**CSE 579**

**Programming Assignment 1**

**CLINGO PROGRAMS**

Problem 1

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| Input  Program | % 10\*10 board size queens problem.  #const n = 10.  % 1. Create a n \* n board  {queen(R, 1..n)}=1:-R=1..n.  % 2. Queens not in the same row.  :- queen(R1, C), queen(R2, C), R1 != R2.  % 3. Queens not in the same column.  :- queen(R, C1), queen(R, C2), C1 != C2.  % 4. No 2 queens in same diagonal  :- queen(R1, C1), queen(R2, C2), R1 != R2, |R1 - R2| == |C1 - C2|.  % 5. No queens in the 4 \* 4 = 16 squares in the 4 to 7 rows and columns of the board  :- queen(R, C), R >= 4, R <= 7, C >= 4, C <= 7. |
| Command  Line | clingo.exe .\P1\_NQueensMod\_Q1.lp 0 |
| Output  of clingo | clingo version 5.6.2  Reading from .\P1\_NQueensMod\_Q1.lp  Solving...  Answer: 1  queen(2,1) queen(9,10) queen(7,9) queen(5,8) queen(3,7) queen(4,2) queen(1,6) queen(6,3) queen(8,4) queen(10,5)  Answer: 2  queen(7,8) queen(3,5) queen(5,1) queen(6,10) queen(2,7) queen(4,3) queen(1,9) queen(10,2) queen(8,6) queen(9,4)  Answer: 3  queen(3,4) queen(6,8) queen(1,5) queen(4,9) queen(5,3) queen(7,2) queen(2,10) queen(9,1) queen(8,7) queen(10,6)  Answer: 4  queen(1,2) queen(2,4) queen(3,6) queen(4,8) queen(5,10) queen(6,1) queen(7,3) queen(10,9) queen(9,7) queen(8,5)  Answer: 5  queen(9,10) queen(5,8) queen(3,7) queen(4,2) queen(1,6) queen(7,1) queen(2,9) queen(6,3) queen(8,4) queen(10,5)  Answer: 6  queen(1,2) queen(3,6) queen(4,8) queen(5,10) queen(6,1) queen(2,9) queen(7,3) queen(9,7) queen(8,5) queen(10,4)  Answer: 7  <Truncated>  Answer: 33  queen(10,10) queen(3,4) queen(7,9) queen(4,1) queen(5,8) queen(1,5) queen(2,7) queen(6,2) queen(9,3) queen(8,6)  Answer: 34  queen(3,4) queen(7,9) queen(4,1) queen(5,8) queen(2,7) queen(6,2) queen(1,10) queen(9,3) queen(8,6) queen(10,5)  Answer: 35  queen(3,5) queen(1,4) queen(5,1) queen(6,10) queen(4,9) queen(2,8) queen(7,2) queen(9,3) queen(8,6) queen(10,7)  Answer: 36  queen(2,2) queen(7,8) queen(3,5) queen(1,4) queen(5,1) queen(6,10) queen(4,9) queen(9,3) queen(8,6) queen(10,7)  Answer: 37  queen(2,3) queen(7,9) queen(3,6) queen(4,2) queen(5,10) queen(6,1) queen(1,7) queen(9,8) queen(8,5) queen(10,4)  Answer: 38  queen(3,6) queen(4,2) queen(5,10) queen(6,1) queen(1,7) queen(2,9) queen(7,3) queen(9,8) queen(8,5) queen(10,4)  Answer: 39  queen(2,4) queen(6,9) queen(3,7) queen(1,6) queen(4,10) queen(5,3) queen(7,2) queen(10,1) queen(9,8) queen(8,5)  Answer: 40  queen(1,1) queen(2,4) queen(6,9) queen(3,7) queen(4,10) queen(5,3) queen(7,2) queen(9,8) queen(8,5) queen(10,6)  SATISFIABLE  Models : 40  Calls : 1  Time : 0.149s (Solving: 0.08s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.016s |

Problem 2

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| --- | --- |
| Input  Program | % 1. Create a n \* n board  {queen(R, 1..n)}=1 :- R=1..n.  % 2. Queens not in the same row.  :- queen(R1, C), queen(R2, C), R1 != R2.  % 3. Queens not in the same column.  :- queen(R, C1), queen(R, C2), C1 != C2.  % 4. No 2 queens in same diagonal  :- queen(R1, C1), queen(R2, C2), R1 != R2, |R1-R2|=|C1-C2|. |
| Command  Line | You should write multiple command lines below.   1. clingo -c n=3 .\P1\_NQueensProblem\_Comp\_Q2.lp 0 2. clingo -c n=4 .\P1\_NQueensProblem\_Comp\_Q2.lp 0 3. clingo -c n=5 .\P1\_NQueensProblem\_Comp\_Q2.lp 0 4. clingo -c n=6 .\P1\_NQueensProblem\_Comp\_Q2.lp 0 5. clingo -c n=7 .\P1\_NQueensProblem\_Comp\_Q2.lp 0 6. clingo -c n=8 .\P1\_NQueensProblem\_Comp\_Q2.lp 0 7. clingo -c n=9 .\P1\_NQueensProblem\_Comp\_Q2.lp 0 8. clingo -c n=10 .\P1\_NQueensProblem\_Comp\_Q2.lp 0 9. clingo -c n=11 .\P1\_NQueensProblem\_Comp\_Q2.lp 0 10. clingo -c n=12 .\P1\_NQueensProblem\_Comp\_Q2.lp 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 | 0.005s | | 4 | 2 | 0.000s | | 5 | 10 | 0.011s | | 6 | 4 | 0.007s | | 7 | 40 | 0.022s | | 8 | 92 | 0.049s | | 9 | 352 | 0.191s | | 10 | 724 | 0.540s | | 11 | 2680 | 3.310s | | 12 | 14200 | 5.281s | |

