ARPI Plan Ontology Background

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Abstract

This paper describes previous relevant work that could be taken into account for the design of the ARPI Plan Representation.

1 ARPI Work on Plan Representations

The AI planning community has used explicit domain description languages and plan definitions for more than 25 years. There is a wealth of experience of defining plan representations for both theoretical studies and practical planning. More recently, there have been a number of initiatives to standardise terminology related to processes in PIF (the Process Interchange Format [6]); workflow (the International Workflow Management Coalition [16]); manufacturing processes (NIST's Process Specification Language [9]); and in the US military planning research community.

In 1992, under the DARPA/Rome Laboratory Planning Initiative (ARPI) [2], a number of participants created the KRSL plan language [7]. Although this has been used for some transfers of information between planning components within the ARPI (in particular IFD-2 [1]), it has not had the widespread impact desired. Its structure is too rigid and KRSL excludes much that is already being done within planners. In 1994, a group was formed to approach the creation of an ontology for plans using new insights gained over the last few years in the knowledge-sharing community in the US and Europe. This led to the outline plan model documented in the appendix to this report (previously published in [12]). However, this work was not brought to a conclusion

In August 1997, DARPA and Rome Laboratory Programme Managers for ARPI proposed a renewed effort to create a shared plan representation suitable for use in ARPI and on applied research programmes in their communities.

2 A Catalogue of Previous Relevant Work

Ontologies and plan representations createds within projects funded within ARPI:

1. ARPI KRSL 2.0.2 [7] as noted above.
2. ARPI KRSL-Plans ontology (in appendix to [12]) as noted above.
3. Edinburgh O-Plan Task Formalism (Domain Description Language) from the ARPI project [14].

4. Edinburgh <I-N-OVA> constraint model of activity from the ARPI O-Plan project [13].
5. SRI International ACT language from the Cypress project [15].
6. CMU OZONE scheduling ontology [10].
7. Process Interchange Format (PIF) standard being worked on by a number of projects interested in exchanging process information [6].

Ontologies created om collaborative projects related to Enterprise Integration:

1. The ontology for the Enterprise Toolkit on the UK Enterprise Project (partners AIAI, Lloyds Register, Logica, IBM UK and Unilever) [3].
2. The TOronto Virtual Enterprise (TOVE) ontology [4].

Representations being considered by standards bodies:

1. International Workflow Management Coalition work in standardising workflow systems and process terminology via their Glossary of Workflow terms [16] and their interface 1 – the Workflow Process Definition Language.
2. Object Management Working Group (OMWG) Core Plan Representation (CPR) [8].
3. National Institute of Standards and Technology (NIST) Process Specification Language (PSL) [9], [5].

In addition, there is relevant work on Structured Analysis and Design Techniques (e.g., SADT), Issue-Based Design Methods (e.g., IBIS), Process Management Models and Methods (e.g., IDEF), Entity-Relationship Modelling, Object-Role Modelling (e.g., NIAM), Process Workflow Support, etc.

Acknowledgements

The KRSL-Plans model in the appendix was created in discussions with members of the KRSL planning ontology development group formed under the DARPA/Rome Laboratory Planning Initiative (ARPI) and the ARPI Plan Ontology Construction Group.

Effort sponsored by the Defense Advanced Projects Research Agency (DARPA) and Rome Laboratory, Air Force Materiel Command, USAF, under grant number F30602-95-1-0022. The U.S. Government is authorised to reproduce and distribute reprints for governmental purposes notwithstanding any copyright notation hereon. The views and conclusions contained herein are those of the author and should not be interpreted as necessarily representing the official policies or endorsements, either expressed or implied, of DARPA, Rome Laboratory or the U.S. Government.

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Appendix: KRSL Plan Ontology Working Group

During 1994, the DARPA/Rome Laboratory Planning Initiative (ARPI) [2] Plan Ontology Construction Group decided to discuss a follow on to the previous KRSL version 2.0.2 [7] used within the ARPI.

What is a Plan?

