Part 1:   1.1: Variabits: columns $\rightarrow$ Q <sub>1</sub> , Q <sub>2</sub> , Q <sub>3</sub> , Q <sub>4</sub> Domains: DQ <sub>1</sub> : DQ <sub>2</sub> : DQ <sub>3</sub> : DQ <sub>4</sub> : $\{1,2,3,4\}$ Retailins:   4 adjacent (supports) $\rightarrow$ $\{(1,3),(1,4),(2,4),(2,1),(4,2),(4,1),(4,2)\}$ 4 skip! (supports) $\rightarrow$ $\{(1,2),(1,4),(2,1),(2,3),(3,2),(3,4),(4,1),(4,3)\}$ 5 skip2 (supports) $\rightarrow$ $\{(1,2),(1,3),(2,1),(2,3),(2,4),(3,1),(3,2),(3,4),(4,2),(4,3)\}$ Constraints 5 12: Q, and Q, with adjacent   5 13: Q, and Q, with skip1   5 24: Q, and Q, with skip1   5 24: Q, and Q, with adjacent   5 25: Q, and Q, with adjacent   5 26: Q, and Q, with adjacent   5 27: Q, and Q, with adjacent   5 28: Q, and Q, with adjacent   6 28: Q, and Q, with adjacent   7 28: Q, and Q, with adjacent   8 28: Q, and Q, with adjacent   8 28: Q, and Q,		ueen Problem	+
1.1:   Variabres: columns - Q, Q, Q, Q, Q, Q, Q, Domains: DQ, DQ, DQ, DQ, El, 2, 3, 43   Relations:   Q, dajacent (supports) - {(1, 2), (1, 4), (2, 4), (3, 1), (4, 1), (4, 2)}   Uskip! (supports) - {(1, 2), (1, 4), (2, 4), (3, 1), (4, 1), (4, 2)}   Uskip! (supports) - {(1, 2), (1, 4), (2, 1), (2, 3), (2, 4), (3, 1), (4, 1), (4, 3)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 3), (2, 4), (3, 1), (3, 2), (3, 4), (4, 2), (4, 3)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 3), (2, 4), (3, 1), (3, 2), (3, 4), (4, 2), (4, 3)}   Uskip! (supports) - {(1, 2), (4, 3), (2, 1), (2, 3), (2, 4), (3, 1), (3, 2), (3, 4), (4, 2), (4, 3)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 3), (2, 4), (3, 1), (3, 2), (3, 4), (4, 2), (4, 3)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 3), (2, 4), (3, 1), (3, 2), (3, 4), (4, 2), (4, 3)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 3), (2, 1), (2, 3), (2, 4), (3, 1), (3, 2), (3, 4), (4, 2), (4, 3)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 3), (2, 1), (2, 3), (2, 4), (3, 1), (4, 1), (4, 2)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 3), (2, 1), (2, 3), (2, 4), (3, 1), (4, 1), (4, 2)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 3), (2, 1), (2, 3), (2, 1), (3, 2), (3, 4), (4, 1), (4, 2)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 3), (2, 1), (2, 3), (2, 1), (2, 3), (2, 1), (3, 2), (3, 4), (4, 1), (4, 2)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 3), (2, 1), (2, 3), (2, 1), (2, 3), (2, 1), (3, 2), (3, 4), (4, 1), (4, 2)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 3), (2, 1), (2, 3), (2, 1), (2, 3), (2, 1), (3, 1), (4, 1), (4, 2)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 3), (2, 1), (2, 3), (2, 1), (2, 1), (2, 3), (2, 1), (2, 1), (2, 3), (2, 1), (3, 1), (3, 1), (4, 1), (4, 2)}   Uskip! (supports) - {(1, 2), (1, 3), (2, 1), (2, 1), (2, 3), (2, 1), (2, 1), (2, 3), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2, 1), (2,			
