

Assignment Project Exam Help

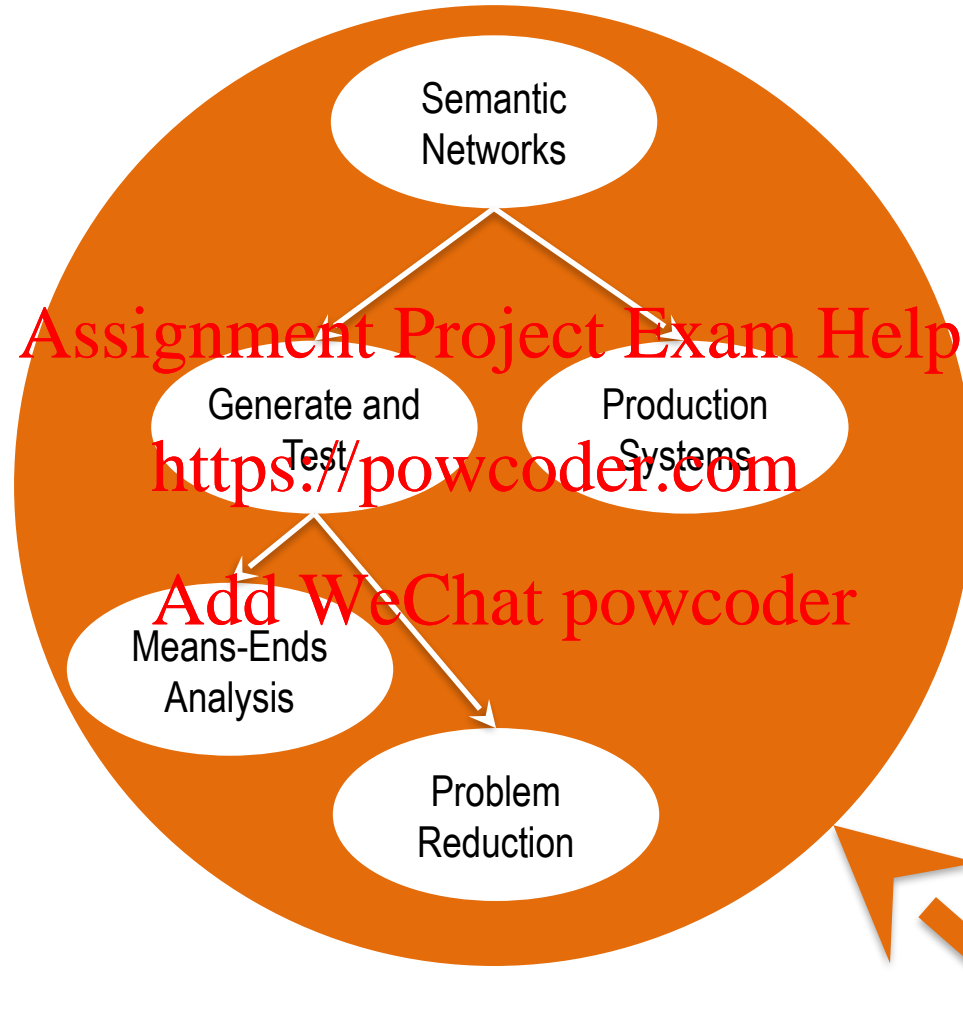
Means-Ends

Analysis and  
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Problem  
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Reduction

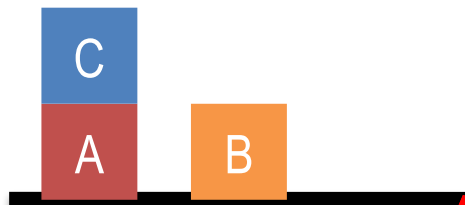
# Fundamentals



# Lesson Preview

- State spaces
  - Means-ends analysis
  - Problem solving with means-ends analysis
  - Problem reduction
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Initial State



A on Table  
B on Table  
C on A

Move the blocks from the initial state to the goal state while obeying these rules:

1. You may only move one block at a time.

2. You may only move blocks that have nothing on top of them.

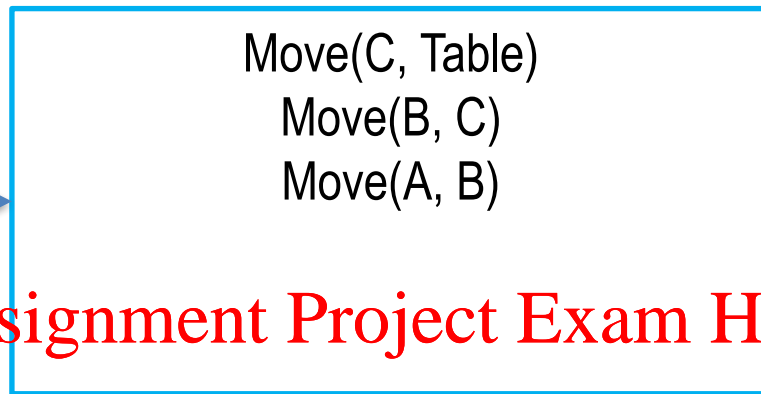
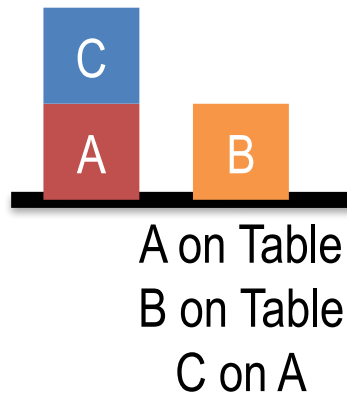
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Goal State

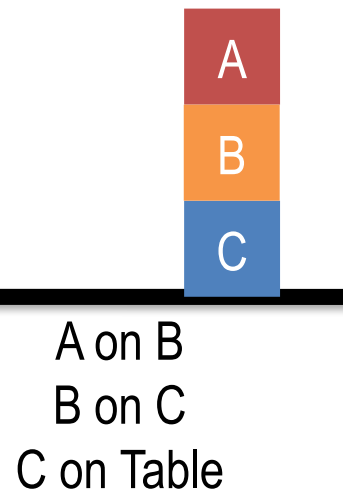


A on B  
B on C  
C on Table

Initial State



Goal State



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Available Operators:  
Move(Object, Location)  
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e.g.:

Move(C, Table)  
moves C onto the table

Move(C, B)  
moves C onto B

Write a list of  
operators that will  
move the blocks into  
the goal state.

