

Fundamentals of Artificial Intelligence

Laboratory

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Algorithms source code

- <https://github.com/aimacode/aima-java>
- Simplified and self-contained version of minimax on the laboratory website.

Arc-consistency

- Given binary-constraint $C_{X,Y}$: D_X, D_Y are arc consistent if $\forall x \in D_X \exists y \in D_Y$ s.t. $\langle x,y \rangle \in C_{X,Y}$
- E.g.: $D_A = \{1, 2, 3, 4\}$, $D_B = \{1, 2, 3, 4\}$, and $C_{A,B} = B < A$ is **NOT** arc consistent as $A = 1$ is not consistent with $C_{A,B}$
 $\Rightarrow D'_A = \{-, 2, 3, 4\}$ and $D'_B = \{1, 2, 3, -\}$

Exercise 7.1

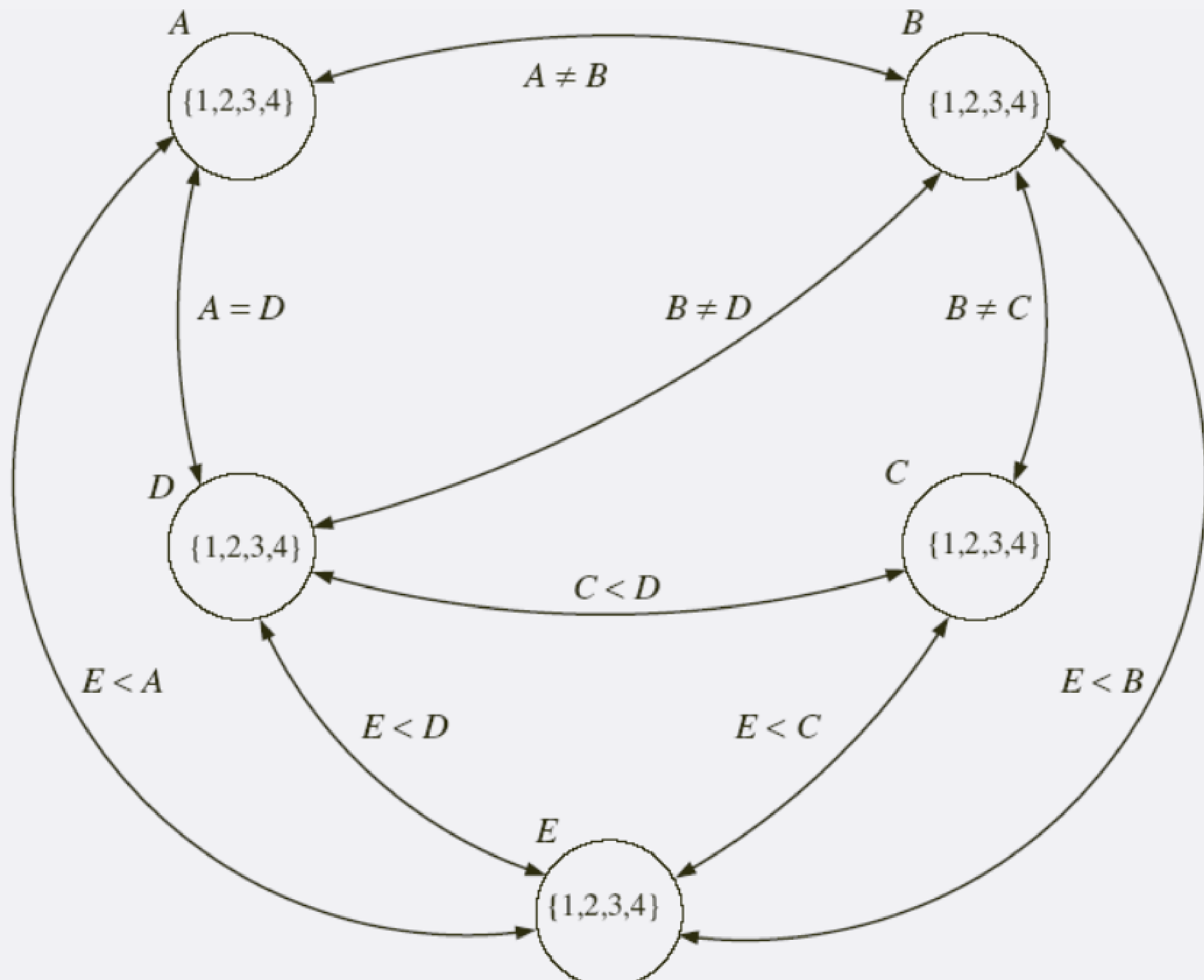
- Scheduling activities
 - Variables: A, B, C, D, E (starting time of activity)
 - Domains: $D_i = \{1, 2, 3, 4\}$, for $i = \mathbf{A, B, \dots, E}$
 - Constraints:
 - $(B \neq 3)$
 - $(C \neq 2)$
 - $(A \neq B)$
 - $(B \neq C)$
 - $(C < D)$
 - $(A = D)$
 - $(E < A)$
 - $(E < B)$
 - $(E < C)$
 - $(E < D)$
 - $(B \neq D)$

- Draw the constraint network and find a solution.

