

MGLAIR Agents in Virtual and other Graphical Environments

Stuart C. Shapiro* and Josephine Anstey† and David E. Pape†
and Trupti Devdas Nayak* and Michael Kandefer* and Orkan Telhan†
University at Buffalo, The State University of New York
Buffalo, NY 14260
{shapiro | jranstey | depape | td23 | mwk3 | otelhan}@buffalo.edu

Abstract

We are demonstrating several intelligent agents built according to the MGLAIR (Modal Grounded Layered Architecture with Integrated Reasoning) agent architecture. The top layer of MGLAIR is implemented in SNePS and its acting subsystem, SNeRE (the SNePS Rational Engine). The major demonstration will be act 3 of *The Trial The Trail*, an interactive drama running on an immersive Virtual Reality system, in which a human participant interacts with several MGLAIR actor-agents. We will also demonstrate several other MGLAIR agents that operate in non-VR graphical environments. All these agents illustrate our approach to building agents with integrated first-person, on-line reasoning and acting.

Introduction

We are demonstrating several intelligent agents built according to the MGLAIR (Modal Grounded Layered Architecture with Integrated Reasoning) agent architecture (Shapiro *et al.* 2005a). The top layer of MGLAIR is implemented in SNePS (Shapiro & The SNePS Implementation Group 2004), and its acting subsystem, SNeRE (the SNePS Rational Engine) (Kumar 1996; Shapiro & The SNePS Implementation Group 2004). These agents illustrate our approach to building agents with integrated first-person, on-line reasoning and acting. The major demonstration will be act 3 of *The Trial The Trail* (Shapiro *et al.* 2005b), an interactive drama running on an immersive Virtual Reality system, in which a human participant interacts with several MGLAIR actor-agents. We will also demonstrate several other MGLAIR agents that operate in non-VR graphical environments. Which are demonstrated will depend on audience interest. Available agents will include FevahrCassie, a self-aware simulated robot that understands and uses a fragment of English (Shapiro & Ismail 2003), and a wumpus world agent (Shapiro & Kandefer 2005).

The MGLAIR Architecture

The MGLAIR architecture (Shapiro *et al.* 2005a), is a modification of GLAIR (Hexmoor, Lammens, & Shapiro 1993), a

*Department of Computer Science and Engineering

†Department of Media Study

Copyright © 2005, American Association for Artificial Intelligence (www.aaai.org). All rights reserved.

layered architecture, the layers of which can be summarized as:

The Mental Layer (ML) is the layer at which conscious reasoning takes place. It is implemented by the SNePS knowledge representation and reasoning system (Shapiro & The SNePS Implementation Group 2004), and its SNeRE (the SNePS Rational Engine) acting subsystem. SNePS, in turn, is implemented in Common Lisp.

The Body Layer (BL) contains the implementations of the actions that are primitive at the ML, and the low-level implementations of the agent's sensors and effectors.

The Environment is built using any of several graphical modeling systems. In *The Trial The Trail*, the Ygdrasil (Pape *et al.* 2003) virtual reality authoring system, C++, and Python are used. Real-time dynamic behaviors and interaction make use of an event-based structure; messages are passed between nodes in response to events. Messages include actions such as loading models, playing sounds, and moving objects.

Modalities

MGLAIR (Modal GLAIR) differs from GLAIR in that the BL is organized into modalities. A modality is a hardware or software resource utilized by an intelligent agent for either sensing or acting. A single modality can support only a limited number of behaviors at a time, but behaviors that occupy different modalities can be simultaneous. The modalities used by the actor-agents in *The Trial The Trail* are animation, hearing, mood, navigation, speech, and vision.

First-Person Beliefs and On-Line Reasoning

Most AI planning systems, and many AI acting systems, are designed to represent information *about* an agent, its world, and its future actions. A SNePS knowledge base, on the other hand, is seen as containing the first-person beliefs *of* the agent, itself. What is criterial for a belief's being in the KB is not that it is true in the world, but that the agent is justified in believing it, even if it is false in the world. Not only is SNePS/SNeRE a first-person reasoning/acting system, it is an on-line acting system. What the SNePS/SNeRE agent does is to act in her world, and, when necessary, to reason about what she should do next based on: her beliefs about herself; her beliefs about the current state of the world; the

evidence of her sensory apparatus; a set of small stored or inferred plans (recipes) for carrying out certain actions or for bringing about certain states. This sensing, reasoning, and inferring is done on-line, while the agent is acting. SNeRE was designed specifically to facilitate integrated first-person, on-line reasoning and acting (Kumar & Shapiro 1994).

The Agents

The Trial The Trail *The Trial The Trail* is an interactive drama designed for an immersive VR system, in which the agents Patofil and Filopat guide a human participant through an absurdist quest. In this demonstration, we present act 3, which begins with an entre-acte in which Filopat tells Patofil and the participant that they must stand all night in a vigil at a ruined chapel. In scene 1, Patofil and the participant are teleported to the mound where the chapel stands. After a short time one or the other tires of the vigil. At first they play with whisps that float through the air, and climb the ruins. Then they leave the mound in direct defiance of Filopat's injunctions. At this point they become separated. The scene ends with the participant hearing Patofil scream. In scene 2, the participant sees Patofil running, pursued by five bad guys. Three of these guys break off and surround the participant, taunting and pushing her. The sun rises. Filopat can be heard calling. The bad guys disappear.

