

A contextual reading of conditional commitments

Juan Manuel Serrano and Sergio Saugar¹ and Rosario Laurendi and Francesco Buccafurri²

Abstract. This paper puts forward a view on conditional commitments as causal rules, using action language K as the specification framework. The proposal builds upon an operational notion of social context, in such a way that conditional commitments are represented as *rules in context*. This approach enables the manipulation of conditional commitments in terms of the manipulation of the social interactions which provide their social contexts. Moreover, it allows the programmer to exploit the ASP metatheory underlying action language K to analyze, simplify and transform commitment-based protocols.

1 Introduction

There is a recent trend in the literature about commitments (e.g. [10, 2]) towards treating conditional commitments as *fundamental*, and considering unconditional ones as special cases in which the antecedent is *true*. This choice has several benefits: it simplifies the study of conditional commitments (e.g. in relation to reasoning patterns [10]) and enables their direct manipulation (e.g. in terms of their creation, cancelation, delegation, and so forth). However, when it comes to the operationalization of formal theories of commitment, e.g. in terms of the C+ action language, it poses several disadvantages, which basically stem from the need of reifying commitment conditions. In particular, this choice complicates the declaration of complex commitment conditions – an issue dealt with in [2], and, more importantly, it undermines the possibility of exploiting the reasoning capabilities of the base formal language to verify properties of commitment specifications or apply protocol transformations. Other operational models of commitments, e.g. [5], gives prominence to unconditional commitments and formalise conditional commitments as *rules*. However, this is done at the expense of the possibility of manipulating conditional commitments.

This paper attempts to provide an operational model of conditional commitments as rules, which at the same time enables their manipulation in some way. The basic idea to achieve this goal is modeling conditional commitments as *rules in context*, in such a way that the manipulation of the social context results into the manipulation of the conditional commitment. The notion of context has long been recognized as an essential ingredient in the semantics of social commitments [9]. This paper exploits the operational notion of *social interaction* introduced in the SPEECH language [7, 8] to represent the social context of conditional commitments. Concerning rules, we employ the notion of *causal rule* provided by action language K and its accompanying planning system DLV^K [4].

2 Context as social interaction

Social interactions represent the *context* within which the activity of agents takes place. For instance, figure 1 shows the activity that takes place within the context of an eBay-like *exchange* for a particular scenario. The activity within this context is hierarchically structured into *sales*, a kind of social interaction devoted to buying and selling some particular good, and *purchases*, viz. attempts to trade the item on sale at a specific price.

The activity of agents within the society is structured around a role-playing hierarchy, where each role represents the behaviour of the agent within a particular social interaction context. For instance, the activity of agents within the top-level *exchange* is represented by *trader* roles. Within the context of a particular sale, a trader may behave as *seller* or *buyer*. In turn, seller and buyers may participate within the context of purchase interactions as *purchase sellers* and *buyers*, respectively.

The activity of agents resolves itself in the performance of speech acts. Thus, the first speech act of the scenario described in figure 1 shows trader t_1 *setting up* a new sale to sell item G . Then, trader t_2 *joins* the sale as buyer, and the seller *sets up* a purchase for a given price V . Trader t_2 is interested in buying the item at that price, so she *joins* the purchase interaction as player of its buyer role. Finally, the seller *gives* the item to the buyer but this agent *leaves* the sale interaction. Immediately, this causes the sale to be automatically finished, together with the enclosed purchase interaction. Note that the *setting up* of a purchase by the seller agent stands for a *quote*, and the *join* action performed by the buyer for its *acceptance*. Thus, these standard declarations capture part of the meaning of these domain-dependent speech acts. The only missing ingredient is commitments.