Exercise 7.1

- Constraints network

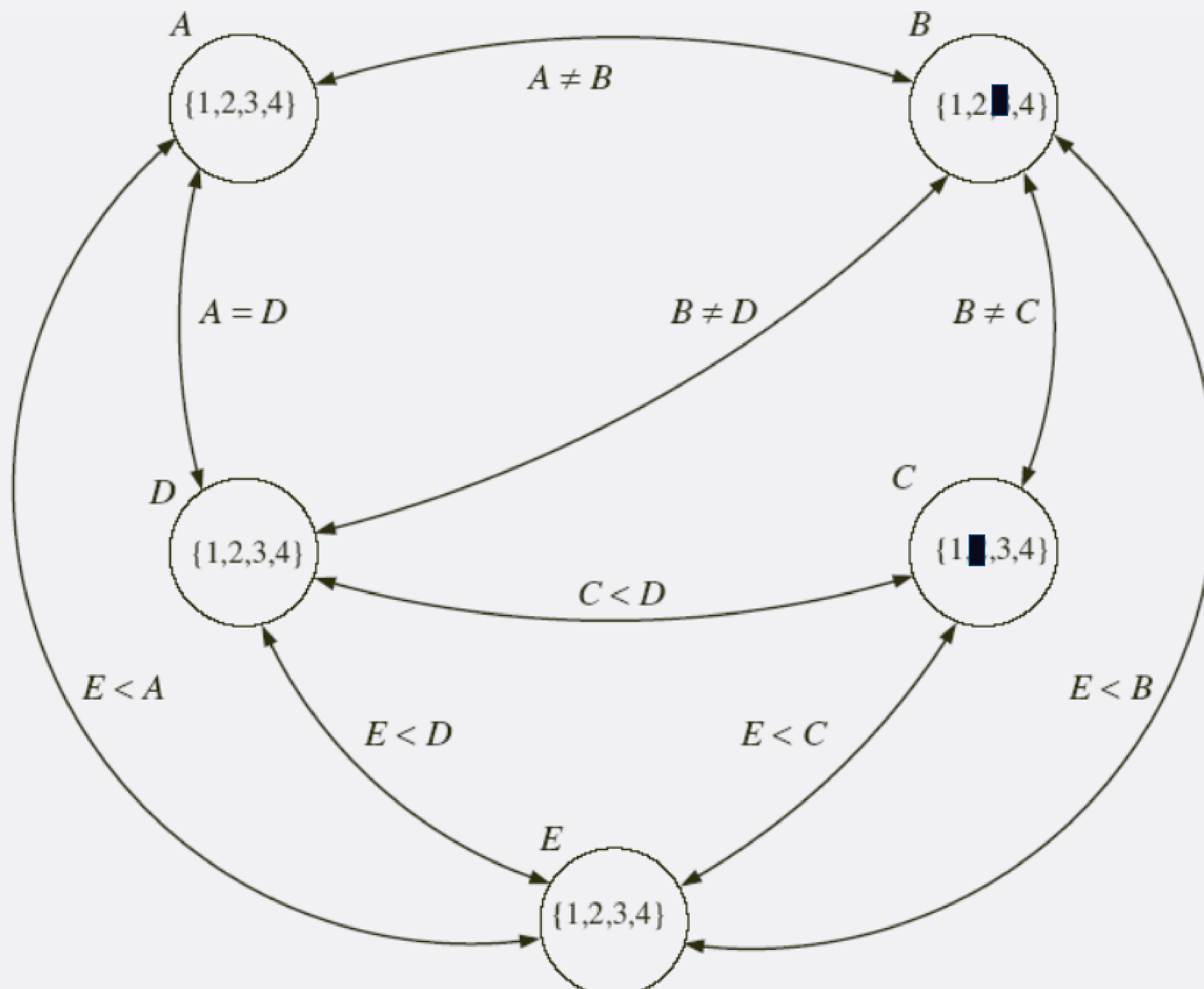
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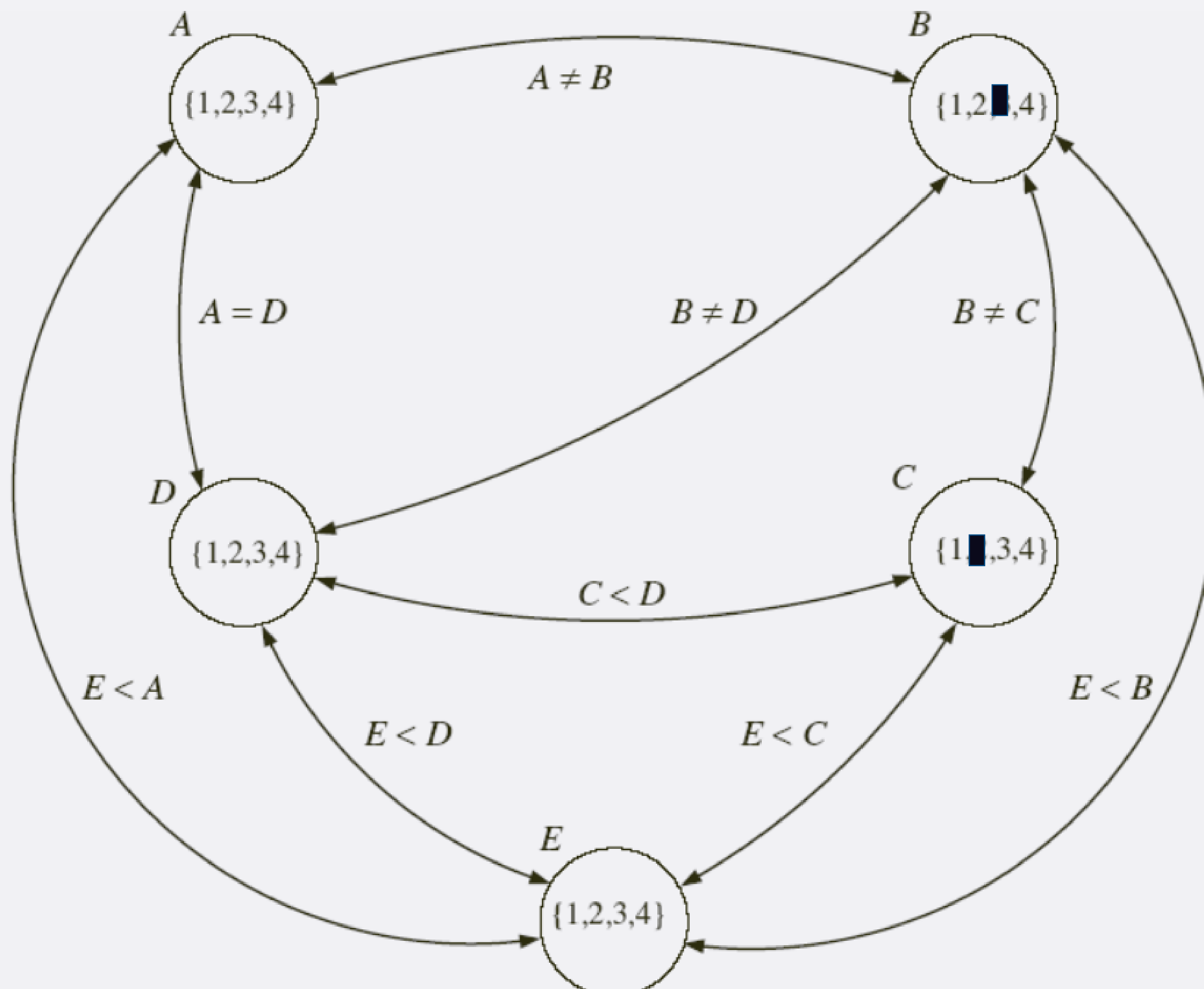
