

**CSE 579**  
**Module 5 Graded Assignment**  
**Template for clingo Work**

Source - CSE 579 Module 5 Slides and Video Lectures

Problem 1

Input Program	<p>In ques01_1.lp file –</p> <pre>location(B) :- block(B). location(table).  :- 2{on(BB,B,T)}, block(B), T=0..m.  on(B,L,T+1) :- move(B,L,T). :- not {move(BB,LL,T)} grippers, T=0..m-1. :- move(B,L,T), on(B1,B,T). :- move(B,B1,T), move(B1,L,T).  1{on(B,LL,0):location(LL)}1 :- block(B). :- not 1{on(B,LL,T)}1, block(B), T=1..m. {move(B,L,T)} :- block(B), location(L), T=0..m-1. {on(B,L,T+1)} :- on(B,L,T), T &lt; m.  :- k+1{on(B,table,T)}, T=0..m. #show move/3.</pre> <p>In ques01_2.lp file –</p> <pre>block(1..6). % inputs :- not on(1,2,0; 2,table,0; 3,4,0; 4,table,0; 5,6,0; 6,table,0).  % goal condtion :- not on(3,2,m; 2,1,m; 1,table,m; 6,5,m; 5,4,m; 4,table,m).</pre>
Command Lines	<pre>clingo ques_01_1.lp ques_01_2.lp -c m=6 -c grippers=1 -c k=3 clingo ques_01_1.lp ques_01_2.lp -c m=7 -c grippers=1 -c k=3 clingo ques_01_1.lp ques_01_2.lp -c m=4 -c grippers=1 -c k=4 clingo ques_01_1.lp ques_01_2.lp -c m=5 -c grippers=1 -c k=4</pre>
Outputs of clingo	<pre>Solving... (for m=6, k=3) UNSATISFIABLE  Models      : 0 Calls       : 1</pre>

	<p>Time : 0.006s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s) CPU Time : 0.016s</p> <p>Solving... (for m=6, k=3) Answer: 1 move(1,3,0) move(2,5,1) move(1,table,2) move(2,1,3) move(3,2,4) move(5,4,5) move(6,5,6) SATISFIABLE</p> <p>Models : 1+ Calls : 1 Time : 0.013s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s) CPU Time : 0.016s</p> <p>Solving... (for m=4, k=4) UNSATISFIABLE</p> <p>Models : 0 Calls : 1 Time : 0.003s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s) CPU Time : 0.000s</p> <p>Solving... (for m=5, k=4) Answer: 1 move(1,table,0) move(2,1,1) move(3,2,2) move(5,4,3) move(6,5,4) SATISFIABLE</p> <p>Models : 1+ Calls : 1 Time : 0.010s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s) CPU Time : 0.000s</p>						
Answer to Questions	<p>Fill in the following table that lists the minimum number of steps to solve the modified block world problem for different values of n, where n is the maximal number of blocks that can be placed directly on the table.</p> <table border="1"> <thead> <tr> <th>n</th><th>Number of steps</th></tr> </thead> <tbody> <tr> <td>3</td><td>7</td></tr> <tr> <td>4</td><td>5</td></tr> </tbody> </table>	n	Number of steps	3	7	4	5
n	Number of steps						
3	7						
4	5						

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PS D:\ASU Courses\Sem-1\Knowledge Representation\Projects\Programming Assignment 2> clingo ques_01_1.lp q
ues_01_2.lp -c m=6 -c grippers=1 -c k=3
clingo version 5.4.0
Reading from ques_01_1.lp ...
Solving...
UNSATISFIABLE

Models      : 0
Calls       : 1
Time        : 0.015s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)
CPU Time    : 0.016s
PS D:\ASU Courses\Sem-1\Knowledge Representation\Projects\Programming Assignment 2> clingo ques_01_1.lp q
ues_01_2.lp -c m=7 -c grippers=1 -c k=3
clingo version 5.4.0
Reading from ques_01_1.lp ...
Solving...
Answer: 1
move(1,3,0) move(2,5,1) move(1,table,2) move(2,1,3) move(3,2,4) move(5,4,5) move(6,5,6)
SATISFIABLE

