**CSE 579**

**Programming Assignment 1- Clingo Work**

Problem 1

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| Input  Program | 1 {queen(Row,1..8)} 1 :- Row=1..8.  :- queen(Row1,Col) , queen(Row2,Col) , Row1!=Row2.  :- queen(Row1,Col1) , queen(Row2,Col2) , Row1!=Row2, |Row1-Row2|==|Col1-Col2|.  :- queen(Row,Col) , Row>=3 , Row<=6 , Col>=3 , Col<=6. |
| Command  Line | clingo p1.lp 0 |
| Output  of clingo | clingo version 5.4.0  Reading from p1.lp  Solving...  Answer: 1  queen(5,7) queen(1,4) queen(2,6) queen(4,2) queen(3,8) queen(6,1) queen(7,3) queen(8,5)  Answer: 2  queen(2,3) queen(3,1) queen(6,8) queen(4,7) queen(1,5) queen(5,2) queen(7,6) queen(8,4)  Answer: 3  queen(2,4) queen(4,1) queen(5,8) queen(3,7) queen(1,6) queen(6,2) queen(7,5) queen(8,3)  Answer: 4  queen(6,7) queen(1,3) queen(2,5) queen(3,2) queen(4,8) queen(5,1) queen(8,6) queen(7,4)  SATISFIABLE  Models : 4  Calls : 1  Time : 0.006s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.006s |

Problem 2

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| Input  Program | 1 {queen(Row,1..n)} 1 :- Row=1..n.  :- queen(Row1,Col) , queen(Row2,Col) , Row1!=Row2.  :- queen(Row1,Col1) , queen(Row2,Col2) , Row1!=Row2, |Row1-Row2|==|Col1-Col2|. |
| Command  Line | You should write multiple command lines below.  clingo p2.lp -c n=3 0  clingo p2.lp -c n=4 0  clingo p2.lp -c n=5 0  clingo p2.lp -c n=6 0  clingo p2.lp -c n=7 0  clingo p2.lp -c n=8 0  clingo p2.lp -c n=9 0  clingo p2.lp -c n=10 0  clingo p2.lp -c n=11 0  clingo p2.lp -c n=12 0 |
| Output  of clingo | Since the output is large, do not copy them into the submission. |
| Answer  to Questions | Draw a table that lists the number of solutions and the times to compute all solutions. Use CPU time that clingo returns.   |  |  |  | | --- | --- | --- | | Value n | Number of solutions | time | | 3 | 0 | CPU Time: 0.004s | | 4 | 2 | CPU Time: 0.004s | | 5 | 10 | CPU Time: 0.005s | | 6 | 4 | CPU Time: 0.005s | | 7 | 40 | CPU Time: 0.006s | | 8 | 92 | CPU Time: 0.011s | | 9 | 352 | CPU Time: 0.030s | | 10 | 724 | CPU Time: 0.185s | | 11 | 2680 | CPU Time: 1.839s | | 12 | 14200 | CPU Time: 21.425s | |

Problem 3

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| Input  Program | 1. p3.lp   1 { sudoku\_puzzle(Row,Col,Num) :Row=1..9,Col=1..9,Row1<=Row,Row<=Row1+2,Col1<=Col,Col<=Col1+2 } 1 :- Num=1..9, Row1 = 3\*(0..2)+1, Col1 = 3\*(0..2)+1.  :- sudoku\_puzzle(Row,Col,Num1), sudoku\_puzzle(Row,Col,Num2), Num1!=Num2.  :- sudoku\_puzzle(Row,Col1,Num), sudoku\_puzzle(Row,Col2,Num), Col1!=Col2.  :- sudoku\_puzzle(Row1,Col,Num), sudoku\_puzzle(Row2,Col,Num), Row1!=Row2.   1. inst3.lp   sudoku\_puzzle(1, 1, 8).  sudoku\_puzzle(3, 2, 7).  sudoku\_puzzle(4, 2, 5).  sudoku\_puzzle(9, 2, 9).  sudoku\_puzzle(2, 3, 3).  sudoku\_puzzle(7, 3, 1).  sudoku\_puzzle(8, 3, 8).  sudoku\_puzzle(2, 4, 6).  sudoku\_puzzle(6, 4, 1).  sudoku\_puzzle(8, 4, 5).  sudoku\_puzzle(3, 5, 9).  sudoku\_puzzle(5, 5, 4).  sudoku\_puzzle(4, 6, 7).  sudoku\_puzzle(5, 6, 5).  sudoku\_puzzle(3, 7, 2).  sudoku\_puzzle(5, 7, 7).  sudoku\_puzzle(9, 7, 4).  sudoku\_puzzle(6, 8, 3).  sudoku\_puzzle(7, 8, 6).  sudoku\_puzzle(8, 8, 1).  sudoku\_puzzle(7, 9, 8). |
| Command  Line | clingo p3.lp inst3.lp 0 |
| Output  of clingo | clingo version 5.4.0  Reading from p3.lp ...  Solving...  Answer: 1  sudoku\_puzzle(1,1,8) sudoku\_puzzle(3,2,7) sudoku\_puzzle(4,2,5) sudoku\_puzzle(9,2,9) sudoku\_puzzle(2,3,3) sudoku\_puzzle(7,3,1) sudoku\_puzzle(8,3,8) sudoku\_puzzle(2,4,6) sudoku\_puzzle(6,4,1) sudoku\_puzzle(8,4,5) sudoku\_puzzle(3,5,9) sudoku\_puzzle(5,5,4) sudoku\_puzzle(4,6,7) sudoku\_puzzle(5,6,5) sudoku\_puzzle(3,7,2) sudoku\_puzzle(5,7,7) sudoku\_puzzle(9,7,4) sudoku\_puzzle(6,8,3) sudoku\_puzzle(7,8,6) sudoku\_puzzle(8,8,1) sudoku\_puzzle(7,9,8) sudoku\_puzzle(4,1,1) sudoku\_puzzle(1,2,1) sudoku\_puzzle(6,1,2) sudoku\_puzzle(7,2,2) sudoku\_puzzle(1,3,2) sudoku\_puzzle(5,1,3) sudoku\_puzzle(8,2,3) sudoku\_puzzle(8,1,4) sudoku\_puzzle(2,2,4) sudoku\_puzzle(4,3,4) sudoku\_puzzle(7,1,5) sudoku\_puzzle(3,3,5) sudoku\_puzzle(3,1,6) sudoku\_puzzle(5,2,6) sudoku\_puzzle(9,3,6) sudoku\_puzzle(9,1,7) sudoku\_puzzle(6,3,7) sudoku\_puzzle(6,2,8) sudoku\_puzzle(2,1,9) sudoku\_puzzle(5,3,9) sudoku\_puzzle(9,5,1) sudoku\_puzzle(3,6,1) sudoku\_puzzle(4,4,2) sudoku\_puzzle(8,5,2) sudoku\_puzzle(2,6,2) sudoku\_puzzle(9,4,3) sudoku\_puzzle(4,5,3) sudoku\_puzzle(1,6,3) sudoku\_puzzle(3,4,4) sudoku\_puzzle(7,6,4) sudoku\_puzzle(1,5,5) sudoku\_puzzle(6,5,6) sudoku\_puzzle(8,6,6) sudoku\_puzzle(1,4,7) sudoku\_puzzle(7,5,7) sudoku\_puzzle(5,4,8) sudoku\_puzzle(2,5,8) sudoku\_puzzle(9,6,8) sudoku\_puzzle(7,4,9) sudoku\_puzzle(6,6,9) sudoku\_puzzle(2,7,1) sudoku\_puzzle(5,9,1) sudoku\_puzzle(5,8,2) sudoku\_puzzle(9,9,2) sudoku\_puzzle(7,7,3) sudoku\_puzzle(3,9,3) sudoku\_puzzle(1,8,4) sudoku\_puzzle(6,9,4) sudoku\_puzzle(6,7,5) sudoku\_puzzle(9,8,5) sudoku\_puzzle(2,9,5) sudoku\_puzzle(1,7,6) sudoku\_puzzle(4,9,6) sudoku\_puzzle(2,8,7) sudoku\_puzzle(8,9,7) sudoku\_puzzle(4,7,8) sudoku\_puzzle(3,8,8) sudoku\_puzzle(8,7,9) sudoku\_puzzle(4,8,9) sudoku\_puzzle(1,9,9)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.030s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.023s |

