**[Knowledge Representation]**

**Assignment -1**

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**Problem 1**

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| Input  Program | **{queen(Ro,1..8)}=1 :- Ro=1..8.**  **:- queen(Ro,Co) , 3<=Co, Co<=6 , 3<=Ro, Ro<=6** .  **:- queen(R01,Co),queen(R02,Co) , R01!=R02.**  **:- queen(R01,C01),queen(R02,C02), R01!=R02 , |R01-R02|=|C01-C02|.** |
| Command  Line | clingo question1.lp 0 |
| Output  of clingo | clingo version 5.5.1  Reading from question1.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 : 0.009s (Solving: 0.02s 1st Model: 0.00s Unsat: 0.02s)  CPU Time: 0.000s |

**Problem 2**

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| Input  Program | **{queen(RG,1..n)}=1 :- RG=1..n.**  **:- queen(R01,C),queen(R02,C) , R01!=R02.**  **:- queen(R01,C01),queen(R02,C2), R01!=R02 , |R01-R02|=|C01-C2|.** |
| Command  Line | clingo question2.lp -c n=3 0  clingo question2.lp -c n=4 0  clingo question2.lp -c n=5 0  clingo question2.lp -c n=6 0  clingo question2.lp -c n=7 0  clingo question2.lp -c n=8 0  clingo question2.lp -c n=9 0  clingo question2.lp -c n=10 0  clingo question2.lp -c n=11 0  clingo question2.lp -c n=12 0 |
| Output/  Answer  to Questions | |  |  |  | | --- | --- | --- | | Value n | Number of solutions | time | | 3 | 0 | Time : **0.001s**  (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: **0.000s** | | 4 | 2 | Time : **0.001s**  (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: **0.000s** | | 5 | 10 | Time : **0.003s**  (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: **0.017s** | | 6 | 4 | Time: **0.004s**  (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: **0.000s** | | 7 | 40 | Time: **0.045s**  (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: **0.000s** | | 8 | 92 | Time : **0.089s**  (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: **0.016s** | | 9 | 352 | Time : **0.477s**  (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: **0.031s** | | 10 | 724 | Time : **0.925s**  (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: **0.281s** | | 11 | 2680 | Time : **3.654s**  (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: **1.047s** | | 12 | 14200 | Time : **27.170s**  (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: **16.287s** | |

**Problem 3**

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| Input  Program | **{swarali\_instance(X1,C1,N1):X1=1..9,C1=1..9,X2<=X1,X1<=X2+2,C2<=C1,C1<=C2+2}=1**  **:- N1=1..9,X2 =3\*(0..2)+1 , C2=3\*(0..2)+1**.  :-**swarali\_instance(X1,C1,N1),swarali\_instance(X1,C2,N1), C1!=C2.**  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X1,C1,N2), N1!=N2**.  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X2,C1,N1), X1!=X2.**  % question3\_instance.lp file for adding instances  swarali\_instance(1,1,8).  swarali\_instance(2,3,3).  swarali\_instance(2,4,6).  swarali\_instance(3,2,7).  swarali\_instance(3,5,9).  swarali\_instance(3,7,2).  swarali\_instance(4,2,5).  swarali\_instance(4,6,7).  swarali\_instance(5,5,4).  swarali\_instance(5,6,5).  swarali\_instance(5,7,7).  swarali\_instance(6,4,1).  swarali\_instance(6,8,3).  swarali\_instance(7,3,1).  swarali\_instance(7,8,6).  swarali\_instance(7,9,8).  swarali\_instance(8,3,8).  swarali\_instance(8,4,5).  swarali\_instance(8,8,1).  swarali\_instance(9,2,9).  swarali\_instance(9,7,4). |
| Command  Line | clingo question3.lp question3\_instance.lp 0 |
| Output  of clingo | clingo version 5.5.1  Reading from question3.lp ...  Solving...  Answer: 1  swarali\_instance(1,1,8) swarali\_instance(2,3,3) swarali\_instance(2,4,6) swarali\_instance(3,2,7) swarali\_instance(3,5,9) swarali\_instance(3,7,2) swarali\_instance(4,2,5) swarali\_instance(4,6,7) swarali\_instance(5,5,4) swarali\_instance(5,6,5) swarali\_instance(5,7,7) swarali\_instance(6,4,1) swarali\_instance(6,8,3) swarali\_instance(7,3,1) swarali\_instance(7,8,6) swarali\_instance(7,9,8) swarali\_instance(8,3,8) swarali\_instance(8,4,5) swarali\_instance(8,8,1) swarali\_instance(9,2,9) swarali\_instance(9,7,4) swarali\_instance(4,1,1) swarali\_instance(1,2,1) swarali\_instance(6,1,2) swarali\_instance(7,2,2) swarali\_instance(1,3,2) swarali\_instance(5,1,3) swarali\_instance(8,2,3) swarali\_instance(8,1,4) swarali\_instance(2,2,4) swarali\_instance(4,3,4) swarali\_instance(7,1,5) swarali\_instance(3,3,5) swarali\_instance(3,1,6) swarali\_instance(5,2,6) swarali\_instance(9,3,6) swarali\_instance(9,1,7) swarali\_instance(6,3,7) swarali\_instance(6,2,8) swarali\_instance(2,1,9) swarali\_instance(5,3,9) swarali\_instance(9,5,1) swarali\_instance(3,6,1) swarali\_instance(4,4,2) swarali\_instance(8,5,2) swarali\_instance(2,6,2) swarali\_instance(9,4,3) swarali\_instance(4,5,3) swarali\_instance(1,6,3) swarali\_instance(3,4,4) swarali\_instance(7,6,4) swarali\_instance(1,5,5) swarali\_instance(6,5,6) swarali\_instance(8,6,6) swarali\_instance(1,4,7) swarali\_instance(7,5,7) swarali\_instance(5,4,8) swarali\_instance(2,5,8) swarali\_instance(9,6,8) swarali\_instance(7,4,9) swarali\_instance(6,6,9) swarali\_instance(2,7,1) swarali\_instance(5,9,1) swarali\_instance(5,8,2) swarali\_instance(9,9,2) swarali\_instance(7,7,3) swarali\_instance(3,9,3) swarali\_instance(1,8,4) swarali\_instance(6,9,4) swarali\_instance(6,7,5) swarali\_instance(9,8,5) swarali\_instance(2,9,5) swarali\_instance(1,7,6) swarali\_instance(4,9,6) swarali\_instance(2,8,7) swarali\_instance(8,9,7) swarali\_instance(4,7,8) swarali\_instance(3,8,8) swarali\_instance(8,7,9) swarali\_instance(4,8,9) swarali\_instance(1,9,9)  SATISFIABLE  Models : 1  Calls: 1  Time: 0.045s (Solving: 0.02s 1st Model: 0.00s Unsat: 0.02s)  CPU Time: 0.034s |

