Regression

- Idea: don't solve one subgoal by itself, but keep track of all subgoals that must be achieved.
- Given a set of goals:
  - If they all hold in the initial state, return the empty plan
  - Otherwise, choose an action *A* that achieves one of the subgoals. This will be the last action in the plan.
  - Determine what must be true immediately before *A* so that all of the goals will be true immediately after. Recursively solve these new goals.

Regression as Path Finding

- The nodes are sets of goals. Arcs correspond to actions.
- A node labeled with goal set G has a neighbor for each action A that achieves one of the goals in G.
- The neighbor corresponding to action A is the node with the goals G_A that must be true immediately before the action A so that all of the goals in G are true immediately after A. G_A is the weakest precondition for action A and goal set G.
- Search can stop when you have a node where all the goals are true in the initial state.

Weakest preconditions

wp(*A*, *GL*, *WP*) is true if *WP* is the weakest precondition that must occur immediately before action *A* so every element of goal list *GL* is true immediately after *A*.

For the STRIPS representation (with all predicates primitive):

- *wp*(*A*, *GL*, *WP*) is *false* if any element of *GL* is on delete list of action *A*.
- Otherwise *WP* is

$$preconds(A) \cup \{G \in GL : G \notin add\_list(A)\}.$$

where *preconds*(*A*) is the list of preconditions of action *A* and *add_list*(*A*) is the add list of action *A*.

Weakest Precondition Example

The weakest precondition for

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

to be true after $move(rob, Pos, lab2)$ is that

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

is true immediately before the action.

A Regression Planner

% *solve*(*GL*, *W*) is true if every element of goal list *GL* is true
% in world *W*.

$$solve(GoalSet, init) \leftarrow$$
$$\quad holdsall(GoalSet, init).$$
$$solve(GoalSet, do(Action, W)) \leftarrow$$
$$\quad consistent(GoalSet) \wedge$$
$$\quad choose\_goal(Goal, GoalSet) \wedge$$
$$\quad choose\_action(Action, Goal) \wedge$$
$$\quad wp(Action, GoalSet, NewGoalSet) \wedge$$
$$\quad solve(NewGoalSet, W).$$

Regression Search Space Example