Domains: $D_{Q_1}: D_{Q_2}: D_{Q_3}: D_{Q_4}: \{1,2,3,4\}$ Relations:  • adjacent (supports) $\rightarrow \{(1,3), (1,4), (2,4), (3,1), (4,1), (4,2)\}$ • skip! (supports) $\rightarrow \{(1,2), (1,4), (2,1), (2,3), (3,2), (3,4), (4,1), (4,3)\}$ • skip2 (supports) $\rightarrow \{(1,2), (1,3), (2,1), (2,3), (2,4), (3,1), (3,2), (3,4), (4,2), (4,3)\}$ Constraints • 12 · Q, and Q, with adjacent • 13 · Q, and Q, with skip! • 14 · Q, and Q, with skip! • 24 · Q, and Q, with skip! • 34 · Q, and Q, with adjacent • 34 · Q, and Q, with adjacent • 34 · Q, and Q, with adjacent • 34 · Q, and Q, with skip! • 35 · Q, and Q, with skip! • 36 · Q, and Q, with skip! • 37 · Q, and Q, with skip! • 38 · Q, and Q, with skip! • 39 · Q, and Q, with skip! • 30 · Q, and Q, with skip! • 30 · Q, and Q, with skip! • 31 · Q, and Q, with skip! • 31 · Q, and Q, with skip! • 32 · Q, and Q, with skip! • 34 · Q, and Q, with skip! • 35 · Q, and Q, with skip! • 36 · Q, and Q, with skip! • 37 · Q, and Q, with skip! • 38 · Q, and Q, with skip! • 39 · Q, and Q, with skip! • 30 · Q, and Q, with skip! • 31 · Q, and Q, with skip! • 31 · Q, and Q, with skip! •			-
Relations:  • adjacent (supports) $\rightarrow \{(1,3), (1,4), (2,4), (3,1), (4,1), (4,2)\}$ • skip! (supports) $\rightarrow \{(1,2), (1,4), (2,1), (2,3), (3,2), (3,4), (4,1), (4,3)\}$ • skip2 (supports) $\rightarrow \{(1,2), (1,3), (2,1), (2,3), (2,4), (3,1), (3,2), (3,4), (4,2), (4,3)\}$ Constraints  • 12 · Q, and Q, with adjacent  • 13 · Q, and Q, with skip!  • 14 · Q, and Q, with skip!  • 24 · Q, and Q, with adjacent  • 25 · Q, and Q, with adjacent  • 26 · Q, and Q, with adjacent  • 27 · Q, and Q, with adjacent  • 28 · Q, and Q, with adjacent  • 29 · Q, and Q, with adjacent  • 20 · Q, and Q, with adjacent  • 21 · Q, and Q, with adjacent  • 22 · Q, and Q, with adjacent  • 29 · Q, and Q, with adjacent  • 20 · Q, and Q, with adjacent  • 21 · Q, and Q, with adjacent  • 22 · Q, and Q, with adjacent  • 24 · Q, and Q, with adjacent  • 25 · Q, and Q, with adjacent  • 26 · Q, and Q, with adjacent  • 27 · Q, and Q, with adjacent  • 28 · Q, and Q, with adjacent  • 29 · Q, and Q, with adjacent  • 20 · Q, and Q, with adjacent  • 21 · Q, and Q, with adjacent  • 22 · Q, and Q, with adjacent  • 24 · Q, and Q, with adjacent  • 25 · Q, and Q, with adjacent  • 26 · Q, and Q, with adjacent  • 27 · Q, and Q, with adjacent  • 28 · Q, and Q, with adjacent  • 29 · Q, and Q, with adjacent  • 20 · Q, and Q, wit	1.1:		
$ \begin{array}{c} \text{$^{\circ}$ adjacent (supports)$} \rightarrow & & & & & & & & & & & & & & & & & & $			+
