Event Calculus with duration

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Abstract

TODO

1 Path Finding in event Calculus

Given a graph $G =< V, E >$, a starting point v_s and a goal v_g.

1.1 Fluents and Events

Event calculus is a sorted predicate calculus (with equality). Here I will describe a very simple variant with only the most important aspect of Event Calculus.

There are the sorts:

- $\mathcal{T}$ Timepoints : $\mathcal{T} = [0, 1, ...h]$.
- $\mathcal{F}$ Fluents : $\forall v \in V, on(v) \in \mathcal{F}$.
- $\mathcal{E}$ Event : $\forall < v_o, v_d > \in E, move(v_o, v_d) \in \mathcal{E}$.

1.2 The four predicates

- $happens \subseteq \mathcal{E} * \mathcal{T}$
- $holds\_at \subseteq \mathcal{F} * \mathcal{T}$
- $initiates \subseteq \mathcal{E} * \mathcal{F} * \mathcal{T}$
- $terminates \subseteq \mathcal{E} * \mathcal{F} * \mathcal{T}$

1.3 E : Domain independant axioms

Thoses axioms are the ones who are present no matter the domain. All the other formulas on this paper are examples for path finding.

1.3.1 Efect of events on fluents

If an event e happens, and this event has the effect of starting f, then f holds the moment after the event.

$$[happens(e, t-1) \ \wedge \ initiates(e, f, t-1)] \Rightarrow holds\_at(f, t) \tag{E.1}$$

If an event e happens, and this event has the effect of ending f, then f don't holds the moment after the event.

$$[happens(e, t-1) \ \wedge \ terminates(e, f, t-1)] \Rightarrow \neg holds\_at(f, t) \tag{E.2}$$

1.3.2 Inertia

If a fluent f holds and is not terminated, it continue to hold the next moment.

$$[holds\_at(f, t-1) \ \wedge \ \neg \exists e(happens(e, t-1) \ \wedge \ terminates(e, f, t-1))] \Rightarrow holds\_at(f, t) \tag{E.3}$$

If a fluent f don't holds and is not started, it continue to not hold the next moment.

$$[\neg holds\_at(f, t-1) \ \wedge \ \neg \exists e(happens(e, t-1) \ \wedge \ initiates(e, f, t-1))] \Rightarrow \neg holds\_at(f, t) \tag{E.4}$$

1.4 Σ : Effects

Those formulas defines the effects of actions. What actions make a fluent true, and what actions make a fluent false.

If an agent move, it goes to another vertex.

$$\forall move(v_o, v_d) \in \mathcal{E}, initiates(move(v_o, v_d), on(v_d), t) \tag{Σ.1}$$

If an agent move, he left his vertex.

$$\forall move(v_o, v_d) \in \mathcal{E}, terminates(move(v_o, v_d), on(v_o), t) \tag{Σ.2}$$

1.5 Γ : Observations

Those formulas are observed facts about which fluent holds when.

The agent has his starting vertex.

$$holds\_at(on(v_s), 0) \tag{Γ_i}$$

The agent has his goal.

$$holds\_at(on(v_g), h) \tag{Γ_f}$$

1.6 Δ : Narrative

Those formulas are observed facts about which action happens when.

In our case, we don't know about them. But we could have facts like this to force a move at some point:

$$happens(move(v_2, v_4), 2) \tag{$example$}$$

1.7 Ψ : Actions preconditions and State constraints

Thoses formulas are other conditions on the fluents. Things like "if those fluent holds, this one can't" for example.

For an agent to move, he must be on the vertex.

$$happens(move(v_o, v_d), t) \Rightarrow holds\_at(on(v_o), t) \qquad (\Psi.1)$$

An agent is on one vertex max at each time.

$$[holds\_at(on(v), t) \ \wedge \ v \neq v'] \Rightarrow \neg holds\_at(on(v'), t) \qquad (\Psi.2)$$

1.8 Ω : Unique names

List of the unique names. [1]

$$U[move, on] \qquad (\Omega)$$

1.9 Domain description

$$CIRC[\Sigma; initiates, terminates] \wedge CIRC[\Delta; happens] \wedge \Omega \wedge \Psi \wedge \Gamma \wedge E \qquad (\Phi)$$

- $\Sigma = \Sigma.1 \wedge \Sigma.2$
- Δ being the conjunction of all event occurrence formulas (aka the "happens facts")
- Ω
- $\Psi = \Psi.1 \wedge \Psi.2 \wedge \Psi.3 \wedge \Psi.4$
- Γ being the conjunction of all observations (aka the "holds_at facts") counting Γ_i and Γ_f
- $E = E.1 \wedge E.2 \wedge E.3 \wedge E.4$

2 Planning

A planning problem consist of taking Σ, Ω, Ψ, Γ (without Γ_f), Γ_f, and E as input, and producing as output zero or more Δ (our plan) such as Φ is consistent and $\Phi \models \Gamma_f$.

To do it:

1. Write every element of Γ_f as a constraints.

$$\forall \gamma \in \Gamma_f, \neg\gamma \Rightarrow \perp \qquad (\Gamma')$$

2. Don't use circumscription on "*happens*". (After all we want to deduce them!)

3. Find model(s) of Φ'

$$CIRC[\Sigma; initiates, terminates] \wedge \Delta \wedge \Omega \wedge \Psi \wedge \Gamma \wedge \Gamma' \wedge E \qquad (\Phi')$$

[1] This is just to say that every on(something) is different to each move(something)

3 Discussion

Paper used : mostly : [1].

References

[1] Erik T Mueller. *Commonsense Reasoning.* Elsevier, 2010.