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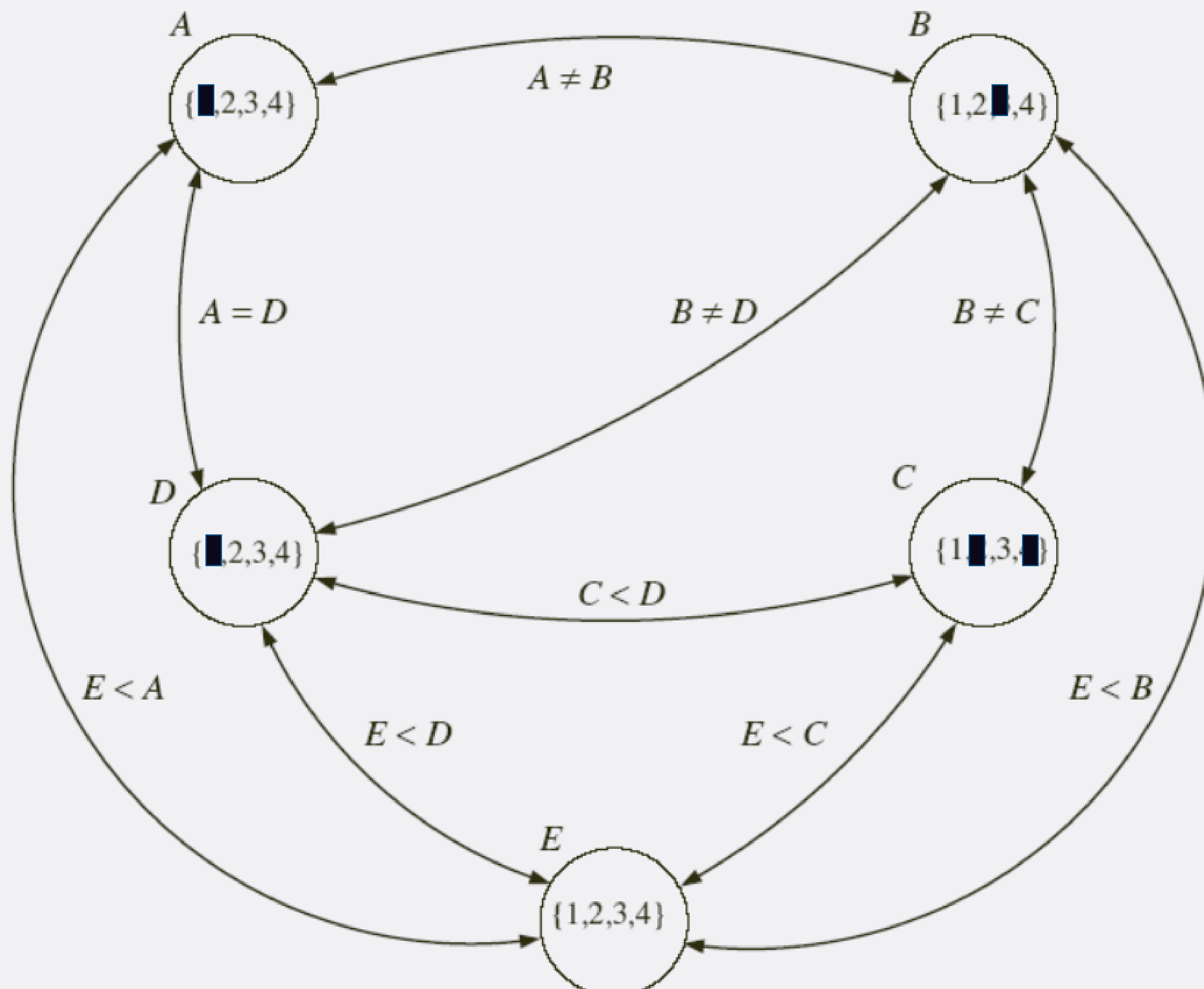
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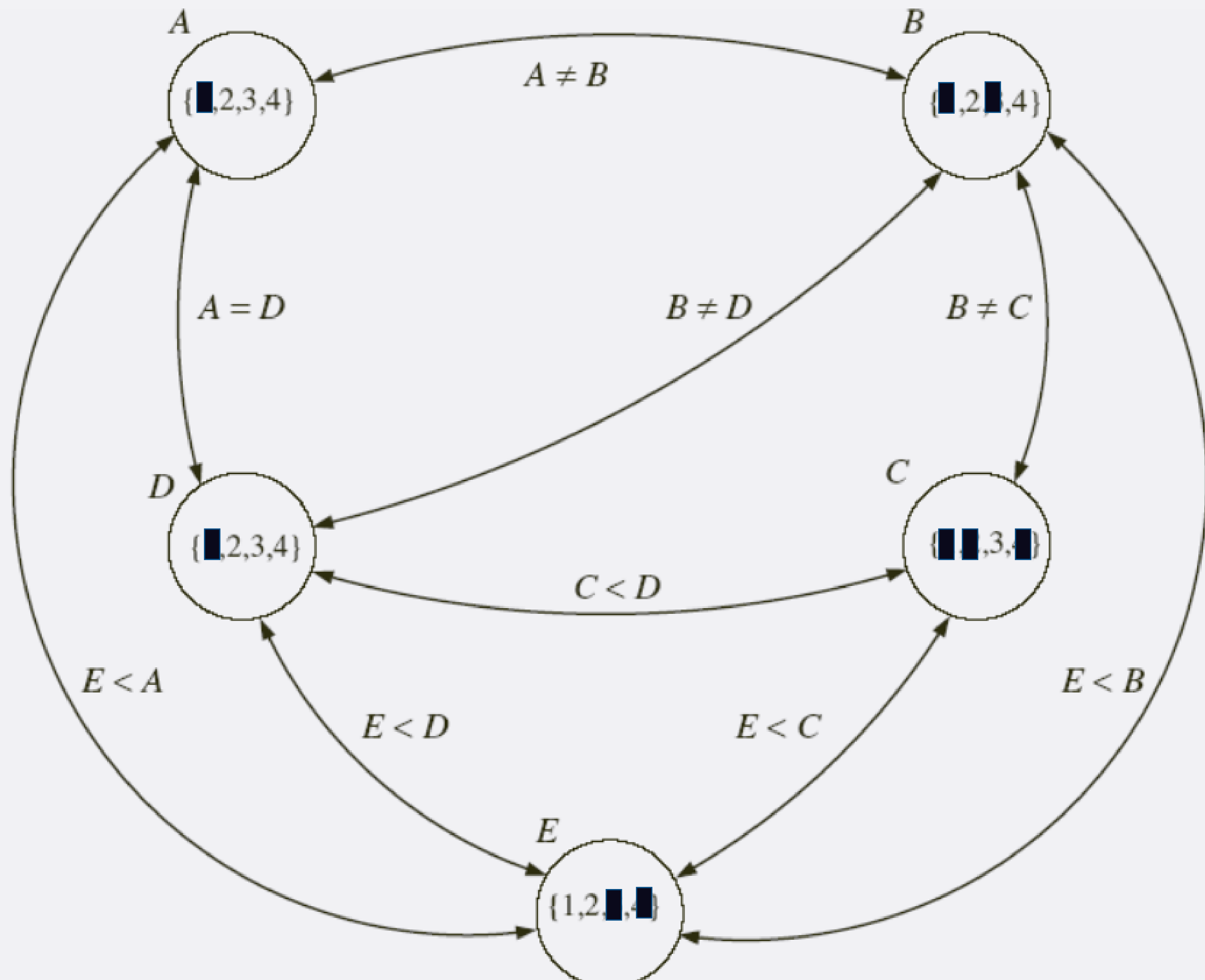