Models      : 1+
Calls       : 1
Time        : 0.007s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)
CPU Time    : 0.016s
PS D:\ASU Courses\Sem-1\Knowledge Representation\Projects\Programming Assignment 2> 

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PS D:\ASU Courses\Sem-1\Knowledge Representation\Projects\Programming Assignment 2> clingo ques_01_1.lp q
ues_01_2.lp -c m=4 -c grippers=1 -c k=4
clingo version 5.4.0
Reading from ques_01_1.lp ...
Solving...
UNSATISFIABLE

Models      : 0
Calls       : 1
Time        : 0.000s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)
CPU Time    : 0.000s
PS D:\ASU Courses\Sem-1\Knowledge Representation\Projects\Programming Assignment 2> clingo ques_01_1.lp q
ues_01_2.lp -c m=5 -c grippers=1 -c k=4
clingo version 5.4.0
Reading from ques_01_1.lp ...
Solving...
Answer: 1
move(1,table,0) move(2,1,1) move(3,2,2) move(5,4,3) move(6,5,4)
SATISFIABLE

Models      : 1+
Calls       : 1
Time        : 0.012s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)
CPU Time    : 0.016s
PS D:\ASU Courses\Sem-1\Knowledge Representation\Projects\Programming Assignment 2> 

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## Problem 2

Input Program	<p>In ques02_1.lp file –</p> <pre> location(B) :- block(B). location(table).  :- 2{on(BB,B,T)}, block(B), T=0..m.  on(B,L,T+1) :- move(B,L,T). :- not {move(BB,LL,T)} grippers, T=0..m-1. :- move(B,L,T), on(B1,B,T). :- move(B,B1,T), move(B1,L,T).  1{on(B,LL,0):location(LL)}1 :- block(B). :- not 1{on(B,LL,T)}1, block(B), T=1..m. {move(B,L,T)} :- block(B), location(L), T=0..m-1. {on(B,L,T+1)} :- on(B,L,T), T &lt; m.  stable(B,L,T) :- on(B,L,T), not on(L,B,T), T=0..m. #show stable/3.  In ques02_2.lp file –  block(1..6). % inputs :- not on(1,2,0; 2,1,0; 3,3,0; 4,table,0; 5,6,0; 6,table,0).</pre>
Command Line	<pre>clingo ques_02_1.lp ques_02_2.lp -c m=0 -c grippers=1</pre>
Output of clingo	<pre> Solving... Answer: 1 stable(4,table,0) stable(6,table,0) stable(5,6,0) SATISFIABLE  Models      : 1 Calls       : 1 Time        : 0.003s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s) CPU Time    : 0.016s</pre>
Answer to Questions	<p>How many valid states are there when there are 6 blocks? (Note that the limitation of blocks introduced in question 1 is not considered here.)</p> <p>3 Valid States for the given example</p>

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PS D:\ASU Courses\Sem-1\Knowledge Representation\Projects\Programming Assignment 2> clingo ques_02_1.lp q
ues_02_2.lp -c m=0 -c grippers=1
clingo version 5.4.0
Reading from ques_02_1.lp ...
Solving...
Answer: 1
stable(4,table,0) stable(6,table,0) stable(5,6,0)
SATISFIABLE

Models      : 1
Calls       : 1
Time        : 0.004s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)
CPU Time    : 0.016s
PS D:\ASU Courses\Sem-1\Knowledge Representation\Projects\Programming Assignment 2> 

