Synthetic Cognitive Agent Situational Awareness Components

Sanford T. Freedman and **Julie A. Adams**
Department of Electrical Engineering and Computer Science
Vanderbilt University, Nashville, Tennessee 37235, USA
sanford.t.freedman@vanderbilt.edu, julie.a.adams@vanderbilt.edu

Synthetic cognitive agents (SCA) often require an understanding of their environment and the ability to predict how their actions will affect both the world and their internal status. Bestowing SCAs with Situational Awareness (SA) may improve this understanding of the dynamism within a domain, action selection, and action execution. The focus of our research is to a) form a list of agent architecture features required to achieve and maintain SA and b) implement and test the effectiveness of these features at developing SA.

Before SA can be achieved in SCAs, the system requirements for its creation need to be determined. SA is not a process in and of itself but a conceptual grouping of processes and phenomena within the human cognition (Flach 1995). It is improbable that a single sound and complete algorithm will ever be found that generates perfect SA across all domains and sensing modalities. Instead, SA may need to be developed through a collection of design features and the carefully crafted interaction of those features both amongst themselves and the rest of the system. It is hard to argue against many features that may contribute to SCA SA but since important design features often counteract each other, a careful review of the specific benefits to SA realized by each feature must be completed. Only then can an optimal balance be achieved. Presently, seven features have been identified as being required. These include: *information filtering*, *error detection and correction*, *hardware and algorithmic adjustability*, *diverse array of capabilities and data representations*, *inter-module communication*, and *store volumes of information and purge stale data*.

These features may be difficult to implement directly but an initial list of design mechanisms that may aid in the development of the above features has been developed. Due to space constraints, only an abridged listing of each mechanism's benefits is presented. *Non-fixed designs* may allow for systems that are customizable to a robot's current goals and environment. *Hierarchical architecture design* provides a layered structure allowing for algorithms and subprocesses to operate at both the correct level of detail and optimal frequency (Connell 1992). *Binding* (Hawes et al. 2007) provides two critical forms of functionality, combining results from multiple modules or sub-systems and generating high level representations or constructs. Modular designs generally have closed modules and fixed APIs, with internal mechanisms and data representations not externally available. *Labyrinthine designs* reveal their inner data structures and processes and may accept wider ranges of inputs, providing a more flexible system (Sloman 1989). *Embodiment* presents robotic architectures with knowledge of its physical form and an understanding of that form. A physical form endows a SCA with the ability to affect its environment and directly sense the status of the domain. *Metacognition*, can be used to allow SCAs to gain an understanding of their own internal operations and adjust their systems to the current environment (Cox 2005). *Commonsense* reasoning may allow SCAs to better understand tasks and goals, possess a set of default actions and thoughts, and increase understanding of situational data requirements. These design mechanisms may assist in the realization of the above features individually, but may also provide emergent benefits that would be otherwise challenging to achieve.

Our work seeks to develop robotic systems capable of both achieving and maintaining SA. Current activities include the creation of a robotic system that uses commonsense reasoning to provide suggestions and propose mental operations to robotic systems developed via traditional methods.

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