

Towards a Framework for Reasoning About Emotional BDI Agents

David Pereira, Nelma Moreira

Eugénio Oliveira

DCC – FC & LIACC

NIAD&R – FEUP & LIACC

University of Porto

University of Porto

{dpereira,nam}@ncc.up.pt

eco@fe.up.pt

Abstract

The BDI model of agency is a well studied concept in Formal Logic for Rational Agents, mainly through the BDI_{CTL} [7] and **KARO** [7] logical frameworks. The former is based on the Branching Time Logic CTL [3], whereas the latter is based on Dynamic Logic [4]. Both have advantages and disadvantages, but the union of some properties of both frameworks provide, in our opinion, all the formal tools that we need to model the more recently introduced concept of Artificial Emotion within the BDI model [2].

In this work we propose an extension to the BDI_{CTL} so its syntax and semantics to support reasoning about Artificial Emotions. We named this extension $\text{BDI}_{\mathbf{E}}-\mathcal{L}_{\mathbf{A}}^{\mathbf{T}}$ logic. More particularly, we want to reason about the role of Artificial Emotions in BDI agents in a logical point of view, and for that we based the development of $\text{BDI}_{\mathbf{E}}-\mathcal{L}_{\mathbf{A}}^{\mathbf{T}}$ in the ideas put forward in [2, 5]. Based on these ideas, we defined in $\text{BDI}_{\mathbf{E}}-\mathcal{L}_{\mathbf{A}}^{\mathbf{T}}$ modal operators for modelling action-execution, capabilities (abstract plans of action) and resources (means to turn capabilities in executable actions). Moreover, we also defined modal operators for Artificial Emotions, in the same level of the BDI modal operators. With all these modal tools at hand, our main goal is to formally model two fundamental aspects of Artificial Emotions: their triggering and their influence in agents behaviour. Since the formal definition of Artificial Emotion and behavioural concepts are already present in the core of $\text{BDI}_{\mathbf{E}}-\mathcal{L}_{\mathbf{A}}^{\mathbf{T}}$, we define the introduced aspects through establishing some interactions between the modal operators representing Artificial Emotions and the ones representing BDI, actions, capabilities and resources.

References

- [1] *The Second International Joint Conference on Autonomous Agents & Multi-agent Systems, AAMAS 2003, July 14-18, 2003, Melbourne, Victoria, Australia, Proceedings.* ACM, 2003.

- [2] Nelma Moreira David Pereira, Eugénio Oliverira and Luís Sarmiento. Towards an architecture for emotional bdi. In *2005 Portuguese Conference On Artificial Intelligence*, pages 40–47. IEEE, 2005.
- [3] E. Allen Emerson. Temporal and modal logic. In *Handbook of Theoretical Computer Science, Volume B: Formal Models and Semantics (B)*, pages 995–1072. 1990.
- [4] David Harel, Dexter Kozen, and Jerzy Tiuryn. *Dynamic Logic*. MIT Press, 2000. HAR d 00:1 1.Ex.
- [5] Eugenio Oliveira and Luís Sarmiento. Emotional advantage for adaptability and autonomy. In *AAMAS* [1], pages 305–312.
- [6] Anand S. Rao and Michael P. Georgeff. Modeling rational agents within a BDI-architecture. In James Allen, Richard Fikes, and Erik Sandewall, editors, *Proceedings of the 2nd International Conference on Principles of Knowledge Representation and Reasoning (KR'91)*, pages 473–484. Morgan Kaufmann publishers Inc.: San Mateo, CA, USA, 1991.
- [7] Wiebe van der Hoek and Michael Wooldridge. Towards a logic of rational agency. *Logic Journal of the IGPL*, 11(2):135–159, 2003.