**Problem 4**

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| Input  Program | **{swarali\_instance(X1,C1,N1):X1=1..16,C1=1..16,X2<=X1,X1<=X2+3,C2<=C1,C1<=C2+3}=1**  **:- N1=1..16,X2 =4\*(0..3)+1 , C2=4\*(0..3)+1.**  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X1,C2,N1), C1!=C2.**  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X1,C1,N2), N1!=N2.**  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X2,C1,N1), X1!=X2.**  swarali\_instance(1, 1, 9).  swarali\_instance(1, 2, 14).  swarali\_instance(1, 6, 3).  swarali\_instance(1, 8, 5).  swarali\_instance(1, 9, 15).  swarali\_instance(1, 11, 2).  swarali\_instance(1, 15, 7).  swarali\_instance(1, 16, 1).  swarali\_instance(2, 1, 6).  swarali\_instance(2, 2, 12).  swarali\_instance(2, 6, 14).  swarali\_instance(2, 11, 10).  swarali\_instance(2, 15, 5).  swarali\_instance(2, 16, 11).  swarali\_instance(3, 1, 4).  swarali\_instance(3, 4, 7).  swarali\_instance(3, 5, 6).  swarali\_instance(3, 8, 13).  swarali\_instance(3, 9, 16).  swarali\_instance(3, 12, 1).  swarali\_instance(3, 13, 2).  swarali\_instance(3, 16, 9).  swarali\_instance(4, 2, 15).  swarali\_instance(4, 3, 16).  swarali\_instance(4, 5, 9).  swarali\_instance(4, 6, 7).  swarali\_instance(4, 11, 11).  swarali\_instance(4, 12, 6).  swarali\_instance(4, 14, 3).  swarali\_instance(4, 15, 14).  swarali\_instance(5, 2, 7).  swarali\_instance(5, 3, 15).  swarali\_instance(5, 14, 2).  swarali\_instance(5, 15, 16).  swarali\_instance(6, 1, 5).  swarali\_instance(6, 3, 13).  swarali\_instance(6, 5, 14).  swarali\_instance(6, 7, 15).  swarali\_instance(6, 10, 10).  swarali\_instance(6, 12, 3).  swarali\_instance(6, 14, 1).  swarali\_instance(6, 16, 8).  swarali\_instance(7, 2, 8).  swarali\_instance(7, 4, 10).  swarali\_instance(7, 6, 9).  swarali\_instance(7, 7, 4).  swarali\_instance(7, 8, 11).  swarali\_instance(7, 9, 13).  swarali\_instance(7, 10, 6).  swarali\_instance(7, 11, 15).  swarali\_instance(7, 13, 14).  swarali\_instance(7, 15, 3).  swarali\_instance(8, 1, 16).  swarali\_instance(8, 5, 5).  swarali\_instance(8, 7, 3).  swarali\_instance(8, 10, 14).  swarali\_instance(8, 12, 9).  swarali\_instance(8, 16, 6).  swarali\_instance(9, 1, 15).  swarali\_instance(9, 5, 16).  swarali\_instance(9, 7, 10).  swarali\_instance(9, 10, 9).  swarali\_instance(9, 12, 13).  swarali\_instance(9, 16, 14).  swarali\_instance(10, 2, 9).  swarali\_instance(10, 4, 6).  swarali\_instance(10, 6, 5).  swarali\_instance(10, 7, 13).  swarali\_instance(10, 8, 3).  swarali\_instance(10, 9, 1).  swarali\_instance(10, 10, 15).  swarali\_instance(10, 11, 4).  swarali\_instance(10, 13, 7).  swarali\_instance(10, 15, 12).  swarali\_instance(11, 1, 2).  swarali\_instance(11, 3, 8).  swarali\_instance(11, 5, 15).  swarali\_instance(11, 7, 14).  swarali\_instance(11, 10, 16).  swarali\_instance(11, 12, 12).  swarali\_instance(11, 14, 5).  swarali\_instance(11, 16, 13).  swarali\_instance(12, 2, 13).  swarali\_instance(12, 3, 12).  swarali\_instance(12, 14, 9).  swarali\_instance(12, 15, 11).  swarali\_instance(13, 2, 5).  swarali\_instance(13, 3, 3).  swarali\_instance(13, 5, 2).  swarali\_instance(13, 6, 16).  swarali\_instance(13, 11, 13).  swarali\_instance(13, 12, 10).  swarali\_instance(13, 14, 12).  swarali\_instance(13, 15, 9).  swarali\_instance(14, 1, 8).  swarali\_instance(14, 4, 4).  swarali\_instance(14, 5, 12).  swarali\_instance(14, 8, 1).  swarali\_instance(14, 9, 6).  swarali\_instance(14, 12, 7).  swarali\_instance(14, 13, 15).  swarali\_instance(14, 16, 3).  swarali\_instance(15, 1, 10).  swarali\_instance(15, 2, 1).  swarali\_instance(15, 6, 15).  swarali\_instance(15, 11, 16).  swarali\_instance(15, 15, 6).  swarali\_instance(15, 16, 2).  swarali\_instance(16, 1, 11).  swarali\_instance(16, 2, 2).  swarali\_instance(16, 6, 8).  swarali\_instance(16, 8, 14).  swarali\_instance(16, 9, 3).  swarali\_instance(16, 11, 1).  swarali\_instance(16, 15, 10).  swarali\_instance(16, 16, 7). |
| Command  Line | clingo question4.lp question4\_i.lp 0 |
| Output  of clingo | clingo version 5.5.1  Reading from question4.lp ...  Solving...  Answer: 1  swarali\_instance(1,1,9) swarali\_instance(1,2,14) swarali\_instance(1,6,3) swarali\_instance(1,8,5) swarali\_instance(1,9,15) swarali\_instance(1,11,2) swarali\_instance(1,15,7) swarali\_instance(1,16,1) swarali\_instance(2,1,6) swarali\_instance(2,2,12) swarali\_instance(2,6,14) swarali\_instance(2,11,10) swarali\_instance(2,15,5) swarali\_instance(2,16,11) swarali\_instance(3,1,4) swarali\_instance(3,4,7) swarali\_instance(3,5,6) swarali\_instance(3,8,13) swarali\_instance(3,9,16) swarali\_instance(3,12,1) swarali\_instance(3,13,2) swarali\_instance(3,16,9) swarali\_instance(4,2,15) swarali\_instance(4,3,16) swarali\_instance(4,5,9) swarali\_instance(4,6,7) swarali\_instance(4,11,11) swarali\_instance(4,12,6) swarali\_instance(4,14,3) swarali\_instance(4,15,14) swarali\_instance(5,2,7) swarali\_instance(5,3,15) swarali\_instance(5,14,2) swarali\_instance(5,15,16) swarali\_instance(6,1,5) swarali\_instance(6,3,13) swarali\_instance(6,5,14) swarali\_instance(6,7,15) swarali\_instance(6,10,10) swarali\_instance(6,12,3) swarali\_instance(6,14,1) swarali\_instance(6,16,8) swarali\_instance(7,2,8) swarali\_instance(7,4,10) swarali\_instance(7,6,9) swarali\_instance(7,7,4) swarali\_instance(7,8,11) swarali\_instance(7,9,13) swarali\_instance(7,10,6) swarali\_instance(7,11,15) swarali\_instance(7,13,14) swarali\_instance(7,15,3) swarali\_instance