

# Worksheet: L08 – Constraint-Based Planning

CSCI-534: Robot Planning & Manipulation

Spring 2020

<http://www.neil.dantam.name/rpm/B08-satplan.pdf>



*You may use this handout to attempt the examples presented on the slides.*

1. **State Variables:** Propositionalize and unroll state variables for predicate  $\text{on}(?x, ?y)$  for objects  $\{A, B\}$  and  $n = 2$ .
  
2. **Action Variables:** Ground and unroll action variables for action  $\text{stack}(?x, ?y)$  for objects  $\{A, B\}$  and  $n = 2$ .
  
3. **Start:** Write the grounded start state for the PDDL facts in Figure 2.
  
4. **Goal:** Write the grounded Goal the PDDL facts in Figure 2.
  
5. **Operator Encoding:** Write the operator encoding constraints for:
  - (a)  $\text{put-down}(A)$  at step 1 (see Figure 1).
  
  - (b)  $\text{unstack}(B, C)$  at step 0 (see Figure 1).

Name:

```
(define (domain blocksworld)
  (:predicates (on ?x ?y) (ontable ?x) (clear ?x)
               (handempty) (holding ?x))
  (:action pick-up :parameters (?x)
            :precondition (and (clear ?x) (ontable ?x) (handempty))
            :effect (and (not (ontable ?x))(not (clear ?x))
                         (not (handempty)) (holding ?x)))
  (:action put-down :parameters (?x)
                :precondition (holding ?x)
                :effect (and (not (holding ?x)) (clear ?x)
                             (handempty)(ontable ?x)))
  (:action stack :parameters (?x ?y)
                :precondition (and (holding ?x) (clear ?y))
                :effect (and (not (holding ?x))(not (clear ?y))
                              (clear ?x)(handempty) (on ?x ?y)))
  (:action unstack :parameters (?x ?y)
                :precondition (and (on ?x ?y) (clear ?x) (handempty))
                :effect (and (holding ?x) (clear ?y)
                              (not (clear ?x))
                              (not (handempty))
                              (not (on ?x ?y)))))
```

Figure 1: Blocksworld Domain

```
(define
  (problem sussman-anomaly-alt)
  (:domain blocks)
  (:objects a b c)
  (:init (ontable c)
         (ontable a)
         (on b a)
         (clear c)
         (clear b)
         (handempty))
  (:goal (and (on c b)
              (on b a))))
```

Figure 2: PDDL Facts

6. **Operator Exclusion:** Write the operator exclusion constraint for `put-down` ( $B$ ) at step 0, considering only `pick-up` and `put-down` actions (see Figure 1).

7. **Frame Axioms:** Write the frame axiom constraint for `holding` ( $B$ ) from step 0 to step 1, considering only `pick-up` and `put-down` actions (see Figure 1).