□ stip! (supports) → $\{(1,2), (1,4), (2,1), (2,3), (3,2), (3,4), (4,1), (4,3)\}$ □ skip2 (supports) → $\{(1,2), (1,3), (2,1), (2,3), (2,4), (3,1), (3,2), (3,4), (4,2), (4,3)\}$ Constraints □ 12 · Q, and Q, with adjacent □ 13 · Q, and Q, with skip1 □ 14 · Q, and Q, with adjacent □ 24 · Q, and Q, with adjacent □ 34 · Q, and Q, with adjacent □ 35 · Q, and Q, with adjacent □ 37 · Q, and Q, with adjacent □ 38 · Q, and Q, with adjacent □ 37 · Q, and Q, with adjacent □ 38 · Q, and Q, with adjacent □ 37 · Q, and Q, with adjacent □ 38 · Q, and Q, with adjacent □ 37 · Q, and Q, with adjacent □ 38 · Q, and Q, with adjacent □ 39 · Q, and Q, with adjacent □ 30 · Q, and Q, with adjacent □			
Using (supports) $\rightarrow \{(1,2),(1,3),(2,1),(2,3),(2,4),(3,1),(3,2),(3,4),(4,2),(4,3)\}$ Constraints  Solve and Q, with adjacent  Solve and Q, with skip!  1.2. $C_{Q_1,Q_1}$ : values of $Q_1$ and $Q_2$ must be such that they are not in the same row or diagonal  1.3. Size of CSP: 256  1.4. Constraint graph  Q, $\{1,2,3,43\}$ $\{1,2,3,43\}$ $\{1,2,3,43\}$			+
Constraints  Cons			+
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			.3)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			
$ \begin{array}{c} \mbox{$ \hookrightarrow$ 14: Q, and } \mbox{$ Q_{4}$ with $skip2$} \\ \mbox{$ \hookrightarrow$ 24: Q_{2}$ and } \mbox{$ Q_{4}$ with $skip1$} \\ \mbox{$ \hookrightarrow$ 24: Q_{3}$ and } \mbox{$ Q_{4}$ with $skip1$} \\ \mbox{$ \hookrightarrow$ 24: Q_{3}$ and } \mbox{$ Q_{4}$ with $adjattnt$} \\ \mbox{$ \bowtie$ 24: Q_{3}$ and } \mbox{$ Q_{4}$ with $adjattnt$} \\ \mbox{$ \bowtie$ 24: Q_{3}$ and } \mbox{$ Q_{4}$ with $adjattnt$} \\ \mbox{$ \bowtie$ 26: Q_{3}$ } \mbox{$ \bowtie$ 26: Q_{4}$ } \\ \mbox{$ \bowtie$ 26: Q_{2}$ } \mbox{$ \bowtie$ 26: Q_{4}$ } \\ \mbox{$ \bowtie$ 26: Q_{2}$ } \mbox{$ \bowtie$ 26: Q_{4}$ } \\ \mbox{$ \bowtie$ 26: Q_{4}$ } \mbox$		5 12 Q and Q, with adjactnt	
Use 27: Q. and Q. with adjacent use 24: Q. and Q. with skip1 use 34: Q. and Q. with adjacent use 34: Q. and Q.			4
1.2 Cai, $\alpha_j$ : values of $\alpha_j$ and $\alpha_j$ with adjacent or diagonal or diagonal 1.3: Size of CSP: 256  1.4: Constraint graph  Q1  Q2  \{\frac{1}{2}, 2, 3, 4\}{\frac{3}{2}}\$  Q2  \{\frac{1}{2}, 2, 3, 4\}{\frac{3}{2}}\$  Q4  \{\frac{1}{2}, 2, 3, 4\}{\frac{3}{2}}\$  Q4  \{\frac{1}{2}, 2, 3, 4\}{\frac{3}{2}}\$			4
1.2. $C_{Q_i,Q_j}$ : values of $Q_i$ and $Q_j$ must be such that they are not in the same row or diagonal  1.3: Size of $CSP: 25 w$ 1.4: Constraint graph  Q <sub>1</sub> $\{1,2,3,43\}$ $Q_2$ $\{1,2,3,43\}$ $\{1,2,3,43\}$ $\{1,2,3,43\}$			
1.2. $C_{Q_i,Q_j}$ : values of $Q_i$ and $Q_j$ must be such that they are not in the same row or diagonal  1.3: Size of $CSP: 25 w$ 1.4: Constraint graph  Q <sub>1</sub> $\{1,2,3,43\}$ $Q_2$ $\{1,2,3,43\}$ $\{1,2,3,43\}$ $\{1,2,3,43\}$			
1.2. Cai.Qj: values of Qi and Qj must be such that they are not in the same row or diagonal  1.3: Size of CSP: 256  1.4: Constraint graph  Qi  1.1.2.3.43  Qi  1.1.2.3.43  Qi  1.1.2.3.43			
or diagonal  1.3: Size of CSP: 256  1.4: Constraint graph  Q1  Q1  Q1  Q2  Q4  Q4  Q1, 2,3,43  Q4  Q1, 2,3,43  Q4  Q1, 2,3,43			