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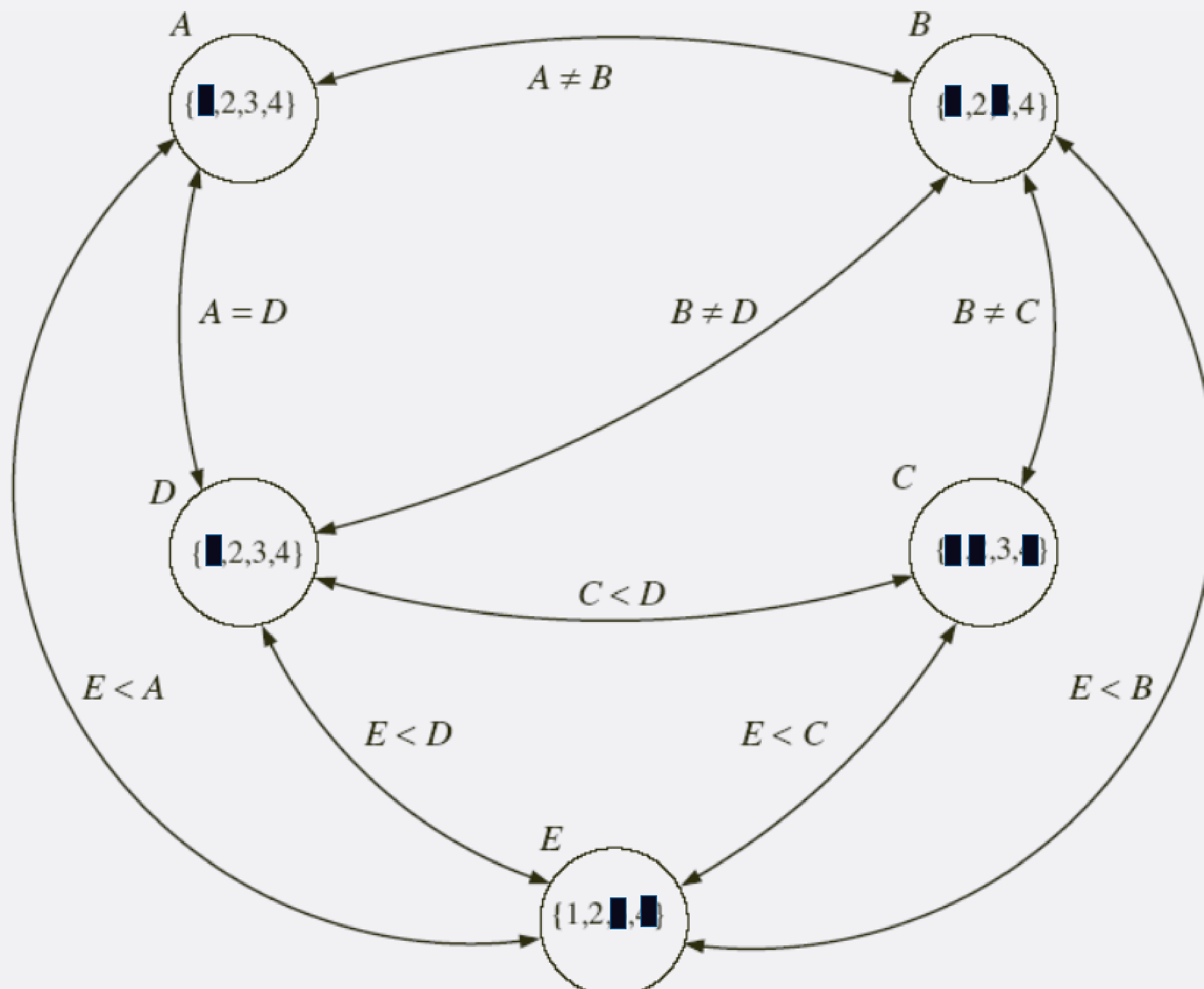
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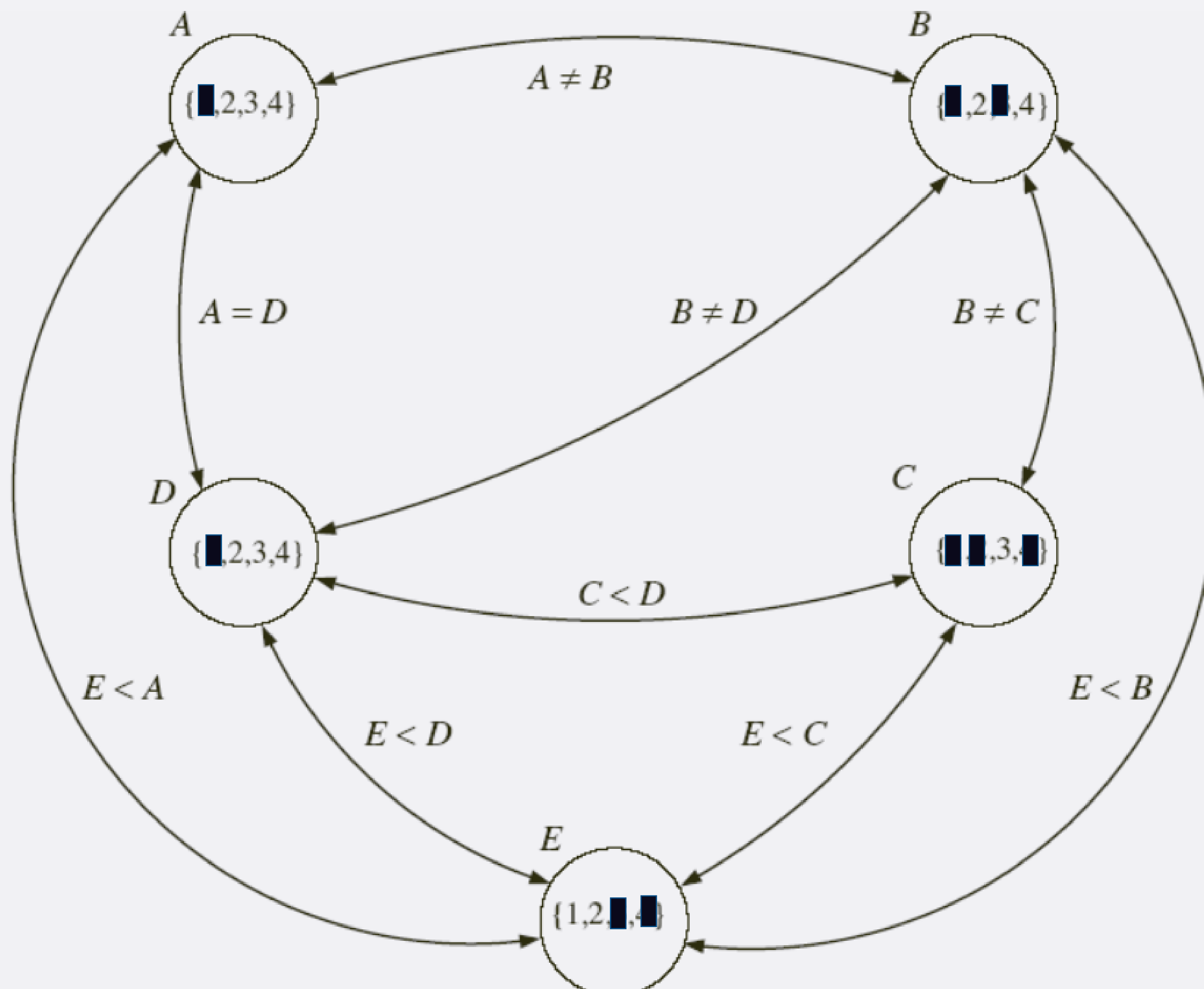