Following some preparatory electronic discussions, at the 12th October 1994 meeting they agreed 4 sentences to define what a plan is and how the principal entities relate to a plan. The definition was:

- A PLAN is a SPECIFICATION of BEHAVIOUR for some PURPOSE(s).
- BEHAVIOUR is something that one or more AGENTs PERFORM.
- An AGENT is an entity that PERFORMs BEHAVIOUR and/or can have PURPOSE(s).
- A PURPOSE is an EFFECT that is [INTENDED or DESIRED] by an AGENT.

KRSL-Plans Ontology for Activity

Over the following months a working group[1] worked on the next level of the ontology and agreed the next level of definition (draft of 2nd February 1995 with minor later lexical edits)[2] .

ACTIVITY is an important building block in the Plan Ontology. A Plan is itself a description of activity but with the additional relationship of the activity to purpose (and the agents which have the purpose).

An Activity can relate directly to an action that is performed in a discrete fashion, or may relate to the period of usage of resources. This can allow the ontological entity of activity to merge both action planning and resource scheduling perspectives.

BEHAVIOUR is the performance of one or more ACTIVITIES (a non-empty set of activities).

An ACTIVITY takes place over a TIME INTERVAL.

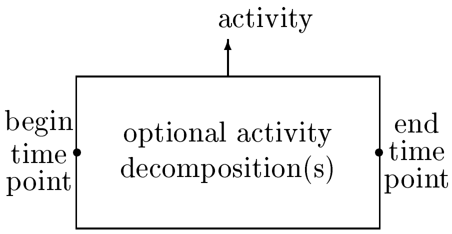
The TIME INTERVAL for an ACTIVITY is identified by its two ends, the BEGIN TIME POINT and the END TIME POINT.

An ACTIVITY may optionally have CONSTRAINTS associated with it or with its TIME INTERVAL.

An ACTIVITY may bring about certain STATES OF AFFAIRS.

[1] Austin Tate (chair), David Wilkins (SRI), Steve Smith (CMU) and Bill Swartout (USC/ISI).

[2] A more detailed level of activity model in the ontology was proposed but is not reproduced here – see `http://www.aiai.ed.ac.uk/~bat/krsl-plans.html`.



Optionally, an ACTIVITY may be decomposed into one or more SUB-ACTIVITIES to provide more detail. There can be several alternative such ACTIVITY DECOMPOSITIONS.

SUB-ACTIVITY: Sub-activities are the constituent activities designated in any ACTIVITY DECOMPOSITION.

Notes: Referring to an activity as a sub-activity refers to the role of an ACTIVITY in a relationship with another ACTIVITY such that performance of the SUB-ACTIVITY is considered to be part of the performance of the other ACTIVITY.

ACTIVITY DECOMPOSITION: The specification of how an ACTIVITY is decomposed into one or more SUB-ACTIVITIES; this may include the specification of constraints on and between the SUB-ACTIVITIES.

Notes: The constraints can be sub-activity orderings, world conditions, effects, resource requirements, organisational permissions, etc.

Notes: Activity decomposition does not necessarily imply that a different level of abstraction to that used in the main activity is used in the description of the sub-activities and the constraints on them. For example, it is possible to provide an activity decompositions which uses recursion by including the parent activity type as a sub-activity. Model Abstraction level is orthogonal to structural activity decomposition level.

PRIMITIVE ACTIVITY is an ACTIVITY with no (further) ACTIVITY DECOMPOSITION.

STATES OF AFFAIRS - broadly defined to mean things we can evaluate as holding or not in the (model of the) world. They can refer to an individual world state (such as NOW), or may refer to world histories, changes between world states, etc.

An ACTIVITY may change the STATE-OF-AFFAIRS during its performance.

CONSTRAINTS can be stated with respect to none, one or more than one time point. They express things which are required to hold. They are evaluable with respect to a specific PLAN as holding or not holding.

Such constraints may refer to world statements (conditions and effects), resource requirements and usage, authority requirements or provision, etc.