1.4: Constraint graph  Q <sub>1</sub> $\{1,2,3,4\}$ $\{1,2,3,4\}$ An adjacent relation  Skip1 relation $\{1,2,3,4\}$ $\{1,2,3,4\}$			
Q <sub>1</sub>		or diagonal	
\[ \begin{align*} \begin{align*} \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\		or diagonal	
Q <sub>2</sub> {1, 2, 3, 43} Q <sub>3</sub> Q <sub>4</sub>	1.3:	or diagonal size of CSP: 256	
Q <sub>2</sub> {1, 2, 3, 43} Q <sub>3</sub>	1.3:	or diagonal  size of CSP: 256  Constraint graph	
{1, 2, 3, 43} {1, 2, 3, 43}	1.3:	or diagonal  Size of CSP: 256  Constraint graph  Alignment relation	
{1, 2, 3, 43} {1, 2, 3, 43}	1.3:	or diagonal  Size of CSP: 256  Constraint graph  Q1  E1. 2, 3, 43  Skipl relation	
Q <sub>3</sub>	1.3:	or diagonal  size of CSP: 256  Constraint graph  Q,  {1,2,3,43}  — skip1 relation  skip2 relation	
Q <sub>3</sub> {1, 2, 3, 43	1.3:	or diagonal  size of CSP: 256  Constraint graph  Q1  {1, 2, 3, 43}  Skipl relation  Skip2 relation	
Q <sub>3</sub> {1, 2, 3, 4}	1.3:	or diagonal  size of CSP: 256  Constraint graph  Q1  {1, 2, 3, 43}  Skipl relation  Skip2 relation	
Q <sub>3</sub> {1, 2, 3, 4}	1.3:	or diagonal  size of CSP: 256  Constraint graph  Q1  {1, 2, 3, 43}  Skipl relation  Skip2 relation	
{1, 2, 3, 43}	1.3:	or diagonal  size of CSP: 256  Constraint graph  Q1  {1, 2, 3, 43}  Skipl relation  Skip2 relation	
	1.3:	or diagonal  Size of CSP: 250  Constraint graph $Q_1$ $\{1,2,3,43\}$ $Q_2$ $\{1,2,3,43\}$ $Q_3$ $\{1,2,3,43\}$ $Q_4$ $\{1,2,3,43\}$ $Q_4$	
	1.3:	or diagonal  Size of CSP: 250  Constraint graph $Q_1$ $\{1,2,3,43\}$ $Q_2$ $\{1,2,3,43\}$ $Q_3$ $\{1,2,3,43\}$ $Q_4$ $\{1,2,3,43\}$ $Q_4$	

1.5: Manual arc-consistency was done by uneuking each relation to make sure each domain value has a tuple for each position since the relations are supports. After checking, no values could be removed. 1.6: For Q, Q2: all values of Q3 and Q4 are supported For Q, Q, values 2,3 are not supported for Q2 - Dq2 = \$1, 1/3,43 For Q, Q4: all values of Q2 and Q3 are supported For Q., Q. values 1,4 are not supported for Q.  $\longrightarrow$  DQ.  $\xi$ , 2,3,43 For Q., Q. values 2,3 are not supported for Q.  $\longrightarrow$  DQ.  $\xi$ , 2,3,43 For Q2, Q4: all values of Q, and Q2 are supported For Q., Q. all values of Q. and Q. are supported For Q., Q4: all values of Q2 and Q3 are supported For Q, Q3: All values of Q2 and Q4 are supported For Q2, Q3: values 1.4 are not supported for Q, -> DQ = 81,2,3,43 After applying (1,2)-consistency, 8 values are removed leaving each variable with new domain of size 2. Part 2 · 2.1. Number of variables: 2N-1 2.2: The domain of variables is  $\{1, ..., k\} \cup \{0\}$  with k being the number of squares in in corresponding diagonal and 0 being no gueens in the diagonal. 2.3: Size of CSP (4-queens) 2.3.4.5.4.3.2 = 2880 2.4 (BONUS): (N+1)! (N!)