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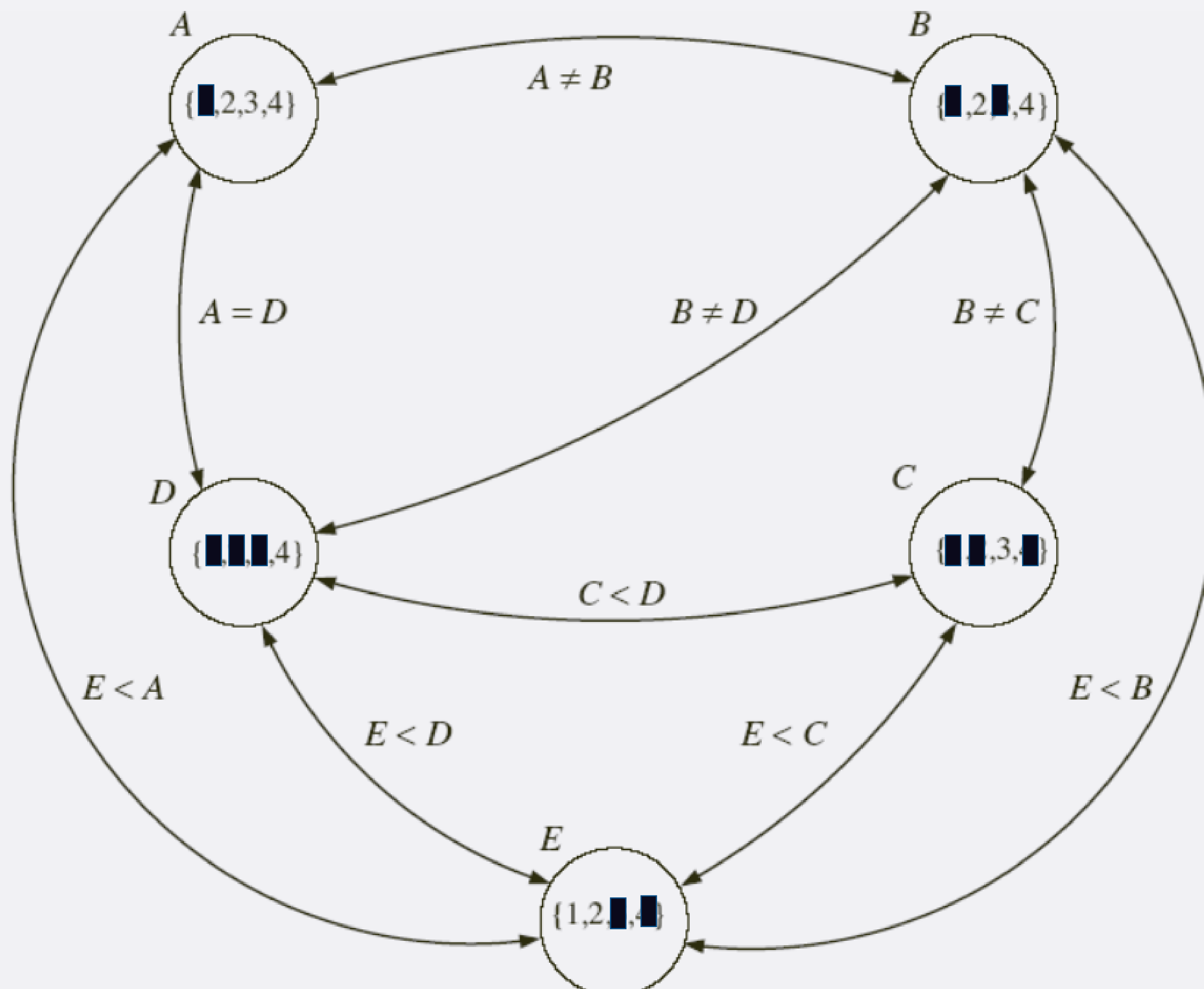
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- Constraints network