Problem 3

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| Input  Program | % First create a grid space which allows numbers from 1 to 9  % in a sudoku grid of size 9  1{ sudoku(X, Y, N): X=1..9, Y=1..9, X>=X1, X<=X1+2, Y>=Y1, Y<=Y1+2 }1 :- N=1..9, X1=3\*(0..2)+1, Y1=3\*(0..2)+1.  % Secondly, no 2 numbers are different in the same row and column  :- sudoku(X, Y, N), sudoku(X, Y, N1), N!=N1.  % Thirdly, no 2 columns are different given a row and number  :- sudoku(X, Y, N), sudoku(X, Y1, N), Y!=Y1.  % fourthly no 2 rows are different given a column and number  :- sudoku(X, Y, N), sudoku(X1, Y, N), X!=X1.  % box 1  sudoku(1, 1, 1).  sudoku(2, 2, 3).  sudoku(3, 3, 9).  % box 2  sudoku(4, 3, 5).  sudoku(5, 2, 1).  sudoku(6, 1, 6).  % box 3  sudoku(7, 1, 3).  sudoku(8, 2, 4).  sudoku(9, 3, 7).  % box 4  sudoku(1, 6, 7).  sudoku(2, 5, 2).  sudoku(3, 4, 6).  % box 5  sudoku(4, 4, 3).  sudoku(5, 5, 8).  sudoku(6, 6, 4).  % box 6  % box 7  sudoku(1, 8, 9).  sudoku(2, 9, 8).  sudoku(3, 7, 5).  % box 8  sudoku(4, 7, 9).  sudoku(5, 9, 2).  % box 9  sudoku(7, 8, 1).  sudoku(8, 9, 7).  sudoku(9, 7, 3). |
| Command  Line | clingo .\P1\_Sudoku\_Solver\_Q3.lp 0 |
| Output  of clingo | clingo version 5.6.2  Reading from .\P1\_Sudoku\_Solver\_Q3.lp  Solving...  Answer: 1  sudoku(1,1,1) sudoku(2,2,3) sudoku(3,3,9) sudoku(4,3,5) sudoku(5,2,1) sudoku(6,1,6) sudoku(7,1,3) sudoku(8,2,4) sudoku(9,3,7) sudoku(1,6,7) sudoku(2,5,2) sudoku(3,4,6) sudoku(4,4,3) sudoku(5,5,8) sudoku(6,6,4) sudoku(1,8,9) sudoku(2,9,8) sudoku(3,7,5) sudoku(4,7,9) sudoku(5,9,2) sudoku(7,8,1) sudoku(8,9,7) sudoku(9,7,3) sudoku(8,3,1) sudoku(8,1,2) sudoku(6,2,2) sudoku(1,3,2) sudoku(5,3,3) sudoku(4,1,4) sudoku(2,3,4) sudoku(2,1,5) sudoku(7,2,5) sudoku(1,2,6) sudoku(7,3,6) sudoku(3,1,7) sudoku(4,2,7) sudoku(9,1,8) sudoku(3,2,8) sudoku(6,3,8) sudoku(5,1,9) sudoku(9,2,9) sudoku(2,4,1) sudoku(4,5,1) sudoku(9,6,1) sudoku(9,4,2) sudoku(4,6,2) sudoku(8,5,3) sudoku(3,6,3) sudoku(7,4,4) sudoku(3,5,4) sudoku(5,4,5) sudoku(1,5,5) sudoku(8,6,5) sudoku(9,5,6) sudoku(5,6,6) sudoku(6,4,7) sudoku(7,5,7) sudoku(1,4,8) sudoku(7,6,8) sudoku(8,4,9) sudoku(6,5,9) sudoku(2,6,9) sudoku(6,7,1) sudoku(3,9,1) sudoku(7,7,2) sudoku(3,8,2) sudoku(6,8,3) sudoku(1,9,3) sudoku(1,7,4) sudoku(5,8,4) sudoku(9,9,4) sudoku(9,8,5) sudoku(6,9,5) sudoku(2,7,6) sudoku(8,8,6) sudoku(4,9,6) sudoku(5,7,7) sudoku(2,8,7) sudoku(8,7,8) sudoku(4,8,8) sudoku(7,9,9)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.020s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.000s |

