Composable Causality in Semantic Robot Programming

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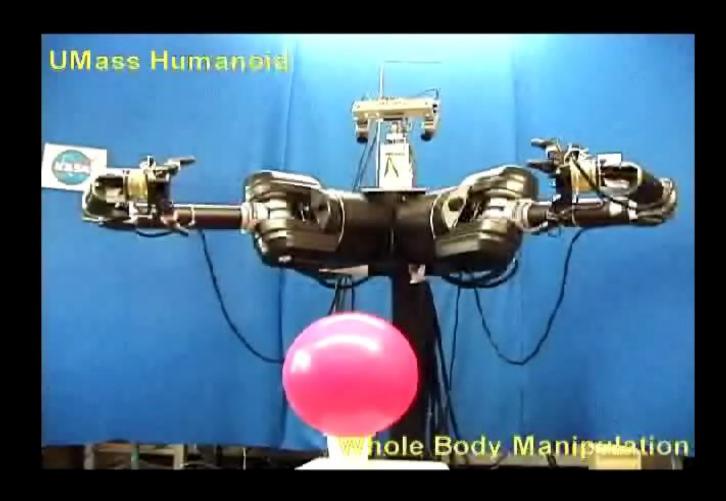
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The Challenges of Assembly Tasks



Executing Multi-Objective Actions



Causal Control Basis

Control basis: behaviors to execute

- $oldsymbol{G}_{T}$ Temporal graphs: decompose symbolic action to controllers
- ${\bf \cdot}$ Causal graphs: behaviors involved in multi-objective action G_C
- Causal control basis:

$$\mathbf{\Phi} = (\Phi, G_T, G_C)$$

Causal Control Basis

Control basis:

Temporal graphs:

$$G_T$$

• Causal graphs:

$$G_C$$

Causal control basis:

$$\mathbf{\Phi} = (\Phi, G_T, G_C)$$

 Use causal control basis to estimate the transition function:

$$P(s' \mid s, a)$$

• Execute composition most likely to achieve composed effects:

$$\underset{a}{\operatorname{argmax}} P(s' \mid s, a)$$

Furniture Assembly Tasks