Problem 4

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| Input  Program | 1. p4.lp   1 { sudoku\_puzzle(Row,Col,Num) :Row=1..16,Col=1..16,Row1<=Row,Row<=Row1+3,Col1<=Col,Col<=Col1+3 } 1 :- Num=1..16, Row1 = 4\*(0..3)+1, Col1 = 4\*(0..3)+1.  :- sudoku\_puzzle(Row,Col,Num1), sudoku\_puzzle(Row,Col,Num2), Num1!=Num2.  :- sudoku\_puzzle(Row,Col1,Num), sudoku\_puzzle(Row,Col2,Num), Col1!=Col2.  :- sudoku\_puzzle(Row1,Col,Num), sudoku\_puzzle(Row2,Col,Num), Row1!=Row2.   1. inst4.lp   sudoku\_puzzle(1, 1, 9).  sudoku\_puzzle(1, 2, 14).  sudoku\_puzzle(1, 6, 3).  sudoku\_puzzle(1, 8, 5).  sudoku\_puzzle(1, 9, 15).  sudoku\_puzzle(1, 11, 2).  sudoku\_puzzle(1, 15, 7).  sudoku\_puzzle(1, 16, 1).  sudoku\_puzzle(2, 1, 6).  sudoku\_puzzle(2, 2, 12).  sudoku\_puzzle(2, 6, 14).  sudoku\_puzzle(2, 11, 10).  sudoku\_puzzle(2, 15, 5).  sudoku\_puzzle(2, 16, 11).  sudoku\_puzzle(3, 1, 4).  sudoku\_puzzle(3, 4, 7).  sudoku\_puzzle(3, 5, 6).  sudoku\_puzzle(3, 8, 13).  sudoku\_puzzle(3, 9, 16).  sudoku\_puzzle(3, 12, 1).  sudoku\_puzzle(3, 13, 2).  sudoku\_puzzle(3, 16, 9).  sudoku\_puzzle(4, 2, 15).  sudoku\_puzzle(4, 3, 16).  sudoku\_puzzle(4, 5, 9).  sudoku\_puzzle(4, 6, 7).  sudoku\_puzzle(4, 11, 11).  sudoku\_puzzle(4, 12, 6).  sudoku\_puzzle(4, 14, 3).  sudoku\_puzzle(4, 15, 14).  sudoku\_puzzle(5, 2, 7).  sudoku\_puzzle(5, 3, 15).  sudoku\_puzzle(5, 14, 2).  sudoku\_puzzle(5, 15, 16).  sudoku\_puzzle(6, 1, 5).  sudoku\_puzzle(6, 3, 13).  sudoku\_puzzle(6, 5, 14).  sudoku\_puzzle(6, 7, 15).  sudoku\_puzzle(6, 10, 10).  sudoku\_puzzle(6, 12, 3).  sudoku\_puzzle(6, 14, 1).  sudoku\_puzzle(6, 16, 8).  sudoku\_puzzle(7, 2, 8).  sudoku\_puzzle(7, 4, 10).  sudoku\_puzzle(7, 6, 9).  sudoku\_puzzle(7, 7, 4).  sudoku\_puzzle(7, 8, 11).  sudoku\_puzzle(7, 9, 13).  sudoku\_puzzle(7, 10, 6).  sudoku\_puzzle(7, 11, 15).  sudoku\_puzzle(7, 13, 14).  sudoku\_puzzle(7, 15, 3).  sudoku\_puzzle(8, 1, 16).  sudoku\_puzzle(8, 5, 5).  sudoku\_puzzle(8, 7, 3).  sudoku\_puzzle(8, 10, 14).  sudoku\_puzzle(8, 12, 9).  sudoku\_puzzle(8, 16, 6).  sudoku\_puzzle(9, 1, 15).  sudoku\_puzzle(9, 5, 16).  sudoku\_puzzle(9, 7, 10).  sudoku\_puzzle(9, 10, 9).  sudoku\_puzzle(9, 12, 13).  sudoku\_puzzle(9, 16, 14).  sudoku\_puzzle(10, 2, 9).  sudoku\_puzzle(10, 4, 6).  sudoku\_puzzle(10, 6, 5).  sudoku\_puzzle(10, 7, 13).  sudoku\_puzzle(10, 8, 3).  sudoku\_puzzle(10, 9, 1).  sudoku\_puzzle(10, 10, 15).  sudoku\_puzzle(10, 11, 4).  sudoku\_puzzle(10, 13, 7).  sudoku\_puzzle(10, 15, 12).  sudoku\_puzzle(11, 1, 2).  sudoku\_puzzle(11, 3, 8).  sudoku\_puzzle(11, 5, 15).  sudoku\_puzzle(11, 7, 14).  sudoku\_puzzle(11, 10, 16).  sudoku\_puzzle(11, 12, 12).  sudoku\_puzzle(11, 14, 5).  sudoku\_puzzle(11, 16, 13).  sudoku\_puzzle(12, 2, 13).  sudoku\_puzzle(12, 3, 12).  sudoku\_puzzle(12, 14, 9).  sudoku\_puzzle(12, 15, 11).  sudoku\_puzzle(13, 2, 5).  sudoku\_puzzle(13, 3, 3).  sudoku\_puzzle(13, 5, 2).  sudoku\_puzzle(13, 6, 16).  sudoku\_puzzle(13, 11, 13).  sudoku\_puzzle(13, 12, 10).  sudoku\_puzzle(13, 14, 12).  sudoku\_puzzle(13, 15, 9).  sudoku\_puzzle(14, 1, 8).  sudoku\_puzzle(14, 4, 4).  sudoku\_puzzle(14, 5, 12).  sudoku\_puzzle(14, 8, 1).  sudoku\_puzzle(14, 9, 6).  sudoku\_puzzle(14, 12, 7).  sudoku\_puzzle(14, 13, 15).  sudoku\_puzzle(14, 16, 3).  sudoku\_puzzle(15, 1, 10).  sudoku\_puzzle(15, 2, 1).  sudoku\_puzzle(15, 6, 15).  sudoku\_puzzle(15, 11, 16).  sudoku\_puzzle(15, 15, 6).  sudoku\_puzzle(15, 16, 2).  sudoku\_puzzle(16, 1, 11).  sudoku\_puzzle(16, 2, 2).  sudoku\_puzzle(16, 6, 8).  sudoku\_puzzle(16, 8, 14).  sudoku\_puzzle(16, 9, 3).  sudoku\_puzzle(16, 11, 1).  sudoku\_puzzle(16, 15, 10).  sudoku\_puzzle(16, 16, 7). |
| Command  Line | clingo p4.lp inst4.lp 0 |
| Output  of clingo | clingo version 5.4.0  Reading from p4.lp ...  Solving...  Answer: 1  sudoku\_puzzle(1,1,9) sudoku\_puzzle(1,2,14) sudoku\_puzzle(1,6,3) sudoku\_puzzle(1,8,5) sudoku\_puzzle(1,9,15) sudoku\_puzzle(1,11,2) sudoku\_puzzle(1,15,7) sudoku\_puzzle(1,16,1) sudoku\_puzzle(2,1,6) sudoku\_puzzle(2,2,12) sudoku\_puzzle(2,6,14) sudoku\_puzzle(2,11,10) sudoku\_puzzle(2,15,5) sudoku\_puzzle(2,16,11) sudoku\_puzzle(3,1,4) sudoku\_puzzle(3,4,7) sudoku\_puzzle(3,5,6) sudoku\_puzzle(3,8,13) sudoku\_puzzle(3,9,16) sudoku\_puzzle(3,12,1) sudoku\_puzzle(3,13,2) sudoku\_puzzle(3,16,9) sudoku\_puzzle(4,2,15) sudoku\_puzzle(4,3,16) sudoku\_puzzle(4,5,9) sudoku\_puzzle(4,6,7) sudoku\_puzzle(4,11,11) sudoku\_puzzle(4,12,6) sudoku\_puzzle(4,14,3) sudoku\_puzzle(4,15,14) sudoku\_puzzle(5,2,7) sudoku\_puzzle(5,3,15) sudoku\_puzzle(5,14,2) sudoku\_puzzle(5,15,16) sudoku\_puzzle(6,1,5) sudoku\_puzzle(6,3,13) sudoku\_puzzle(6,5,14) sudoku\_puzzle(6,7,15) sudoku\_puzzle(6,10,10) sudoku\_puzzle(6,12,3) sudoku\_puzzle(6,14,1) sudoku\_puzzle(6,16,8) sudoku\_puzzle(7,2,8) 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sudoku\_puzzle(16,7,9) sudoku\_puzzle(11,8,9) sudoku\_puzzle(1,5,10) sudoku\_puzzle(14,6,10) sudoku\_puzzle(5,8,10) sudoku\_puzzle(10,5,11) sudoku\_puzzle(3,6,11) sudoku\_puzzle(13,7,11) sudoku\_puzzle(6,6,12) sudoku\_puzzle(3,7,12) sudoku\_puzzle(9,8,12) sudoku\_puzzle(16,5,13) sudoku\_puzzle(5,6,13) sudoku\_puzzle(2,8,15) sudoku\_puzzle(1,7,16) sudoku\_puzzle(6,8,16) sudoku\_puzzle(5,10,1) sudoku\_puzzle(6,9,2) sudoku\_puzzle(14,10,2) sudoku\_puzzle(10,12,2) sudoku\_puzzle(3,10,3) sudoku\_puzzle(11,11,3) sudoku\_puzzle(5,9,4) sudoku\_puzzle(16,10,4) sudoku\_puzzle(1,12,4) sudoku\_puzzle(4,9,5) sudoku\_puzzle(12,10,5) sudoku\_puzzle(5,11,5) sudoku\_puzzle(15,12,5) sudoku\_puzzle(12,11,6) sudoku\_puzzle(11,9,7) sudoku\_puzzle(2,10,7) sudoku\_puzzle(6,11,7) sudoku\_puzzle(8,9,8) sudoku\_puzzle(13,10,8) sudoku\_puzzle(9,11,8) sudoku\_puzzle(2,12,8) sudoku\_puzzle(2,9,9) sudoku\_puzzle(14,11,9) sudoku\_puzzle(12,9,10) sudoku\_puzzle(9,9,11) sudoku\_puzzle(15,10,11) sudoku\_puzzle(5,12,11) 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sudoku\_puzzle(16,14,16) sudoku\_puzzle(10,16,16)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.143s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.136s |