Problem 4

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| Input  Program | % First create a grid space which allows numbers from 1 to 16  % in a sudoku grid of size 16  { sudoku(X, Y, N): X=1..16, Y=1..16, X>=X1, X<=X1+3, Y>=Y1, Y<=Y1+3 }=1 :- N=1..16, X1=4\*(0..3)+1, Y1=4\*(0..3)+1.  % Secondly, no 2 numbers are different in the same row and column  :- sudoku(X, Y, N), sudoku(X, Y, N1), N!=N1.  % Thirdly, no 2 columns are different given a row and number  :- sudoku(X, Y, N), sudoku(X, Y1, N), Y!=Y1.  % fourthly no 2 rows are different given a column and number  :- sudoku(X, Y, N), sudoku(X1, Y, N), X!=X1.  % Box 1  sudoku(1, 2, 6).  sudoku(2, 1, 15).  sudoku(2, 2, 11).  sudoku(3, 1, 13).  sudoku(3, 3, 9).  sudoku(3, 4, 12).  sudoku(4, 1, 2).  sudoku(4, 3, 16).  % Box 2  sudoku(5, 2, 15).  sudoku(5, 3, 11).  sudoku(5, 4, 10).  sudoku(6, 1, 12).  sudoku(6, 2, 13).  sudoku(7, 1, 5).  sudoku(7, 3, 6).  sudoku(7, 4, 1).  sudoku(8, 2, 2).  % Box 3  sudoku(9, 1, 10).  sudoku(9, 2, 7).  sudoku(9, 3, 15).  sudoku(9, 4, 11).  sudoku(10, 1, 9).  sudoku(11, 1, 1).  sudoku(11, 3, 4).  sudoku(11, 4, 6).  sudoku(12, 1, 16).  sudoku(12, 2, 14).  %Box 4  sudoku(13, 1, 11).  sudoku(13, 2, 10).  sudoku(13, 4, 15).  sudoku(14, 3, 12).  sudoku(15, 3, 5).  sudoku(16, 1, 3).  sudoku(16, 2, 16).  %Box 5  sudoku(1, 8, 8).  sudoku(2, 6, 16).  sudoku(2, 7, 14).  sudoku(4, 5, 11).  sudoku(4, 7, 15).  sudoku(4, 8, 10).  %Box 6  sudoku(5, 7, 16).  sudoku(5, 8, 2).  sudoku(6, 5, 4).  sudoku(6, 6, 1).  sudoku(6, 7, 5).  sudoku(6, 8, 6).  sudoku(7, 5, 12).  sudoku(7, 7, 9).  sudoku(8, 6, 10).  sudoku(8, 8, 11).  %Box 7  sudoku(9, 5, 16).  sudoku(10, 7, 1).  sudoku(11, 5, 9).  sudoku(11, 6, 13).  sudoku(12, 5, 7).  sudoku(12, 7, 10).  sudoku(12, 8, 15).  %Box 8  sudoku(13, 8, 16).  sudoku(14, 5, 1).  sudoku(14, 6, 4).  sudoku(14, 7, 6).  sudoku(15, 5, 8).  sudoku(15, 6, 12).  sudoku(15, 7, 13).  sudoku(16, 5, 10).  sudoku(16, 8, 7).  %Box 9  sudoku(1, 9, 11).  sudoku(1, 12, 15).  sudoku(2, 11, 12).  sudoku(3, 9, 3).  sudoku(3, 10, 16).  sudoku(3, 11, 14).  sudoku(4, 9, 1).  %Box 10  sudoku(5, 9, 13).  sudoku(5, 10, 8).  sudoku(5, 11, 9).  sudoku(5, 12, 12).  sudoku(6, 9, 2).  sudoku(6, 10, 3).  sudoku(7, 9, 15).  sudoku(7, 10, 11).  sudoku(7, 11, 10).  sudoku(7, 12, 7).  sudoku(8, 9, 6).  sudoku(8, 11, 5).  %Box 11  sudoku(9, 9, 12).  sudoku(9, 10, 13).  sudoku(10, 10, 2).  sudoku(10, 12, 16).  sudoku(11, 9, 7).  sudoku(11, 11, 11).  sudoku(12, 9, 4).  sudoku(12, 10, 6).  sudoku(12, 11, 1).  %Box 12  sudoku(13, 9, 9).  sudoku(13, 10, 12).  sudoku(13, 11, 13).  sudoku(14, 9, 16).  sudoku(15, 9, 10).  sudoku(15, 12, 11).  sudoku(16, 11, 6).  %Box 13  sudoku(1, 13, 14).  sudoku(1, 16, 16).  sudoku(2, 14, 6).  sudoku(3, 13, 15).  sudoku(3, 14, 11).  sudoku(3, 15, 10).  %Box 14  sudoku(6, 15, 11).  sudoku(6, 16, 10).  sudoku(7, 13, 16).  sudoku(7, 16, 3).  sudoku(8, 14, 13).  sudoku(8, 16, 9).  %Box 15  sudoku(9, 16, 6).  sudoku(10, 13, 10).  sudoku(10, 16, 11).  sudoku(11, 13, 3).  sudoku(11, 14, 16).  sudoku(12, 15, 13).  sudoku(12, 16, 8).  %Box 16  sudoku(13, 14, 1).  sudoku(13, 15, 5).  sudoku(13, 16, 4).  sudoku(14, 13, 11).  sudoku(14, 14, 10).  sudoku(15, 13, 2).  sudoku(15, 16, 14).  sudoku(16, 15, 12). |
| Command  Line | clingo .\P1\_Sudoku\_Solver\_Q4.lp 0 |
| Output  of clingo | clingo version 5.6.2  Reading from .\P1\_Sudoku\_Solver\_Q4.lp  Solving...  Answer: 1  sudoku(1,2,6) sudoku(2,1,15) sudoku(2,2,11) sudoku(3,1,13) sudoku(3,3,9) sudoku(3,4,12) sudoku(4,1,2) sudoku(4,3,16) sudoku(5,2,15) sudoku(5,3,11) sudoku(5,4,10) sudoku(6,1,12) sudoku(6,2,13) sudoku(7,1,5) sudoku(7,3,6) sudoku(7,4,1) sudoku(8,2,2) sudoku(9,1,10) sudoku(9,2,7) sudoku(9,3,15) sudoku(9,4,11) sudoku(10,1,9) sudoku(11,1,1) sudoku(11,3,4) sudoku(11,4,6) sudoku(12,1,16) sudoku(12,2,14) sudoku(13,1,11) sudoku(13,2,10) sudoku(13,4,15) sudoku(14,3,12) sudoku(15,3,5) sudoku(16,1,3) sudoku(16,2,16) sudoku(1,8,8) sudoku(2,6,16) sudoku(2,7,14) sudoku(4,5,11) sudoku(4,7,15) sudoku(4,8,10) sudoku(5,7,16) sudoku(5,8,2) sudoku(6,5,4) sudoku(6,6,1) sudoku(6,7,5) sudoku(6,8,6) sudoku(7,5,12) sudoku(7,7,9) sudoku(8,6,10) sudoku(8,8,11) sudoku(9,5,16) sudoku(10,7,1) sudoku(11,5,9) sudoku(11,6,13) sudoku(12,5,7) sudoku(12,7,10) sudoku(12,8,15) sudoku(13,8,16) sudoku(14,5,1) sudoku(14,6,4) sudoku(14,7,6) sudoku(15,5,8) sudoku(15,6,12) sudoku(15,7,13) sudoku(16,5,10) sudoku(16,8,7) sudoku(1,9,11) sudoku(1,12,15) sudoku(2,11,12) sudoku(3,9,3) sudoku(3,10,16) sudoku(3,11,14) sudoku(4,9,1) sudoku(5,9,13) sudoku(5,10,8) sudoku(5,11,9) sudoku(5,12,12) sudoku(6,9,2) sudoku(6,10,3) sudoku(7,9,15) sudoku(7,10,11) sudoku(7,11,10) sudoku(7,12,7) sudoku(8,9,6) sudoku(8,11,5) sudoku(9,9,12) sudoku(9,10,13) sudoku(10,10,2) sudoku(10,12,16) sudoku(11,9,7) sudoku(11,11,11) sudoku(12,9,4) sudoku(12,10,6) sudoku(12,11,1) sudoku(13,9,9) sudoku(13,10,12) sudoku(13,11,13) sudoku(14,9,16) sudoku(15,9,10) sudoku(15,12,11) sudoku(16,11,6) sudoku(1,13,14) sudoku(1,16,16) sudoku(2,14,6) sudoku(3,13,15) sudoku(3,14,11) sudoku(3,15,10) sudoku(6,15,11) sudoku(6,16,10) sudoku(7,13,16) sudoku(7,16,3) sudoku(8,14,13) sudoku(8,16,9) sudoku(9,16,6) sudoku(10,13,10) sudoku(10,16,11) sudoku(11,13,3) sudoku(11,14,16) sudoku(12,15,13) sudoku(12,16,8) sudoku(13,14,1) sudoku(13,15,5) sudoku(13,16,4) sudoku(14,13,11) sudoku(14,14,10) sudoku(15,13,2) sudoku(15,16,14) sudoku(16,15,12) sudoku(15,2,1) sudoku(1,3,1) sudoku(12,3,2) sudoku(16,4,2) sudoku(4,2,3) sudoku(8,3,3) sudoku(12,4,3) sudoku(1,1,4) sudoku(7,2,4) sudoku(15,4,4) sudoku(11,2,5) sudoku(1,4,5) sudoku(15,1,6) sudoku(5,1,7) sudoku(13,3,7) sudoku(2,4,7) sudoku(14,1,8) sudoku(3,2,8) sudoku(6,3,8) sudoku(10,4,8) sudoku(14,2,9) sudoku(6,4,9) sudoku(2,3,10) sudoku(10,2,12) sudoku(10,3,13) sudoku(14,4,13) sudoku(8,1,14) sudoku(16,3,14) sudoku(4,4,14) sudoku(8,4,16) sudoku(3,8,1) sudoku(2,5,2) sudoku(13,6,2) sudoku(9,7,2) sudoku(5,5,3) sudoku(9,6,3) sudoku(13,7,3) sudoku(2,8,3) sudoku(3,7,4) sudoku(10,8,4) sudoku(10,5,5) sudoku(3,6,5) sudoku(14,8,5) sudoku(3,5,6) sudoku(10,6,6) sudoku(4,6,7) sudoku(8,7,7) sudoku(7,6,8) sudoku(11,7,8) sudoku(1,6,9) sudoku(15,8,9) sudoku(12,6,11) sudoku(16,7,11) sudoku(1,7,12) sudoku(11,8,12) sudoku(1,5,13) sudoku(7,8,13) sudoku(13,5,14) sudoku(5,6,14) sudoku(9,8,14) sudoku(8,5,15) sudoku(16,6,15) sudoku(16,10,1) sudoku(8,12,1) sudoku(14,11,2) sudoku(3,12,2) sudoku(10,11,3) sudoku(14,12,3) sudoku(8,10,4) sudoku(4,11,4) sudoku(16,12,4) sudoku(16,9,5) sudoku(4,10,5) sudoku(9,12,5) sudoku(4,12,6) sudoku(15,10,7) sudoku(1,11,7) sudoku(2,9,8) sudoku(9,11,8) sudoku(13,12,8) sudoku(2,10,9) sudoku(12,12,9) sudoku(1,10,10) sudoku(11,12,10) sudoku(2,12,13) sudoku(10,9,14) sudoku(14,10,14) sudoku(6,12,14) sudoku(11,10,15) sudoku(15,11,15) sudoku(6,11,16) sudoku(2,13,1) sudoku(9,15,1) sudoku(5,16,1) sudoku(1,14,2) sudoku(7,15,2) sudoku(11,16,2) sudoku(15,14,3) sudoku(1,15,3) sudoku(5,13,4) sudoku(9,14,4) sudoku(2,15,4) sudoku(12,13,5) sudoku(5,14,5) sudoku(2,16,5) sudoku(13,13,6) sudoku(5,15,6) sudoku(6,13,7) sudoku(10,14,7) sudoku(14,15,7) sudoku(3,16,7) sudoku(16,13,8) sudoku(4,14,8) sudoku(8,15,8) sudoku(9,13,9) sudoku(16,14,9) sudoku(4,15,9) sudoku(8,13,12) sudoku(12,14,12) sudoku(4,16,12) sudoku(4,13,13) sudoku(16,16,13) sudoku(7,14,14) sudoku(11,15,14) sudoku(6,14,15) sudoku(10,15,15) sudoku(14,16,15) sudoku(15,15,16)  <Truncated>  doku(6,12,14) sudoku(11,10,15) sudoku(15,11,15) sudoku(6,11,16) sudoku(9,13,1) sudoku(2,15,1) sudoku(5,16,1) sudoku(1,14,2) sudoku(7,15,2) sudoku(11,16,2) sudoku(15,14,3) sudoku(1,15,3) sudoku(2,13,4) sudoku(5,14,4) sudoku(9,15,4) sudoku(5,13,5) sudoku(9,14,5) sudoku(2,16,5) sudoku(13,13,6) sudoku(5,15,6) sudoku(6,13,7) sudoku(10,14,7) sudoku(14,15,7) sudoku(3,16,7) sudoku(16,13,8) sudoku(4,14,8) sudoku(8,15,8) sudoku(12,13,9) sudoku(16,14,9) sudoku(4,15,9) sudoku(8,13,12) sudoku(12,14,12) sudoku(4,16,12) sudoku(4,13,13) sudoku(16,16,13) sudoku(7,14,14) sudoku(11,15,14) sudoku(6,14,15) sudoku(10,15,15) sudoku(14,16,15) sudoku(15,15,16)  SATISFIABLE  Models : 80  Calls : 1  Time : 1.093s (Solving: 1.00s 1st Model: 0.00s Unsat: 0.02s)  CPU Time : 0.063s |

