

Actions with Typical Effects: Epistemic Characterization of Scenarios *

(extended abstract)

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To meet recent requirements regarding modelling the behaviour of a rational agent in a multi-agent system one has to cope with the complexity of actions with typical, but not necessarily certain results. The generic characteristics of these actions, called Δ -actions, is that they have different effects in typical and atypical performances. We model these actions by extending the epistemic/dynamic framework presented in [1] designed to deal with both knowledge and abilities of agents, and with effects of actions they perform.

A general notion of agent's *abilities* covers physical, mental and moral capacities and is formalized by an expression $A_i\alpha$ which states that agent i is capable to perform the action α .

Epistemic aspect of agent is expressed in terms of the formula $K_i\varphi$ which states that the agent i knows the fact represented by φ .

We consider actions of two kinds: traditionally viewed basic actions with certain effects (atomic actions, sequential composition, conditional action or repetitive action) and atomic Δ -actions. The results of basic actions performed by an agent are formalized by the following formula from (propositional) dynamic logic $\langle do_i(\alpha) \rangle \varphi$, denoting the fact that the agent i has the *opportunity* to perform action α and that doing α leads to φ . Similiary, the result of performing Δ -action is represented by $\langle do_i(\alpha) \rangle \varphi, \psi$, denoting that the agent i has the opportunity to perform the action α and as a result of this event φ (always) holds and *typically* ψ holds. Both kinds of actions are assumed to be deterministic.

By $SCD(i, \{\gamma_{pre}\} \langle \alpha_1, \dots, \alpha_n \rangle \{\gamma_{post}\})$ we denote a *scenario* which is viewed as a sequence of basic and/or atomic Δ -actions to be performed by an agent i , together with initial (γ_{pre}) and final (γ_{post}) observations.

Rational agents usually deal with scenarios reflecting a "typical" pattern of behaviour, i.e. s/he prefers to perform typically as many actions as possible. This scenario realization is formalized in terms of a *nonmonotonic preferential strategy* which amounts to minimization of atypical performances of actions.

Adopting a commonsense perspective we assume that whenever an agent cannot perform some action in the scenario (i.e. s/he has not the opportunity or s/he is unable to execute it), the scenario will be resumed from the first executable one.

The final goal of a scenario realization is to determine a set of *desirable conclusions*. Including an adequate preferential strategy, a scenario realization leads to certain situations (*states*). To complete the procedure we determine a set of desirable conclusions, i.e. all statements holding in these states.

In the paper we adopt a model-theoretic approach based on the concept of a *Kripke model*. Semantically, a scenario realization is viewed as a sequence, called an *epistemic path*, of state transitions resulting from the performance (by an agent) of consecutive actions. Clearly, various scenario realizations are reflected in different epistemic paths.

A *model for a scenario SCD* is called a Kripke model where the corresponding epistemic path is nonempty. The preferential strategy is formalized via minimization of abnormal state transitions occurring on a given epistemic path. Finally, we prefer those models for a scenario, where a number of abnormal state transitions, for some (*preferred*) epistemic path, is minimal. The last states of preferred epistemic paths in the chosen models, i.e. those where γ_{post} holds, are called *concluding states*. The set of desirable conclusions consists of statements satisfiable in all concluding states.

The details of this approach may be found in [2], while in [3] the nondeterministic case is discussed.

References

- [1] W. van der Hoek, B. van Linder, J. -J. Ch. Meyer: A logic of capabilities, Technical Report IR-330, Vrije Universiteit Amsterdam, 1993.
- [2] B. Dunin-Keplicz and A. Radzikowska: Epistemic Approach to Actions with Typical Effects, to appear in *Proc. ECSQARU'95*.
- [3] B. Dunin-Keplicz and A. Radzikowska: Nondeterministic Actions with Typical Effects, submitted to *AI*IA-95*.

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