Interactive Trace Replay for Event-B Models

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PROB [6] is an animator and model checker that can be used in particular for animation of Event-B models created with Rodin. Along with animation, PROB allows to store and replay traces, i.e. sequences of transitions, to validate the correctness of the model's behaviour at different stages of its development. In many cases, traces created for a previous or abstract version of a model can only be partially replayed (or not at all) due to breaking changes, e.g. newly introduced or replaced/renamed events and variables. Refactoring such traces after changes to complex formal models can be tedious.

To address this, we present an integration of interactive trace replay for the PROB tooling, namely for PROB2-UI [2] and the PROB Tcl/Tk interface. This could be particularly beneficial in the following three scenarios:

Refinement of Traces. Insert new trace steps between two abstract steps by manual animation of new or refined events (cf. Fig. 1a).

Abstraction of Traces. Skip steps with unavailable concrete events (cf. Fig. 1b). Trace Refactoring. Repair/refactor traces of complex models after major changes.

So far, ProB in its core itself features an "intelligent" trace replay that tries to resolve possible failure scenarios automatically during the replay. It first tries to replay a trace perfectly, matching operation names, parameters and variable values after each trace step. If this is not possible, the replay tries to soften the replay constraints, e.g., allowing to use other parameter values or different operation names (e.g., when an operation has been renamed). The replay can also skip trace steps where the original operation is unavailable. However, this automated replay is not always possible, and more insights are necessary to adapt the old trace for the new model.

This is why we combine the existing logic with the interactive replay so that conflicts that cannot be handled automatically can be resolved by the modeller.

This means that we have two states during an interactive replay: the current trace step and the state of the animator. Based on this, our implementation currently includes the following control options:

- *Replay* the next trace step using a matching transition, if possible
- "Fast Forward": automatic replay until the next step cannot be replayed
- *Skip* the current trace step (this is always possible)
- Add manual animation steps anywhere in the trace using the animator
- Undo the last replayed transition (from manual animation or replayed)

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In the future, we would like to provide further options, such as restricting the precision or allowing the user to explicitly select the next replayed transition.

There has been research addressing the problem of trace refinement, like an algorithmic approach by Stock et al. [7]. There is also related work on refinement checking [4,5] and there are some similarities to the interface of the CODA simulator [3]. Also, the interactive manual animation is somehow related to interactive real-time simulation covered by SimB [8].

In summary, we believe that the interactive trace replay can be a useful extension to PROB, especially in the context of abstraction and refinement.

References

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(b) Abstraction of a Trace

Fig. 1: Interactive Replay in PROB2-UI for "Controlling Cars on a Bridge" [1]