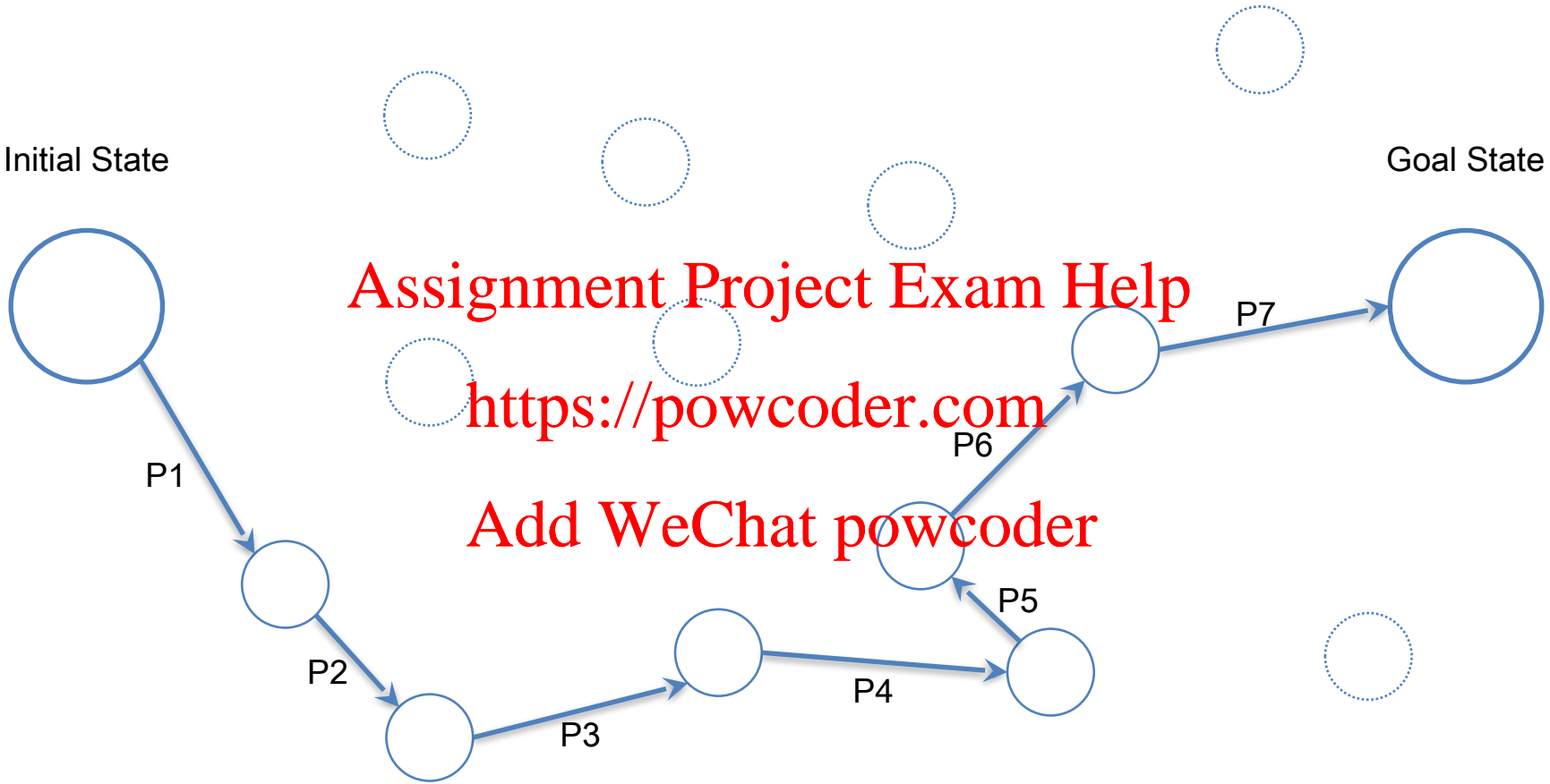
Initial State

Goal State

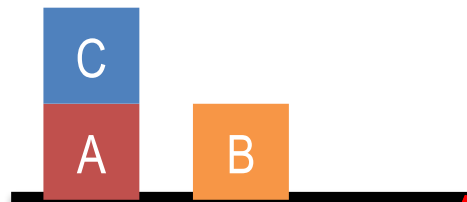
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Initial State



