

# STRIPS Planner

- Divide and conquer: to create a plan to achieve a conjunction of goals, create a plan to achieve one goal, and then create a plan to achieve the rest of the goals.
- To achieve a list of goals:
  - choose one of them to achieve.
  - If it is not already achieved
    - choose an action that makes the goal true
    - achieve the preconditions of the action
    - carry out the action
  - achieve the rest of the goals.



# STRIPS Planner Code

*% achieve\_all(Gs, W<sub>1</sub>, W<sub>2</sub>)* is true if *W<sub>2</sub>* is the world resulting  
*%* from achieving every element of the list *Gs* of goals from  
*%* the world *W<sub>1</sub>*.

*achieve\_all*([ ], *W<sub>0</sub>*, *W<sub>0</sub>*).

*achieve\_all*(*Goals*, *W<sub>0</sub>*, *W<sub>2</sub>*) ←  
    *remove*(*G*, *Goals*, *Rem\_Gs*) ∧  
    *achieve*(*G*, *W<sub>0</sub>*, *W<sub>1</sub>*) ∧  
    *achieve\_all*(*Rem\_Gs*, *W<sub>1</sub>*, *W<sub>2</sub>*).

% *achieve*( $G, W_0, W_1$ ) is true if  $W_1$  is the resulting world  
% after achieving goal  $G$  from the world  $W_0$ .

*achieve*( $G, W, W$ )  $\leftarrow$   
*holds*( $G, W$ ).

*achieve*( $G, W_0, W_1$ )  $\leftarrow$   
*clause*( $G, B$ )  $\wedge$   
*achieve\_all*( $B, W_0, W_1$ ).

*achieve*( $G, W_0, do(\text{Action}, W_1)$ )  $\leftarrow$   
*achieves*( $\text{Action}, G$ )  $\wedge$   
*preconditions*( $\text{Action}, Pre$ )  $\wedge$   
*achieve\_all*( $Pre, W_0, W_1$ ).



# Undoing Achieved Goals

**Example:** consider trying to achieve

$[carrying(rob, parcel), sitting\_at(rob, lab2)]$

**Example:** consider trying to achieve

$[sitting\_at(rob, lab2), carrying(rob, parcel)]$

- The STRIPS algorithm, as presented, is unsound.
- Achieving one subgoal may undo already achieved subgoals.

# Fixing the STRIPS Algorithm

Two ideas to make STRIPS sound:

- **Protect subgoals** so that, once achieved, until they are needed, they cannot be undone. Let *remove* return different choices.
- **Reachieve subgoals** that have been undone.
  - Protecting subgoals makes STRIPS incomplete.
  - Reaching subgoals finds longer plans than necessary.

# Does protecting always work?

- **Example** Suppose the robot can only carry one item at a time. Consider the goal:

$$\textit{sitting\_at}(\textit{rob}, \textit{lab2}) \wedge \textit{carrying}(\textit{rob}, \textit{parcel})$$

- We cannot consider the subgoals in isolation!