Problem 5

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| --- | --- |
| Input  Program | % First create a grid space which allows numbers from 1 to 9  % in a sudoku grid of size 9  1{ sudoku(X, Y, N): X=1..9, Y=1..9, X>=X1, X<=X1+2, Y>=Y1, Y<=Y1+2 }1 :- N=1..9, X1=3\*(0..2)+1, Y1=3\*(0..2)+1.  % Secondly, no 2 numbers are different in the same row and column  :- sudoku(X, Y, N), sudoku(X, Y, N1), N!=N1.  % Thirdly, no 2 columns are different given a row and number  :- sudoku(X, Y, N), sudoku(X, Y1, N), Y!=Y1.  % Fourthly no 2 rows are different given a column and number  :- sudoku(X, Y, N), sudoku(X1, Y, N), X!=X1.  % Fifthly check the same colored offsets do not have same number  :- sudoku(X, Y, N), sudoku(X1, Y1, N), X \ 3 == X1 \ 3, Y \ 3 == Y1 \ 3, 1{X != X1; Y != Y1}.  % Box 1  sudoku(1, 1, 4).  sudoku(2, 1, 6).  sudoku(2, 2, 1).  sudoku(2, 3, 9).  sudoku(3, 1, 5).  % Box 2  sudoku(4, 3, 4).  sudoku(5, 3, 5).  sudoku(6, 2, 6).  sudoku(6, 3, 3).  %Box 3  sudoku(7, 1, 7).  sudoku(7, 2, 8).  sudoku(7, 3, 1).  sudoku(8, 1, 9).  sudoku(9, 2, 5).  sudoku(9, 3, 2).  %Box 4  sudoku(1, 6, 6).  sudoku(2, 4, 3).  sudoku(2, 5, 2).  sudoku(2, 6, 7).  sudoku(3, 5, 4).  sudoku(3, 6, 1).  %Box 5  sudoku(4, 4, 6).  sudoku(4, 5, 9).  sudoku(4, 6, 2).  sudoku(5, 5, 3).  sudoku(5, 6, 4).  sudoku(6, 4, 1).  sudoku(6, 6, 5).  %Box 6  sudoku(7, 4, 2).  sudoku(7, 5, 6).  sudoku(8, 4, 5).  sudoku(8, 6, 3).  sudoku(9, 5, 1).  %Box 7  sudoku(1, 7, 1).  sudoku(1, 8, 3).  sudoku(2, 8, 5).  sudoku(3, 7, 9).  sudoku(3, 9, 6).  %Box 8  sudoku(4, 7, 3).  sudoku(4, 9, 5).  sudoku(5, 8, 6).  sudoku(6, 7, 7).  sudoku(6, 9, 4).  %Box 9  sudoku(7, 8, 4).  sudoku(7, 9, 3).  sudoku(8, 7, 2).  sudoku(8, 9, 1).  sudoku(9, 7, 6).  sudoku(9, 8, 7).  sudoku(9, 9, 9). |
| Command  Line | clingo .\P1\_Offset\_Sudoku\_Solver\_Q5.lp 0 |
| Output  of clingo | clingo version 5.6.2  Reading from .\P1\_Offset\_Sudoku\_Solver\_Q5.lp  Solving...  Answer: 1  sudoku(1,1,4) sudoku(2,1,6) sudoku(2,2,1) sudoku(2,3,9) sudoku(3,1,5) sudoku(4,3,4) sudoku(5,3,5) sudoku(6,2,6) sudoku(6,3,3) sudoku(7,1,7) sudoku(7,2,8) sudoku(7,3,1) sudoku(8,1,9) sudoku(9,2,5) sudoku(9,3,2) sudoku(1,6,6) sudoku(2,4,3) sudoku(2,5,2) sudoku(2,6,7) sudoku(3,5,4) sudoku(3,6,1) sudoku(4,4,6) sudoku(4,5,9) sudoku(4,6,2) sudoku(5,5,3) sudoku(5,6,4) sudoku(6,4,1) sudoku(6,6,5) sudoku(7,4,2) sudoku(7,5,6) sudoku(8,4,5) sudoku(8,6,3) sudoku(9,5,1) sudoku(1,7,1) sudoku(1,8,3) sudoku(2,8,5) sudoku(3,7,9) sudoku(3,9,6) sudoku(4,7,3) sudoku(4,9,5) sudoku(5,8,6) sudoku(6,7,7) sudoku(6,9,4) sudoku(7,8,4) sudoku(7,9,3) sudoku(8,7,2) sudoku(8,9,1) sudoku(9,7,6) sudoku(9,8,7) sudoku(9,9,9) sudoku(4,1,8) sudoku(7,7,5) sudoku(5,1,1) sudoku(5,4,7) sudoku(5,7,8) sudoku(5,2,9) sudoku(8,2,4) sudoku(8,5,7) sudoku(8,8,8) sudoku(5,9,2) sudoku(8,3,6) sudoku(6,1,2) sudoku(9,1,3) sudoku(9,4,4) sudoku(1,3,8) sudoku(1,9,7) sudoku(7,6,9) sudoku(2,9,8) sudoku(3,2,3) sudoku(3,8,2) sudoku(3,3,7) sudoku(9,6,8) sudoku(1,4,9) sudoku(1,2,2) sudoku(1,5,5) sudoku(4,2,7) sudoku(4,8,1) sudoku(2,7,4) sudoku(6,5,8) sudoku(6,8,9) sudoku(3,4,8)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.060s (Solving: 0.01s 1st Model: 0.00s Unsat: 0.01s)  CPU Time : 0.031s |