(8,1,16) swarali\_instance(8,5,5) swarali\_instance(8,7,3) swarali\_instance(8,10,14) swarali\_instance(8,12,9) swarali\_instance(8,16,6) swarali\_instance(9,1,15) swarali\_instance(9,5,16) swarali\_instance(9,7,10) swarali\_instance(9,10,9) swarali\_instance(9,12,13) swarali\_instance(9,16,14) swarali\_instance(10,2,9) swarali\_instance(10,4,6) swarali\_instance(10,6,5) swarali\_instance(10,7,13) swarali\_instance(10,8,3) swarali\_instance(10,9,1) swarali\_instance(10,10,15) swarali\_instance(10,11,4) swarali\_instance(10,13,7) swarali\_instance(10,15,12) swarali\_instance(11,1,2) swarali\_instance(11,3,8) swarali\_instance(11,5,15) swarali\_instance(11,7,14) swarali\_instance(11,10,16) swarali\_instance(11,12,12) swarali\_instance(11,14,5) swarali\_instance(11,16,13) swarali\_instance(12,2,13) swarali\_instance(12,3,12) swarali\_instance(12,14,9) swarali\_instance(12,15,11) swarali\_instance(13,2,5) swarali\_instance(13,3,3) swarali\_instance(13,5,2) swarali\_instance(13,6,16) swarali\_instance(13,11,13) swarali\_instance(13,12,10) swarali\_instance(13,14,12) swarali\_instance(13,15,9) swarali\_instance(14,1,8) swarali\_instance(14,4,4) swarali\_instance(14,5,12) swarali\_instance(14,8,1) swarali\_instance(14,9,6) swarali\_instance(14,12,7) swarali\_instance(14,13,15) swarali\_instance(14,16,3) swarali\_instance(15,1,10) swarali\_instance(15,2,1) swarali\_instance(15,6,15) swarali\_instance(15,11,16) swarali\_instance(15,15,6) swarali\_instance(15,16,2) swarali\_instance(16,1,11) swarali\_instance(16,2,2) swarali\_instance(16,6,8) swarali\_instance(16,8,14) swarali\_instance(16,9,3) swarali\_instance(16,11,1) swarali\_instance(16,15,10) swarali\_instance(16,16,7) swarali\_instance(12,1,1) swarali\_instance(2,3,1) swarali\_instance(8,4,1) swarali\_instance(7,3,2) swarali\_instance(4,4,2) swarali\_instance(5,1,3) swarali\_instance(9,2,3) swarali\_instance(2,4,3) swarali\_instance(11,2,4) swarali\_instance(8,3,4) swarali\_instance(3,3,5) swarali\_instance(9,4,5) swarali\_instance(6,2,6) swarali\_instance(16,3,6) swarali\_instance(13,1,7) swarali\_instance(9,3,7) swarali\_instance(1,4,8) swarali\_instance(15,3,9) swarali\_instance(6,4,9) swarali\_instance(3,2,10) swarali\_instance(10,3,10) swarali\_instance(8,2,11) swarali\_instance(1,3,11) swarali\_instance(11,4,11) swarali\_instance(7,1,12) swarali\_instance(16,4,12) swarali\_instance(4,1,13) swarali\_instance(15,4,13) swarali\_instance(10,1,14) swarali\_instance(14,3,14) swarali\_instance(5,4,14) swarali\_instance(13,4,15) swarali\_instance(14,2,16) swarali\_instance(12,4,16) swarali\_instance(7,5,1) swarali\_instance(9,6,1) swarali\_instance(4,7,1) swarali\_instance(8,6,2) swarali\_instance(2,7,2) swarali\_instance(12,8,2) swarali\_instance(15,5,3) swarali\_instance(2,5,4) swarali\_instance(12,6,4) swarali\_instance(15,8,4) swarali\_instance(14,7,5) swarali\_instance(11,6,6) swarali\_instance(5,7,6) swarali\_instance(13,8,6) swarali\_instance(12,5,7) swarali\_instance(15,7,7) swarali\_instance(8,8,7) swarali\_instance(5,5,8) swarali\_instance(12,7,8) swarali\_instance(4,8,8) swarali\_instance(16,7,9) swarali\_instance(11,8,9) swarali\_instance(1,5,10) swarali\_instance(14,6,10) swarali\_instance(5,8,10) swarali\_instance(10,5,11) swarali\_instance(3,6,11) swarali\_instance(13,7,11) swarali\_instance(6,6,12) swarali\_instance(3,7,12) swarali\_instance(9,8,12) swarali\_instance(16,5,13) swarali\_instance(5,6,13) swarali\_instance(2,8,15) swarali\_instance(1,7,16) swarali\_instance(6,8,16) swarali\_instance(5,10,1) swarali\_instance(6,9,2) swarali\_instance(14,10,2) swarali\_instance(10,12,2) swarali\_instance(3,10,3) swarali\_instance(11,11,3) swarali\_instance(5,9,4) swarali\_instance(16,10,4) swarali\_instance(1,12,4) swarali\_instance(4,9,5) swarali\_instance(12,10,5) swarali\_instance(5,11,5) swarali\_instance(15,12,5) swarali\_instance(12,11,6) swarali\_instance(11,9,7) swarali\_instance(2,10,7) swarali\_instance(6,11,7) swarali\_instance(8,9,8) swarali\_instance(13,10,8) swarali\_instance(9,11,8) swarali\_instance(2,12,8) swarali\_instance(2,9,9) swarali\_instance(14,11,9) swarali\_instance(12,9,10) swarali\_instance(9,9,11) swarali\_instance(15,10,11) swarali\_instance(5,12,11) swarali\_instance(15,9,12) swarali\_instance(4,10,12) swarali\_instance(8,11,12) swarali\_instance(1,10,13) swarali\_instance(13,9,14) swarali\_instance(3,11,14) swarali\_instance(12,12,14) swarali\_instance(16,12,15) swarali\_instance(7,12,16) swarali\_instance(13,13,1) swarali\_instance(11,15,1) swarali\_instance(9,15,2) swarali\_instance(12,13,3) swarali\_instance(4,13,4) swarali\_instance(9,14,4) swarali\_instance(6,15,4) swarali\_instance(13,16,4) swarali\_instance(16,13,5) swarali\_instance(7,16,5) swarali\_instance(9,13,6) swarali\_instance(1,14,6) swarali\_instance(7,14,7) swarali\_instance(15,13,8) swarali\_instance(10,14,8) swarali\_instance(3,15,8) swarali\_instance(5,13,9) swarali\_instance(11,13,10) swarali\_instance(8,14,10) swarali\_instance(4,16,10) swarali\_instance(6,13,11) swarali\_instance(14,14,11) swarali\_instance(1,13,12) swarali\_instance(5,16,12) swarali\_instance(8,13,13) swarali\_instance(2,14,13) swarali\_instance(14,15,13) swarali\_instance(15,14,14) swarali\_instance(3,14,15) swarali\_instance(8,15,15) swarali\_instance(12,16,15) swarali\_instance(2,13,16) swarali\_instance(16,14,16) swarali\_instance(10,16,16)  SATISFIABLE  Models : 1  Calls : 1  Time: 0.172s (Solving: 0.01s 1st Model: 0.00s Unsat: 0.01s)  CPU Time: 0.157s |

