Unifying Control in a Layered Agent Architecture*

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The agent architecture INTERRAP (Figure 1) is a layered approach to agent design. Control layers correspond to specific desirable properties and abilities an agent (e.g. an autonomous robot) is required to have: reactivity, efficiency, goal-directed behavior, and the ability to interact with other agents. In INTERRAP the former two requirements are implemented by the lowest control layer, the behavior-based layer (BBL): it maintains a set of patterns of behavior (PoBs) describing the agent's reactive skills and her procedural knowledge. The requirement of locally goal-directed behavior is achieved by the Local Planning Layer (LPL). Finally, the Cooperative Planning Layer (CPL) enables the agent to devise multiagent plans to achieve tasks collectively, or to resolve conflicts.

A considerable number of research work has dealt with architectures trying to reconcile reactivity and deliberation, and also procedural knowledge. The actual contribution of INTERRAP has been to extend the scope of these architectures to knowledge and control aspects of agent interaction.

This abstract describes a redesign of INTERRAP based on the observation that the BBL, the LPL, and the CPL provide differing instantiations of three general functions: (i) Belief Revision (BR), mapping an agent's current perception and beliefs into a new set of beliefs; (ii) Situation recognition and Goal activation (SG), which derives new goals from the agents current beliefs and goals; (iii) Planning and Scheduling (PS) which means determining the agent's new intentions (courses of action to commit to) based on its current beliefs, goals, and intentions. Each layer provides different implementations of these functions. At the BBL for example, BR is done by simple updates of the world model directly based on sensor information. SG is done by evaluating trigger conditions for PoBs to recognize vital contingencies. PS is restricted to be a direct link from trigger conditions to an executable procedure. Implementing these functions in a layered architecture allows to take into account the different requirements to be imposed on the layers: at the BBL, a simple knowledge representation, fast situation recognition and a short deliberation time are required to cope with time-critical situations. At the higher layers, more time for deliberation is available; the focus is on efficient mechanisms for goal recognition, planning, and cooperation.

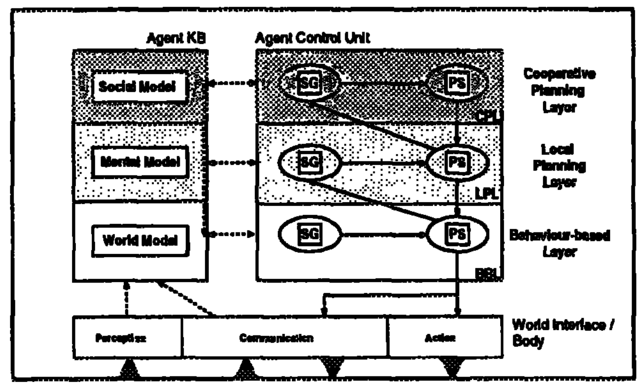

Figure 1: The INTERRAP Agent Architecture

Each INTERRAP layer consists of two processes, implementing SG and PS[1]. These processes interact with each other and with the neighbor layers. For a detailed description of inter-process and inter-layer communication, we refer to the full paper. It is important to notice that the different control layers, even though arranged and activated in a hierarchy, work concurrently. Thus, the agent remains receptive to contingencies (or cooperation requests) while she is planning.

The architecture has been evaluated by the FORKS application modeling forklift robots in an automated loading dock. This application as well as empirical results measuring the performance and properties of different types of agents is described in detail in the full paper.

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[1] BR is provided by an active knowledge base process.