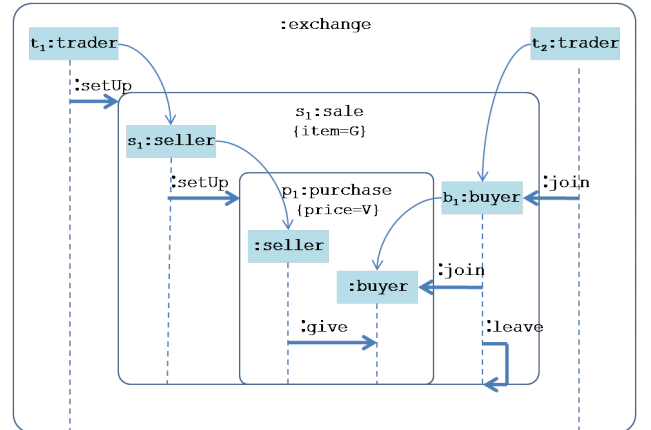


Figure 1. A marketplace scenario

¹ University Rey Juan Carlos, Madrid, Spain, email: juan-manuel.serrano@urjc.es sergio.saugar@urjc.es

² DIMET - Università Mediterranea di Reggio Calabria, Italy, email: rosario.laurendi@unirc.it bucca@unirc.it

3 Conditional commitments as contextual rules

Commitments are conceptualised as a new kind of social entity, just like agent roles, speech acts and social interactions – the three other kinds of social entities that populate the social ontology. A commitment represents the obligation of some agent, the *debtor*, to achieve a certain state of affairs or perform some action within the *context* provided by some social interaction. The satisfaction of this *discharging* condition or *consequent* of the commitment may also be directly related to some *creditor* agent, which can be omitted if there is no such particular agent, or it can be identified from the social interaction context. Commitments are created or instantiated when certain circumstances hold, represented by its *antecedent* or *precondition*. Both the antecedent and consequent of the commitment depend, in general, on the type of commitment being instantiated. For instance, within the context of purchase interactions a *commitment to pay* the specified price is created for the buyer agent, when the seller gives her the item. Commitments of this type do not need to specify the creditor agent, since it is unambiguously identified by the purchase context.

Using action language K, conditional commitments are formalised through the declaration of a new predicate which represents the new type of commitment (e.g. `c_to_pay/1`), and the corresponding fluents (viz. `debtor/2`, `state_c/2`, etc.) and actions (viz. `commit/3`, `discharge/1` and `cancel/1`) which represent the runtime state and dynamics of commitments. The antecedent and consequent of the new type of commitment are modeled through causal rules of the form **executed A if B**, where this expression stands for a new macro defined in the following way:

$$\text{executed } a \text{ if } B \Leftrightarrow \begin{array}{l} \text{executable } a \text{ if } B \\ \text{caused false after not } a, B \end{array}$$

Thus, a conditional commitment to pay the price specified by a given purchase is partially represented through the causal rules shown below³. These rules represent the antecedent and consequent of the commitment, respectively. The first one establishes that a new commitment to pay *c* will be created for the buyer *B* of a purchase *P*, when the seller *s* performs a *give* action *G*. The missing part of the rule's body refers to some nuances of the specification concerning the management of the pool of available commitment objects. The second rule says that a commitment to pay *c* is discharged when the buyer *B* (i.e. the debtor) performs the payment *Pay*. The specification allows for the commitment to be created and discharged simultaneously. In that case, the discharge takes precedence over the creation, i.e. the commitment is directly created in a *fulfilled* state, rather than in a *pending* state. Moreover, the formalisation allows for the payment to be performed before, after or simultaneously to the performance of the *give* action.

```
executed commit(C,B,P) if c_to_pay(C),
    purchase(P), state_i(P,open),
    buyer_p(P,B), state_a(B,playing),
    seller_p(P,S), state_a(S,playing),
    give(G), perform(G), performer(G,S), ...

executed discharge(C) if
    c_to_pay(C), (commit(C,B,P);
        state_c(C,pending), debtor(C,B)),
    pay(Pay), (perform(Pay); performed(Pay)),
    performer(Pay,B).
```

When the buyer joins the purchase that the seller has set up previously, then the necessary conditions to activate the “antecedent”

rule are satisfied. At that moment, we say that the conditional commitment has been *created*. The *cancellation* of a conditional commitment occurs when the prospect debtor or creditor are abandoned, e.g. when the buyer leaves the purchase. Similarly, the *delegation* and *assignment* of a conditional commitment are represented through changes in the social interaction context, namely in the player agent of participating roles. Thus, a trader may delegate its buyer role within a given sale to another agent, thereby delegating the possible conditional commitment endorsed within that context.