Problem 6

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| Input  Program | % First create a grid space which allows numbers from 1 to 9  % in a sudoku grid of size 9  1{ sudoku(X, Y, N): X=1..9, Y=1..9, X1<=X, X<=X1+2, Y1<=Y, Y<=Y1+2 }1 :- N=1..9, X1=3\*(0..2)+1, Y1=3\*(0..2)+1.  % Secondly, no 2 numbers are different in the same row and column  :- sudoku(X, Y, N), sudoku(X, Y, N1), N!=N1.  % Thirdly, no 2 columns are different given a row and number  :- sudoku(X, Y, N), sudoku(X, Y1, N), Y!=Y1.  % Fourthly no 2 rows are different given a column and number  :- sudoku(X, Y, N), sudoku(X1, Y, N), X!=X1.  % Fifthly look for knight movements having same number and add as constraint  :- sudoku(X, Y, N), sudoku(X1, Y1, N), |X - X1| + |Y - Y1| == 3.  % BOX 1  sudoku(1, 2, 8).  sudoku(2, 1, 2).  % bOX 2  sudoku(4, 1, 6).  sudoku(6, 3, 8).  % box 3  sudoku(7, 1, 5).  % Box 4  sudoku(2, 4, 7).  sudoku(3, 6, 6).  % Box 5  sudoku(4, 4, 4).  sudoku(6, 6, 9).  % box 6  sudoku(7, 4, 8).  sudoku(8, 6, 5).  % box 7  sudoku(3, 9, 9).  % box 8  sudoku(4, 7, 7).  sudoku(6, 9, 5).  % box 9  sudoku(8, 9, 6).  sudoku(9, 8, 1). |
| Command  Line | clingo .\P1\_AntiKnight\_Sudoku\_Solver\_Q6.lp 0 |
| Output  of clingo | clingo version 5.6.2  Reading from .\P1\_AntiKnight\_Sudoku\_Solver\_Q6.lp  Solving...  Answer: 1  sudoku(1,2,8) sudoku(2,1,2) sudoku(4,1,6) sudoku(6,3,8) sudoku(7,1,5) sudoku(2,4,7) sudoku(3,6,6) sudoku(4,4,4) sudoku(6,6,9) sudoku(7,4,8) sudoku(8,6,5) sudoku(3,9,9) sudoku(4,7,7) sudoku(6,9,5) sudoku(8,9,6) sudoku(9,8,1) sudoku(2,3,1) sudoku(3,4,1) sudoku(6,1,1) sudoku(1,4,2) sudoku(5,2,2) sudoku(4,5,2) sudoku(1,1,3) sudoku(4,2,3) sudoku(2,6,3) sudoku(3,1,4) sudoku(1,6,4) sudoku(6,2,4) sudoku(3,2,5) sudoku(2,5,5) sudoku(4,3,5) sudoku(5,4,5) sudoku(1,3,6) sudoku(3,3,7) sudoku(5,1,7) sudoku(3,5,8) sudoku(1,5,9) sudoku(2,2,9) sudoku(5,3,9) sudoku(1,7,1) sudoku(5,6,1) sudoku(3,8,2) sudoku(3,7,3) sudoku(5,5,3) sudoku(2,9,4) sudoku(5,7,4) sudoku(1,8,5) sudoku(2,7,6) sudoku(6,4,6) sudoku(1,9,7) sudoku(6,5,7) sudoku(2,8,8) sudoku(4,6,8) sudoku(4,8,9) sudoku(4,9,1) sudoku(6,7,2) sudoku(6,8,3) sudoku(5,8,6) sudoku(5,9,8) sudoku(7,2,1) sudoku(8,3,2) sudoku(9,3,3) sudoku(8,4,3) sudoku(7,3,4) sudoku(9,2,6) sudoku(7,5,6) sudoku(8,2,7) sudoku(9,1,8) sudoku(8,1,9) sudoku(8,5,1) sudoku(7,6,2) sudoku(9,5,4) sudoku(9,6,7) sudoku(7,8,7) sudoku(8,7,8) sudoku(7,7,9) sudoku(9,4,9) sudoku(9,9,2) sudoku(7,9,3) sudoku(8,8,4) sudoku(9,7,5)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.018s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.000s |