Problem 5

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| Input  Program | 1. p5.lp   1 { sudoku\_puzzle(Row,Col,Num) :Row=1..9,Col=1..9,Row1<=Row,Row<=Row1+2,Col1<=Col,Col<=Col1+2 } 1 :- Num=1..9, Row1 = 3\*(0..2)+1, Col1 = 3\*(0..2)+1.  :- sudoku\_puzzle(Row,Col,Num1), sudoku\_puzzle(Row,Col,Num2), Num1!=Num2.  :- sudoku\_puzzle(Row,Col1,Num), sudoku\_puzzle(Row,Col2,Num), Col1!=Col2.  :- sudoku\_puzzle(Row1,Col,Num), sudoku\_puzzle(Row2,Col,Num), Row1!=Row2.  :- sudoku\_puzzle(Row1,Col1,Num), sudoku\_puzzle(Row2,Col2,Num), Row1\3 == Row2\3, Col1\3 == Col2\3, 1{Row1 !=Row2; Col1!=Col2}.   1. inst5.lp   sudoku\_puzzle(1, 3, 7).  sudoku\_puzzle(1, 7, 8).  sudoku\_puzzle(2, 2, 2).  sudoku\_puzzle(2, 8, 4).  sudoku\_puzzle(3, 1, 8).  sudoku\_puzzle(3, 3, 4).  sudoku\_puzzle(3, 5, 2).  sudoku\_puzzle(3, 7, 5).  sudoku\_puzzle(3, 9, 1).  sudoku\_puzzle(4, 5, 7).  sudoku\_puzzle(5, 3, 8).  sudoku\_puzzle(5, 4, 3).  sudoku\_puzzle(5, 5, 6).  sudoku\_puzzle(5, 6, 4).  sudoku\_puzzle(5, 7, 2).  sudoku\_puzzle(6, 5, 9).  sudoku\_puzzle(7, 1, 3).  sudoku\_puzzle(7, 3, 2).  sudoku\_puzzle(7, 5, 8).  sudoku\_puzzle(7, 7, 7).  sudoku\_puzzle(7, 9, 4).  sudoku\_puzzle(8, 2, 7).  sudoku\_puzzle(8, 8, 8).  sudoku\_puzzle(9, 3, 6).  sudoku\_puzzle(9, 7, 9). |
| Command  Line | clingo p5.lp inst5.lp 0 |
| Output  of clingo | clingo version 5.4.0  Reading from p5.lp ...  Solving...  Answer: 1  sudoku\_puzzle(1,3,7) sudoku\_puzzle(1,7,8) sudoku\_puzzle(2,2,2) sudoku\_puzzle(2,8,4) sudoku\_puzzle(3,1,8) sudoku\_puzzle(3,3,4) sudoku\_puzzle(3,5,2) sudoku\_puzzle(3,7,5) sudoku\_puzzle(3,9,1) sudoku\_puzzle(4,5,7) sudoku\_puzzle(5,3,8) sudoku\_puzzle(5,4,3) sudoku\_puzzle(5,5,6) sudoku\_puzzle(5,6,4) sudoku\_puzzle(5,7,2) sudoku\_puzzle(6,5,9) sudoku\_puzzle(7,1,3) sudoku\_puzzle(7,3,2) sudoku\_puzzle(7,5,8) sudoku\_puzzle(7,7,7) sudoku\_puzzle(7,9,4) sudoku\_puzzle(8,2,7) sudoku\_puzzle(8,8,8) sudoku\_puzzle(9,3,6) sudoku\_puzzle(9,7,9) sudoku\_puzzle(4,3,1) sudoku\_puzzle(4,6,8) sudoku\_puzzle(4,9,6) sudoku\_puzzle(7,6,5) sudoku\_puzzle(4,1,2) sudoku\_puzzle(4,4,5) sudoku\_puzzle(4,7,4) sudoku\_puzzle(7,4,9) sudoku\_puzzle(5,2,9) sudoku\_puzzle(5,8,1) sudoku\_puzzle(8,5,3) sudoku\_puzzle(6,1,6) sudoku\_puzzle(6,4,1) sudoku\_puzzle(6,7,3) sudoku\_puzzle(9,1,4) sudoku\_puzzle(9,4,2) sudoku\_puzzle(6,3,5) sudoku\_puzzle(6,6,2) sudoku\_puzzle(6,9,8) sudoku\_puzzle(9,6,7) sudoku\_puzzle(9,9,3) sudoku\_puzzle(6,2,4) sudoku\_puzzle(6,8,7) sudoku\_puzzle(9,2,8) sudoku\_puzzle(9,5,1) sudoku\_puzzle(9,8,5) sudoku\_puzzle(1,2,5) sudoku\_puzzle(1,5,4) sudoku\_puzzle(1,8,2) sudoku\_puzzle(7,2,1) sudoku\_puzzle(7,8,6) sudoku\_puzzle(2,3,3) sudoku\_puzzle(2,6,1) sudoku\_puzzle(2,9,7) sudoku\_puzzle(8,3,9) sudoku\_puzzle(8,6,6) sudoku\_puzzle(8,9,2) sudoku\_puzzle(2,1,9) sudoku\_puzzle(2,4,8) sudoku\_puzzle(2,7,6) sudoku\_puzzle(8,1,5) sudoku\_puzzle(8,4,4) sudoku\_puzzle(8,7,1) sudoku\_puzzle(2,5,5) sudoku\_puzzle(3,2,6) sudoku\_puzzle(3,8,3) sudoku\_puzzle(1,1,1) sudoku\_puzzle(1,4,6) sudoku\_puzzle(1,6,3) sudoku\_puzzle(1,9,9) sudoku\_puzzle(4,2,3) sudoku\_puzzle(4,8,9) sudoku\_puzzle(3,6,9) sudoku\_puzzle(3,4,7) sudoku\_puzzle(5,1,7) sudoku\_puzzle(5,9,5)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.062s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.051s |

