A brain-inspired cognitive architecture for
self-referential autonomous learning of situation representations

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Scene understanding and situation recognition is an essential technological prerequisite for intelligent systems applications such as autonomous driving or mobile human support systems. Current approaches towards scene analysis and situation understanding face several essential problems. For example, real world scenes are too complex and undergo too many variations that simple appearance based methods would be useful for predicting future episodes of behavior in similar situations. Moreover, state-of-the-art systems cannot adequately solve the problem of autonomous learning of structured scene or situation representations that are usefully constrained by behavioral needs.

Here we propose a cognitive architecture for self-referential autonomous learning of situation representation. Our system is inspired by brain architecture and includes subsystems for working memory, episodic memory, and semantic memory that includes structured situation representations and hierarchical behavioral models for planning and decision making. By self-referential learning we mean the control process of autonomously extending subjective knowledge representations by defining what to learn and how to integrate it into the already established relational architecture of knowledge representation via behavioral reward evaluation [1].

We demonstrate such autonomous learning of a behaving system in a restricted simulated traffic scenario. During exploration the system stores episodes that are structured in accordance with the current knowledge base of behaviorally grounded situation models and valued by a reward system. Behavioral models are optimized by reinforcement learning and extension of the hierarchy of situation models is triggered by a mismatch between predicted and actual action outcomes. As a result our system can autonomously learn novel situation types and integrate them into the ontology of previously acquired situation models.

[1] E.Körner, G.Matsumoto: Cortical architecture and self-referential control for brain-like computation. IEEE Engineering in medicine and biology 21(5):121-133, 2002