Problem 7

|  |  |
| --- | --- |
| Input  Program | % Define the possible values for each cell  1 { sudoku(X,Y,V) : V=1..26 } 1 :- X=1..9, Y=1..9.  % Secondly, no 2 numbers are different in the same row and column  :- sudoku(X, Y, N), sudoku(X, Y, N1), N!=N1.  % Each row must contain unique values  :- sudoku(X,Y,V), sudoku(X,Y1,V), Y!=Y1.  % Each column must contain unique values  :- sudoku(X,Y,V), sudoku(X1,Y,V), X!=X1.  % Define the alphabet  alphabet("ABCDEFGHIJKLMNOPQRSTUVWXYZ").  % Show the solutions as letters instead of numbers  #show sudoku/3.  % Define the grid.  % Box 1  sudoku(1, 1, 5).  sudoku(1, 3, 6).  sudoku(2, 1, 2).  sudoku(2, 3, 26).  sudoku(3, 2, 4).  % box 2  sudoku(6, 1, 7).  sudoku(6, 3, 5).  % Box 3  sudoku(7, 2, 7).  sudoku(8, 1, 26).  sudoku(8, 2, 6).  sudoku(9, 2, 5).  sudoku(9, 3, 1).  % Box 4  sudoku(1, 5, 2).  sudoku(2, 4, 5).  sudoku(2, 5, 6).  sudoku(3, 4, 8).  % Box 5  sudoku(4, 6, 5).  sudoku(5, 5, 8).  sudoku(5, 6, 26).  sudoku(6, 5, 3).  % Box 6  sudoku(7, 4, 2).  sudoku(7, 6, 6).  sudoku(9, 4, 26).  sudoku(9, 6, 8).  % Box 7  sudoku(1, 7, 4).  sudoku(1, 8, 26).  sudoku(3, 8, 2).  sudoku(3, 9, 6).  % Box 8  sudoku(4, 7, 26).  sudoku(4, 9, 4).  sudoku(5, 7, 2).  sudoku(5, 8, 3).  sudoku(6, 7, 6).  % Box 9  sudoku(7, 9, 26).  sudoku(8, 7, 8).  sudoku(8, 9, 7).  sudoku(9, 7, 3). |
| Command  Line | clingo .\P1\_Alphabet\_Sudoku\_Solver\_Q7.lp 1 |
| Output  of clingo | clingo version 5.6.2  Reading from .\P1\_Alphabet\_Sudoku\_Solver\_Q7.lp  Solving...  Answer: 1  sudoku(1,1,5) sudoku(1,3,6) sudoku(2,1,2) sudoku(2,3,26) sudoku(3,2,4) sudoku(6,1,7) sudoku(6,3,5) sudoku(7,2,7) sudoku(8,1,26) sudoku(8,2,6) sudoku(9,2,5) sudoku(9,3,1) sudoku(1,5,2) sudoku(2,4,5) sudoku(2,5,6) sudoku(3,4,8) sudoku(4,6,5) sudoku(5,5,8) sudoku(5,6,26) sudoku(6,5,3) sudoku(7,4,2) sudoku(7,6,6) sudoku(9,4,26) sudoku(9,6,8) sudoku(1,7,4) sudoku(1,8,26) sudoku(3,8,2) sudoku(3,9,6) sudoku(4,7,26) sudoku(4,9,4) sudoku(5,7,2) sudoku(5,8,3) sudoku(6,7,6) sudoku(7,9,26) sudoku(8,7,8) sudoku(8,9,7) sudoku(9,7,3) sudoku(3,1,1) sudoku(7,1,3) sudoku(5,1,4) sudoku(9,1,6) sudoku(4,1,8) sudoku(5,2,1) sudoku(4,2,2) sudoku(2,2,3) sudoku(1,2,8) sudoku(6,2,26) sudoku(8,3,2) sudoku(3,3,3) sudoku(4,3,7) sudoku(7,3,8) sudoku(5,3,16) sudoku(4,4,3) sudoku(8,4,4) sudoku(5,4,6) sudoku(1,4,7) sudoku(6,4,22) sudoku(4,5,1) sudoku(7,5,4) sudoku(8,5,5) sudoku(9,5,23) sudoku(3,5,26) sudoku(1,6,1) sudoku(6,6,2) sudoku(8,6,3) sudoku(2,6,4) sudoku(3,6,7) sudoku(7,7,1) sudoku(3,7,5) sudoku(2,7,7) sudoku(8,8,1) sudoku(6,8,4) sudoku(7,8,5) sudoku(4,8,6) sudoku(9,8,7) sudoku(2,8,8) sudoku(2,9,1) sudoku(9,9,2) sudoku(1,9,3) sudoku(5,9,5) sudoku(6,9,8)  <TRUNCATED>  Answer: 224382  sudoku(1,1,5) sudoku(1,3,6) sudoku(2,1,2) sudoku(2,3,26) sudoku(3,2,4) sudoku(6,1,7) sudoku(6,3,5) sudoku(7,2,7) sudoku(8,1,26) sudoku(8,2,6) sudoku(9,2,5) sudoku(9,3,1) sudoku(1,5,2) sudoku(2,4,5) sudoku(2,5,6) sudoku(3,4,8) sudoku(4,6,5) sudoku(5,5,8) sudoku(5,6,26) sudoku(6,5,3) sudoku(7,4,2) sudoku(7,6,6) sudoku(9,4,26) sudoku(9,6,8) sudoku(1,7,4) sudoku(1,8,26) sudoku(3,8,2) sudoku(3,9,6) sudoku(4,7,26) sudoku(4,9,4) sudoku(5,7,2) sudoku(5,8,3) sudoku(6,7,6) sudoku(7,9,26) sudoku(8,7,8) sudoku(8,9,7) sudoku(9,7,3) sudoku(3,1,1) sudoku(7,1,3) sudoku(5,1,4) sudoku(4,1,8) sudoku(9,1,17) sudoku(4,2,2) sudoku(2,2,3) sudoku(1,2,8) sudoku(5,2,9) sudoku(6,2,26) sudoku(8,3,2) sudoku(3,3,3) sudoku(4,3,7) sudoku(7,3,8) sudoku(5,3,16) sudoku(4,4,3) sudoku(8,4,4) sudoku(5,4,6) sudoku(1,4,7) sudoku(6,4,22) sudoku(4,5,1) sudoku(7,5,4) sudoku(8,5,5) sudoku(9,5,15) sudoku(3,5,26) sudoku(1,6,1) sudoku(6,6,2) sudoku(8,6,3) sudoku(2,6,4) sudoku(3,6,7) sudoku(3,7,5) sudoku(2,7,11) sudoku(7,7,17) sudoku(8,8,1) sudoku(6,8,4) sudoku(7,8,5) sudoku(4,8,6) sudoku(9,8,7) \*\*\* Info : (clingo): Queueing signal...  sudoku(2,8,8) sudoku(2,9,1) sudoku(1,9,3) sudoku(5,9,5) sudoku(6,9,8) sudoku(9,9,10)  \*\*\* Info : (clingo): INTERRUPTED by signal!  SATISFIABLE  INTERRUPTED : 1  Models : 224382+  Calls : 1  Time : 809.277s (Solving: 809.23s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 15.313s |

