When Not to Act?

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Outline

- Automated Planning
- Avoidance Expressions
- Inducing Avoidance Expressions
- Proof of Concept
Automated Planning

\[ s = \{ \text{on-earth}(a), \text{on-earth}(b), \text{loaded}(c), \text{on-earth}(\text{rocket}) \} \]

\[ g = \{ \text{on-moon}(a), \text{on-moon}(b), \text{on-moon}(c) \} \]

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Automated Planning

**States**

\[ s = \{ \text{on-earth}(a), \text{on-earth}(b), \text{loaded}(c), \text{on-earth}(rocket) \} \]
## Automated Planning

### States

\[ s = \{\text{on-earth}(a), \text{on-earth}(b), \text{loaded}(c), \text{on-earth}(\text{rocket})\} \]

### Goal

\[ g = \{\text{on-moon}(a), \text{on-moon}(b), \text{on-moon}(c)\} \]
Automated Planning

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Actions

fly
Pre: on-earth(rocket)
Eff: on-moon(rocket),
    ¬on-earth(rocket)
Avoidance Expressions

Basics

- formula
- relates to
  - state
  - action
  - goal

Syntax

-state marker: \( s(l) \)

-goal marker: \( g(l) \)

\( \neg, \land, \lor, \forall, \exists \)

Avoid unloading \( a \):

\[ g(on-moon(a)) \land s(on-earth(rocket)) \]

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Avoidance Expressions

Basics

- formula
- relates to
  - state
  - action
  - goal

Syntax

- state marker :s(l)
- goal marker :g(l)
- ¬, ∧, ∨, ∀, ∃
Avoidance Expressions

Basics
- formula
- relates to
  - state
  - action
  - goal

Syntax
- state marker :s(l)
- goal marker :g(l)
- ¬, ∧, ∨, ∀, ∃

Avoid unloading a
:g(on-moon(a)) ∧ :s(on-earth(rocket))
Inducing Avoidance Expressions

Examples

- state-action-goal tuples
- exhaustive exploration
Inducing Avoidance Expressions

Examples
- state-action-goal tuples
- exhaustive exploration

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- state id
- extend and replicate predicates
- target predicate
Induction Example

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Induction Example

State \( s_5 \)

\[
\begin{align*}
&\text{s-on-earth}(a,s5). \\
&\text{s-on-earth}(b,s5). \\
&\text{s-on-earth}(\text{rocket},s5). \\
&\text{s-loaded}(c,s5). \\
&\text{g-on-moon}(a,s5). \\
&\text{g-on-moon}(b,s5). \\
&\text{g-on-moon}(c,s5).
\end{align*}
\]

Target Relation

\[
\begin{align*}
\text{avoid-fly}(s5).
\end{align*}
\]
Design

- rocket domain
- different problems
- 122 examples
- FOIL
Proof-of-concept

Design
- rocket domain
- different problems
- 122 examples
- FOIL

Avoid fly
$$\exists x( : s(\text{on-earth}(x)) \land : g(\text{on-moon}(x))) \lor$$
$$\exists x( : s(\text{loaded}(x)) \land : g(\text{on-earth}(x)))$$
Take-away Message

If your problem can be encoded as an automated-planning problem then you can learn additional domain knowledge from small problem instances.