Problem 6

|  |  |
| --- | --- |
| Input  Program | 1. p6.lp   1 { sudoku\_puzzle(Row,Col,Num) :Row=1..9,Col=1..9,Row1<=Row,Row<=Row1+2,Col1<=Col,Col<=Col1+2 } 1 :- Num=1..9, Row1 = 3\*(0..2)+1, Col1 = 3\*(0..2)+1.  :- sudoku\_puzzle(Row,Col,Num1), sudoku\_puzzle(Row,Col,Num2), Num1!=Num2.  :- sudoku\_puzzle(Row,Col1,Num), sudoku\_puzzle(Row,Col2,Num), Col1!=Col2.  :- sudoku\_puzzle(Row1,Col,Num), sudoku\_puzzle(Row2,Col,Num), Row1!=Row2.  :- sudoku\_puzzle(Row,Col,Num), sudoku\_puzzle(Row-2,Col-1,Num).  :- sudoku\_puzzle(Row,Col,Num), sudoku\_puzzle(Row-2,Col+1,Num).  :- sudoku\_puzzle(Row,Col,Num), sudoku\_puzzle(Row-1,Col-2,Num).  :- sudoku\_puzzle(Row,Col,Num), sudoku\_puzzle(Row-1,Col+2,Num).  :- sudoku\_puzzle(Row,Col,Num), sudoku\_puzzle(Row+1,Col-2,Num).  :- sudoku\_puzzle(Row,Col,Num), sudoku\_puzzle(Row+1,Col+2,Num).  :- sudoku\_puzzle(Row,Col,Num), sudoku\_puzzle(Row+2,Col-1,Num).  :- sudoku\_puzzle(Row,Col,Num), sudoku\_puzzle(Row+2,Col+1,Num).   1. inst6.lp   sudoku\_puzzle(1, 1, 3).  sudoku\_puzzle(1, 9, 4).  sudoku\_puzzle(2, 4, 6).  sudoku\_puzzle(2, 6, 9).  sudoku\_puzzle(3, 3, 6).  sudoku\_puzzle(3, 7, 9).  sudoku\_puzzle(4, 2, 8).  sudoku\_puzzle(4, 4, 3).  sudoku\_puzzle(4, 6, 2).  sudoku\_puzzle(4, 8, 6).  sudoku\_puzzle(5, 5, 7).  sudoku\_puzzle(6, 2, 1).  sudoku\_puzzle(6, 4, 8).  sudoku\_puzzle(6, 6, 5).  sudoku\_puzzle(6, 8, 7).  sudoku\_puzzle(7, 3, 7).  sudoku\_puzzle(7, 7, 8).  sudoku\_puzzle(8, 4, 7).  sudoku\_puzzle(8, 6, 8).  sudoku\_puzzle(9, 1, 9).  sudoku\_puzzle(9, 9, 7). |
| Command  Line | clingo p6.lp inst6.lp 0 |
| Output  of clingo | clingo version 5.4.0  Reading from p6.lp ...  Solving...  Answer: 1  sudoku\_puzzle(1,1,3) sudoku\_puzzle(1,9,4) sudoku\_puzzle(2,4,6) sudoku\_puzzle(2,6,9) sudoku\_puzzle(3,3,6) sudoku\_puzzle(3,7,9) sudoku\_puzzle(4,2,8) sudoku\_puzzle(4,4,3) sudoku\_puzzle(4,6,2) sudoku\_puzzle(4,8,6) sudoku\_puzzle(5,5,7) sudoku\_puzzle(6,2,1) sudoku\_puzzle(6,4,8) sudoku\_puzzle(6,6,5) sudoku\_puzzle(6,8,7) sudoku\_puzzle(7,3,7) sudoku\_puzzle(7,7,8) sudoku\_puzzle(8,4,7) sudoku\_puzzle(8,6,8) sudoku\_puzzle(9,1,9) sudoku\_puzzle(9,9,7) sudoku\_puzzle(3,2,7) sudoku\_puzzle(1,2,9) sudoku\_puzzle(1,3,1) sudoku\_puzzle(3,6,1) sudoku\_puzzle(1,5,2) sudoku\_puzzle(3,5,3) sudoku\_puzzle(3,4,4) sudoku\_puzzle(1,4,5) sudoku\_puzzle(3,9,2) sudoku\_puzzle(3,8,5) sudoku\_puzzle(1,7,6) sudoku\_puzzle(1,6,7) sudoku\_puzzle(1,8,8) sudoku\_puzzle(2,2,2) sudoku\_puzzle(5,3,3) sudoku\_puzzle(2,1,4) sudoku\_puzzle(6,3,4) sudoku\_puzzle(5,2,5) sudoku\_puzzle(4,1,7) sudoku\_puzzle(3,1,8) sudoku\_puzzle(4,3,9) sudoku\_puzzle(4,5,1) sudoku\_puzzle(5,6,4) sudoku\_puzzle(2,3,5) sudoku\_puzzle(6,5,6) sudoku\_puzzle(2,5,8) sudoku\_puzzle(5,4,9) sudoku\_puzzle(5,8,1) sudoku\_puzzle(5,7,2) sudoku\_puzzle(2,8,3) sudoku\_puzzle(6,7,3) sudoku\_puzzle(4,7,4) sudoku\_puzzle(4,9,5) sudoku\_puzzle(2,7,7) sudoku\_puzzle(5,9,8) sudoku\_puzzle(6,9,9) sudoku\_puzzle(7,1,1) sudoku\_puzzle(6,1,2) sudoku\_puzzle(8,3,2) sudoku\_puzzle(9,2,3) sudoku\_puzzle(7,2,4) sudoku\_puzzle(5,1,6) sudoku\_puzzle(8,2,6) sudoku\_puzzle(9,3,8) sudoku\_puzzle(9,4,1) sudoku\_puzzle(7,4,2) sudoku\_puzzle(7,6,3) sudoku\_puzzle(9,5,4) sudoku\_puzzle(7,5,5) sudoku\_puzzle(9,6,6) sudoku\_puzzle(8,5,9) sudoku\_puzzle(8,7,1) sudoku\_puzzle(9,8,2) sudoku\_puzzle(8,9,3) sudoku\_puzzle(8,8,4) sudoku\_puzzle(9,7,5) sudoku\_puzzle(7,9,6) sudoku\_puzzle(7,8,9) sudoku\_puzzle(2,9,1) sudoku\_puzzle(8,1,5)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.032s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.025s |

