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Building a Hierarchy of Functional Representations for Domain-Independent Reinforcement Learning in Non-Markovian Environments

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This project explores dependencies between specific ways of representing sensomotoric data, identifying its functional role and in how far it enables inferring appropriate conclusions about different rewarding environments. Following the initial proposal of Harnad (1990), a hybrid architecture has been designed that consists of a sub-symbolic and a symbolic layer. The project is motivated by the assumption that symbols need not be grounded in communication, but can also be exclusively mental in nature. Therefore it differs from other research in Symbol Grounding like Steels (1999) where a community of artificial speakers tries to agree upon a common dictionary for designating objects. Furthermore, the motivation for grounding is not consensus but reward in a continuous environment. Successful interaction with different rewarding environments can be approached by Temporal Difference Learning (Sutton & Barto, 1998). But optimality of this method is limited to environments where the agent's sensorimotor states are dependent only on the frequency of previously experienced states (Markov assumption).

This does not hold for interaction with natural environments. Therefore different inductive biases besides probability have been examined (sequentiality, hierarchical structure and functional role of input data).

Inductive transfer is the problem of how obtained knowledge from one domain may be reused in a significantly different domain (e.g. Pan and Yang (2010)). By subsuming representations according to function rather than structural features, knowledge from structurally different domains can be interchanged. In future research, inductive transfer promises to be a fertile field for determining whether symbols have been grounded "the right way." Function centered representations also connect to research in modeling affordances and designing according algorithms (Rome, Hertzberg, & Dorffner, 2008).

The system's modules have been identified. Algorithms for initial partitioning of sensorimotor space have been determined. Also several different Markov predictors have been modified to produce hierarchical representations on different levels of generalization. Hierarchisation of representations, however, has not yet overcome the probabilistic limitation of Markov predictors. Alternatives like L* (Angluin, 1980) and Stochastic Context Free Grammars are being investigated for applicability.

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