Problem 8

|  |  |
| --- | --- |
| Input  Program | % 1. create a chess grid  {bishop(R, 1..n)}=1 :- R=1..n.  % 2. Find bishops in the same diagonal and remove them.  :- bishop(R1, C1), bishop(R2, C2), |R1 - R2| == |C1 - C2|, R1 != R2.  % 3. Maximize the value of bishops in the solution  #maximize{ 1, X, Y : bishop(X, Y) }. |
| Command  Line | You should write multiple command lines below.   1. clingo -c n=3 .\P1\_Bishop\_Problem\_Q8.lp 0 2. clingo -c n=4 .\P1\_Bishop\_Problem\_Q8.lp 0 3. clingo -c n=5 .\P1\_Bishop\_Problem\_Q8.lp 0 4. clingo -c n=6 .\P1\_Bishop\_Problem\_Q8.lp 0 5. clingo -c n=7 .\P1\_Bishop\_Problem\_Q8.lp 0 6. clingo -c n=8 .\P1\_Bishop\_Problem\_Q8.lp 0 |
| Output  of clingo | **n=3**  clingo version 5.6.2  Reading from .\P1\_Bishop\_Problem\_Q8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  bishop(1,1)  Optimization: -1  Answer: 3  bishop(1,1) bishop(3,1)  Optimization: -2  Answer: 4  bishop(1,1) bishop(3,1) bishop(1,2)  Optimization: -3  Answer: 5  bishop(1,1) bishop(3,1) bishop(1,2) bishop(3,2)  Optimization: -4  OPTIMUM FOUND  Models : 5  Optimum : yes  Optimization : -4  Calls : 1  Time : 0.001s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.000s  **n=4**  clingo version 5.6.2  Reading from .\P1\_Bishop\_Problem\_Q8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  bishop(3,4)  Optimization: -1  Answer: 3  bishop(2,4) bishop(3,4)  Optimization: -2  Answer: 4  bishop(4,1) bishop(2,4) bishop(3,4)  Optimization: -3  Answer: 5  bishop(4,1) bishop(2,4) bishop(3,4) bishop(4,4)  Optimization: -4  Answer: 6  bishop(3,1) bishop(4,1) bishop(2,4) bishop(3,4) bishop(4,4)  Optimization: -5  Answer: 7  bishop(1,1) bishop(2,1) bishop(3,1) bishop(4,1) bishop(2,4) bishop(3,4)  Optimization: -6  OPTIMUM FOUND  Models : 7  Optimum : yes  Optimization : -6  Calls : 1  Time : 0.004s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.000s  **n=5**  clingo version 5.6.2  Reading from .\P1\_Bishop\_Problem\_Q8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  bishop(1,5)  Optimization: -1  Answer: 3  bishop(2,1) bishop(1,5)  Optimization: -2  Answer: 4  bishop(2,1) bishop(1,5) bishop(2,5)  Optimization: -3  Answer: 5  bishop(2,1) bishop(5,1) bishop(2,5) bishop(4,5)  Optimization: -4  Answer: 6  bishop(2,1) bishop(5,1) bishop(2,5) bishop(4,5) bishop(5,5)  Optimization: -5  Answer: 7  bishop(2,1) bishop(1,5) bishop(2,5) bishop(3,5) bishop(4,5) bishop(5,5)  Optimization: -6  Answer: 8  bishop(1,1) bishop(2,1) bishop(3,1) bishop(5,1) bishop(2,5) bishop(3,5) bishop(4,5)  Optimization: -7  Answer: 9  bishop(1,1) bishop(2,1) bishop(5,1) bishop(5,2) bishop(1,3) bishop(5,3) bishop(1,4) bishop(4,5)  Optimization: -8  OPTIMUM FOUND  Models : 9  Optimum : yes  Optimization : -8  Calls : 1  Time : 0.008s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.000s  **n=6**  clingo version 5.6.2  Reading from .\P1\_Bishop\_Problem\_Q8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  bishop(6,1)  Optimization: -1  Answer: 3  bishop(6,1) bishop(6,6)  Optimization: -2  Answer: 4  bishop(6,1) bishop(3,6) bishop(6,6)  Optimization: -3  Answer: 5  bishop(6,1) bishop(1,2) bishop(3,6) bishop(6,6)  Optimization: -4  Answer: 6  bishop(6,1) bishop(1,2) bishop(1,5) bishop(3,6) bishop(6,6)  Optimization: -5  Answer: 7  bishop(6,1) bishop(1,2) bishop(1,5) bishop(3,6) bishop(4,6) bishop(6,6)  Optimization: -6  Answer: 8  bishop(1,2) bishop(6,5) bishop(1,6) bishop(2,6) bishop(3,6) bishop(4,6) bishop(6,6)  Optimization: -7  Answer: 9  bishop(6,1) bishop(1,2) bishop(6,2) bishop(1,5) bishop(6,5) bishop(3,6) bishop(4,6) bishop(6,6)  Optimization: -8  Answer: 10  bishop(6,1) bishop(1,2) bishop(6,2) bishop(1,3) bishop(6,4) bishop(1,5) bishop(6,5) bishop(3,6) bishop(6,6)  Optimization: -9  Answer: 11  bishop(3,1) bishop(4,1) bishop(1,2) bishop(6,2) bishop(1,5) bishop(6,5) bishop(1,6) bishop(3,6) bishop(4,6) bishop(6,6)  Optimization: -10  OPTIMUM FOUND  Models : 11  Optimum : yes  Optimization : -10  Calls : 1  Time : 0.020s (Solving: 0.01s 1st Model: 0.00s Unsat: 0.01s)  CPU Time : 0.016s  **n=7**  clingo version 5.6.2  Reading from .\P1\_Bishop\_Problem\_Q8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  bishop(1,3)  Optimization: -1  Answer: 3  bishop(1,3) bishop(7,5)  Optimization: -2  Answer: 4  bishop(7,1) bishop(1,3) bishop(7,5)  Optimization: -3  Answer: 5  bishop(7,1) bishop(1,3) bishop(7,4) bishop(7,5)  Optimization: -4  Answer: 6  bishop(7,1) bishop(1,3) bishop(7,4) bishop(7,5) bishop(3,7)  Optimization: -5  Answer: 7  bishop(7,1) bishop(1,3) bishop(7,5) bishop(1,6) bishop(3,7) bishop(4,7)  Optimization: -6  Answer: 8  bishop(7,1) bishop(1,3) bishop(7,5) bishop(1,6) bishop(3,7) bishop(4,7) bishop(7,7)  Optimization: -7  Answer: 9  bishop(7,1) bishop(1,2) bishop(1,3) bishop(7,5) bishop(1,6) bishop(3,7) bishop(4,7) bishop(7,7)  Optimization: -8  Answer: 10  bishop(7,1) bishop(1,2) bishop(1,3) bishop(7,5) bishop(1,6) bishop(7,6) bishop(3,7) bishop(4,7) bishop(7,7)  Optimization: -9  Answer: 11  bishop(7,1) bishop(1,2) bishop(7,2) bishop(1,3) bishop(1,5) bishop(7,5) bishop(1,6) bishop(7,6) bishop(4,7) bishop(7,7)  Optimization: -10  Answer: 12  bishop(3,1) bishop(5,1) bishop(1,2) bishop(7,2) bishop(7,4) bishop(1,6) bishop(7,6) bishop(1,7) bishop(3,7) bishop(5,7) bishop(7,7)  Optimization: -11  Answer: 13  bishop(4,1) bishop(5,1) bishop(7,1) bishop(1,2) bishop(7,2) bishop(1,3) bishop(7,5) bishop(1,6) bishop(7,6) bishop(3,7) bishop(4,7) bishop(7,7)  Optimization: -12  OPTIMUM FOUND  Models : 13  Optimum : yes  Optimization : -12  Calls : 1  Time : 0.485s (Solving: 0.49s 1st Model: 0.00s Unsat: 0.48s)  CPU Time : 0.359s  **n=8**  clingo version 5.6.2  Reading from .