Problem 7

|  |  |
| --- | --- |
| Input  Program | 1. p7.lp   1 { sudoku\_puzzle(Row,Col,Num) :Row=1..9,Col=1..9,Row1<=Row,Row<=Row1+2,Col1<=Col,Col<=Col1+2 } 1 :- Num=1..9, Row1 = 3\*(0..2)+1, Col1 = 3\*(0..2)+1.  :- sudoku\_puzzle(Row,Col,Num1), sudoku\_puzzle(Row,Col,Num2), Num1!=Num2.  :- sudoku\_puzzle(Row,Col1,Num), sudoku\_puzzle(Row,Col2,Num), Col1!=Col2.  :- sudoku\_puzzle(Row1,Col,Num), sudoku\_puzzle(Row2,Col,Num), Row1!=Row2.  :- sudoku\_puzzle(Row1,Col1,Num1), sudoku\_puzzle(Row2,Col2,Num2), greater\_than(Row1,Col1,Row2,Col2), Num1 <=Num2.   1. inst7.lp   greater\_than(1, 2, 1, 1).  greater\_than(1, 3, 1, 2).  greater\_than(1, 3, 2, 3).  greater\_than(1, 4, 1, 5).  greater\_than(1, 6, 1, 5).  greater\_than(1, 6, 2, 6).  greater\_than(1, 7, 2, 7).  greater\_than(1, 8, 2, 8).  greater\_than(1, 9, 1, 8).  greater\_than(1, 9, 2, 9).  greater\_than(2, 1, 1, 1).  greater\_than(2, 2, 2, 1).  greater\_than(2, 2, 2, 3).  greater\_than(2, 2, 1, 2).  greater\_than(2, 2, 3, 2).  greater\_than(2, 3, 3, 3).  greater\_than(2, 4, 3, 4).  greater\_than(2, 5, 1, 5).  greater\_than(2, 5, 2, 4).  greater\_than(2, 5, 2, 6).  greater\_than(2, 5, 3, 5).  greater\_than(2, 6, 3, 6).  greater\_than(2, 8, 2, 7).  greater\_than(2, 9, 2, 8).  greater\_than(2, 9, 3, 9).  greater\_than(3, 1, 3, 2).  greater\_than(3, 4, 3, 5).  greater\_than(3, 5, 3, 6).  greater\_than(3, 7, 2, 7).  greater\_than(3, 7, 3, 8).  greater\_than(3, 8, 2, 8).  greater\_than(4, 1, 4, 2).  greater\_than(4, 1, 5, 1).  greater\_than(4, 3, 4, 2).  greater\_than(4, 3, 5, 3).  greater\_than(4, 6, 4, 5).  greater\_than(4, 6, 5, 6).  greater\_than(4, 7, 4, 8).  greater\_than(4, 9, 4, 8).  greater\_than(5, 2, 5, 1).  greater\_than(5, 2, 5, 3).  greater\_than(5, 2, 4, 2).  greater\_than(5, 2, 6, 2).  greater\_than(5, 4, 4, 4).  greater\_than(5, 4, 6, 4).  greater\_than(5, 4, 5, 5).  greater\_than(5, 5, 4, 5).  greater\_than(5, 5, 6, 5).  greater\_than(5, 6, 5, 5).  greater\_than(5, 7, 4, 7).  greater\_than(5, 7, 5, 8).  greater\_than(5, 8, 5, 9).  greater\_than(5, 8, 4, 8).  greater\_than(5, 9, 4, 9).  greater\_than(6, 1, 5, 1).  greater\_than(6, 2, 6, 1).  greater\_than(6, 2, 6, 3).  greater\_than(6, 5, 6, 4).  greater\_than(6, 6, 6, 5).  greater\_than(6, 6, 5, 6).  greater\_than(6, 7, 5, 7).  greater\_than(6, 8, 6, 7).  greater\_than(6, 8, 6, 9).  greater\_than(6, 8, 5, 8).  greater\_than(6, 9, 5, 9).  greater\_than(7, 1, 7, 2).  greater\_than(7, 1, 8, 1).  greater\_than(7, 3, 7, 2).  greater\_than(7, 3, 8, 3).  greater\_than(7, 4, 7, 5).  greater\_than(7, 4, 8, 4).  greater\_than(7, 6, 8, 6).  greater\_than(7, 6, 7, 5).  greater\_than(7, 7, 8, 7).  greater\_than(7, 8, 7, 7).  greater\_than(7, 8, 7, 9).  greater\_than(8, 1, 9, 1).  greater\_than(8, 1, 8, 2).  greater\_than(8, 2, 8, 3).  greater\_than(8, 2, 7, 2).  greater\_than(8, 5, 8, 4).  greater\_than(8, 5, 8, 6).  greater\_than(8, 5, 7, 5).  greater\_than(8, 6, 9, 6).  greater\_than(8, 7, 9, 7).  greater\_than(8, 8, 8, 7).  greater\_than(8, 8, 7, 8).  greater\_than(8, 8, 9, 8).  greater\_than(8, 9, 8, 8).  greater\_than(8, 9, 7, 9).  greater\_than(8, 9, 9, 9).  greater\_than(9, 2, 8, 2).  greater\_than(9, 2, 9, 1).  greater\_than(9, 2, 9, 3).  greater\_than(9, 3, 8, 3).  greater\_than(9, 4, 8, 4).  greater\_than(9, 5, 9, 4).  greater\_than(9, 5, 9, 6).  greater\_than(9, 5, 8, 5).  greater\_than(9, 8, 9, 7).  greater\_than(9, 9, 9, 8). |
| Command  Line | clingo p7.lp inst7.lp 0 |
| Output  of clingo | clingo version 5.4.0  Reading from p7.lp ...  Solving...  Answer: 1  greater\_than(1,2,1,1) greater\_than(1,3,1,2) greater\_than(1,3,2,3) greater\_than(1,4,1,5) greater\_than(1,6,1,5) greater\_than(1,6,2,6) greater\_than(1,7,2,7) greater\_than(1,8,2,8) greater\_than(1,9,1,8) greater\_than(1,9,2,9) greater\_than(2,1,1,1) greater\_than(2,2,2,1) greater\_than(2,2,2,3) greater\_than(2,2,1,2) greater\_than(2,2,3,2) greater\_than(2,3,3,3) greater\_than(2,4,3,4) greater\_than(2,5,1,5) greater\_than(2,5,2,4) greater\_than(2,5,2,6) greater\_than(2,5,3,5) greater\_than(2,6,3,6) greater\_than(2,8,2,7) greater\_than(2,9,2,8) greater\_than(2,9,3,9) greater\_than(3,1,3,2) greater\_than(3,4,3,5) greater\_than(3,5,3,6) greater\_than(3,7,2,7) greater\_than(3,7,3,8) greater\_than(3,8,2,8) greater\_than(4,1,4,2) greater\_than(4,1,5,1) greater\_than(4,3,4,2) greater\_than(4,3,5,3) greater\_than(4,6,4,5) greater\_than(4,6,5,6) greater\_than(4,7,4,8) greater\_than(4,9,4,8) greater\_than(5,2,5,1) greater\_than(5,2,5,3) greater\_than(5,2,4,2) greater\_than(5,2,6,2) greater\_than(5,4,4,4) greater\_than(5,4,6,4) greater\_than(5,4,5,5) greater\_than(5,5,4,5) greater\_than(5,5,6,5) greater\_than(5,6,5,5) greater\_than(5,7,4,7) greater\_than(5,7,5,8) greater\_than(5,8,5,9) greater\_than(5,8,4,8) greater\_than(5,9,4,9) greater\_than(6,1,5,1) greater\_than(6,2,6,1) greater\_than(6,2,6,3) greater\_than(6,5,6,4) greater\_than(6,6,6,5) greater\_than(6,6,5,6) greater\_than(6,7,5,7) greater\_than(6,8,6,7) greater\_than(6,8,6,9) greater\_than(6,8,5,8) greater\_than(6,9,5,9) greater\_than(7,1,7,2) greater\_than(7,1,8,1) greater\_than(7,3,7,2) greater\_than(7,3,8,3) greater\_than(7,4,7,5) greater\_than(7,4,8,4) greater\_than(7,6,8,6) greater\_than(7,6,7,5) greater\_than(7,7,8,7) greater\_than(7,8,7,7) greater\_than(7,8,7,9) greater\_than(8,1,9,1) greater\_than(8,1,8,2) greater\_than(8,2,8,3) greater\_than(8,2,7,2) greater\_than(8,5,8,4) greater\_than(8,5,8,6) greater\_than(8,5,7,5) greater\_than(8,6,9,6) greater\_than(8,7,9,7) greater\_than(8,8,8,7) greater\_than(8,8,7,8) greater\_than(8,8,9,8) greater\_than(8,9,8,8) greater\_than(8,9,7,9) greater\_than(8,9,9,9) greater\_than(9,2,8,2) greater\_than(9,2,9,1) greater\_than(9,2,9,3) greater\_than(9,3,8,3) greater\_than(9,4,8,4) greater\_than(9,5,9,4) greater\_than(9,5,9,6) greater\_than(9,5,8,5) greater\_than(9,8,9,7) greater\_than(9,9,9,8) sudoku\_puzzle(1,1,2) sudoku\_puzzle(1,2,3) sudoku\_puzzle(1,3,9) sudoku\_puzzle(2,3,6) sudoku\_puzzle(1,5,1) sudoku\_puzzle(1,4,5) sudoku\_puzzle(1,6,4) sudoku\_puzzle(2,6,3) sudoku\_puzzle(2,7,1) sudoku\_puzzle(1,7,6) sudoku\_puzzle(2,8,2) sudoku\_puzzle(1,8,7) sudoku\_puzzle(1,9,8) sudoku\_puzzle(2,9,5) sudoku\_puzzle(2,1,4) sudoku\_puzzle(2,2,7) sudoku\_puzzle(3,2,1) sudoku\_puzzle(3,3,5) sudoku\_puzzle(3,4,7) sudoku\_puzzle(2,4,8) sudoku\_puzzle(2,5,9) sudoku\_puzzle(3,5,6) sudoku\_puzzle(3,6,2) sudoku\_puzzle(3,9,4) sudoku\_puzzle(3,1,8) sudoku\_puzzle(3,7,9) sudoku\_puzzle(3,8,3) sudoku\_puzzle(4,2,6) sudoku\_puzzle(4,1,9) sudoku\_puzzle(5,1,1) sudoku\_puzzle(4,3,7) sudoku\_puzzle(5,3,2) sudoku\_puzzle(4,5,4) sudoku\_puzzle(4,6,8) sudoku\_puzzle(5,6,6) sudoku\_puzzle(4,8,1) sudoku\_puzzle(4,7,5) sudoku\_puzzle(4,9,2) sudoku\_puzzle(5,2,8) sudoku\_puzzle(6,2,5) sudoku\_puzzle(4,4,3) sudoku\_puzzle(5,4,9) sudoku\_puzzle(6,4,1) sudoku\_puzzle(5,5,5) sudoku\_puzzle(6,5,2) sudoku\_puzzle(5,7,7) sudoku\_puzzle(5,8,4) sudoku\_puzzle(5,9,3) sudoku\_puzzle(6,1,3) sudoku\_puzzle(6,3,4) sudoku\_puzzle(6,6,7) sudoku\_puzzle(6,7,8) sudoku\_puzzle(6,8,9) sudoku\_puzzle(6,9,6) sudoku\_puzzle(7,2,2) sudoku\_puzzle(7,1,7) sudoku\_puzzle(8,1,6) sudoku\_puzzle(7,3,8) sudoku\_puzzle(8,3,1) sudoku\_puzzle(7,5,3) sudoku\_puzzle(7,4,6) sudoku\_puzzle(8,4,2) sudoku\_puzzle(8,6,5) sudoku\_puzzle(7,6,9) sudoku\_puzzle(8,7,3) sudoku\_puzzle(7,7,4) sudoku\_puzzle(7,8,5) sudoku\_puzzle(7,9,1) sudoku\_puzzle(9,1,5) sudoku\_puzzle(8,2,4) sudoku\_puzzle(8,5,7) sudoku\_puzzle(9,6,1) sudoku\_puzzle(9,7,2) sudoku\_puzzle(8,8,8) sudoku\_puzzle(9,8,6) sudoku\_puzzle(8,9,9) sudoku\_puzzle(9,9,7) sudoku\_puzzle(9,2,9) sudoku\_puzzle(9,3,3) sudoku\_puzzle(9,4,4) sudoku\_puzzle(9,5,8)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.289s (Solving: 0.25s 1st Model: 0.24s Unsat: 0.01s)  CPU Time : 0.283s |

