

DHMP: Distributed Hierarchical Multi-resolution Planner

By Mustapha Abdallah and Catherine Antoniou

EXTENDED ABSTRACT: In Real-time Multi-agent Systems there can be limitations on maximum computation time and processing resources while infinitely many options may need to be investigated for an agent to make the best decision. In addition to the distribution in Multi-agent Systems where each agent makes autonomous decisions for itself, this paper presents distribution on another level where decision load is distributed on agents where agents with less load participate in decision making for agents with higher load. In addition to distribution, Hierarchical Multi-resolution is needed to dynamically decide about the size of the finite subset of infinite options to be investigated by each agent according to time constraints, processing resources constraints and size of distribution.

DHMP aims at a generic Hierarchical Multi-resolution planning architecture where one agent can make a plan for another agent to perform, more generally the planning of various agents is combined for one agent to perform the collective output of combined planning.

The testing environment for DHMP is the RoboCup Soccer Simulation 2D League. The advantages of choosing this environment are:

- Agents are controllable in various ways including arm pointing and neck turning where doing exactly the same action multiple times does not always give the same result, moreover not all agents are of the same abilities (e.g.: one agent can be faster than another).
- Information that the agent is able to gather are noisy rather than exact.
- Communication between agents is not reliable, depends on distance and out of multiple messages said at the same time a maximum of one message can be heard by any agent.
- Agents have local views on both visual and communication levels.
- Agents have stamina that forces planning to consider doing only the necessary actions in a mindful way compromising what is needed with the agent's stamina and the remaining game time.

For an agent to decide about one action to execute, every possible action should evaluate to a comparable representation where the action with the best evaluation is executed. But since the way one action (e.g.: pass) is evaluated is completely different from the way another action is evaluated (e.g.: shoot), it is difficult to say which of them is better. To solve the comparability problem a general Fuzzy Controller was designed where the satisfaction of the design rules lead to the ability to compare any set of entities regardless of differences between them. Every category of actions/entities should have its own Fuzzy Control for calculating the evaluation value. The output membership functions can be as many as needed but min and max values should be the same for all controllers to unify the evaluation range of values.

The main aim behind distribution is the ability to explore more options leading to choosing the best option which is also a more precise one. DHMP's distribution architecture is mainly divided into:

- Choice of agents to distribute load on.
- The amount/ type of load to assign to each of the chosen agents.
- The communication protocol used for assigning load and sending back result(s).
- Evaluation mechanism at the source agent after getting back results.

Hierarchical Multi-resolution is solving a problem multiple times at different levels where the first level is the fastest (uses minimal data) with the lowest precision and the last level is the slowest (uses maximal data) with the highest precision, and each level can provide a separate result. In a Real-time Multi-agent System, timing is one of the most critical factors. Delivering a lower precision result on time is better than delivering a higher precision result off time especially when there is a group of opposing agents where actions must be done quickly before opponents can oppose them. Locally at each co-planning agent, given the amount (percentage) of actions to investigate and a dead-line, it is the agent's responsibility to decide about the level to start from.

To improve DHMP, future work may include working on a planner that helps co-planning agents decide about which part to co-plan without the main agent having to ask them what to do. That way efficiency will increase as most of the time needed for communication will be cut off and credibility will increase as there will be no prediction errors since each agent will better be able to decide about which set of actions to work on.