**Problem 5**

|  |  |
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| Input  Program | **{swarali\_instance(X1,C1,N1):X1=1..9,C1=1..9,X2<=X1,X1<=X2+2,C2<=C1,C1<=C2+2}=1**  **:- N1=1..9,X2 =3\*(0..2)+1 , C2=3\*(0..2)+1.**  **:-swarali\_instance(Ro1,Co1,N),swarali\_instance(Ro2,Co2,N),Ro1 != Ro2 , Co1 !=Co2, Ro1\3 == Ro2\3 , Co1\3 == Co2\3**.  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X1,C2,N1), C1!=C2**.  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X1,C1,N2), N1!=N2.**  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X2,C1,N1), X1!=X2.**  swarali\_instance(1, 3, 7).swarali\_instance(1, 7, 8). swarali\_instance(2, 2, 2). swarali\_instance(2, 8, 4). swarali\_instance(3, 1, 8). swarali\_instance(3, 3, 4). swarali\_instance(3, 5, 2).swarali\_instance(3, 7, 5). swarali\_instance(3, 9, 1). swarali\_instance(4, 5, 7). swarali\_instance(5, 3, 8). swarali\_instance(5, 4, 3). swarali\_instance(5, 5, 6). swarali\_instance(5, 6, 4). swarali\_instance(5, 7, 2). swarali\_instance(6, 5, 9). swarali\_instance(7, 1, 3). swarali\_instance(7, 3, 2). swarali\_instance(7, 5, 8). swarali\_instance(7, 7, 7). swarali\_instance(7, 9, 4).swarali\_instance(8, 2, 7). swarali\_instance(8, 8, 8). swarali\_instance(9, 3, 6). swarali\_instance(9, 7, 9). |
| Command  Line | clingo question5.lp question5\_instance.lp 0 |
| Output  of clingo | clingo version 5.5.1  Reading from question5.lp ...  Solving...  Answer: 1  swarali\_instance(1,3,7) swarali\_instance(1,7,8) swarali\_instance(2,2,2) swarali\_instance(2,8,4) swarali\_instance(3,1,8) swarali\_instance(3,3,4) swarali\_instance(3,5,2) swarali\_instance(3,7,5) swarali\_instance(3,9,1) swarali\_instance(4,5,7) swarali\_instance(5,3,8) swarali\_instance(5,4,3) swarali\_instance(5,5,6) swarali\_instance(5,6,4) swarali\_instance(5,7,2) swarali\_instance(6,5,9) swarali\_instance(7,1,3) swarali\_instance(7,3,2) swarali\_instance(7,5,8) swarali\_instance(7,7,7) swarali\_instance(7,9,4) swarali\_instance(8,2,7) swarali\_instance(8,8,8) swarali\_instance(9,3,6) swarali\_instance(9,7,9) swarali\_instance(1,1,1) swarali\_instance(7,2,1) swarali\_instance(4,3,1) swarali\_instance(4,1,2) swarali\_instance(4,2,3) swarali\_instance(2,3,3) swarali\_instance(9,1,4) swarali\_instance(6,2,4) swarali\_instance(8,1,5) swarali\_instance(1,2,5) swarali\_instance(6,3,5) swarali\_instance(6,1,6) swarali\_instance(3,2,6) swarali\_instance(5,1,7) swarali\_instance(9,2,8) swarali\_instance(2,1,9) swarali\_instance(5,2,9) swarali\_instance(8,3,9) swarali\_instance(6,4,1) swarali\_instance(9,5,1) swarali\_instance(2,6,1) swarali\_instance(9,4,2) swarali\_instance(6,6,2) swarali\_instance(8,5,3) swarali\_instance(1,6,3) swarali\_instance(8,4,4) swarali\_instance(1,5,4) swarali\_instance(4,4,5) swarali\_instance(2,5,5) swarali\_instance(7,6,5) swarali\_instance(1,4,6) swarali\_instance(8,6,6) swarali\_instance(3,4,7) swarali\_instance(9,6,7) swarali\_instance(2,4,8) swarali\_instance(4,6,8) swarali\_instance(7,4,9) swarali\_instance(3,6,9) swarali\_instance(8,7,1) swarali\_instance(5,8,1) swarali\_instance(1,8,2) swarali\_instance(8,9,2) swarali\_instance(6,7,3) swarali\_instance(3,8,3) swarali\_instance(9,9,3) swarali\_instance(4,7,4) swarali\_instance(9,8,5) swarali\_instance(5,9,5) swarali\_instance(2,7,6) swarali\_instance(7,8,6) swarali\_instance(4,9,6) swarali\_instance(6,8,7) swarali\_instance(2,9,7) swarali\_instance(6,9,8) swarali\_instance(4,8,9) swarali\_instance(1,9,9)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.072s (Solving: 0.02s 1st Model: 0.00s Unsat: 0.02s)  CPU Time: 0.066s |

**Problem 6**

|  |  |
| --- | --- |
| Input  Program | **{swarali\_instance(X1,C1,N1):X1=1..9,C1=1..9,X2<=X1,X1<=X2+2,C2<=C1,C1<=C2+2}=1**  **:- N1=1..9,X2 =3\*(0..2)+1 , C2=3\*(0..2)+1.**  **:-swarali\_instance(A1,B1,Numb),swarali\_instance(A2,B2,Numb) , |A1-A2|+|B1-B2|==3.**  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X1,C2,N1), C1!=C2.**  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X1,C1,N2), N1!=N2.**  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X2,C1,N1), X1!=X2.**  swarali\_instance(1, 1, 3).  swarali\_instance(1, 9, 4).  swarali\_instance(2, 4, 6).  swarali\_instance(2, 6, 9).  swarali\_instance(3, 3, 6).  swarali\_instance(3, 7, 9).  swarali\_instance(4, 2, 8).  swarali\_instance(4, 4, 3).  swarali\_instance(4, 6, 2).  swarali\_instance(4, 8, 6).  swarali\_instance(5, 5, 7).  swarali\_instance(6, 2, 1).  swarali\_instance(6, 4, 8).  swarali\_instance(6, 6, 5).  swarali\_instance(6, 8, 7).  swarali\_instance(7, 3, 7).  swarali\_instance(7, 7, 8).  swarali\_instance(8, 4, 7).  swarali\_instance(8, 6, 8).  swarali\_instance(9, 1, 9).  swarali\_instance(9, 9, 7). |
| Command  Line | Clingo question6.lp question6\_instance.lp 0 |
| Output  of clingo | clingo version 5.5.1  Reading from question6.lp ...  Solving...  Answer: 1  swarali\_instance(1,1,3) swarali\_instance(1,9,4) swarali\_instance(2,4,6) swarali\_instance(2,6,9) swarali\_instance(3,3,6) swarali\_instance(3,7,9) swarali\_instance(4,2,8) swarali\_instance(4,4,3) swarali\_instance(4,6,2) swarali\_instance(4,8,6) swarali\_instance(5,5,7) swarali\_instance(6,2,1) swarali\_instance(6,4,8) swarali\_instance(6,6,5) swarali\_instance(6,8,7) swarali\_instance(7,3,7) swarali\_instance(7,7,8) swarali\_instance(8,4,7) swarali\_instance(8,6,8) swarali\_instance(9,1,9) swarali\_instance(9,9,7) swarali\_instance(7,1,1) swarali\_instance(1,3,1) swarali\_instance(6,1,2) swarali\_instance(2,2,2) swarali\_instance(8,3,2) swarali\_instance(9,2,3) swarali\_instance(5,3,3) swarali\_instance(2,1,4) swarali\_instance(7,2,4) swarali\_instance(6,3,4) swarali\_instance(8,1,5) swarali\_instance(5,2,5) swarali\_instance(2,3,5) swarali\_instance(5,1,6) swarali\_instance(8,2,6) swarali\_instance(4,1,7) swarali\_instance(3,2,7) swarali\_instance(3,1,8) swarali\_instance(9,3,8) swarali\_instance(1,2,9) swarali\_instance(4,3,9) swarali\_instance(9,4,1) swarali\_instance(4,5,1) swarali\_instance(3,6,1) swarali\_instance(7,4,2) swarali\_instance(1,5,2) swarali\_instance(3,5,3) swarali\_instance(7,6,3) swarali\_instance(3,4,4) swarali\_instance(9,5,4) swarali\_instance(5,6,4) swarali\_instance(1,4,5) swarali\_instance(7,5,5) swarali\_instance(6,5,6) swarali\_instance(9,6,6) swarali\_instance(1,6,7) swarali\_instance(2,5,8) swarali\_instance(5,4,9) swarali\_instance(8,5,9) swarali\_instance(8,7,1) swarali\_instance(5,8,1) swarali\_instance(2,9,1) swarali\_instance(5,7,2) swarali\_instance(9,8,2) swarali\_instance(3,9,2) swarali\_instance(6,7,3) swarali\_instance(2,8,3) swarali\_instance(8,9,3) swarali\_instance(4,7,4) swarali\_instance(8,8,4) swarali\_instance(9,7,5) swarali\_instance(3,8,5) swarali\_instance(4,9,5) swarali\_instance(1,7,6) swarali\_instance(7,9,6) swarali\_instance(2,7,7) swarali\_instance(1,8,8) swarali\_instance(5,9,8) swarali\_instance(7,8,9) swarali\_instance(6,9,9)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.088s (Solving: 0.01s 1st Model: 0.00s Unsat: 0.01s)  CPU Time: 0.075s |