Problem 8

|  |  |
| --- | --- |
| Input  Program | {bishops\_puzzle(Row,1..n)} :- Row=1..n.  :- bishops\_puzzle(Row1,Col1) , bishops\_puzzle(Row2,Col2) , Row1!=Row2, |Row1-Row2|==|Col1-Col2|.  #maximize{ 1, Row, Col : bishops\_puzzle(Row, Col)}. |
| Command  Line | You should write multiple command lines below.  clingo p8.lp -c n=3 0  clingo p8.lp -c n=4 0  clingo p8.lp -c n=5 0  clingo p8.lp -c n=6 0  clingo p8.lp -c n=7 0  clingo p8.lp -c n=8 0 |
| Output  of clingo | 1. clingo p8.lp -c n=3 0   clingo version 5.4.0  Reading from p8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  bishops\_puzzle(1,1)  Optimization: -1  Answer: 3  bishops\_puzzle(1,1) bishops\_puzzle(3,1)  Optimization: -2  Answer: 4  bishops\_puzzle(1,1) bishops\_puzzle(3,1) bishops\_puzzle(1,2)  Optimization: -3  Answer: 5  bishops\_puzzle(1,1) bishops\_puzzle(3,1) bishops\_puzzle(1,2) bishops\_puzzle(3,2)  Optimization: -4  OPTIMUM FOUND  Models : 5  Optimum : yes  Optimization : -4  Calls : 1  Time : 0.015s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.005s   1. clingo p8.lp -c n=4 0   clingo version 5.4.0  Reading from p8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  bishops\_puzzle(3,4)  Optimization: -1  Answer: 3  bishops\_puzzle(2,4) bishops\_puzzle(3,4)  Optimization: -2  Answer: 4  bishops\_puzzle(4,1) bishops\_puzzle(2,4) bishops\_puzzle(3,4)  Optimization: -3  Answer: 5  bishops\_puzzle(4,1) bishops\_puzzle(2,4) bishops\_puzzle(3,4) bishops\_puzzle(4,4)  Optimization: -4  Answer: 6  bishops\_puzzle(3,1) bishops\_puzzle(4,1) bishops\_puzzle(2,4) bishops\_puzzle(3,4) bishops\_puzzle(4,4)  Optimization: -5  Answer: 7  bishops\_puzzle(1,1) bishops\_puzzle(2,1) bishops\_puzzle(3,1) bishops\_puzzle(4,1) bishops\_puzzle(2,4) bishops\_puzzle(3,4)  Optimization: -6  OPTIMUM FOUND  Models : 7  Optimum : yes  Optimization : -6  Calls : 1  Time : 0.010s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.004s   1. clingo p8.lp -c n=5 0   clingo version 5.4.0  Reading from p8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  bishops\_puzzle(1,5)  Optimization: -1  Answer: 3  bishops\_puzzle(2,1) bishops\_puzzle(1,5)  Optimization: -2  Answer: 4  bishops\_puzzle(2,1) bishops\_puzzle(1,5) bishops\_puzzle(2,5)  Optimization: -3  Answer: 5  bishops\_puzzle(2,1) bishops\_puzzle(5,1) bishops\_puzzle(2,5) bishops\_puzzle(4,5)  Optimization: -4  Answer: 6  bishops\_puzzle(2,1) bishops\_puzzle(5,1) bishops\_puzzle(2,5) bishops\_puzzle(4,5) bishops\_puzzle(5,5)  Optimization: -5  Answer: 7  bishops\_puzzle(2,1) bishops\_puzzle(1,5) bishops\_puzzle(2,5) bishops\_puzzle(3,5) bishops\_puzzle(4,5) bishops\_puzzle(5,5)  Optimization: -6  Answer: 8  bishops\_puzzle(1,1) bishops\_puzzle(2,1) bishops\_puzzle(3,1) bishops\_puzzle(5,1) bishops\_puzzle(2,5) bishops\_puzzle(3,5) bishops\_puzzle(4,5)  Optimization: -7  Answer: 9  bishops\_puzzle(1,1) bishops\_puzzle(2,1) bishops\_puzzle(5,1) bishops\_puzzle(5,2) bishops\_puzzle(1,3) bishops\_puzzle(5,3) bishops\_puzzle(1,4) bishops\_puzzle(4,5)  Optimization: -8  OPTIMUM FOUND  Models : 9  Optimum : yes  Optimization : -8  Calls : 1  Time : 0.011s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.005s   1. clingo p8.lp -c n=6 0   clingo version 5.4.0  Reading from p8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  bishops\_puzzle(6,1)  Optimization: -1  Answer: 3  bishops\_puzzle(6,1) bishops\_puzzle(6,6)  Optimization: -2  Answer: 4  bishops\_puzzle(6,1) bishops\_puzzle(3,6) bishops\_puzzle(6,6)  Optimization: -3  Answer: 5  bishops\_puzzle(6,1) bishops\_puzzle(1,2) bishops\_puzzle(3,6) bishops\_puzzle(6,6)  Optimization: -4  Answer: 6  bishops\_puzzle(6,1) bishops\_puzzle(1,2) bishops\_puzzle(1,5) bishops\_puzzle(3,6) bishops\_puzzle(6,6)  Optimization: -5  Answer: 7  bishops\_puzzle(6,1) bishops\_puzzle(1,2) bishops\_puzzle(1,5) bishops\_puzzle(3,6) bishops\_puzzle(4,6) bishops\_puzzle(6,6)  Optimization: -6  Answer: 8  bishops\_puzzle(1,2) bishops\_puzzle(6,5) bishops\_puzzle(1,6) bishops\_puzzle(2,6) bishops\_puzzle(3,6) bishops\_puzzle(4,6) bishops\_puzzle(6,6)  Optimization: -7  Answer: 9  bishops\_puzzle(6,1) bishops\_puzzle(1,2) bishops\_puzzle(6,2) bishops\_puzzle(1,5) bishops\_puzzle(6,5) bishops\_puzzle(3,6) bishops\_puzzle(4,6) bishops\_puzzle(6,6)  Optimization: -8  Answer: 10  bishops\_puzzle(6,1) bishops\_puzzle(1,2) bishops\_puzzle(6,2) bishops\_puzzle(1,3) bishops\_puzzle(6,4) bishops\_puzzle(1,5) bishops\_puzzle(6,5) bishops\_puzzle(3,6) bishops\_puzzle(6,6)  Optimization: -9  Answer: 11  bishops\_puzzle(3,1) bishops\_puzzle(4,1) bishops\_puzzle(1,2) bishops\_puzzle(6,2) bishops\_puzzle(1,5) bishops\_puzzle(6,5) bishops\_puzzle(1,6) bishops\_puzzle(3,6) bishops\_puzzle(4,6) bishops\_puzzle(6,6)  Optimization: -10  OPTIMUM FOUND  Models : 11  Optimum : yes  Optimization : -10  Calls : 1  Time : 0.024s (Solving: 0.01s 1st Model: 0.00s Unsat: 0.01s)  CPU Time : 0.019s   1. clingo p8.lp -c n=7 0   clingo version 5.4.0  Reading from p8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  bishops\_puzzle(1,3)  Optimization: -1  Answer: 3  bishops\_puzzle(1,3) bishops\_puzzle(7,5)  Optimization: -2  Answer: 4  bishops\_puzzle(7,1) bishops\_puzzle(1,3) bishops\_puzzle(7,5)  