and implemented from traditional symbolic architectures towards probabilistic cognitive architectures for predictive processing (Pfeffer & Lynn, 2018). However, computational implementation of predictive probabilistic processing is still faced with serious problems of intractability (Kwisthout & van Rooij, 2019). Different solutions have been proposed to overcome this challenge, such as sampling the environment by the agent (Friston, et al., 2012) and heuristic solutions in the predictive architectures of software agents (Alt, Baez & Darken, 2011).

This MSc project will continue the work started in the MSc project by Kirikal (2020), where a Minimal Viable Product of a chatbot capable of reflecting the emotions by its users was designed and implemented. The resulting chatbot will serve as a prototypic solution for a social robot that can emotionally relate to its owner and for a software agent to be embedded in an Interactive Digital Narrative (Koenitz, 2015).

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Designing and implementing a computer simulation of the predictive brain

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Predictive probabilistic processing in the brain (Clark, 2013) is increasingly considered to be as important for neuroscience as the theory of evolution is for biology. According to the theory of predictive probabilistic processing, a human brain invisibly constructs everything one experiences by matching the given situation with the most similar situation from the past, which is found by very fast predictive simulations in the brain, and by "storing" each new situation. The theory claims, as expressed by Pfeffer & Lynn (2018), that our beliefs about the state of the world (or about the state of our bodies) yield predictions about incoming sensory signals, based on the conceptual representations of the world stored in our brain. The predictions become more and more specific as they pass down the hierarchy towards the primary sensory level, where they come to specify the lowest level sensory features. What is encoded by the sensory level, then, is not stimulus features, but prediction error – the difference between the prediction and the sensory signals. It is prediction error, not a stimulus representation per se, that is passed back up the hierarchy to be operated on by cognitive processes. This considerably decreases the information processing load by the brain and thereby increases the efficiency of the brain.

The topic of the M.Sc. thesis is to design and implement a computer simulation of the predictive brain by applying the belief propagation (or sum-product) algorithm as described by Jardri & Deneve (2013b). The resulting computer simulation can be used for simulating mental diseases and conditions, such as schizophrenia (Jardri & Deneve, 2013a).

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