A on Table  
B on Table  
C on A

Goal State



A on B  
B on C  
C on Table

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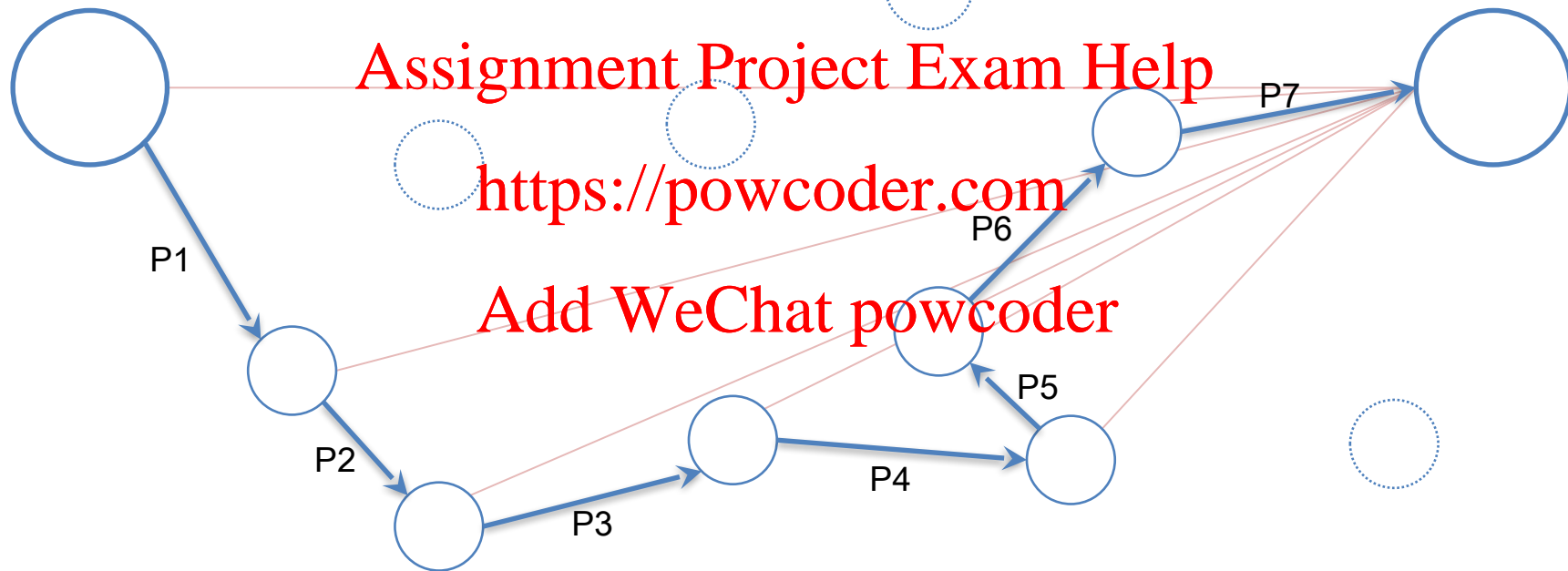
A on Table  
B on Table  
C on Table



A on Table  
B on C  
C on A

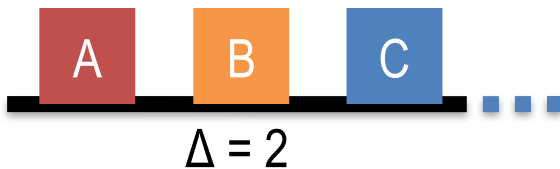
Initial State

Goal State

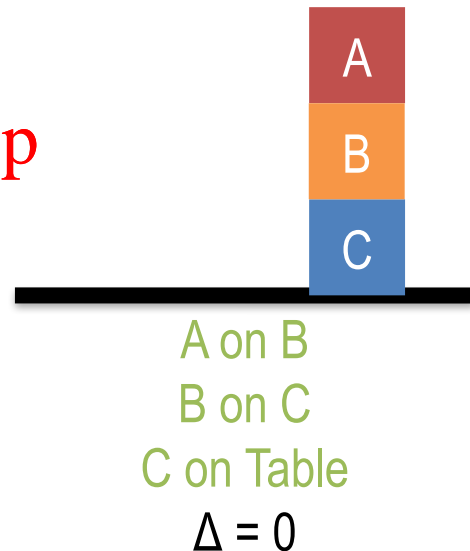




Initial State



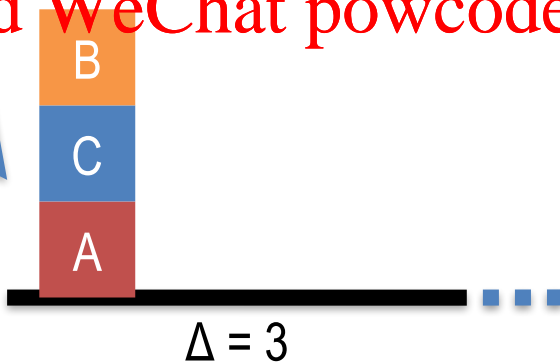
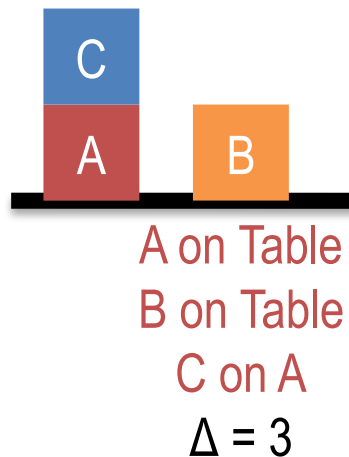
Goal State



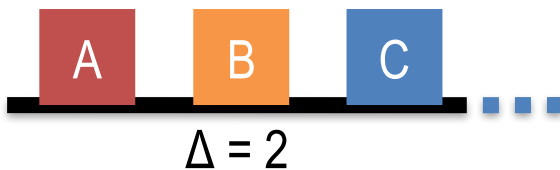
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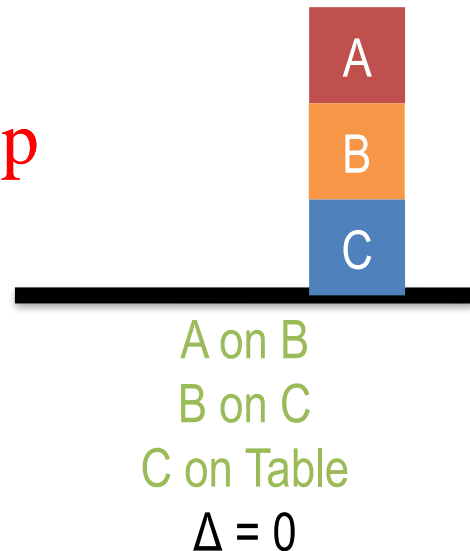
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Initial State