**Problem 7**

|  |  |
| --- | --- |
| Input  Program | **{swarali\_instance(X1,C1,N1):X1=1..9,C1=1..9,X2<=X1,X1<=X2+2,C2<=C1,C1<=C2+2}=1**  **:- N1=1..9,X2 =3\*(0..2)+1 , C2=3\*(0..2)+1.**  **:- swarali\_instance(Ro1,Co1,N1),swarali\_instance(Ro2,Co2,N2),greatercomparison(Ro1,Co1,Ro2,Co2) ,N1<=N2**.  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X1,C2,N1), C1!=C2.**  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X1,C1,N2), N1!=N2.**  **:-swarali\_instance(X1,C1,N1),swarali\_instance(X2,C1,N1), X1!=X2.**  greatercomparison(1, 2, 1, 1). greatercomparison(1, 3, 1, 2). greatercomparison(1, 3, 2, 3). greatercomparison(1, 4, 1, 5). greatercomparison(1, 6, 1, 5). greatercomparison(1, 6, 2, 6). greatercomparison(1, 7, 2, 7). greatercomparison(1, 8, 2, 8). greatercomparison(1, 9, 1, 8). greatercomparison(1, 9, 2, 9). greatercomparison(2, 1, 1, 1). greatercomparison(2, 2, 2, 1). greatercomparison(2, 2, 2, 3). greatercomparison(2, 2, 1, 2). greatercomparison(2, 2, 3, 2). greatercomparison(2, 3, 3, 3). greatercomparison(2, 4, 3, 4). greatercomparison(2, 5, 1, 5). greatercomparison(2, 5, 2, 4). greatercomparison(2, 5, 2, 6). greatercomparison(2, 5, 3, 5). greatercomparison(2, 6, 3, 6). greatercomparison(2, 8, 2, 7). greatercomparison(2, 9, 2, 8). greatercomparison(2, 9, 3, 9). greatercomparison(3, 1, 3, 2). greatercomparison(3, 4, 3, 5). greatercomparison(3, 5, 3, 6). greatercomparison(3, 7, 2, 7). greatercomparison(3, 7, 3, 8). greatercomparison(3, 8, 2, 8). greatercomparison(4, 1, 4, 2). greatercomparison(4, 1, 5, 1). greatercomparison(4, 3, 4, 2). greatercomparison(4, 3, 5, 3). greatercomparison(4, 6, 4, 5). greatercomparison(4, 6, 5, 6). greatercomparison(4, 7, 4, 8). greatercomparison(4, 9, 4, 8). greatercomparison(5, 2, 5, 1). greatercomparison(5, 2, 5, 3). greatercomparison(5, 2, 4, 2). greatercomparison(5, 2, 6, 2). greatercomparison(5, 4, 4, 4). greatercomparison(5, 4, 6, 4). greatercomparison(5, 4, 5, 5). greatercomparison(5, 5, 4, 5). greatercomparison(5, 5, 6, 5). greatercomparison(5, 6, 5, 5). greatercomparison(5, 7, 4, 7). greatercomparison(5, 7, 5, 8). greatercomparison(5, 8, 5, 9). greatercomparison(5, 8, 4, 8). greatercomparison(5, 9, 4, 9). greatercomparison(6, 1, 5, 1). greatercomparison(6, 2, 6, 1). greatercomparison(6, 2, 6, 3). greatercomparison(6, 5, 6, 4). greatercomparison(6, 6, 6, 5). greatercomparison(6, 6, 5, 6). greatercomparison(6, 7, 5, 7). greatercomparison(6, 8, 6, 7). greatercomparison(6, 8, 6, 9). greatercomparison(6, 8, 5, 8). greatercomparison(6, 9, 5, 9). greatercomparison(7, 1, 7, 2). greatercomparison(7, 1, 8, 1). greatercomparison(7, 3, 7, 2). greatercomparison(7, 3, 8, 3). greatercomparison(7, 4, 7, 5). greatercomparison(7, 4, 8, 4). greatercomparison(7, 6, 8, 6). greatercomparison(7, 6, 7, 5). greatercomparison(7, 7, 8, 7). greatercomparison(7, 8, 7, 7). greatercomparison(7, 8, 7, 9). greatercomparison(8, 1, 9, 1). greatercomparison(8, 1, 8, 2). greatercomparison(8, 2, 8, 3). greatercomparison(8, 2, 7, 2). greatercomparison(8, 5, 8, 4). greatercomparison(8, 5, 8, 6). greatercomparison(8, 5, 7, 5). greatercomparison(8, 6, 9, 6). greatercomparison(8, 7, 9, 7). greatercomparison(8, 8, 8, 7). greatercomparison(8, 8, 7, 8). greatercomparison(8, 8, 9, 8). greatercomparison(8, 9, 8, 8). greatercomparison(8, 9, 7, 9). greatercomparison(8, 9, 9, 9). greatercomparison(9, 2, 8, 2). greatercomparison(9, 2, 9, 1). greatercomparison(9, 2, 9, 3). greatercomparison(9, 3, 8, 3). greatercomparison(9, 4, 8, 4). greatercomparison(9, 5, 9, 4). greatercomparison(9, 5, 9, 6). greatercomparison(9, 5, 8, 5). greatercomparison(9, 8, 9, 7). greatercomparison(9, 9, 9, 8). |
| Command  Line | clingo question7.lp question7\_instance.lp 0 |
| Output  of clingo | clingo version 5.5.1  Reading from question7.lp ...  Solving...  Answer: 1  greatercomparison(1,2,1,1) greatercomparison(1,3,1,2) greatercomparison(1,3,2,3) greatercomparison(1,4,1,5) greatercomparison(1,6,1,5) greatercomparison(1,6,2,6) greatercomparison(1,7,2,7) greatercomparison(1,8,2,8) greatercomparison(1,9,1,8) greatercomparison(1,9,2,9) greatercomparison(2,1,1,1) greatercomparison(2,2,2,1) greatercomparison(2,2,2,3) greatercomparison(2,2,1,2) greatercomparison(2,2,3,2) greatercomparison(2,3,3,3) greatercomparison(2,4,3,4) greatercomparison(2,5,1,5) greatercomparison(2,5,2,4) greatercomparison(2,5,2,6) greatercomparison(2,5,3,5) greatercomparison(2,6,3,6) greatercomparison(2,8,2,7) greatercomparison(2,9,2,8) greatercomparison(2,9,3,9) greatercomparison(3,1,3,2) greatercomparison(3,4,3,5) greatercomparison(3,5,3,6) greatercomparison(3,7,2,7) greatercomparison(3,7,3,8) greatercomparison(3,8,2,8) greatercomparison(4,1,4,2) greatercomparison(4,1,5,1) greatercomparison(4,3,4,2) greatercomparison(4,3,5,3) greatercomparison(4,6,4,5) greatercomparison(4,6,5,6) greatercomparison(4,7,4,8) greatercomparison(4,9,4,8) greatercomparison(5,2,5,1) greatercomparison(5,2,5,3) greatercomparison(5,2,4,2) greatercomparison(5,2,6,2) greatercomparison(5,4,4,4) greatercomparison(5,4,6,4) greatercomparison(5,4,5,5) greatercomparison(5,5,4,5) greatercomparison(5,5,6,5) greatercomparison(5,6,5,5) greatercomparison(5,7,4,7) greatercomparison(5,7,5,8) greatercomparison(5,8,5,9) greatercomparison(5,8,4,8) greatercomparison(5,9,4,9) greatercomparison(6,1,5,1) greatercomparison(6,2,6,1) greatercomparison(6,2,6,3) greatercomparison(6,5,6,4) greatercomparison(6,6,6,5) greatercomparison(6,6,5,6) greatercomparison(6,7,5,7) greatercomparison(6,8,6,7) greatercomparison(6,8,6,9) greatercomparison(6,8,5,8) greatercomparison(6,9,5,9) greatercomparison(7,1,7,2) greatercomparison(7,1,8,1) greatercomparison(7,3,7,2) greatercomparison(7,3,8,3) greatercomparison(7,4,7,5) greatercomparison(7,4,8,4) greatercomparison(7,6,8,6) greatercomparison(7,6,7,5) greatercomparison(7,7,8,7) greatercomparison(7,8,7,7) greatercomparison(7,8,7,9) greatercomparison(8,1,9,1) greatercomparison(8,1,8,2) greatercomparison(8,2,8,3) greatercomparison(8,2,7,2) greatercomparison(8,5,8,4) greatercomparison(8,5,8,6) greatercomparison(8,5,7,5) greatercomparison(8,6,9,6) greatercomparison(8,7,9,7) greatercomparison(8,8,8,7) greatercomparison(8,8,7,8) greatercomparison(8,8,9,8) greatercomparison(8,9,8,8) greatercomparison(8,9,7,9) greatercomparison(8,9,9,9) greatercomparison(9,2,8,2) greatercomparison(9,2,9,1) greatercomparison(9,2,9,3) greatercomparison(9,3,8,3) greatercomparison(9,4,8,4) greatercomparison(9,5,9,4) greatercomparison(9,5,9,6) greatercomparison(9,5,8,5) greatercomparison(9,8,9,7) greatercomparison(9,9,9,8)  swarali\_instance(5,1,1) swarali\_instance(3,2,1) swarali\_instance(8,3,1) swarali\_instance(1,1,2) swarali\_instance(7,2,2) swarali\_instance(5,3,2) swarali\_instance(6,1,3) swarali\_instance(1,2,3) swarali\_instance(9,3,3) swarali\_instance(2,1,4) swarali\_instance(8,2,4) swarali\_instance(6,3,4) swarali\_instance(9,1,5) swarali\_instance(6,2,5) swarali\_instance(3,3,5) swarali\_instance(8,1,6) swarali\_instance(4,2,6) swarali\_instance(2,3,6) swarali\_instance(7,1,7) swarali\_instance(2,2,7) swarali\_instance(4,3,7) swarali\_instance(3,1,8) swarali\_instance(5,2,8) swarali\_instance(7,3,8) swarali\_instance(4,1,9) swarali\_instance(9,2,9) swarali\_instance(1,3,9) swarali\_instance(6,4,1) swarali\_instance(1,5,1) swarali\_instance(9,6,1) swarali\_instance(8,4,2) swarali\_instance(6,5,2) swarali\_instance(3,6,2) swarali\_instance(4,4,3) swarali\_instance(7,5,3) swarali\_instance(2,6,3) swarali\_instance(9,4,4) swarali\_instance(4,5,4) swarali\_instance(1,6,4) swarali\_instance(1,4,5) swarali\_instance(5,5,5) swarali\_instance(8,6,5) swarali\_instance(7,4,6) swarali\_instance(3,5,6) swarali\_instance(5,6,6) swarali\_instance(3,4,7) swarali\_instance(8,5,7) swarali\_instance(6,6,7) swarali\_instance(2,4,8) swarali\_instance(9,5,8) swarali\_instance(4,6,8) swarali\_instance(5,4,9) swarali\_instance(2,5,9) swarali\_instance(7,6,9) swarali\_instance(2,7,1) swarali\_instance(4,8,1) swarali\_instance(7,9,1) swarali\_instance(9,7,2) swarali\_instance(2,8,2) swarali\_instance(4,9,2) swarali\_instance(8,7,3) swarali\_instance(3,8,3) swarali\_instance(5,9,3) swarali\_instance(7,7,4) swarali\_instance(5,8,4) swarali\_instance(3,9,4) swarali\_instance(4,7,5) swarali\_instance(7,8,5) swarali\_instance(2,9,5) swarali\_instance(1,7,6) swarali\_instance(9,8,6) swarali\_instance(6,9,6) swarali\_instance(5,7,7) swarali\_instance(1,8,7) swarali\_instance(9,9,7) swarali\_instance(6,7,8) swarali\_instance(8,8,8) swarali\_instance(1,9,8) swarali\_instance(3,7,9) swarali\_instance(6,8,9) swarali\_instance(8,9,9)  SATISFIABLE  Models : 1  Calls : 1  Time: 0.458s (Solving: 0.44s 1st Model: 0.30s Unsat: 0.14s)  CPU Time: 0.569s |