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### Problem 3

Input Program	<p>In ques03_1.lp file –</p> <pre> location(B) :- block(B). location(table).  :- 2{on(BB,B,T)}, block(B), T=0..m.  on(B,L,T+1) :- move(B,L,T). :- not {move(BB,LL,T)} grippers, T=0..m-1. :- move(B,L,T), on(B1,B,T). :- move(B,B1,T), move(B1,L,T).  1{on(B,LL,0):location(LL)}1 :- block(B). :- not 1{on(B,LL,T)}1, block(B), T=1..m. {move(B,L,T)} :- block(B), location(L), T=0..m-1. {on(B,L,T+1)} :- on(B,L,T), T &lt; m.  :- move(B,L1,T), move(L1,L,T), T=0..z-1. #show move/3. </pre> <p>In ques03_2.lp file –</p> <pre> block(1..15). #const a=1. #const b=2. #const c=3. #const d=4. #const e=5. #const f=6. #const g=7. #const h=8. #const i=9. #const j=10. #const k=11. #const l=12. #const m=13. #const n=14. #const o=15.  % inputs :- not on(m,table,0; l,m,0; a,l,0; b,a,0; c,b,0; o,table,0; n,o,0; d,n,0; e,d,0; j,e,0; k,j,0; f,table,0; g,f,0; h,g,0; i,h,0). </pre>
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	% goal condition :- not on(e,j,z; a,e,z; n,a,z; i,d,z; h,i,z; m,h,z; o,m,z; k,g,z; c,k,z; b,c,z; l,b,z).
Command Line	clingo ques_03_1.lp ques_03_2.lp -c z=8 -c grippers=3
Output of clingo	Solving... Answer: 1 move(3,table,0) move(9,table,0) move(11,table,0) move(2,table,1) move(8,table,1) move(10,table,1) move(1,table,2) move(5,10,2) move(7,table,2) move(4,6,3) move(11,7,3) move(12,table,3) move(3,11,4) move(9,4,4) move(14,1,4) move(2,3,5) move(8,9,5) move(14,15,5) move(1,5,6) move(13,8,6) move(14,table,6) move(12,2,7) move(14,1,7) move(15,13,7) SATISFIABLE  Models : 1+ Calls : 1 Time : 0.083s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s) CPU Time : 0.078s

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PS D:\ASU Courses\Sem-1\Knowledge Representation\Projects\Programming Assignment 2> clingo ques_03_1.lp q
ues_03_2.lp -c z=8 -c grippers=3
clingo version 5.4.0
Reading from ques_03_1.lp ...
Solving...
Answer: 1
move(3,table,0) move(9,table,0) move(11,table,0) move(2,table,1) move(8,table,1) move(10,table,1) move(1,
table,2) move(5,10,2) move(7,table,2) move(4,6,3) move(11,7,3) move(12,table,3) move(3,11,4) move(9,4,4)
move(14,1,4) move(2,3,5) move(8,9,5) move(14,15,5) move(1,5,6) move(13,8,6) move(14,table,6) move(12,2,7)
move(14,1,7) move(15,13,7)
SATISFIABLE

Models      : 1+
Calls       : 1
Time        : 0.057s (Solving: 0.01s 1st Model: 0.00s Unsat: 0.00s)
CPU Time    : 0.047s
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#### Problem 4

Input Program	<p>In ques04_1.lp file –</p> <pre> location(B) :- block(B). location(table).  :- 2{on(BB,B,T)}, block(B), T=0..m.  on(B,L,T+1) :- move(B,L,T). :- not {move(BB,LL,T)} grippers, T=0..m-1. :- move(B,L,T), on(B1,B,T). :- move(B,B1,T), move(B1,L,T).  1{on(B,LL,0):location(LL)}1 :- block(B). :- not 1{on(B,LL,T)}1, block(B), T=1..m. {move(B,L,T)} :- block(B), location(L), T=0..m-1. {on(B,L,T+1)} :- on(B,L,T), T &lt; m.  #minimize{1,B,L,T: move(B,L,T)}. </pre> <p>In ques04_2.lp file –</p> <pre> block(1..15). #const a=1. #const b=2. #const c=3. #const d=4. #const e=5. #const f=6. #const g=7. #const h=8. #const i=9. #const j=10. #const k=11. #const l=12. #const m=13. #const n=14. #const o=15.  % inputs :- not on(m,table,0; l,m,0; a,l,0; b,a,0; c,b,0; o,table,0; n,o,0; d,n,0; e,d,0; j,e,0; k,j,0; f,table,0; g,f,0; h,g,0; i,h,0).  % goal condition :- not on(e,j,z; a,e,z; n,a,z; i,d,z; h,i,z; m,h,z; o,m,z; k,g,z; c,k,z; b,c,z; l,b,z). </pre>
Command Line	<pre> clingo ques_04_1.lp ques_04_2.lp -c z=8 -c grippers=3 clingo ques_04_1.lp ques_04_2.lp -c z=9 -c grippers=3 clingo ques_04_1.lp ques_04_2.lp -c z=10 -c grippers=3 </pre>
Output of clingo	<pre> Answer: 8 (for z=8) move(9,table,0) move(11,3,0) move(8,table,1) move(10,table,1) move(11,7,1) move(3,11,2) move(5,10,2) move(2,3,3) move(4,table,3) move(1,5,4) move(9,4,4) move(8,9,5) move(12,2,5) move(14,1,5) move(13,8,6) move(15,13,7) Optimization: 16 OPTIMUM FOUND </pre>