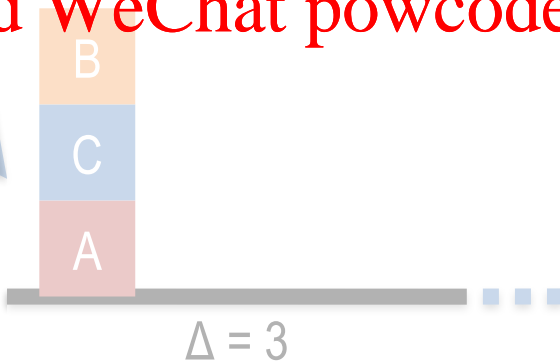
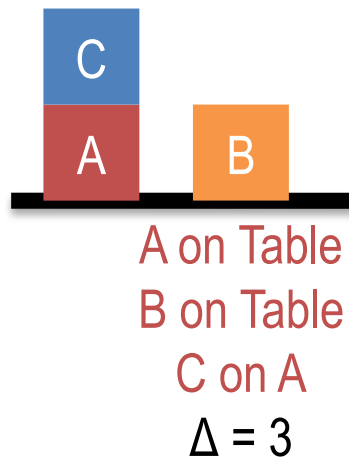
Goal State



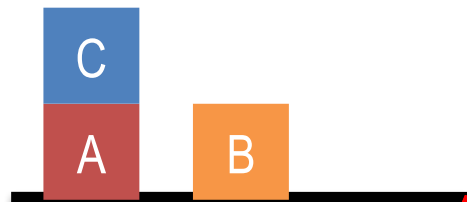
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Initial State



A on Table  
B on Table  
C on A  
 $\Delta = 3$

Goal State



A on B  
B on C  
C on Table  
 $\Delta = 0$

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A on Table  
B on Table  
C on Table  
 $\Delta = 2$



A on Table  
B on C  
C on Table  
 $\Delta = 1$

# Means-Ends Analysis

For each operator that can be applied:

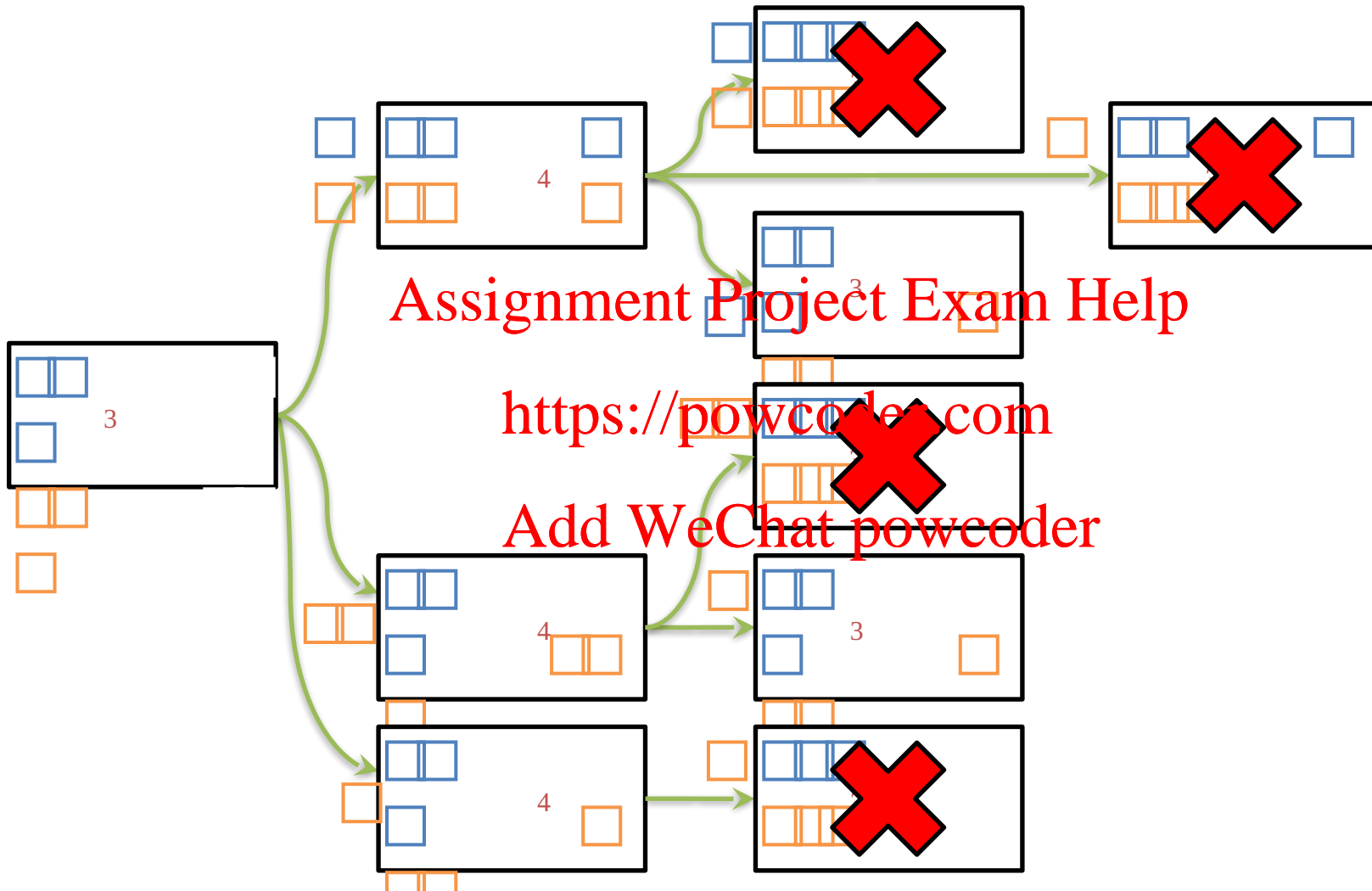
- Apply the operator to the current state
- Calculate difference between new state and goal state