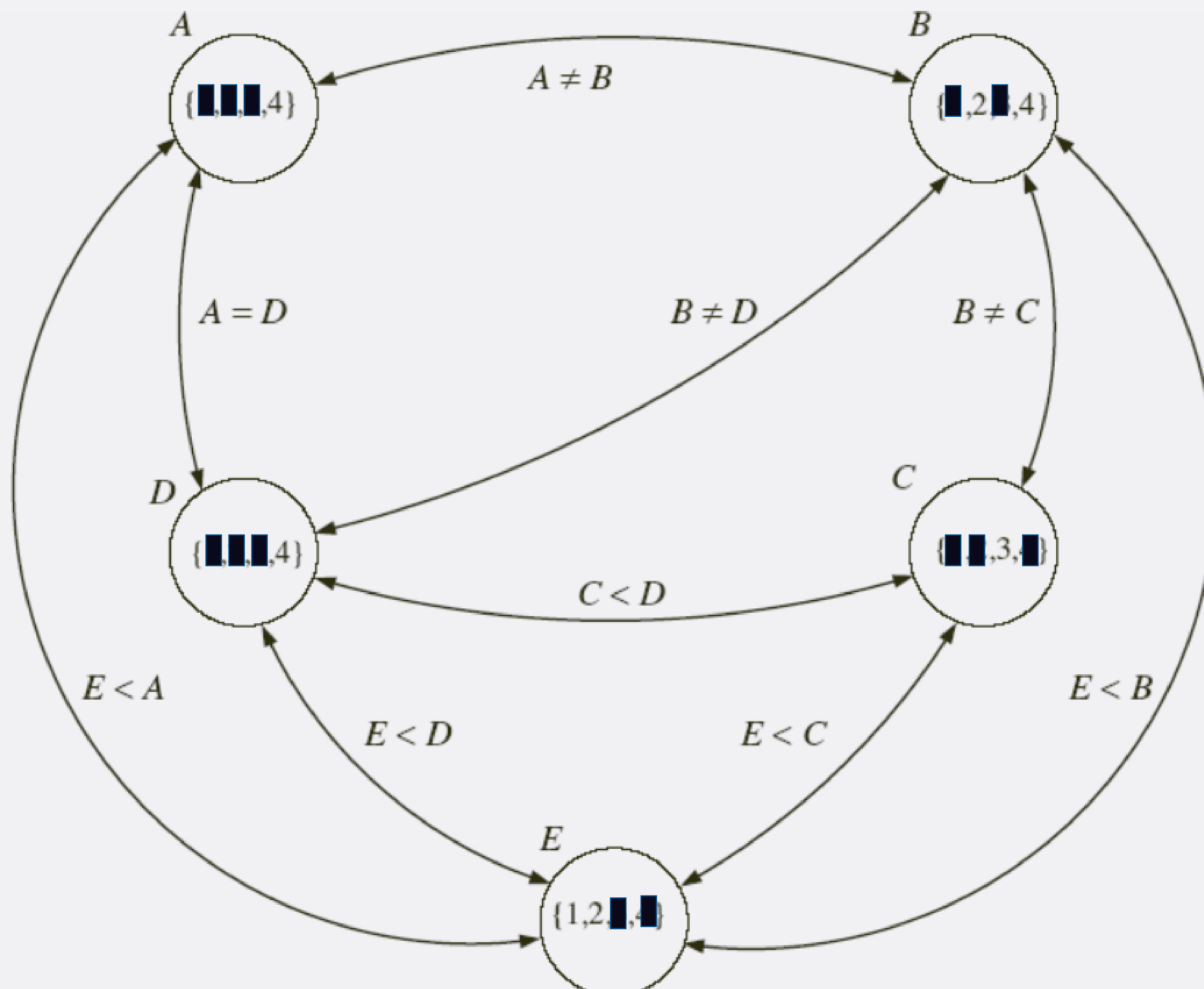
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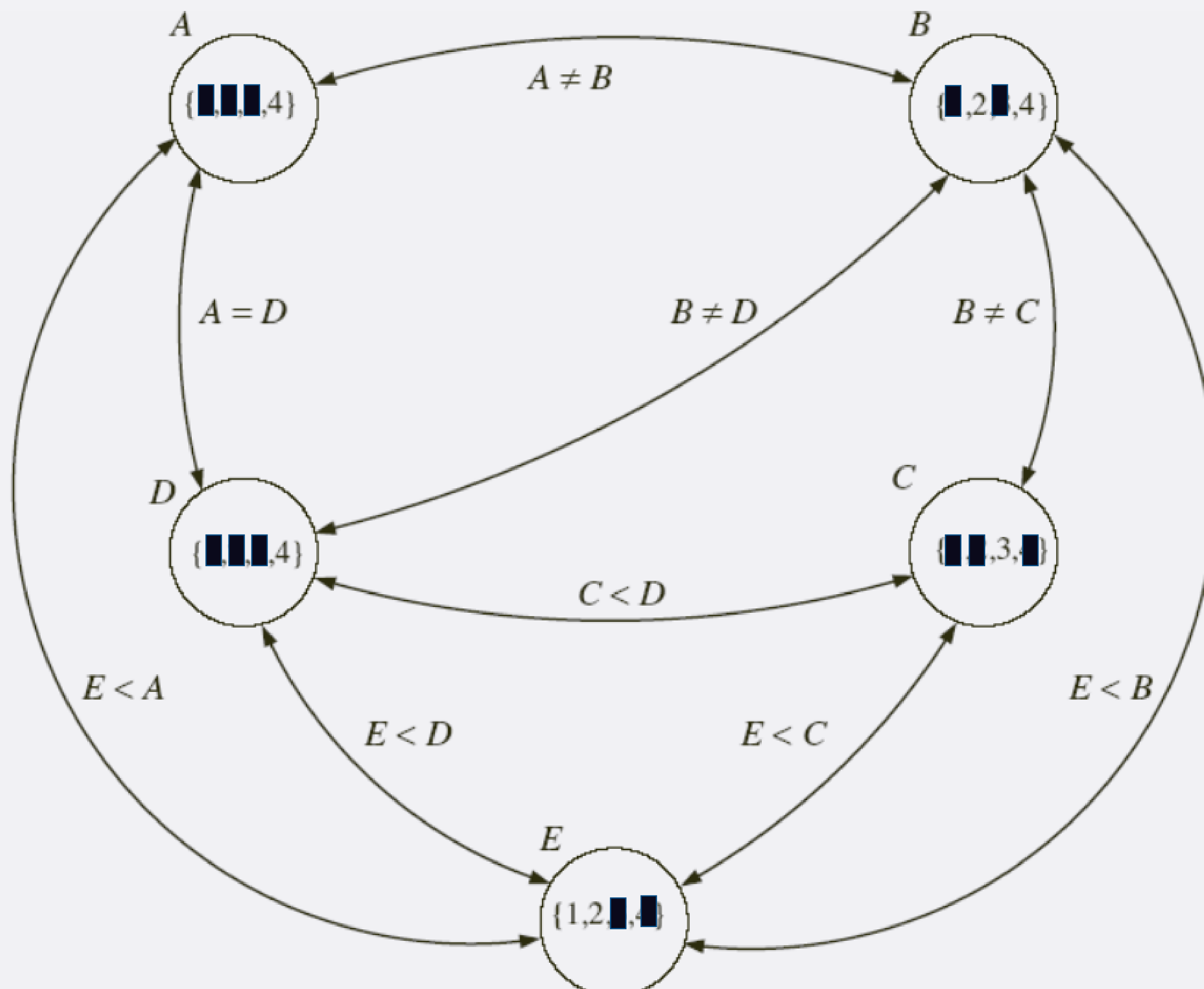
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