Optimization: -3  Answer: 5  bishops\_puzzle(7,1) bishops\_puzzle(1,3) bishops\_puzzle(7,4) bishops\_puzzle(7,5)  Optimization: -4  Answer: 6  bishops\_puzzle(7,1) bishops\_puzzle(1,3) bishops\_puzzle(7,4) bishops\_puzzle(7,5) bishops\_puzzle(3,7)  Optimization: -5  Answer: 7  bishops\_puzzle(7,1) bishops\_puzzle(1,3) bishops\_puzzle(7,5) bishops\_puzzle(1,6) bishops\_puzzle(3,7) bishops\_puzzle(4,7)  Optimization: -6  Answer: 8  bishops\_puzzle(7,1) bishops\_puzzle(1,3) bishops\_puzzle(7,5) bishops\_puzzle(1,6) bishops\_puzzle(3,7) bishops\_puzzle(4,7) bishops\_puzzle(7,7)  Optimization: -7  Answer: 9  bishops\_puzzle(7,1) bishops\_puzzle(1,2) bishops\_puzzle(1,3) bishops\_puzzle(7,5) bishops\_puzzle(1,6) bishops\_puzzle(3,7) bishops\_puzzle(4,7) bishops\_puzzle(7,7)  Optimization: -8  Answer: 10  bishops\_puzzle(7,1) bishops\_puzzle(1,2) bishops\_puzzle(1,3) bishops\_puzzle(7,5) bishops\_puzzle(1,6) bishops\_puzzle(7,6) bishops\_puzzle(3,7) bishops\_puzzle(4,7) bishops\_puzzle(7,7)  Optimization: -9  Answer: 11  bishops\_puzzle(7,1) bishops\_puzzle(1,2) bishops\_puzzle(7,2) bishops\_puzzle(1,3) bishops\_puzzle(1,5) bishops\_puzzle(7,5) bishops\_puzzle(1,6) bishops\_puzzle(7,6) bishops\_puzzle(4,7) bishops\_puzzle(7,7)  Optimization: -10  Answer: 12  bishops\_puzzle(3,1) bishops\_puzzle(5,1) bishops\_puzzle(1,2) bishops\_puzzle(7,2) bishops\_puzzle(7,4) bishops\_puzzle(1,6) bishops\_puzzle(7,6) bishops\_puzzle(1,7) bishops\_puzzle(3,7) bishops\_puzzle(5,7) bishops\_puzzle(7,7)  Optimization: -11  Answer: 13  bishops\_puzzle(4,1) bishops\_puzzle(5,1) bishops\_puzzle(7,1) bishops\_puzzle(1,2) bishops\_puzzle(7,2) bishops\_puzzle(1,3) bishops\_puzzle(7,5) bishops\_puzzle(1,6) bishops\_puzzle(7,6) bishops\_puzzle(3,7) bishops\_puzzle(4,7) bishops\_puzzle(7,7)  Optimization: -12  OPTIMUM FOUND  Models : 13  Optimum : yes  Optimization : -12  Calls : 1  Time : 0.706s (Solving: 0.70s 1st Model: 0.00s Unsat: 0.69s)  CPU Time : 0.700s   1. clingo p8.lp -c n=8 0   clingo version 5.4.0  Reading from p8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  bishops\_puzzle(7,8)  Optimization: -1  Answer: 3  bishops\_puzzle(3,1) bishops\_puzzle(7,8)  Optimization: -2  Answer: 4  bishops\_puzzle(3,1) bishops\_puzzle(2,8) bishops\_puzzle(7,8)  Optimization: -3  Answer: 5  bishops\_puzzle(3,1) bishops\_puzzle(8,5) bishops\_puzzle(2,8) bishops\_puzzle(7,8)  Optimization: -4  Answer: 6  bishops\_puzzle(3,1) bishops\_puzzle(1,5) bishops\_puzzle(8,5) bishops\_puzzle(2,8) bishops\_puzzle(7,8)  Optimization: -5  Answer: 7  bishops\_puzzle(1,3) bishops\_puzzle(1,5) bishops\_puzzle(8,5) bishops\_puzzle(1,7) bishops\_puzzle(8,7) bishops\_puzzle(3,8)  Optimization: -6  Answer: 8  bishops\_puzzle(3,1) bishops\_puzzle(4,1) bishops\_puzzle(8,1) bishops\_puzzle(1,5) bishops\_puzzle(8,7) bishops\_puzzle(2,8) bishops\_puzzle(3,8)  Optimization: -7  Answer: 9  bishops\_puzzle(3,1) bishops\_puzzle(6,1) bishops\_puzzle(8,1) bishops\_puzzle(1,5) bishops\_puzzle(8,5) bishops\_puzzle(1,7) bishops\_puzzle(8,7) bishops\_puzzle(3,8)  Optimization: -8  Answer: 10  bishops\_puzzle(4,1) bishops\_puzzle(6,1) bishops\_puzzle(8,1) bishops\_puzzle(1,3) bishops\_puzzle(8,4) bishops\_puzzle(1,5) bishops\_puzzle(8,7) bishops\_puzzle(2,8) bishops\_puzzle(3,8)  Optimization: -9  Answer: 11  bishops\_puzzle(3,1) bishops\_puzzle(6,1) bishops\_puzzle(8,1) bishops\_puzzle(8,2) bishops\_puzzle(8,4) bishops\_puzzle(1,5) bishops\_puzzle(8,5) bishops\_puzzle(1,7) bishops\_puzzle(3,8) bishops\_puzzle(7,8)  Optimization: -10  Answer: 12  bishops\_puzzle(2,1) bishops\_puzzle(7,3) bishops\_puzzle(8,3) bishops\_puzzle(2,4) bishops\_puzzle(8,5) bishops\_puzzle(1,6) bishops\_puzzle(2,6) bishops\_puzzle(3,6) bishops\_puzzle(6,6) bishops\_puzzle(8,6) bishops\_puzzle(7,8)  Optimization: -11  Answer: 13  bishops\_puzzle(2,1) bishops\_puzzle(4,1) bishops\_puzzle(5,1) bishops\_puzzle(6,1) bishops\_puzzle(7,1) bishops\_puzzle(8,1) bishops\_puzzle(2,2) bishops\_puzzle(8,6) bishops\_puzzle(5,7) bishops\_puzzle(6,7) bishops\_puzzle(2,8) bishops\_puzzle(3,8)  Optimization: -12  Answer: 14  bishops\_puzzle(2,1) bishops\_puzzle(4,1) bishops\_puzzle(5,1) bishops\_puzzle(6,1) bishops\_puzzle(7,1) bishops\_puzzle(8,1) bishops\_puzzle(2,2) bishops\_puzzle(8,6) bishops\_puzzle(5,7) bishops\_puzzle(2,8) bishops\_puzzle(3,8) bishops\_puzzle(5,8) bishops\_puzzle(7,8)  Optimization: -13  Answer: 15  bishops\_puzzle(1,1) bishops\_puzzle(2,1) bishops\_puzzle(6,1) bishops\_puzzle(8,2) bishops\_puzzle(1,3) bishops\_puzzle(1,4) bishops\_puzzle(8,4) bishops\_puzzle(1,5) bishops\_puzzle(8,5) bishops\_puzzle(8,6) bishops\_puzzle(1,7) bishops\_puzzle(1,8) bishops\_puzzle(3,8) bishops\_puzzle(7,8)  Optimization: -14    OPTIMUM FOUND  Models : 15  Optimum : yes  Optimization : -14  Calls : 1  Time : 21.537s (Solving: 21.53s 1st Model: 0.00s Unsat: 21.16s)  CPU Time : 21.523s |
| Answer  to Questions | Draw a table that lists the maximum value of bishops when the chessboard is n by n, where n is 3, 4, 5, 6, 7, 8. Infer the general function f(n) that returns the maximum value of bishops.   |  |  | | --- | --- | | Value n | f(n) | | 3 | 4 | | 4 | 6 | | 5 | 8 | | 6 | 10 | | 7 | 12 | | 8 | 14 |   f(n) = 2n-2 |