\P1\_Bishop\_Problem\_Q8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  bishop(7,8)  Optimization: -1  Answer: 3  bishop(3,1) bishop(7,8)  Optimization: -2  Answer: 4  bishop(3,1) bishop(2,8) bishop(7,8)  Optimization: -3  Answer: 5  bishop(3,1) bishop(8,5) bishop(2,8) bishop(7,8)  Optimization: -4  Answer: 6  bishop(3,1) bishop(1,5) bishop(8,5) bishop(2,8) bishop(7,8)  Optimization: -5  Answer: 7  bishop(1,3) bishop(1,5) bishop(8,5) bishop(1,7) bishop(8,7) bishop(3,8)  Optimization: -6  Answer: 8  bishop(3,1) bishop(4,1) bishop(8,1) bishop(1,5) bishop(8,7) bishop(2,8) bishop(3,8)  Optimization: -7  Answer: 9  bishop(3,1) bishop(6,1) bishop(8,1) bishop(1,5) bishop(8,5) bishop(1,7) bishop(8,7) bishop(3,8)  Optimization: -8  Answer: 10  bishop(4,1) bishop(6,1) bishop(8,1) bishop(1,3) bishop(8,4) bishop(1,5) bishop(8,7) bishop(2,8) bishop(3,8)  Optimization: -9  Answer: 11  bishop(3,1) bishop(6,1) bishop(8,1) bishop(8,2) bishop(8,4) bishop(1,5) bishop(8,5) bishop(1,7) bishop(3,8) bishop(7,8)  Optimization: -10  Answer: 12  bishop(2,1) bishop(7,3) bishop(8,3) bishop(2,4) bishop(8,5) bishop(1,6) bishop(2,6) bishop(3,6) bishop(6,6) bishop(8,6) bishop(7,8)  Optimization: -11  Answer: 13  bishop(2,1) bishop(4,1) bishop(5,1) bishop(6,1) bishop(7,1) bishop(8,1) bishop(2,2) bishop(8,6) bishop(5,7) bishop(6,7) bishop(2,8) bishop(3,8)  Optimization: -12  Answer: 14  bishop(2,1) bishop(4,1) bishop(5,1) bishop(6,1) bishop(7,1) bishop(8,1) bishop(2,2) bishop(8,6) bishop(5,7) bishop(2,8) bishop(3,8) bishop(5,8) bishop(7,8)  Optimization: -13  Answer: 15  bishop(1,1) bishop(2,1) bishop(6,1) bishop(8,2) bishop(1,3) bishop(1,4) bishop(8,4) bishop(1,5) bishop(8,5) bishop(8,6) bishop(1,7) bishop(1,8) bishop(3,8) bishop(7,8)  Optimization: -14  OPTIMUM FOUND  Models : 15  Optimum : yes  Optimization : -14  Calls : 1  Time : 16.070s (Solving: 16.06s 1st Model: 0.00s Unsat: 15.79s)  CPU Time : 13.547s |
| 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 | {in(I, 1..k)}=1:- I=1..n.  :- in(I, S), in(J, S), in(I+J, S), I!=J. |
| Command  Line | You should write multiple command lines below.   1. clingo -c k=1 -c n=2 .\P1\_SchurrMod\_Q9.lp 0 2. clingo -c k=2 -c n=8 .\P1\_SchurrMod\_Q9.lp 0 3. clingo -c k=3 -c n=23 .\P1\_SchurrMod\_Q9.lp 0 4. clingo -c k=4 -c n=66 .\P1\_SchurrMod\_Q9.lp 0 |
| Output  of clingo | **k=1, n=2**  clingo version 5.6.2  Reading from .\P1\_SchurrMod\_Q9.lp  Solving...  Answer: 1  in(1,1) in(2,1)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.000s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.000s  **k=2, n= 8**  clingo version 5.6.2  Reading from .\P1\_SchurrMod\_Q9.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 : 0.000s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.000s  **k=3, n= 23**  clingo version 5.6.2  Reading from .\P1\_SchurrMod\_Q9.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 : 0.062s (Solving: 0.05s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.000s  **k=4, n= 66**  <Truncated>  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(16,4) 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(35,3) in(36,2) in(37,3) in(38,2) in(39,4) in(40,2) in(41,2) in(42,2) in(43,2) in(44,2) in(45,2) in(46,4) in(47,2) in(48,2) in(49,2) in(50,3) in(51,3) in(52,3) in(53,4) in(54,1) in(55,1) in(56,1) in(57,1) in(58,4) in(59,1) in(60,1) in(61,1) in(62,1) in(63,4) in(64,3) in(65,3) in(66,3)  Answer: 9885  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(16,4) 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(35,3) in(36,2) in(37,3) in(38,2) in(39,4) in(40,2) in(41,2) in(42,2) in(43,2) in(44,2) in(45,2) in(46,4) in(47,2) in(48,2) in(49,2) in(50,3) in(51,3) in(52,3) in(53,4) 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(63,4) in(64,3) in(65,3) in(66,3)  Answer: 9886  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(16,4) 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(35,3) in(36,2) in(37,3) in(38,2) in(39,4) in(40,2) in(41,2) in(42,2) in(43,2) in(44,2) in(45,2) in(46,4) in(47,2) in(48,2) in(49,2) in(50,3) in(51,3) in(52,3) in(53,4) 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(63,4) in(64,3) in(65,3) in(66,4)  Answer: 9887  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(35,3) in(36,2) in(37,3) \*\*\* Info : (clingo): Queueing signal...  in(38,2) in(39,4) in(40,2) in(41,2) in(42,2) in(43,2) in(44,2) in(45,2) in(46,4) in(47,2) in(48,2) in(49,2) in(50,3) in(51,3) in(52,3) in(53,4) in(54,1) in(55,1) in(56,1) in(57,1) in(58,1) in(59,1) in(60,4) in(61,1) in(62,1) in(63,4) in(64,3) in(65,3) in(66,3)  \*\*\* Info : (clingo): INTERRUPTED by signal!  SATISFIABLE  INTERRUPTED : 1  Models : 9887+  Calls : 1  Time : 428.750s (Solving: 428.70s 1st Model: 394.19s Unsat: 0.00s)  CPU Time : 331.953s |
| 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. | 66 | |