

FALCON-X: An Integrated Neural Cognitive Architecture

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Abstract

A neural network based cognitive architecture, known as Fusion Architecture for Learning and Cognition - eXtension (FALCON-X), is proposed herein, based on an integration of the Adaptive Control of Thought (ACT-R) cognitive architecture [1] and the fusion Adaptive Resonance Theory (fusion ART) neural model [2]. Fusion ART is a generalization of self-organizing neural models known as Adaptive Resonance Theory (ART). By extending the original ART model consisting of a single pattern field into a multi-channel architecture, fusion ART unifies a number of network designs as well as a myriad of learning paradigms, including unsupervised learning, supervised learning and reinforcement learning. While retaining the structure of the perceptual (visual), motor (manual), intentional and declarative memory modules, the proposed architecture replaces the central production system of ACT-R with a fusion ART neural network serving as the core inference area for fusing and updating the pattern activities in the four memory buffers. In addition, a critic module is incorporated that provides reinforcement signals to regulate the attentional and learning processes of the core inference area.

The FALCON-X architecture potentially could be used to model a wide range of cognitive processes. In this paper, we describe how procedural knowledge can be learned as sensory-motor mappings through reinforcement learning. We also show how declarative knowledge can be encoded using a class of *composite neurons* as long-term memories. The proposed architecture has been used to build virtual robots for battles in a simulated *RoboCode* domain. Based on this domain, we demonstrate how the learned procedural and declarative knowledge can be integrated for decision making and problem solving.

References

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- [2] Tan, A.-H.; Carpenter, G.-A.; and Grossberg, S. (2007) Intelligence through interaction: Towards a unified theory for learning. In *Proceedings ISNN, LNCS4491*, 1098-1107.