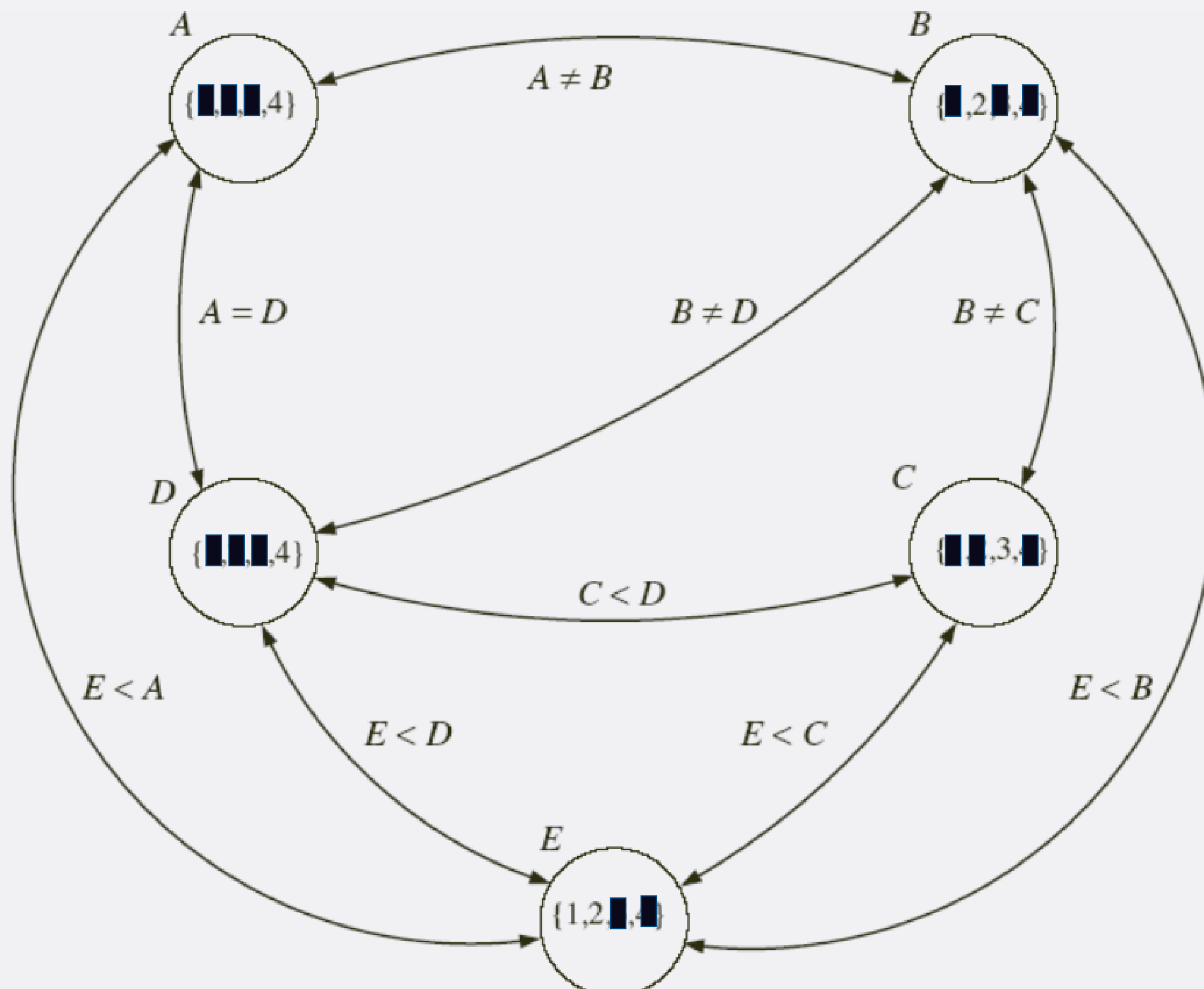
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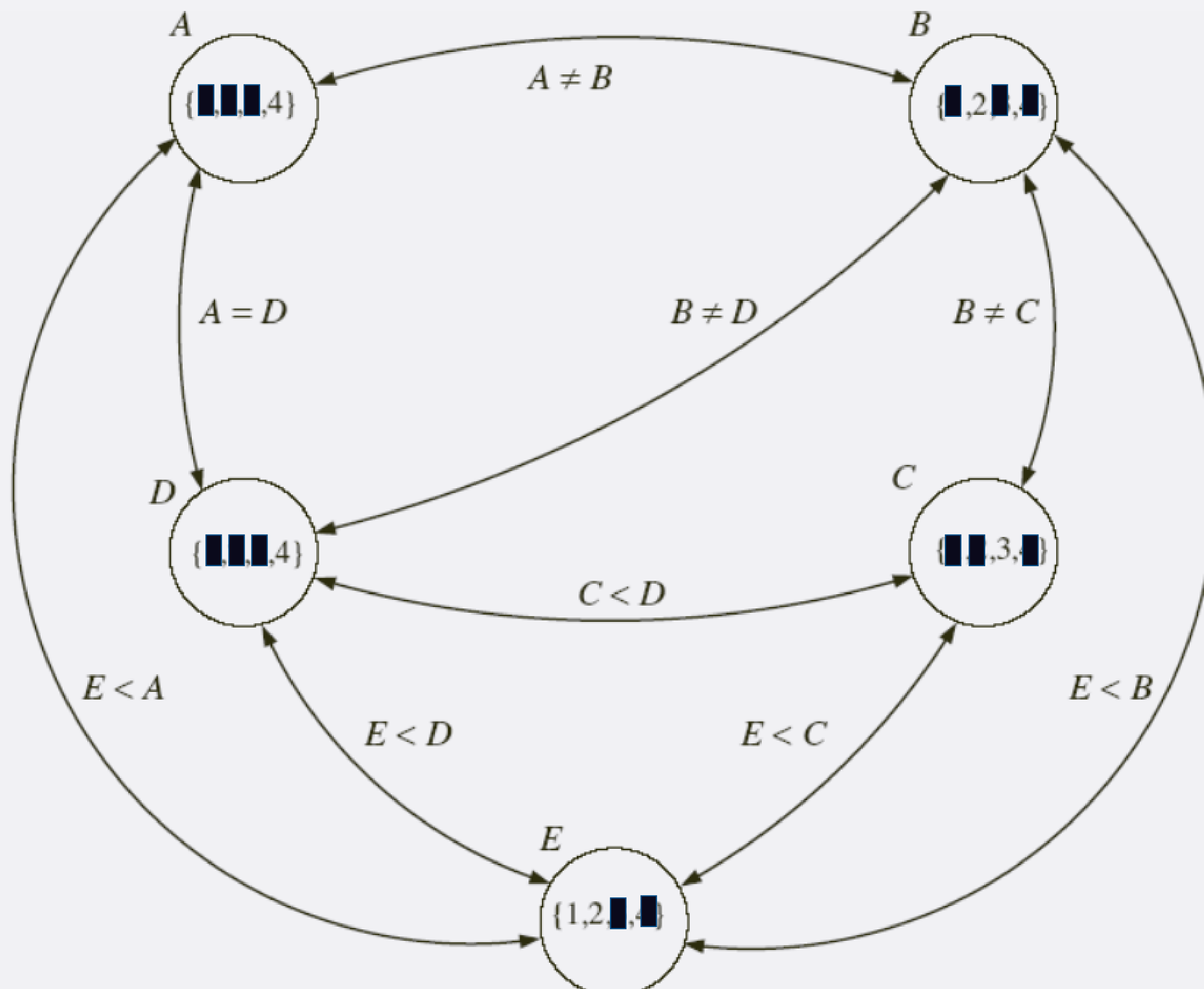
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Exercise 7.1