4 Conclusion

The proposed formalisation of commitments in action language K resembles the proposal of [2] in some respects, such as the way in which we deal with concurrent commitment actions. It significantly departs, however, in the treatment of the social context and commitment conditions. In particular, our approach shows the interplay between the social context and commitments at runtime, and naturally models commitment conditions as rules of the base action language. This greatly simplifies the modeling of complex commitment conditions (e.g. with nested commitments), and, more importantly, it allows the programmer to exploit the ASP metatheory [6] underlying action language K to analyze, simplify and transform commitment-based protocols. We plan to pursue this line of research by checking the soundness of the current commitment operationalization against the reasoning postulates put forward in [10]. Also, we are interested in the application of ASP-based social modalities [1] in reasoning about commitments.

ACKNOWLEDGEMENTS

Research sponsored by the Spanish Ministry of Science and Innovation, project TIN2009-14562-C05-05

REFERENCES

- [1] Francesco Buccafurri, Gianluca Caminiti, and Rosario Laurendi, ‘A logic language with stable model semantics for social reasoning’, in *ICLP*, eds., Maria Garcia de la Banda and Enrico Pontelli, volume 5366 of *Lecture Notes in Computer Science*, pp. 718–723. Springer, (2008).
- [2] Nirmal Desai, Amit K. Chopra, and Munindar P. Singh, ‘Representing and reasoning about commitments in business processes’, in *AAAI*, pp. 1328–1333, (2007).
- [3] Nirmal Desai and Munindar P. Singh, ‘A modular action description language for protocol composition’, in *AAAI*, pp. 962–967, (2007).
- [4] Thomas Eiter, Wolfgang Faber, Nicola Leone, Gerald Pfeifer, and Axel Polleres, ‘A logic programming approach to knowledge-state planning, II: The DLV^K system’, *Artif. Intell.*, **144**(1-2), 157–211, (2003).
- [5] Nicoletta Fornara, Francesco Viganò, and Marco Colombetti, ‘Agent communication and artificial institutions’, *Autonomous Agents and Multi-Agent Systems*, **14**(2), 121–142, (2007).
- [6] David Pearce, ‘Sixty years of stable models’, in *ICLP*, eds., Maria Garcia de la Banda and Enrico Pontelli, volume 5366 of *Lecture Notes in Computer Science*, p. 52. Springer, (2008).
- [7] Juan Manuel Serrano and Sergio Saugar, ‘Operational semantics of multiagent interactions’, in *AAMAS’07*, eds., Edmund H. Durfee, Makoto Yokoo, Michael N. Huhns, and Onn Shehory, pp. 889–896. IFAAMAS, (2007).
- [8] Juan Manuel Serrano and Sergio Saugar, ‘Run-time semantics of a language for programming social processes’, in *CLIMA IX*, eds., Michael Fisher, Fariba Sadri, and Michael Thielscher, volume 5405 of *LNAI*, pp. 37–56. Springer, (2009).
- [9] Munindar P. Singh, ‘An ontology for commitments in multiagent systems’, *Artif. Intell. Law*, **7**(1), 97–113, (1999).
- [10] Munindar P. Singh, ‘Semantical considerations on dialectical and practical commitments’, in *AAAI*, eds., Dieter Fox and Carla P. Gomes, pp. 176–181. AAAI Press, (2008).

³ The full implementation can be downloaded from the address <http://www.speechlang.org/k>.