Prefer state that minimizes distance between new state and goal state

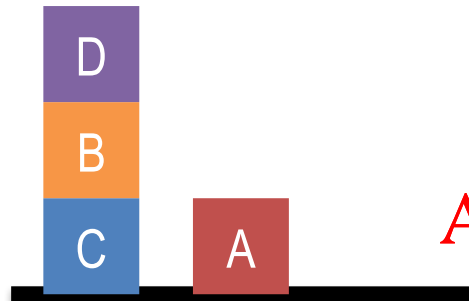
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Initial State



A on Table

B on C

C on Table

D on B

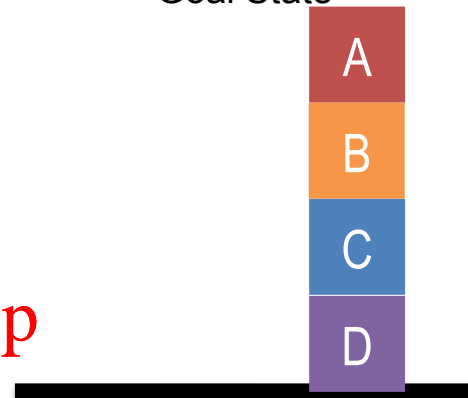
$\Delta = 3$

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Goal State



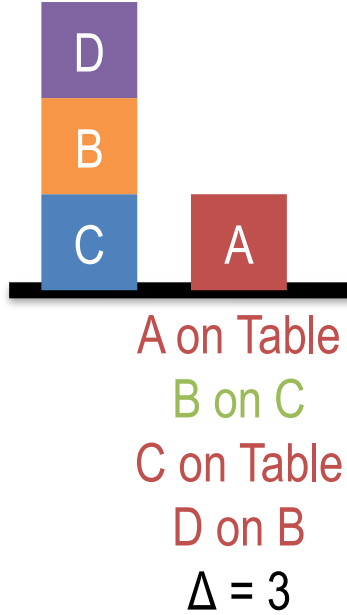
A on B

B on C

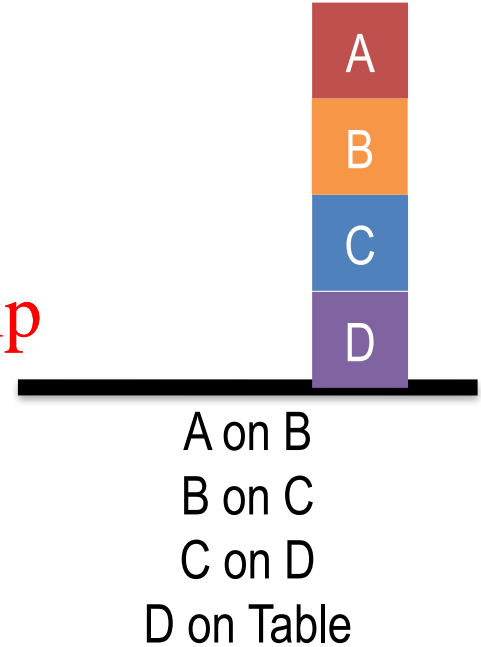
C on D

D on Table

Initial State



Goal State



A on D  
B on C  
C on Table  
D on B  
 $\Delta = 3$

A on Table  
B on C  
C on Table  
D on A  
 $\Delta = 3$

A on Table  
B on C  
C on Table  
D on Table  
 $\Delta = 2$

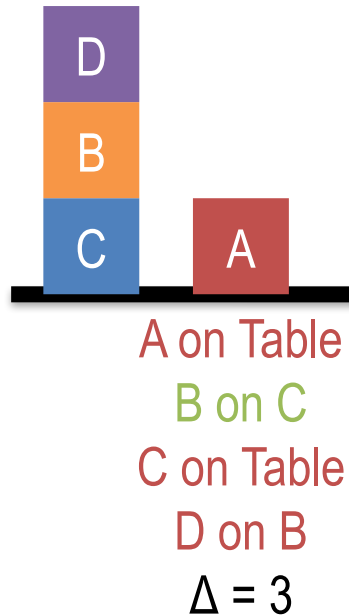
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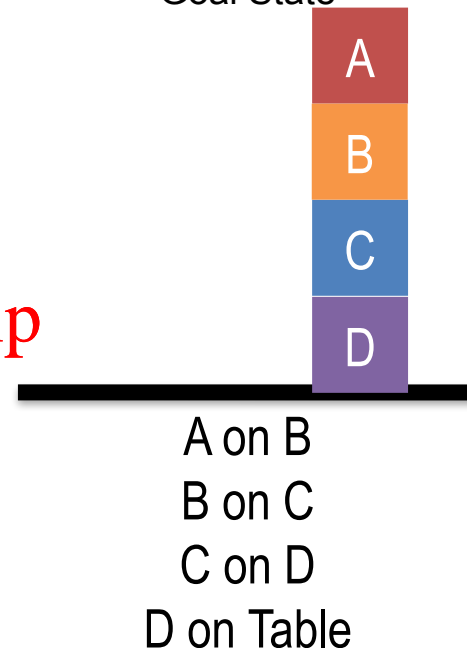
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What is the difference between each state and the goal state?

