

DIPLECS: Extending the COSPAL Architecture to Dynamic and Interactive Environments

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In the COSPAL project, we proposed a new Artificial Cognitive Systems (ACS) architecture, where we combined techniques from the field of artificial intelligence (AI) for symbolic reasoning and learning of artificial neural networks (ANN) for association of percepts and states in a bidirectional way.

We established feedback loops through the continuous and the symbolic parts of the system, which allow perception-action feedback at several levels in the system. After an initial bootstrapping phase, incremental learning techniques are used to train the system simultaneously at different levels, allowing adaptation and exploration.

The COSPAL architecture followed a new approach to cognitive systems, in order finally to solve hard, large scale, inverse problems where classical AI and statistical methods have failed. The COSPAL project was a first attempt to realize systems following the new architectural concepts. As every new approach, the COSPAL architecture was tested first in very simple settings, which seemed to be trivial in context of classical methods using predefined models or rule sets to solve these simple problems much more efficient.

However, in contrast to the latter approaches, the COSPAL system learns solution strategies instead of following a predefined strategy and optimizing a few parameters of this strategy. Thus, the COSPAL architecture is scalable to larger problems in a way that does not require more complex models, which are eventually impossible to design, but just more computational power and time to learn. Due to the internal design the latter two complexities grow approximately linearly with the size of the problem.

Hence, and in contrast to classical approaches, a working COSPAL system for a simple problem can directly be extended to larger problems. However, in context of COSPAL, only static problems were considered, i.e., the COSPAL system was the only actuator. This is different in DIPLECS (Dynamic Interactive Perception-action LEarning in Cognitive Systems), where, as the title implies, dynamic and interactive problems are considered.

As a demonstrator scenario, we chose the field of car safety since this is an area of high societal relevance. To make progress toward the goal of reducing fatalities and accidents on our roads, designers of safety systems have focused on the prevention or mitigation of accidents. Due to the complexity of real environments and since human drivers play an important role in the pre-crash phase, systems that protect occupants and pedestrians must be seen as joint cognitive systems rather than as isolated engineered systems.

The DIPLECS project aims to design an ACS capable of learning and adapting to respond in the everyday situations humans take for granted. The primary demonstration of its capability will be providing assistance and advice to the driver of a car. The system will learn by watching humans, how they act and react while driving, building models of their behaviour and predicting what a driver would do when presented with a specific driving scenario. The end goal is to provide a flexible cognitive system architecture demonstrated within the domain of a driver assistance system, thus potentially increasing future road safety.

In order to achieve these goals, the DIPLECS architecture must allow for learning and adaptation in dynamic, real-time and real-world scenarios. Starting from a basic, rudimentary capability, it must constantly refine and improve its capability by observing a human driver, the car data and the surrounding environment. The architecture applies a hierarchical design principle, where adjacent levels are connected by feedback-loops. Learning occurs in two ways, either by analysing human-car-environment interaction or by (cognitive) bootstrapping of its own capabilities.

The architecture and its components will be evaluated in three different settings: off-line with data recorded in a real vehicle, on-line in the real vehicle, and on-line for a model car. The three settings allow for evaluating different assistance capabilities: general, passive real-time, and active real-time in a safe environment.

In the presentation, the transition from the COSPAL to the DIPLECS architecture will be reflected. Similarities and differences will be considered and early results will be mentioned.