Problem 9

|  |  |
| --- | --- |
| Input  Program | 1 {in(F,1..k)} 1 :- F= 1..n.  :- in(F,S), in(L,S), in(F+L,S), F!=L. |
| Command  Line | You should write multiple command lines below.  clingo p9.lp -c k=1 -c n=2 0  clingo p9.lp -c k=2 -c n=8 0  clingo p9.lp -c k=3 -c n=23 0  clingo p9.lp -c k=4 -c n=66 0 |
| Output  of clingo | 1. clingo p9.lp -c k=1 -c n=2 0   clingo version 5.4.0  Reading from p9.lp  Solving...  Answer: 1  in(1,1) in(2,1)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.072s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.006s   1. clingo p9.lp -c k=2 -c n=8 0   clingo version 5.4.0  Reading from p9.lp  Solving...  Answer: 1  in(1,1) in(2,1) in(3,2) in(4,1) in(5,2) in(6,2) in(7,2) in(8,1)  Answer: 2  in(3,1) in(1,2) in(2,2) in(4,2) in(5,1) in(6,1) in(7,1) in(8,2)  SATISFIABLE  Models : 2  Calls : 1  Time : 0.010s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.004s   1. clingo p9.lp -c k=3 -c n=23 0   clingo version 5.4.0  Reading from p9.lp  Solving...  Answer: 1  in(1,2) in(2,2) in(3,3) in(4,2) in(5,3) in(6,3) in(7,3) in(8,2) in(9,1) in(10,1) in(11,2) in(12,1) in(13,1) in(14,1) in(15,1) in(16,2) in(17,1) in(18,1) in(19,3) in(20,1) in(21,3) in(22,2) in(23,3)  Answer: 2  in(1,2) in(2,2) in(3,3) in(4,2) in(5,3) in(6,3) in(7,3) in(8,2) in(9,1) in(10,1) in(11,2) in(12,1) in(13,1) in(14,1) in(15,1) in(16,1) in(17,1) in(18,1) in(19,3) in(20,1) in(21,3) in(22,2) in(23,3)  Answer: 3  in(1,2) in(2,2) in(3,3) in(4,2) in(5,3) in(6,3) in(7,3) in(8,2) in(9,1) in(10,1) in(11,2) in(12,1) in(13,1) in(14,1) in(15,1) in(16,1) in(17,2) in(18,1) in(19,3) in(20,1) in(21,3) in(22,2) in(23,3)  Answer: 4  in(3,2) in(1,3) in(2,3) in(4,3) in(5,2) in(6,2) in(7,2) in(8,3) in(9,1) in(10,1) in(11,3) in(12,1) in(13,1) in(14,1) in(15,1) in(16,1) in(17,1) in(18,1) in(19,2) in(20,1) in(21,2) in(22,3) in(23,2)  Answer: 5  in(3,2) in(1,3) in(2,3) in(4,3) in(5,2) in(6,2) in(7,2) in(8,3) in(9,1) in(10,1) in(11,3) in(12,1) in(13,1) in(14,1) in(15,1) in(16,1) in(17,3) in(18,1) in(19,2) in(20,1) in(21,2) in(22,3) in(23,2)  Answer: 6  in(3,2) in(1,3) in(2,3) in(4,3) in(5,2) in(6,2) in(7,2) in(8,3) in(9,1) in(10,1) in(11,3) in(12,1) in(13,1) in(14,1) in(15,1) in(16,3) in(17,1) in(18,1) in(19,2) in(20,1) in(21,2) in(22,3) in(23,2)  Answer: 7  in(1,1) in(2,1) in(3,3) in(4,1) in(5,3) in(6,3) in(7,3) in(8,1) in(9,2) in(10,2) in(11,1) in(12,2) in(13,2) in(14,2) in(15,2) in(16,1) in(17,2) in(18,2) in(19,3) in(20,2) in(21,3) in(22,1) in(23,3)  Answer: 8  in(1,1) in(2,1) in(3,3) in(4,1) in(5,3) in(6,3) in(7,3) in(8,1) in(9,2) in(10,2) in(11,1) in(12,2) in(13,2) in(14,2) in(15,2) in(16,2) in(17,1) in(18,2) in(19,3) in(20,2) in(21,3) in(22,1) in(23,3)  Answer: 9  in(1,1) in(2,1) in(3,3) in(4,1) in(5,3) in(6,3) in(7,3) in(8,1) in(9,2) in(10,2) in(11,1) in(12,2) in(13,2) in(14,2) in(15,2) in(16,2) in(17,2) in(18,2) in(19,3) in(20,2) in(21,3) in(22,1) in(23,3)  Answer: 10  in(1,1) in(2,1) in(3,2) in(4,1) in(5,2) in(6,2) in(7,2) in(8,1) in(9,3) in(10,3) in(11,1) in(12,3) in(13,3) in(14,3) in(15,3) in(16,1) in(17,3) in(18,3) in(19,2) in(20,3) in(21,2) in(22,1) in(23,2)  Answer: 11  in(1,1) in(2,1) in(3,2) in(4,1) in(5,2) in(6,2) in(7,2) in(8,1) in(9,3) in(10,3) in(11,1) in(12,3) in(13,3) in(14,3) in(15,3) in(16,3) in(17,1) in(18,3) in(19,2) in(20,3) in(21,2) in(22,1) in(23,2)  Answer: 12  in(1,1) in(2,1) in(3,2) in(4,1) in(5,2) in(6,2) in(7,2) in(8,1) in(9,3) in(10,3) in(11,1) in(12,3) in(13,3) in(14,3) in(15,3) in(16,3) in(17,3) in(18,3) in(19,2) in(20,3) in(21,2) in(22,1) in(23,2)  Answer: 13  in(3,1) in(1,2) in(2,2) in(4,2) in(5,1) in(6,1) in(7,1) in(8,2) in(9,3) in(10,3) in(11,2) in(12,3) in(13,3) in(14,3) in(15,3) in(16,3) in(17,3) in(18,3) in(19,1) in(20,3) in(21,1) in(22,2) in(23,1)  Answer: 14  in(3,1) in(1,2) in(2,2) in(4,2) in(5,1) in(6,1) in(7,1) in(8,2) in(9,3) in(10,3) in(11,2) in(12,3) in(13,3) in(14,3) in(15,3) in(16,2) in(17,3) in(18,3) in(19,1) in(20,3) in(21,1) in(22,2) in(23,1)  Answer: 15  in(3,1) in(1,2) in(2,2) in(4,2) in(5,1) in(6,1) in(7,1) in(8,2) in(9,3) in(10,3) in(11,2) in(12,3) in(13,3) in(14,3) in(15,3) in(16,3) in(17,2) in(18,3) in(19,1) in(20,3) in(21,1) in(22,2) in(23,1)  Answer: 16  in(3,1) in(1,3) in(2,3) in(4,3) in(5,1) in(6,1) in(7,1) in(8,3) in(9,2) in(10,2) in(11,3) in(12,2) in(13,2) in(14,2) in(15,2) in(16,3) in(17,2) in(18,2) in(19,1) in(20,2) in(21,1) in(22,3) in(23,1)  Answer: 17  in(3,1) in(1,3) in(2,3) in(4,3) in(5,1) in(6,1) in(7,1) in(8,3) in(9,2) in(10,2) in(11,3) in(12,2) in(13,2) in(14,2) in(15,2) in(16,2) in(17,2) in(18,2) in(19,1) in(20,2) in(21,1) in(22,3) in(23,1)  Answer: 18  in(3,1) in(1,3) in(2,3) in(4,3) in(5,1) in(6,1) in(7,1) in(8,3) in(9,2) in(10,2) in(11,3) in(12,2) in(13,2) in(14,2) in(15,2) in(16,2) in(17,3) in(18,2) in(19,1) in(20,2) in(21,1) in(22,3) in(23,1)  SATISFIABLE  Models : 18  Calls : 1  Time : 0.059s (Solving: 0.04s 1st Model: 0.01s Unsat: 0.00s)  CPU Time : 0.044s   1. clingo p9.lp -c k=4 -c n=66 0   Answer: 29930  in(3,3) in(1,4) in(2,4) in(4,4) in(5,3) in(6,3) in(7,3) in(8,4) in(9,1) in(10,1) in(11,4) in(12,1) in(13,1) in(14,1) in(15,1) in(16,1) in(17,1) in(18,1) in(19,3) in(20,1) in(21,3) in(22,4) in(23,3) in(24,2) in(25,4) in(26,2) in(27,2) in(28,2) in(29,2) in(30,2) in(31,2) in(32,4) in(33,2) in(34,2) in(35,4) in(36,2) in(37,3) in(38,3) in(39,3) in(40,2) in(41,2) in(42,2) in(43,2) in(44,2) in(45,4) in(46,2) in(47,2) in(48,2) in(49,2) in(50,4) in(51,3) in(52,3) in(53,3) in(54,1) in(55,1) in(56,1) in(57,1) in(58,1) in(59,1) in(60,1) in(61,1) in(62,1) in(63,3) in(64,3) in(65,3) in(66,4)  Answer: 29931  in(3,3) in(1,4) in(2,4) in(4,4) in(5,3) in(6,3) in(7,3) in(8,4) in(9,1) in(10,1) in(11,4) in(12,1) in(13,1) in(14,1) in(15,1) in(16,1) in(17,1) in(18,1) in(19,3) in(20,1) in(21,3) in(22,4) in(23,3) in(24,2) in(25,4) in(26,2) in(27,2) in(28,2) in(29,2) in(30,2) in(31,2) in(32,4) in(33,2) in(34,2) in(35,4) in(36,2) in(37,3) in(38,3) in(39,3) in(40,2) in(41,2) in(42,2) in(43,2) in(44,2) in(45,4) in(46,2) in(47,2) in(48,2) in(49,2) in(50,4) in(51,3) in(52,3) in(53,3) in(54,1) in(55,1) in(56,1) in(57,1) in(58,1) in(59,4) in(60,1) in(61,1) in(62,1) in(63,3) in(64,3) in(65,3) in(66,4)  ^C\*\*\* Info : (clingo): INTERRUPTED by signal!  SATISFIABLE  INTERRUPTED : 1  Models : 29931+  Calls : 1  Time : 4024.611s (Solving: 4024.48s 1st Model: 525.60s Unsat: 0.00s)  CPU Time : 1753.509s |
| Answer  to Questions | Fill in the values accordingly.   |  |  | | --- | --- | | Exact value of A(1) | 2 | | Exact value of A(2) | 8 | | Exact value of A(3) | 23 | | Largest lower bound for A(4)  Note: it would take longer time when you increase the value of n. Thus, you may stop increasing the value of n when your program does not terminate within 10 minutes and submit the last trial of n. | Did not terminate within 10 minutes of execution. | |