Initial State



Goal State



A on D  
B on C  
C on Table  
D on B  
 $\Delta = 3$

A on Table  
B on C  
C on Table  
D on A  
 $\Delta = 3$

A on Table  
B on C  
C on Table  
D on Table  
 $\Delta = 2$

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Using means-ends  
analysis, which move  
will be chosen?



Current State



A on Table  
B on C  
C on Table  
D on Table  
 $\Delta = 2$

How many possible next states  
are there?

7

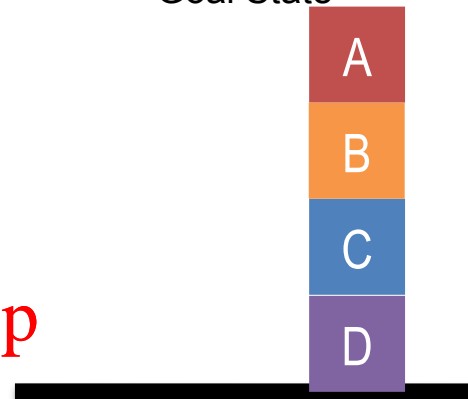
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How many of those states reduce  
the difference to the goal?  
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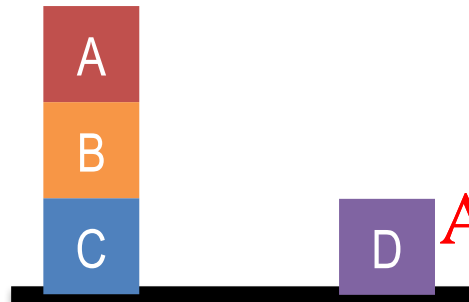
1

Goal State



A on B  
B on C  
C on D  
D on Table

Current State



A on B

B on C

C on Table

D on Table

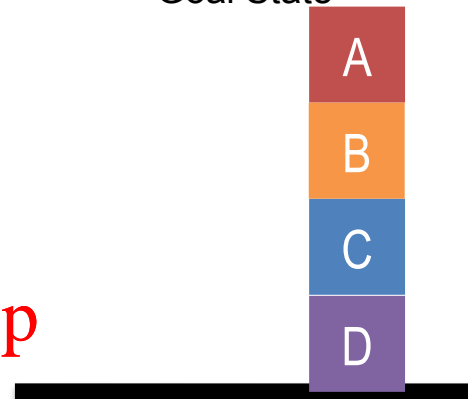
$\Delta = 1$

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Goal State



A on B

B on C

C on D

D on Table

Current State



A on B

B on C

C on Table

D on Table

$\Delta = 1$

How many possible next states  
are there?

3

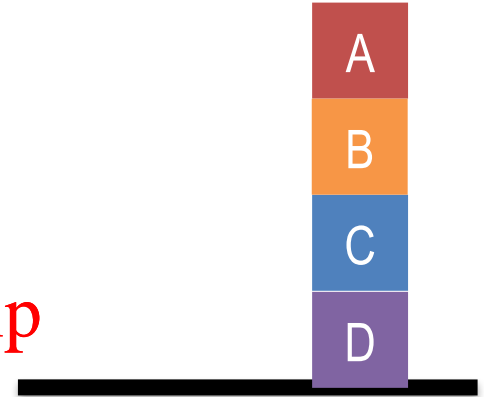
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How many of those states reduce  
the difference to the goal?

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0

Goal State



A on B

B on C

C on D

D on Table

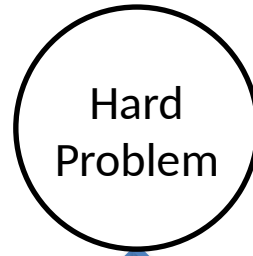
# **Assignment**

How would you use means-ends analysis to design an agent that could answer Raven's Progressive Matrices?

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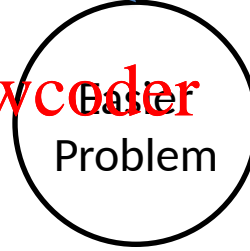
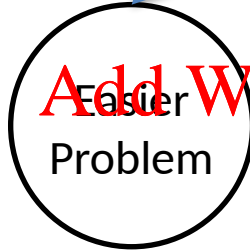
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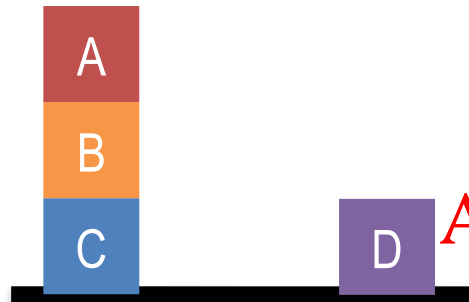
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Current State



