Procedia Computer Science
Volume 88, 2016, Pages 444–449
7th Annual International Conference on Biologically Inspired Cognitive Architectures, BICA 2016

Using Automatic Case Generation to Enable Advanced Behaviors in Agents

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* Supported by MAST Collaborative Technology Alliance – Contract No. W911NF-08-2-004 and U.S. Department of Education – Grant No. P031B090207

Abstract
GPME enhances the function of host agents by enabling them to develop and apply advanced behaviors. In this paper, we demonstrate the subset of GPME algorithms that are used to identify host behaviors from a time-series of perceptions about host observations and host actions.

Keywords: Cognitive Systems, Metacognition, Time-Series, Perception, Prediction

1 Introduction

Observing living beings, we can identify three broad classes of behavior; instinctive, acquired and deliberate. Instinctive behavior requires the least cognitive deliberation. All living beings are born with instinctive behaviors that need not be learned (Chouhan, Wolf, Helfrich-Förster, & Heisenberg, 2015; Heisenberg, 2014). Deliberate behavior requires the highest degree of cognitive deliberation during its performance. While these behaviors can be the most complex ones a being exhibits, the performance of these behaviors tends to be slow, in comparison to instinctive behaviors, because of substantial participation of cognitive deliberation. Acquired behavior is deliberate behavior that, through repetition, requires substantially less cognitive deliberation than deliberate behavior. In effect, acquired behaviors are "soft" instinctive behaviors created from deliberate behaviors. A living being performs an acquired behavior faster than a deliberate behavior because of lesser reliance on active deliberation. However, the performance of acquired behaviors is slower than that of instinctive behaviors.

An example of a behavior is shooting a basketball. A player engages instinctive behaviors; such as grasping the ball and maintaining their balance. The novice player learns through practice; that is, by shooting the basketball several times. The player crafts the shooting technique by creating several deliberate behaviors. She actively thinks about how to hold the ball, the placement of her feet, the follow through of the shot, and so on. Once the player identifies the behavior that produces the best results, she actively attempts to repeat it. Eventually, the player doesn't have to think about each step in the act of shooting. The deliberate behavior becomes an acquired behavior. Once shooting the

Selection and peer-review under responsibility of the Scientific Programme Committee of BICA 2016

doi:10.1016/j.procs.2016.07.462

basketball becomes an acquired behavior, the player can use her deliberate faculties on the game situation and not on the mechanics of the shot.

When a stimulus occurs, the agent triggers an appropriate behavior to respond, which is the output of a Response Selection function. Initially, as depicted in Figure 1, there are only instinctive behaviors to choose from. For example, a baby's response to most negative stimuli is to cry. We claim, without substantiation, that crying is an instinctive behavior in babies because they appear to do it without being taught. Over time, deliberate behaviors appear. A baby learns to hear and pronounce words. The same stimulus that caused the baby to cry earlier might now cause the utterance of words, along with crying. Eventually, deliberate behaviors become acquired behaviors. When a toddler calls her mother by name (mom, mama, etc.), the behavior appears instinctive and not deliberate. However, since the baby did not call the mother by name at birth, the behavior is acquired and not instinctive.

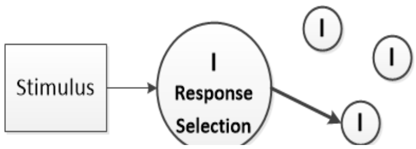

Figure 1 - Simple Stimulus Response Behavior

The response selection function is flexible enough to change its output from an instinctive response to an acquired response or a deliberate response for the same stimulus. Where the baby first responded to discomfort by crying only, the baby now responds by crying and calling for its mother , or, better yet, by just calling for its mother. The crying behavior is not lost; there is a new behavior available that produces better results. For the response selection function to change its choice of the default (instinctive) response, it needs some information about the outcomes of the available behaviors as depicted on Figure 2.

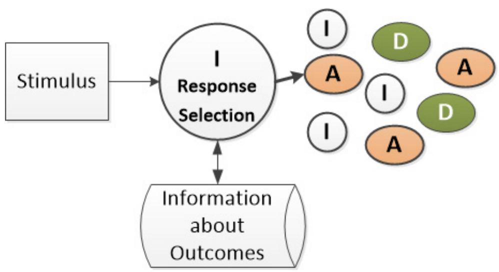

Figure 2 - Expanded Stimulus Response Behavior

In living beings, stimuli are embedded in the time-series of physical and mental perceptions that include actions performed and data points about the environment and the being's internal state. The information about outcomes is a projection of the utility of the behavior in the given situation. Therefore, we can view the process of creating behaviors as the result of the analysis of a time-series of perceptions. This analysis results in the identification of many deliberate behaviors that mature into acquired behavior once their utility is demonstrated.

Deliberate behaviors that are performed infrequently remain available but always require a high degree of cognitive deliberation to perform them. Deliberate behaviors that are performed frequently become acquired behavior and require a substantially lesser degree of cognitive deliberation to perform them. This model requires another function, one that creates the deliberate behaviors and compiles a useful deliberate behavior into an acquired behavior.

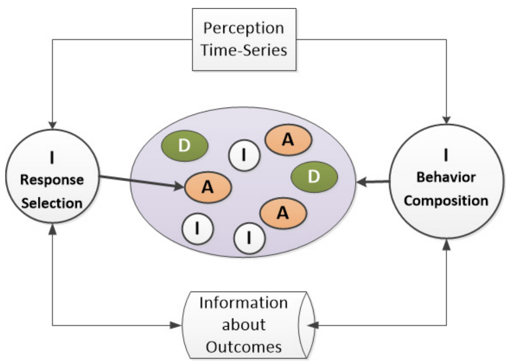

Figure 3 - Complete Stimulus Response Behavior

The Behavior Composition function administers the body of behaviors in the manner we have described thus far as depicted on Figure 3. It creates, modifies and deletes acquired and deliberate behaviors, as it processes the time-series of perceptions. Since the number of behaviors grows rapidly, behaviors with low utility are expunged.