**Problem 8**

|  |  |
| --- | --- |
| Input  Program | **{swarali\_instancebishopuzzle(Ro,1..n)} :- Ro=1..n**.  **#maximize{1,Ro,C:swarali\_instancebishopuzzle(Ro,C)}.**  **:-swarali\_instancebishopuzzle(Ro1,Co1),swarali\_instancebishopuzzle(Ro2,Co2),Ro1!=Ro2,|Ro1-Ro2|==|Co1-Co2|.** |
| Command  Line | clingo question8.lp -c n=3 0  clingo question8.lp -c n=4 0  clingo question8.lp -c n=5 0  clingo question8.lp -c n=6 0  clingo question8.lp -c n=7 0  clingo question8.lp -c n=8 0 |
| Output  of clingo | %discuss below is the function f(n) that returns the maximum value of bishops   |  |  | | --- | --- | | Value n | f(n) | | 3 | f(n) = (2\*n)-2  **4** | | 4 | f(n) = (2\*n)-2  **6** | | 5 | f(n) = (2\*n)-2  **8** | | 6 | f(n) = (2\*n)-2  **10** | | 7 | f(n) = (2\*n)-2  **12** | | 8 | f(n) = (2\*n)-2  **14** |   **N=3**  clingo version 5.5.1  Reading from question8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  swarali\_instancebishopuzzle(1,1)  Optimization: -1  Answer: 3  swarali\_instancebishopuzzle(1,1) swarali\_instancebishopuzzle(3,1)  Optimization: -2  Answer: 4  swarali\_instancebishopuzzle(1,1) swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(1,2)  Optimization: -3  Answer: 5  swarali\_instancebishopuzzle(1,1) swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(3,2)  Optimization: -4  OPTIMUM FOUND  Models : 5  Optimum : yes  Optimization : - **4**  Calls : 1  Time : 0.009s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: 0.000s  **N=4**  clingo version 5.5.1  Reading from question8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  swarali\_instancebishopuzzle(3,4)  Optimization: -1  Answer: 3  swarali\_instancebishopuzzle(2,4) swarali\_instancebishopuzzle(3,4)  Optimization: -2  Answer: 4  swarali\_instancebishopuzzle(4,1) swarali\_instancebishopuzzle(2,4) swarali\_instancebishopuzzle(3,4)  Optimization: -3  Answer: 5  swarali\_instancebishopuzzle(4,1) swarali\_instancebishopuzzle(2,4) swarali\_instancebishopuzzle(3,4) swarali\_instancebishopuzzle(4,4)  Optimization: -4  Answer: 6  swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(4,1) swarali\_instancebishopuzzle(2,4) swarali\_instancebishopuzzle(3,4) swarali\_instancebishopuzzle(4,4)  Optimization: -5  Answer: 7  swarali\_instancebishopuzzle(1,1) swarali\_instancebishopuzzle(2,1) swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(4,1) swarali\_instancebishopuzzle(2,4) swarali\_instancebishopuzzle(3,4)  Optimization: -6  OPTIMUM FOUND  Models : 7  Optimum : yes  Optimization : - **6**  Calls : 1  Time : 0.004s (Solving: 0.01s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: 0.000s  **N=5**  clingo version 5.5.1  Reading from question8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  swarali\_instancebishopuzzle(1,5)  Optimization: -1  Answer: 3  swarali\_instancebishopuzzle(2,1) swarali\_instancebishopuzzle(1,5)  Optimization: -2  Answer: 4  swarali\_instancebishopuzzle(2,1) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(2,5)  Optimization: -3  Answer: 5  swarali\_instancebishopuzzle(2,1) swarali\_instancebishopuzzle(5,1) swarali\_instancebishopuzzle(2,5) swarali\_instancebishopuzzle(4,5)  Optimization: -4  Answer: 6  swarali\_instancebishopuzzle(2,1) swarali\_instancebishopuzzle(5,1) swarali\_instancebishopuzzle(2,5) swarali\_instancebishopuzzle(4,5) swarali\_instancebishopuzzle(5,5)  Optimization: -5  Answer: 7  swarali\_instancebishopuzzle(2,1) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(2,5) swarali\_instancebishopuzzle(3,5) swarali\_instancebishopuzzle(4,5) swarali\_instancebishopuzzle(5,5)  Optimization: -6  Answer: 8  swarali\_instancebishopuzzle(1,1) swarali\_instancebishopuzzle(2,1) swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(5,1) swarali\_instancebishopuzzle(2,5) swarali\_instancebishopuzzle(3,5) swarali\_instancebishopuzzle(4,5)  Optimization: -7  Answer: 9  swarali\_instancebishopuzzle(1,1) swarali\_instancebishopuzzle(2,1) swarali\_instancebishopuzzle(5,1) swarali\_instancebishopuzzle(5,2) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(5,3) swarali\_instancebishopuzzle(1,4) swarali\_instancebishopuzzle(4,5)  Optimization: -8  OPTIMUM FOUND  Models : 9  Optimum : yes  Optimization : - **8**  Calls : 1  Time : 0.014s (Solving: 0.01s 1st Model: 0.00s Unsat: 0.01s)  CPU Time: 0.000s  **N=6**  clingo version 5.5.1  Reading from question8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  swarali\_instancebishopuzzle(6,1)  Optimization: -1  Answer: 3  swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(6,6)  Optimization: -2  Answer: 4  swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(3,6) swarali\_instancebishopuzzle(6,6)  Optimization: -3  Answer: 5  swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(3,6) swarali\_instancebishopuzzle(6,6)  Optimization: -4  Answer: 6  swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(3,6) swarali\_instancebishopuzzle(6,6)  Optimization: -5  Answer: 7  swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(3,6) swarali\_instancebishopuzzle(4,6) swarali\_instancebishopuzzle(6,6)  Optimization: -6  Answer: 8  swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(6,5) swarali\_instancebishopuzzle(1,6) swarali\_instancebishopuzzle(2,6) swarali\_instancebishopuzzle(3,6) swarali\_instancebishopuzzle(4,6) swarali\_instancebishopuzzle(6,6)  Optimization: -7  Answer: 9  swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(6,2) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(6,5) swarali\_instancebishopuzzle(3,6) swarali\_instancebishopuzzle(4,6) swarali\_instancebishopuzzle(6,6)  Optimization: -8  Answer: 10  swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(6,2) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(6,4) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(6,5) swarali\_instancebishopuzzle(3,6) swarali\_instancebishopuzzle(6,6)  Optimization: -9  Answer: 11  swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(4,1) swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(6,2) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(6,5) swarali\_instancebishopuzzle(1,6) swarali\_instancebishopuzzle(3,6) swarali\_instancebishopuzzle(4,6) swarali\_instancebishopuzzle(6,6)  Optimization: -10  OPTIMUM FOUND  Models : 11  Optimum: yes  Optimization : - **10**  Calls : 1  Time : 0.044s (Solving: 0.05s 1st Model: 0.01s Unsat: 0.03s)  CPU Time: 0.027s  **N=7**  clingo version 5.5.1  Reading from question8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  swarali\_instancebishopuzzle(1,3)  Optimization: -1  Answer: 3  swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(7,5)  Optimization: -2  Answer: 4  swarali\_instancebishopuzzle(7,1) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(7,5)  