A on B

B on C

C on Table

D on Table

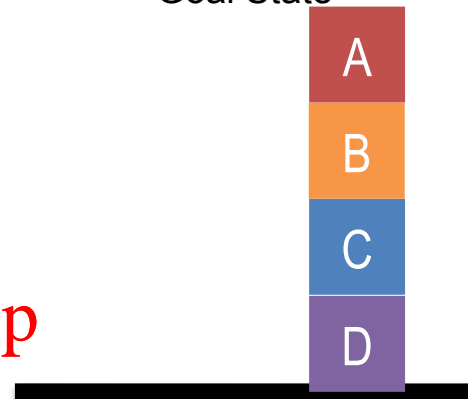
$\Delta = 1$

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Goal State



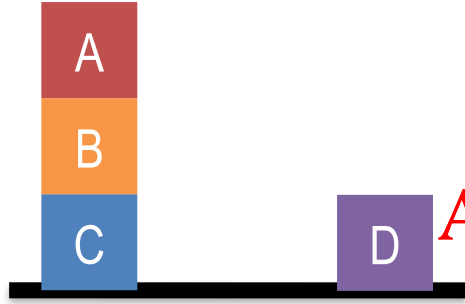
A on B

B on C

C on D

D on Table

Current State



A on B

B on C

C on Table

D on Table

$\Delta = 1$

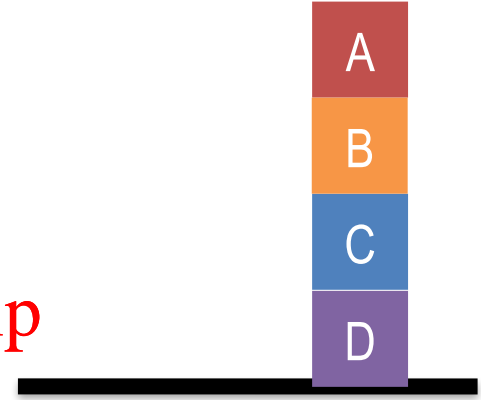
Subgoal



C on D

D on Table

Goal State



A on B

B on C

C on D

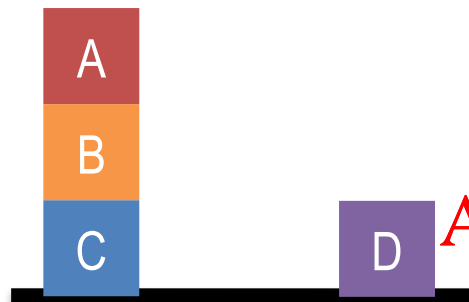
D on Table

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Current State



A on B

B on C

C on Table

D on Table

$\Delta = 1$

Subgoal



C on D

D on Table

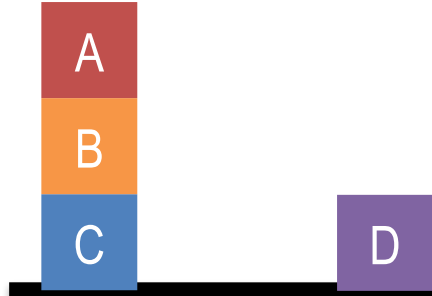
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Current State



A on B  
B on C  
C on Table  
D on Table  
 $\Delta = 1$

Subgoal



C on D  
D on Table

A on D  
B on C  
C on Table  
D on Table

$\Delta = 1$

A on B  
B on C  
C on Table  
D on A

$\Delta = 2$

A on Table  
B on C  
C on Table  
D on Table

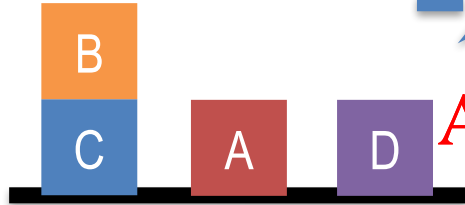
$\Delta = 1$

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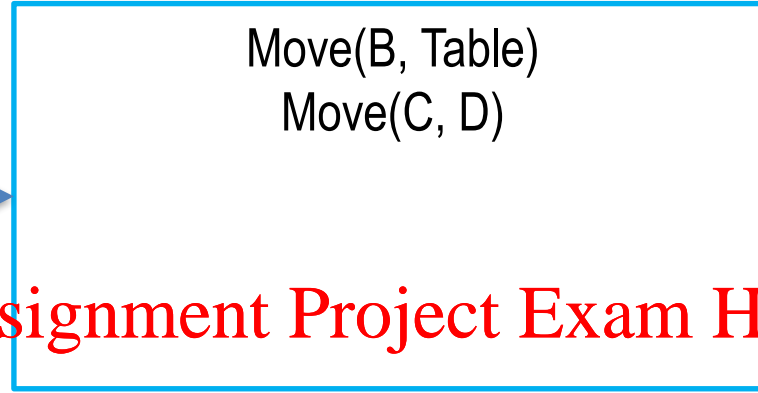
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Current State



A on Table  
B on C  
C on Table  
D on Table  
 $\Delta = 1$



Subgoal



C on D  
D on Table

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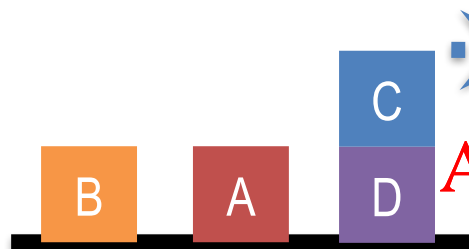
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Available Operators:  
Move(Object, Location)  
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e.g.:

Move(C, Table)  
moves C onto the table

Move(C, B)  
moves C onto B

Current State



A on Table  
B on Table  
C on D  
D on Table  
 $\Delta = 2$

Move(B, C)  
Move(A, B)

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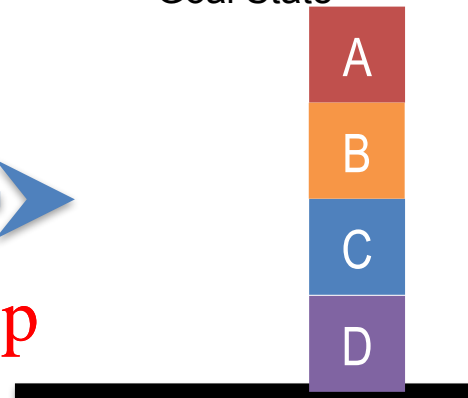
<https://powcoder.com>

Available Operators:  
Move(Object, Location)  
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e.g.:

Move(C, Table)  
moves C onto the table

Move(C, B)  
moves C onto B

Goal State



A on B  
B on C  
C on D  
D on Table

# **Assignment**

How would you use problem reduction to design an agent that could answer Raven's Progressive Matrices?

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## To recap...