	<p>Models : 8 Optimum : yes Optimization : 16 Calls : 1 Time : 0.545s (Solving: 0.48s 1st Model: 0.02s Unsat: 0.11s) CPU Time : 0.516s</p> <p>Answer: 9 (for z=9) move(9,table,0) move(8,table,1) move(11,7,1) move(3,11,2) move(10,table,2) move(2,3,3) move(5,10,3) move(1,5,4) move(4,table,4) move(9,4,5) move(12,2,5) move(14,1,5) move(8,9,6) move(13,8,7) move(15,13,8) Optimization: 15 OPTIMUM FOUND</p> <p>Models : 9 Optimum : yes Optimization : 15 Calls : 1 Time : 433.818s (Solving: 433.72s 1st Model: 0.01s Unsat: 1.64s) CPU Time : 429.641s</p> <p>Answer: 6 move(3,table,0) move(11,table,0) move(2,table,1) move(10,table,1) move(1,table,2) move(5,10,2) move(4,table,3) move(12,table,3) move(9,4,5) move(8,9,6) move(11,7,6) move(1,5,7) move(3,11,7) move(13,8,7) move(2,3,8) move(14,1,8) move(12,2,9) move(15,13,9) Optimization: 18 *** Info : (clingo): INTERRUPTED by signal! SATISFIABLE</p> <p>INTERRUPTED : 1 (for z=10)* Models : 6+ Optimum : unknown Optimization : 18 Calls : 1 Time : 1948.618s (Solving: 1948.55s 1st Model: 0.00s Unsat: 0.00s) CPU Time : 1946.750s</p>				
Answer to Questions	<p>What is the least number of actions when maxstep m is 8, 9, and 10?</p> <table><tr><th>m</th><th>least number of actions</th></tr><tr><td>8</td><td>16</td></tr></table>	m	least number of actions	8	16
m	least number of actions				
8	16				



	9	15
	10	$\leq 15$

\*Tried for the value of  $z=10$ , but got stuck at Optimization 18 for more than 30 min, and the program seems to be still running on that.

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Answer: 5
move(3,table,0) move(9,table,0) move(11,table,0) move(2,table,1) move(8,table,1) move(10,table,1) move(5,
10,2) move(9,8,2) move(11,7,2) move(1,5,3) move(3,11,3) move(4,table,3) move(2,3,4) move(9,4,4) move(14,1
,4) move(8,9,5) move(12,2,5) move(13,8,6) move(15,13,7)
Optimization: 19
Answer: 6
move(9,table,0) move(11,3,0) move(8,table,1) move(10,table,1) move(11,7,1) move(3,11,2) move(5,10,2) move
(9,8,2) move(2,3,3) move(4,table,3) move(1,5,4) move(9,4,4) move(8,9,5) move(12,table,5) move(14,1,5) mov
e(13,8,6) move(12,2,7) move(15,13,7)
Optimization: 18
Answer: 7
move(9,table,0) move(11,3,0) move(8,table,1) move(10,table,1) move(11,7,1) move(3,11,2) move(5,10,2) move
(9,8,2) move(2,3,3) move(4,table,3) move(1,5,4) move(9,4,4) move(8,9,5) move(12,2,5) move(14,1,5) move(13
,8,6) move(15,13,7)
Optimization: 17
Answer: 8
move(9,table,0) move(11,3,0) move(8,table,1) move(10,table,1) move(11,7,1) move(3,11,2) move(5,10,2) move
(2,3,3) move(4,table,3) move(1,5,4) move(9,4,4) move(8,9,5) move(12,2,5) move(14,1,5) move(13,8,6) move(1
5,13,7)
Optimization: 16
OPTIMUM FOUND