Optimization: -3  Answer: 5  swarali\_instancebishopuzzle(7,1) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(7,4) swarali\_instancebishopuzzle(7,5)  Optimization: -4  Answer: 6  swarali\_instancebishopuzzle(7,1) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(7,4) swarali\_instancebishopuzzle(7,5) swarali\_instancebishopuzzle(3,7)  Optimization: -5  Answer: 7  swarali\_instancebishopuzzle(7,1) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(7,5) swarali\_instancebishopuzzle(1,6) swarali\_instancebishopuzzle(3,7) swarali\_instancebishopuzzle(4,7)  Optimization: -6  Answer: 8  swarali\_instancebishopuzzle(7,1) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(7,5) swarali\_instancebishopuzzle(1,6) swarali\_instancebishopuzzle(3,7) swarali\_instancebishopuzzle(4,7) swarali\_instancebishopuzzle(7,7)  Optimization: -7  Answer: 9  swarali\_instancebishopuzzle(7,1) swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(7,5) swarali\_instancebishopuzzle(1,6) swarali\_instancebishopuzzle(3,7) swarali\_instancebishopuzzle(4,7) swarali\_instancebishopuzzle(7,7)  Optimization: -8  Answer: 10  swarali\_instancebishopuzzle(7,1) swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(7,5) swarali\_instancebishopuzzle(1,6) swarali\_instancebishopuzzle(7,6) swarali\_instancebishopuzzle(3,7) swarali\_instancebishopuzzle(4,7) swarali\_instancebishopuzzle(7,7)  Optimization: -9  Answer: 11  swarali\_instancebishopuzzle(7,1) swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(7,2) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(7,5) swarali\_instancebishopuzzle(1,6) swarali\_instancebishopuzzle(7,6) swarali\_instancebishopuzzle(4,7) swarali\_instancebishopuzzle(7,7)  Optimization: -10  Answer: 12  swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(5,1) swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(7,2) swarali\_instancebishopuzzle(7,4) swarali\_instancebishopuzzle(1,6) swarali\_instancebishopuzzle(7,6) swarali\_instancebishopuzzle(1,7) swarali\_instancebishopuzzle(3,7) swarali\_instancebishopuzzle(5,7) swarali\_instancebishopuzzle(7,7)  Optimization: -11  Answer: 13  swarali\_instancebishopuzzle(4,1) swarali\_instancebishopuzzle(5,1) swarali\_instancebishopuzzle(7,1) swarali\_instancebishopuzzle(1,2) swarali\_instancebishopuzzle(7,2) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(7,5) swarali\_instancebishopuzzle(1,6) swarali\_instancebishopuzzle(7,6) swarali\_instancebishopuzzle(3,7) swarali\_instancebishopuzzle(4,7) swarali\_instancebishopuzzle(7,7)  Optimization: -12  OPTIMUM FOUND  Models : 13  Optimum : yes  Optimization : - **12**  Calls : 1  Time : 0.604s (Solving**:** 0.59s 1st Model: 0.00s Unsat: 0.69s)  CPU Time : 0.789s)  **N=8**  clingo version 5.5.1  Reading from question8.lp  Solving...  Answer: 1  Optimization: 0  Answer: 2  swarali\_instancebishopuzzle(7,8)  Optimization: -1  Answer: 3  swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(7,8)  Optimization: -2  Answer: 4  swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(2,8) swarali\_instancebishopuzzle(7,8)  Optimization: -3  Answer: 5  swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(8,5) swarali\_instancebishopuzzle(2,8) swarali\_instancebishopuzzle(7,8)  Optimization: -4  Answer: 6  swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(8,5) swarali\_instancebishopuzzle(2,8) swarali\_instancebishopuzzle(7,8)  Optimization: -5  Answer: 7  swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(8,5) swarali\_instancebishopuzzle(1,7) swarali\_instancebishopuzzle(8,7) swarali\_instancebishopuzzle(3,8)  Optimization: -6  Answer: 8  swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(4,1) swarali\_instancebishopuzzle(8,1) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(8,7) swarali\_instancebishopuzzle(2,8) swarali\_instancebishopuzzle(3,8)  Optimization: -7  Answer: 9  swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(8,1) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(8,5) swarali\_instancebishopuzzle(1,7) swarali\_instancebishopuzzle(8,7) swarali\_instancebishopuzzle(3,8)  Optimization: -8  Answer: 10  swarali\_instancebishopuzzle(4,1) swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(8,1) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(8,4) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(8,7) swarali\_instancebishopuzzle(2,8) swarali\_instancebishopuzzle(3,8)  Optimization: -9  Answer: 11  swarali\_instancebishopuzzle(3,1) swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(8,1) swarali\_instancebishopuzzle(8,2) swarali\_instancebishopuzzle(8,4) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(8,5) swarali\_instancebishopuzzle(1,7) swarali\_instancebishopuzzle(3,8) swarali\_instancebishopuzzle(7,8)  Optimization: -10  Answer: 12  swarali\_instancebishopuzzle(2,1) swarali\_instancebishopuzzle(7,3) swarali\_instancebishopuzzle(8,3) swarali\_instancebishopuzzle(2,4) swarali\_instancebishopuzzle(8,5) swarali\_instancebishopuzzle(1,6) swarali\_instancebishopuzzle(2,6) swarali\_instancebishopuzzle(3,6) swarali\_instancebishopuzzle(6,6) swarali\_instancebishopuzzle(8,6) swarali\_instancebishopuzzle(7,8)  Optimization: -11  Answer: 13  swarali\_instancebishopuzzle(2,1) swarali\_instancebishopuzzle(4,1) swarali\_instancebishopuzzle(5,1) swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(7,1) swarali\_instancebishopuzzle(8,1) swarali\_instancebishopuzzle(2,2) swarali\_instancebishopuzzle(8,6) swarali\_instancebishopuzzle(5,7) swarali\_instancebishopuzzle(6,7) swarali\_instancebishopuzzle(2,8) swarali\_instancebishopuzzle(3,8)  Optimization: -12  Answer: 14  swarali\_instancebishopuzzle(2,1) swarali\_instancebishopuzzle(4,1) swarali\_instancebishopuzzle(5,1) swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(7,1) swarali\_instancebishopuzzle(8,1) swarali\_instancebishopuzzle(2,2) swarali\_instancebishopuzzle(8,6) swarali\_instancebishopuzzle(5,7) swarali\_instancebishopuzzle(2,8) swarali\_instancebishopuzzle(3,8) swarali\_instancebishopuzzle(5,8) swarali\_instancebishopuzzle(7,8)  Optimization: -13  Answer: 15  swarali\_instancebishopuzzle(1,1) swarali\_instancebishopuzzle(2,1) swarali\_instancebishopuzzle(6,1) swarali\_instancebishopuzzle(8,2) swarali\_instancebishopuzzle(1,3) swarali\_instancebishopuzzle(1,4) swarali\_instancebishopuzzle(8,4) swarali\_instancebishopuzzle(1,5) swarali\_instancebishopuzzle(8,5) swarali\_instancebishopuzzle(8,6) swarali\_instancebishopuzzle(1,7) swarali\_instancebishopuzzle(1,8) swarali\_instancebishopuzzle(3,8) swarali\_instancebishopuzzle(7,8)  Optimization: -14  OPTIMUM FOUND  Models : 15  Optimum : yes  Optimization : - **14**  Calls : 1  Time: 27.633s (Solving: 16.54s 1st Model: 0.00s Unsat: 26.24s)  CPU Time : 26.543s |