- State spaces
  - Means-ends analysis
  - Problem solving with means-ends analysis
  - Problem reduction
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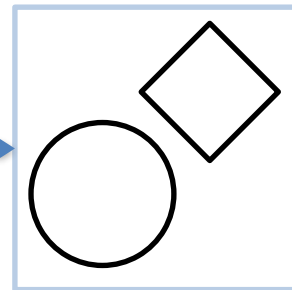
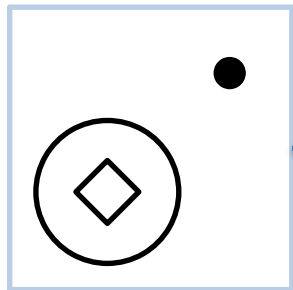
Initial State

Goal State

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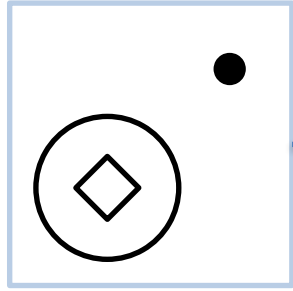
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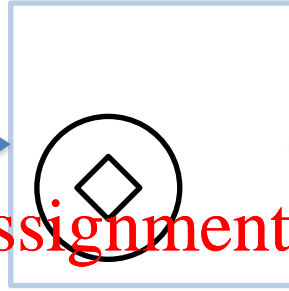


Set of Transformations

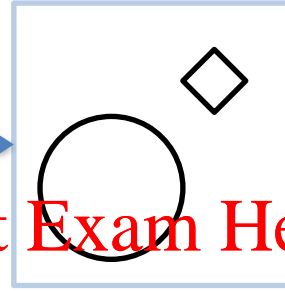
Initial State



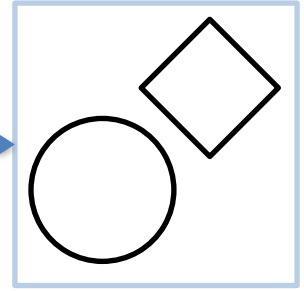
delete



move



expand



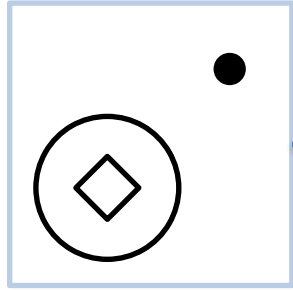
Goal State

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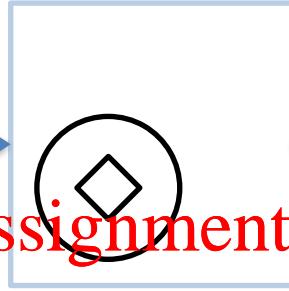
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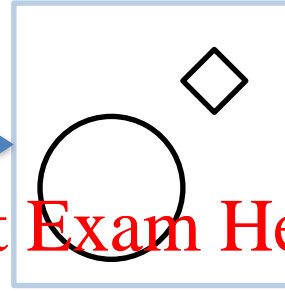
Initial State



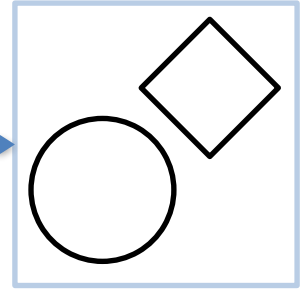
delete



move



expand

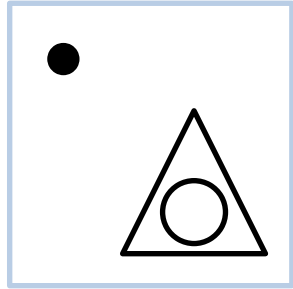


Goal State

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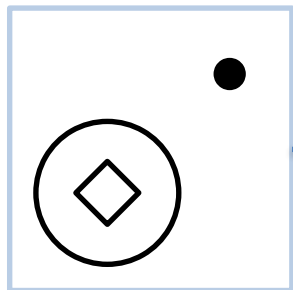
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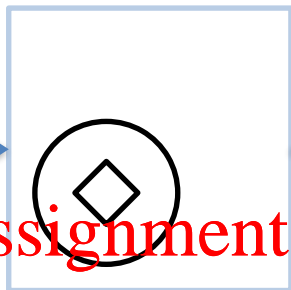




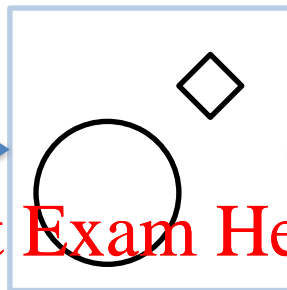
Initial State



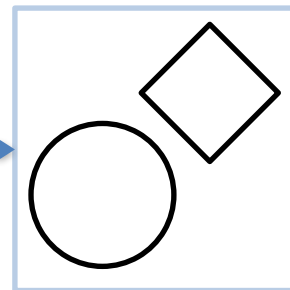
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move



expand

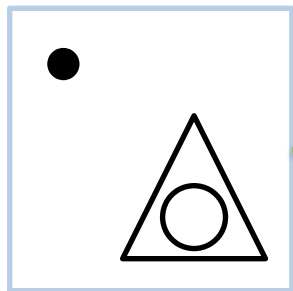


Goal State

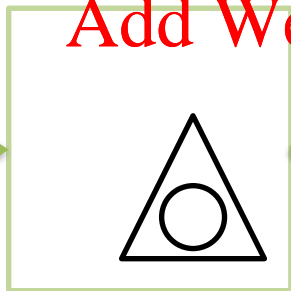
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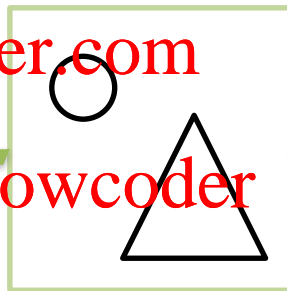
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delete



move



expand