Models      : 8
  Optimum   : yes
Optimization : 16
Calls       : 1
Time        : 0.367s (Solving: 0.32s 1st Model: 0.00s Unsat: 0.10s)
CPU Time    : 0.328s
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Optimization: 19
Answer: 6
move(9,table,0) move(11,3,0) move(8,table,1) move(10,table,1) move(11,7,1) move(3,11,2) move(5,10,2) move
(2,9,3) move(4,table,3) move(1,5,4) move(2,3,4) move(9,4,5) move(12,1,5) move(8,9,6) move(12,2,7) move(13
,8,7) move(14,1,7) move(15,13,8)
Optimization: 18
Answer: 7
move(9,table,0) move(11,3,0) move(8,table,1) move(10,table,1) move(11,7,1) move(3,11,2) move(5,10,2) move
(2,3,3) move(4,table,3) move(1,5,4) move(9,4,5) move(12,1,5) move(8,9,6) move(12,2,7) move(13,8,7) move(1
4,1,7) move(15,13,8)
Optimization: 17
Answer: 8
move(9,table,0) move(11,table,0) move(8,table,1) move(10,table,1) move(11,7,1) move(3,11,2) move(5,10,2)
move(2,3,3) move(4,table,3) move(1,5,4) move(9,4,4) move(8,9,5) move(12,2,5) move(14,1,5) move(13,8,6) mo
ve(15,13,7)
Optimization: 16
Answer: 9
move(9,table,0) move(8,table,1) move(11,7,1) move(3,11,2) move(10,table,2) move(2,3,3) move(5,10,3) move(
1,5,4) move(4,table,4) move(9,4,5) move(12,2,5) move(14,1,5) move(8,9,6) move(13,8,7) move(15,13,8)
Optimization: 15
OPTIMUM FOUND

Models      : 9
  Optimum   : yes
Optimization : 15
Calls       : 1
Time        : 446.857s (Solving: 446.80s 1st Model: 0.00s Unsat: 1.63s)
CPU Time    : 445.297s
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move(3,table,0) move(9,table,0) move(11,table,0) move(2,table,1) move(8,table,1) move(10,table,1) move(1,
table,2) move(5,10,2) move(7,table,2) move(4,table,3) move(12,table,3) move(11,7,4) move(9,4,5) move(1,5,
6) move(3,11,6) move(8,9,6) move(2,3,7) move(13,8,7) move(14,1,7) move(12,2,8) move(15,13,8)
Optimization: 21
Answer: 4
move(3,table,0) move(9,table,0) move(11,table,0) move(2,table,1) move(8,table,1) move(10,table,1) move(1,
table,2) move(5,10,2) move(7,table,2) move(4,table,3) move(11,7,4) move(3,11,5) move(9,4,5) move(2,3,6) m
ove(8,9,6) move(1,5,7) move(12,2,7) move(13,8,8) move(14,1,8) move(15,13,9)
Optimization: 20
Answer: 5
move(3,table,0) move(11,table,0) move(2,table,1) move(10,table,1) move(1,table,2) move(5,10,2) move(4,tab
le,3) move(12,table,3) move(9,4,4) move(8,9,5) move(11,7,5) move(3,11,6) move(5,10,6) move(1,5,7) move(2,
3,7) move(13,8,7) move(12,2,8) move(14,1,8) move(15,13,9)
Optimization: 19
Answer: 6
move(3,table,0) move(11,table,0) move(2,table,1) move(10,table,1) move(1,table,2) move(5,10,2) move(4,tab
le,3) move(12,table,3) move(9,4,5) move(8,9,6) move(11,7,6) move(1,5,7) move(3,11,7) move(13,8,7) move(2,
3,8) move(14,1,8) move(12,2,9) move(15,13,9)
Optimization: 18
*** Info : (clingo): INTERRUPTED by signal!
SATISFIABLE

INTERRUPTED : 1
Models      : 6+
  Optimum   : unknown
Optimization : 18
Calls       : 1
Time        : 1318.991s (Solving: 1318.94s 1st Model: 0.01s Unsat: 0.00s)
CPU Time    : 1315.469s
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