Agent Coordination by Process Calculus for Plan Execution*

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Introduction

This short paper will outline a process calculus-based agent coordination model for enabling plan execution and repair in an open environment. The aim of this work is to create a framework to allow the flexible execution of distributed plans.

The Distributed Planning Problem

The restrictive assumptions of the classical planning problem are that a domain is finite, static, fully observable and deterministic (Nau, Ghallab, and Traverso 2004). These assumptions allow the reduction of complex planning problems into more manageable problems in order to develope approaches. The classical planning problem provides a well formalised and well characterised problem for these domains.

As the assumptions of the classical planning problem are relaxed, the problem becomes less well defined. However this allows the problems to more closely reflect real world environments. The real world environment motivating this research is the Search and Rescue domain, a domain which is dynamic, multi-agent, continuous and stochastic. This domain is characterised by different sets of agents acting together to achieve high level goals, whilst performing tasks independently within a command structure. Plans in this kind of environment are distributed plans for multiple agents, which is the focus of this research.

Within distributed planning, there are few formal definitions that are widely applicable and even some debate as to what the term "distributed" means. Distributed can mean that the plan is to be created by distributed agents and combined into a complete plan, that a plan is to be derived centrally to be performed by distributed agents or that both the planning and the plan are to be distributed.

Research in Progress

This research is concerned with distributed agents performing plans created both centrally and in a distributed fashion. The latter case arises during execution as a means of plan repair, where the initial plan being executed has been created centrally. It is assumed whilst planning that all agents are willing to take part in the plan and act as instructed by a central control agent. The key characteristics of the domain are that it is dynamic and multi-agent.

When planning in an open environment, discovering available agents and the capabilities of those agents presents a problem to be addressed before planning can begin. It is proposed to utilise the Open Knowledge (OK) Kernel (de Pinninck Bas et al. 2007) to perform agent discovery. The OK Kernel forms the core of the OK System (Siebes et al. 2007), which supports agent interactions. The interactions are based on the process calculus, Lightweight Coordination Calculus (LCC)(Robertson 2004). Agents subscribe to take part in interactions based on the notion of roles which they are capable of playing, and their willingness to perform activities. Once agents have subscribed to interactions they can be incorporated into plans. The kernel also provides a uniform communications strategy for agent communications.

Once a set of agents has been established it is possible to create plans for these agents. This will take the form of a centralised plan for distributed agents. The I-Plan planner from the I-X agent architecture (Tate 2000) will be used to create plans. Once the initial plan has been created it will be extended to incorporate synchronisation elements to facilitate execution of the plan. These synchronisation elements are LCC interaction models. LCC has been used as it provides the ability to define performatives and constraints placed upon the agents.

To enable interactions to take place at execution time it is intend to create the necessary LCC interaction models and

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incorporate these into the ground plan created by the centralised planner. An algorithm will be created which processes an I-Plan plan and adds LCC communications elements to create a dual action and communication plan.

As plans are executed new challenges arise. How can flexible plans be created that allow high level goals to be met, when the actual execution differs from the expected execution? This research proposes to use LCC interactions to allow the agents to communicate difficulties in execution, to perform plan repair, to report that tasks cannot be achieved and that re-planning is required. LCC will also be used to facilitate the flow of knowledge between the agents and also to report progress. Further to this the balance between allowing agents to perform distributed plan repair to recover from difficulties during execution and the requirement to re-plan for all agents by a centralised planner shall be investigated.

Expected Outcome

By exploring the balance between plan repair and re-planning at execution time it is expected that robust plan execution can be achieved. Furthermore it is expected that a more flexible execution of plans can be created by augmenting plans with LCC.

References

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