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# Primary and Secondary Events

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## Abstract

A formal, logical, theory of events is developed and used as the basis for a definition of causation and to provide a pragmatics for causal counterfactuals.

The theory begins with with a logical formalization of events as represented in the planner STRIPS. The resulting *inertial theories* include a common sense law of inertia and their pragmatics is based on the principle of chronological minimization. The theory of events is then developed by removing some of the simplifying assumptions of the STRIPS representation.

To begin with the assumption that events always succeed, given that their preconditions are true when they occur, is dropped. Instead a common sense law of change is introduced with the effect that events normally succeed but may fail if some qualification (some unusual or unexpected condition) arises. The pragmatics of the resulting *causal theories* is provided by refining the pragmatics of inertial theories. In particular, where there is a conflict between change and inertia, preference is given to change.

The resulting defeasibility of events makes it possible to remove the STRIPS assumption that only one event occurs at any given time; as conflicting events now result in failure rather than inconsistency. However it is desirable to provide a means for adjudicating between conflicting events. Consequently the theory is extended so that qualification preferences can be specified and the pragmatics are refined accordingly.

A further STRIPS assumption is that the effects of an event are invariant. In order to remove this assumption a distinction is drawn between primary events, events of the kind described above, and secondary events. Secondary events are invoked by primary events in appropriate contexts, they are causally dependent on primary events and when successful produce the additional, variant, effects of the primary events which invoke them. As a result, both the context-dependent effects of events (their ramifications) and non-deterministic events (events whose outcome is uncertain) can be represented.

The theory of primary and secondary events is then used as the basis for a definition of causation which can be seen as providing a formal account of Mackie's definition of a cause as an INUS condition.

A major theme of this paper is the conflict between the opposite but complementary principles of change and inertia. For much of the paper the emphasis is on restricting the effects of inertia and favouring change. The resulting imbalance becomes unnatural when considering the combined effects of several events. However the definition of causation makes it possible to state a law of change and inertia, which is used to regulate change and inertia and thus ensure a proper balance between them: while *caused* change is preferred to inertia, inertia is preferred to *uncaused* change.

The theory is then used to provide a pragmatics for causal counterfactuals, thereby extending the representation of actual causal reasoning to counterfactual causal reasoning. This is illustrated by the use of causal counterfactuals in order to obtain explanations.

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