**Problem 9**

|  |  |
| --- | --- |
| Input  Program | {in(B,1..k)} =1 :- B=1..n.  :- in(B,S), in(C,S), in(B+C,S) , B!=C. |
| Command  Line | clingo question9.lp -c k=1 -c n=2 0  clingo question9.lp -c k=2 -c n=8 0  clingo question9.lp -c k=3 -c n=23 0  clingo question9.lp -c k=4 -c n=66 |
| Output  of clingo | |  |  | | --- | --- | | Exact value of A(1) | 2 | | Exact value of A(2) | 8 | | Exact value of A(3) | 23 | | Largest lower bound for A(4) | 66 |   **N=2,k=1**  clingo version 5.5.1  Reading from question9.lp  Solving...  Answer: 1  in(1,1) in(2,1)  SATISFIABLE  Models : 1  Calls : 1  Time : 0.003s (Solving: 0.00s 1st Model: 0.00s Unsat: 0.00s)  CPU Time : 0.000s  **N=8,k=2**  clingo version 5.5.1  Reading from question9.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 : 0.006s (Solving: 0.01s 1st Model: 0.00s Unsat: 0.00s)  CPU Time: 0.000s  **N=23,k=3**  clingo version 5.5.1  Reading from question9.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 : 0.208s (Solving: 0.11s 1st Model: 0.02s Unsat: 0.00s)  CPU Time: 0.047s  **N=66,k=4**  **% Presenting one solution since the output could be very large**  clingo version 5.5.1  Reading from question9.lp  Solving...  Answer: 1  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(31,4) in(32,2) in(33,2) in(34,2) in(35,2) in(36,2) in(37,2) in(38,2) in(39,2) in(40,2) in(41,2) in(42,2) in(43,2) in(44,2) in(45,2) 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)  SATISFIABLE  Models : 1+  Calls: 1  Time : 658.541s (Solving: 456.21s 1st Model: 456.21s Unsat: 0.00s)  CPU Time : 431.233s |