Planning

Planning is finding and choosing a sequence (or a "program") of actions to achieve goals.

Planning *states* are described by specifying which *atomic sentences* are true.

The *goals* are described by specifying which atoms should be true and false.

Actions are described by specifying what changes occur.

Search can perform planning. Planning states map to search states, and actions map to operators.

A *progression* planner searches from the current state to a goal state. A *regression* planner searches from the goals to the current state.

Planning Operators

A planning operator can be specified by:
name: name and parameters of action
preconditions: what atoms must be true
effects: what becomes true and false

Example: Blocks-world with a table T and three blocks named A, B, and C.

Atomic sentences:
$on(A, T), on(A, B), on(A, C), \ldots$
$clear(A), clear(B), clear(C)$

The state where C is on A and B is by itself:
$clear(C), on(C, A), on(A, T), clear(B), on(B, T)$

Goals to have A on B, and B on C:
$on(A, B), on(B, C)$

Operator schema to move block x from y to z:
name: $move(x, y, z)$
pre: $clear(x), on(x, y), clear(z)$
add: $clear(y), on(x, z)$
del: $on(x, y), clear(z)$

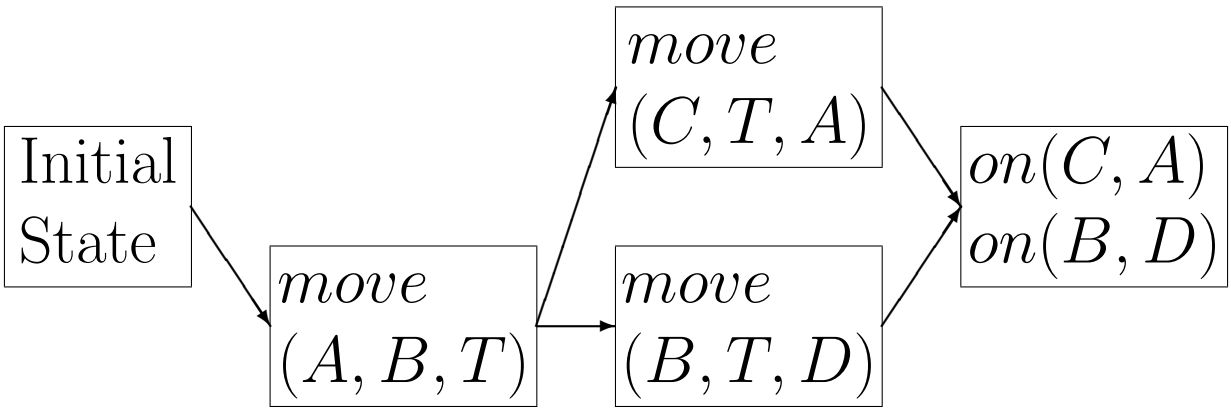
Partial Order Planning

Progression and regression planning require that operators be totally ordered. Partial order planning only specifies those orderings that are needed.

Example: Blocks-world with a table T and four blocks, A, B, C, and D.

Initial state: $clear(A), on(A, B), on(B, T), clear(C), on(C, T), clear(D), on(D, T)$

Goals: $on(C, A), on(B, D)$



Partial Order Causal-Link Planning

A partial-order plan consists of the following:

- A set of steps. Start step, operators, finish step. The start and finish steps encode the initial state and goals.
- A set of orderings between pairs of steps.
- A set of causal links. Each causal link goes from a postcondition of one step to a precondition of another step.

A flaw in a partial-order plan is:

- a precondition that is not supported by a causal link, or
- a causal link that is threatened by another step (the threat).

A flaw can be fixed by:

- adding a causal link, possibly adding an operator to support the causal link, or
- ordering the threat before the causal link ("demotion") of after ("promotion").