Position Paper for AAAI-96 Workshop – Theories of Action, Planning and Control: Bridging the Gap

Using Constraints for Task-oriented Communication, Planning and Control

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Work is described which seeks to use a common representation of tasks, plans, processes and activities based on the notion that these are all "constraints on behaviour". This representation can form a basis for mixed initiative user/system agents working together to mutually constrain task descriptions and plans and to coordinate the task-oriented enactment of those plans. It is well suited to an incremental refinement approach to planning as is found in many modern planners. It forms a potentially useful bridge between practical work on planning, theoretical descriptions of planning, constraint management, and work in other fields such as workflow and process management.

Two papers describe the approach:

- Tate, A. (1996) Representing Plans as a Set of Constraints – the <I-N-OVA> Model, Proceedings of the Third International Conference on Artificial Intelligence Planning Systems (AIPS-96), pp. 221-228, (Drabble, B., ed.) Edinburgh, Scotland, AAAI Press. Available at `ftp://www.aiai.ed.ac.uk/pub/documents/1996/96-aips-inova.ps`
- Tate, A. (1994) Mixed Initiative Planning in O-Plan2, Proceedings of the ARPA/Rome Laboratory Planning Initiative Workshop, pp. 512-516, (Burstein, M., ed.), Tucson, Arizona, USA, Morgan Kaufmann. Available at `ftp://www.aiai.ed.ac.uk/pub/documents/1994/94-arpi-mixed-initiative.ps`

Representing Plans as a Set of Constraints on Behaviour

The <I-N-OVA>[1] (*Issues – Nodes – Orderings/Variables/Auxiliary*) Model is a means to represent and manipulate plans as a set of constraints. By having a clear description of the different components within a plan, the model allows for plans to be manipulated and used separately to the environments in which they are generated.

In Tate (1996), the <I-N-OVA> model is used to characterise the plan representation used within O-Plan and is related to the plan refinement planning method used in O-Plan. The <I-N-OVA> work is related to emerging formal analyses of plans and planning. This synergy of practical and formal approaches can stretch the formal methods to cover realistic plan representations as needed for real problem solving, and can improve the analysis that is possible for production planning systems.

[1] <I-N-OVA> is pronounced as in "Innovate".

<I-N-OVA> is intended to act as a bridge to improve dialogue between a number of communities working on formal planning theories, practical planning systems and systems engineering process management methodologies. It is intended to support new work on automatic manipulation of plans, human communication about plans, principled and reliable acquisition of plan information, and formal reasoning about plans.

A plan is represented as a set of constraints which together limit the behaviour that is desired when the plan is executed. The set of constraints are of three principal types with a number of sub-types reflecting practical experience in a number of planning systems.

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Plan Constraints
  I   - Implied Constraints
  N   - Node Constraints
  OVA - Detailed Constraints
        O - Ordering Constraints
        V - Variable Constraints
        A - Auxiliary Constraints
            - Authority Constraints
            - Condition Constraints
            - Resource Constraints
            - Other Constraints
```

The node constraints (these are often of the form "include activity") in the <I-N-OVA> model set the space within which a plan may be further constrained. The I (issues) and OVA constraints restrict the plans within that space which are valid. Ordering (temporal) and variable constraints are distinguished from all other auxiliary constraints since these act as *cross-constraints*, usually being involved in describing the others – such as in a resource constraint which will often refer to plan objects/variables and to time points or ranges.

Mutually Constraining Plans for Mixed Initiative Planning and Control

The model of Mixed Initiative Planning that can be supported by the approach is *the mutual constraining of behaviour* by refining a set of alternative partial plans. Users and systems can work in harmony though employing a common view of their roles as being to constrain the space of admitted behaviour. Further detail is given in Tate (1994).

Workflow ordering and priorities can be applied to impose specific styles of authority to plan within the system. One extreme of user driven plan expansion followed by system "filling-in" of details, or the opposite extreme of fully automatic system driven planning (with perhaps occasional appeals to an user to take predefined decisions) are possible. In more practical use, we envisage a mixed initiative form of interaction in which users and systems proceed by mutually constraining the plan using their own areas of strength.