The Trial, The Trail runs on several computers, the ML and upper BL of each agent on one computer, the lower BL and the environment on another. Communication is via IP sockets organized by modality, one socket for each. The sockets provide the mind-body connection, with the "mind" running on one computer, and the "body" on another.

Several modalities provide feedback about what the agent, itself, says or does. This keeps her from starting one action while still performing the previous action. For example, Patofil's hearing her own lines prevents her from starting to say something while she is still delivering her previous lines.

Each actor-agent has a script, which constitutes a set of beliefs in its ML specifying how and when it should say its lines and perform its actions. Some actions are strictly sequenced; some involve arbitrary choice among several possibilities; some are event-driven. The script is expressed in SNePSLOG (Shapiro & The SNePS Implementation Group 2004), a symbolic-logic-like interface language to SNePS.

Occasionally, an actor-agent is to engage in an activity for a set amount of time. To do this, she may make use of an arbitrary number of timers, which can be set to expire in some number of seconds, triggering some other act, and may be paused, restarted, and cancelled. During the vigil, after 14 seconds of neither Patofil nor the participant doing anything, Patofil will start giggling.

The cast of computational actor-agents constitutes a multi-agent system, especially in act 3, scene 2, where three bad guys are required to cooperatively harass the human participant. The ML of each bad guy runs in a separate SNePS image, perceiving their own and each others' utterances and actions via their socket-endowed modalities.

FevahrCassie FevahrCassie is a robot that exists in a closed room with two people and four other robots. Al-

though FevahrCassie only uses SNeRE to a small extent, she is interesting because she was the first embodied SNePS/SNeRE agent (Shapiro 1998), and is still the only one to understand English statements, commands, and questions, to generate English output, and to remember and answer questions about what she has done.

A Wumpus World Agent An MGLAIR wumpus world agent (Russell & Norvig 1995; Shapiro & Kandefer 2005) make the most extensive use of SNePS and SNeRE constructs among the agents being demonstrated, and so is an excellent illustration of the integrated first-person reasoning, on-line acting operating style of these agents.

References

- Hexmoor, H.; Lammens, J.; and Shapiro, S. C. 1993. Embodiment in GLAIR: a grounded layered architecture with integrated reasoning for autonomous agents. In Dankel II, D. D., and Stewman, J., eds., *Proc. FLAIRS 93*. The Florida AI Research Society. 325–329.
- Kumar, D., and Shapiro, S. C. 1994. Acting in service of inference (and *vice versa*). In Dankel II, D. D., ed., *Proc. FLAIRS 94*. The Florida AI Research Society. 207–211.
- Kumar, D. 1996. The SNePS BDI architecture. *Decision Support Systems* 16(1):3–19.
- Pape, D.; Anstey, J.; Dolinsky, M.; and Dambik, E. J. 2003. Ygdrasil—a framework for composing shared virtual worlds. *Future Generation Computer Systems* 19(6):1041–1049.
- Russell, S. J., and Norvig, P. 1995. *Artificial Intelligence: A Modern Approach*. Upper Saddle River, NJ: Prentice Hall.
- Shapiro, S. C., and Ismail, H. O. 2003. Anchoring in a grounded layered architecture with integrated reasoning. *Robotics and Autonomous Systems* 43(2–3):97–108.
- Shapiro, S. C., and Kandefer, M. 2005. A SNePS approach to the wumpus world agent or Cassie meets the wumpus. In Morgenstern, L., and Pagnucco, M., eds., *Proceedings of The Sixth Workshop on Nonmonotonic Reasoning, Action, and Change*. Edinburgh, Scotland: IJCAI. in press.
- Shapiro, S. C., and The SNePS Implementation Group. 2004. *SNePS 2.6.1 User's Manual*. Department of Computer Science and Engineering, University at Buffalo, The State University of New York, Buffalo, NY.
- Shapiro, S. C.; Anstey, J.; Pape, D. E.; Nayak, T. D.; Kandefer, M.; and Telhan, O. 2005a. MGLAIR agents in a virtual reality drama. Technical Report 2005-08, Department of Computer Science & Engineering, University at Buffalo, Buffalo, NY.
- Shapiro, S. C.; Anstey, J.; Pape, D. E.; Nayak, T. D.; Kandefer, M.; and Telhan, O. 2005b. *The Trial The Trail, Act 3: A virtual reality drama using intelligent agents*. In *Proc., AIIDE-05*. Menlo Park, CA: AAAI Press. in press.
- Shapiro, S. C. 1998. Embodied Cassie. In *Cognitive Robotics: Papers from the 1998 AAAI Fall Symposium, Technical Report FS-98-02*. Menlo Park, California: AAAI Press. 136–143.