On semantics of STRIPS
By Vladimir Lifschitz

Presented by Forrest Sheng Bao

KR Seminar, Dept. of Computer Science, Texas Tech University

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Outline

1. Introduction to STRIPS

2. Semantics of STRIPS

- It operates on world models, represented by sets of formulas of first-order logic.
- World model are changed by operators.
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- Start with an arbitrary first-order language $L$.
- A *world model* is any set of sentences of $L$.
- An *operator description* is a triple of sentences of $L$, $\langle P, D, A \rangle$
  - $P$: precondition
  - $D$: delete list
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- a family of operator descriptions $\{P_\alpha, D_\alpha, A_\alpha\}_{\alpha \in Op}$
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An example
modified from original STRIPS paper

operator $\text{pushto}(X, Y)$: robot pushes object $X$ next to $Y$

- Precondition: $\text{pushable}(X) \land \text{nextto}(\text{robot}, X)$

- Delete list:
  - $\text{atrobot}($)
  - $\text{nextto}(\text{robot},$)
  - $\text{nextto}($, $X$)
  - $\text{at}(X,)$
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- Add list: $\text{nextto}(X, Y)$, $\text{nextto}(Y, X)$, $\text{nextto}(\text{robot}, X)$
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Plans in STRIPS

For a STRIPS system $\Sigma$, a plan is any finite sequence of its operators, denoted as $\bar{\alpha} = (\alpha_1, \ldots, \alpha_N)$ where $\alpha_i \in Op$, $\forall i \in 1..N$.

A plan defines a sequence of world models $M_0, M_1, \ldots, M_N$, where $M_0$ is the initial world model and $M_i = (M_{i-1} \setminus D_{\alpha_i}) \cup A_{\alpha_i}$, $\forall i \in 1..N$.

$\bar{\alpha}$ is accepted by the system if $M_{i-1} \vdash P_{\alpha_i}$, $\forall i \in 1..N$.

We call $M_N$ the result of executing $\bar{\alpha}$ and denote it as $R(\bar{\alpha})$. 
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Interpreted STRIPS system

- The world described by language $L$ at any instant is in a state.
- An action is a partial function from states to states.
- If $f(s)$ is defined, we say that $f$ is applicable in state $s$ and $f(s)$ is the result of action $f$.
- We assume that each operator $\alpha$ in STRIPS is associated with an action $f_\alpha$.
- A STRIPS system along with the information above is called an interpreted STRIPS system.
- For each plan $\bar{\alpha} = (\alpha_1, \ldots, \alpha_N)$ of an interpreted STRIPS system, we define $f_{\bar{\alpha}}$ to be the composite action $f_{\alpha_N} \ldots f_{\alpha_1}$.
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Soundness

How sound is STRIPS in describing a world?

**Definition A**

An operator description \((P, D, A)\) is **sound** relative to an action \(f\) if, for every state \(s\) such that \(P\) is satisfied in \(s\),

- \(f\) is applicable in state \(s\),
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Soundness cond.

Is this semantics good?
Problems

• Atoms in the delete list of $\text{pushto}(X,Y)$ are obviously not the only sentences that may become false after action execution.

• Their conjunction or disjunction, e.g., $\text{atrobot}(\$) \land \text{nextto}(X,\$)$, or any sentence of the form $A \land F$ ($A$ is an atom in delete list and $F$ is any sentence in $L$) is also a such sentence. By definition A, the delete list will be infinite.

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Non-atomic sentences in world model

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Second try on semantics

**Definition B**

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“One more thing”

- The delete list of $push(X, Y)$ includes $nextto(robot, \$)$ but not $nextto(\$, robot)$.

- This is “a trick carefully planned by the authors.”

- $nextto(\$, robot)$ never appears in initial model or add list of any operator.

- We need to slightly modify Definition B.
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The general semantics of STRIPS

Suppose we have a special set $E$ of ground atoms. Formulas from $E$ is called essential.

**Definition C**

An operator description $(P, D, A)$ is **sound** relative to an action $f$ if, for every state $s$ such that $P$ is satisfied in $s$,

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In memory of

Steve Jobs
1955-2011