Event Calculus with duration

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Abstract

TODO

1 MAPF in event Calculus

Given a graph $G =< V, E >$, a list of agent R, a starting point and a goal for each agent $O =< A, V, V >$.

1.1 Fluents and Events

Event calculus is a sorted predicate calculus (with equality). There are the sorts:

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

1.2 The four predicates

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

1.3 Domain independant axioms

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.

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

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

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

1.4 Domain dependant rules

List of the unique names.

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

The agents have their starting vertices.

$$\forall < r, v_s, v_g > \ in \ O, holds\_at(on(r, v_s), 0) \quad (\Gamma.\mathrm{i})$$

The agents have their goals.

$$\forall < r, v_s, v_g > \ in \ O, holds\_at(on(r, v_g), h) \quad (\Gamma.\mathrm{f})$$

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

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

If an agent move, it goes to another vertice.

$$\forall move(r, v_o, v_d) \in \mathcal{E}, initiates(move(r, v_o, v_d), on(r, v_d), t) \quad (\Sigma.1)$$

If an agent move, he left his vertice.

$$\forall move(r, v_o, v_d) \in \mathcal{E}, terminates(move(r, v_o, v_d), on(r, v_o), t) \quad (\Sigma.2)$$

A vertice has place for one agent only at each time.

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

An agent is on one vertice max at each time.

$$[holds\_at(on(r, v), t) \ \wedge \ v \neq v'] \Rightarrow \neg holds\_at(on(r, v'), t) \quad (\Psi.3)$$

Agents cannot switch places

$$[holds\_at(on(r, v), t) \ \wedge \ holds\_at(on(r', v'), t) \ \wedge \ holds\_at(on(r', v), t+1) \\ \wedge \ v \neq v' \ \wedge \ r \neq r'] \Rightarrow \neg holds\_at(on(r, v'), t+1) \quad (\Psi.4)$$

1.5 Domain description

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

- $\Sigma = \Sigma.1 \land \Sigma.2$
- Δ being the cojunction of all event occurence formulas (aka the "happens facts")
- Ω
- $\Psi = \Psi.1 \land \Psi.2 \land \Psi.3 \land \Psi.4$
- Γ being the cojunction of all observations (aka the "holds_at facts") counting $\Gamma.i$ and $\Gamma.f$
- $E = E.1 \land E.2 \land E.3 \land E.4$

1.6 Planning

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

2 Background

3 Approach

3.1 Without touching Event Calculus

3.2 With changes in Event Calculus

4 Discussion

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