- Constraints network

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Exercise 7.2

- Consider the following binary constraint network:
 - There are 4 variables: X_1, X_2, X_3, X_4
 - Domains: $D_1=\{1,2,3,4\}$, $D_2=\{3,4,5,8,9\}$, $D_3=\{2,3,5,6,7,9\}$, $D_4=\{3,5,7,8,9\}$
 - The constraints are
 - $X_1 \geq X_2$
 - $X_2 > X_3$ or $X_3 - X_2 = 2$
 - $X_3 \neq X_4$.

- Tasks:
 - a. Is the network arc-consistent? If not, compute the arc-consistent network. (show the whole process of enforcing arc-consistency and not just the final network)
 - b. Is the network consistent? If yes, give a solution.

Exercise 7.2 - Solution

- Task (a)

No, it is not arc-consistent.

Enforce arc-consistency between X_1 and X_2 : $D_1 = \{3, 4\}$ $D_2 = \{3, 4\}$

X_2 and X_3 : $D_2 = \{3, 4\}$ $D_3 = \{2, 3, 5, 6\}$

X_3 and X_4 : $D_3 = \{2, 3, 5, 6\}$ $D_4 = \{3, 5, 7, 8, 9\}$

So the arc-consistent domains are

$D_1 = \{3, 4\}$ $D_2 = \{3, 4\}$ $D_3 = \{2, 3, 5, 6\}$ $D_4 = \{3, 5, 7, 8, 9\}$

- Task (b)

$X_1 = 4, X_2 = 4, X_3 = 3, X_4 = 9$

Exercise 7.5

- Download “Problem 7.5 Text” from the laboratory website.

Exercise 7.5

■ Question 1

5 variables: AR-1, AR-2, MLR, CR, IWR

4 constraints:

1. IAR says ≤ 1 of 15-381, 15-681, and 19-601 can be assigned to the 5 variables.
2. BAR says ≤ 1 of 15-211 and 70-122 can be assigned to the 5 variables
3. OR says ≤ 1 of 21-484 and 70-311 can be assigned to the 5 variables
4. No double counting says if a variable is assigned to one variable it can't be assigned to another variable

Initial domains:

AR-1: 15-211, 15-212, 15-381, 15-681, 21-484

AR-2: 15-211, 15-212, 15-381, 15-681, 21-484

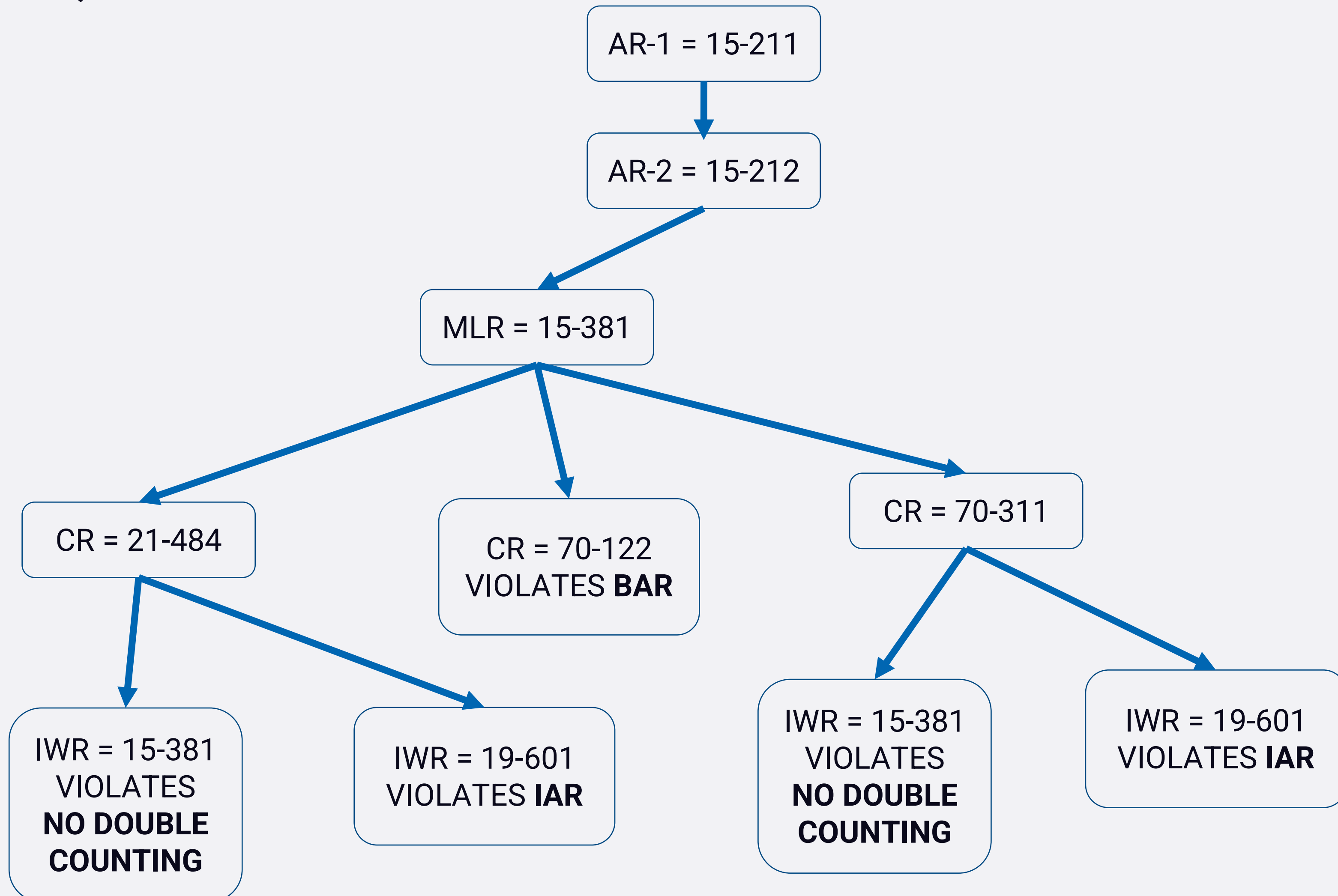
MLR: 15-381, 15-681, 80-310

CR: 21-484, 70-122, 70-311

IWR: 15-381, 19-601

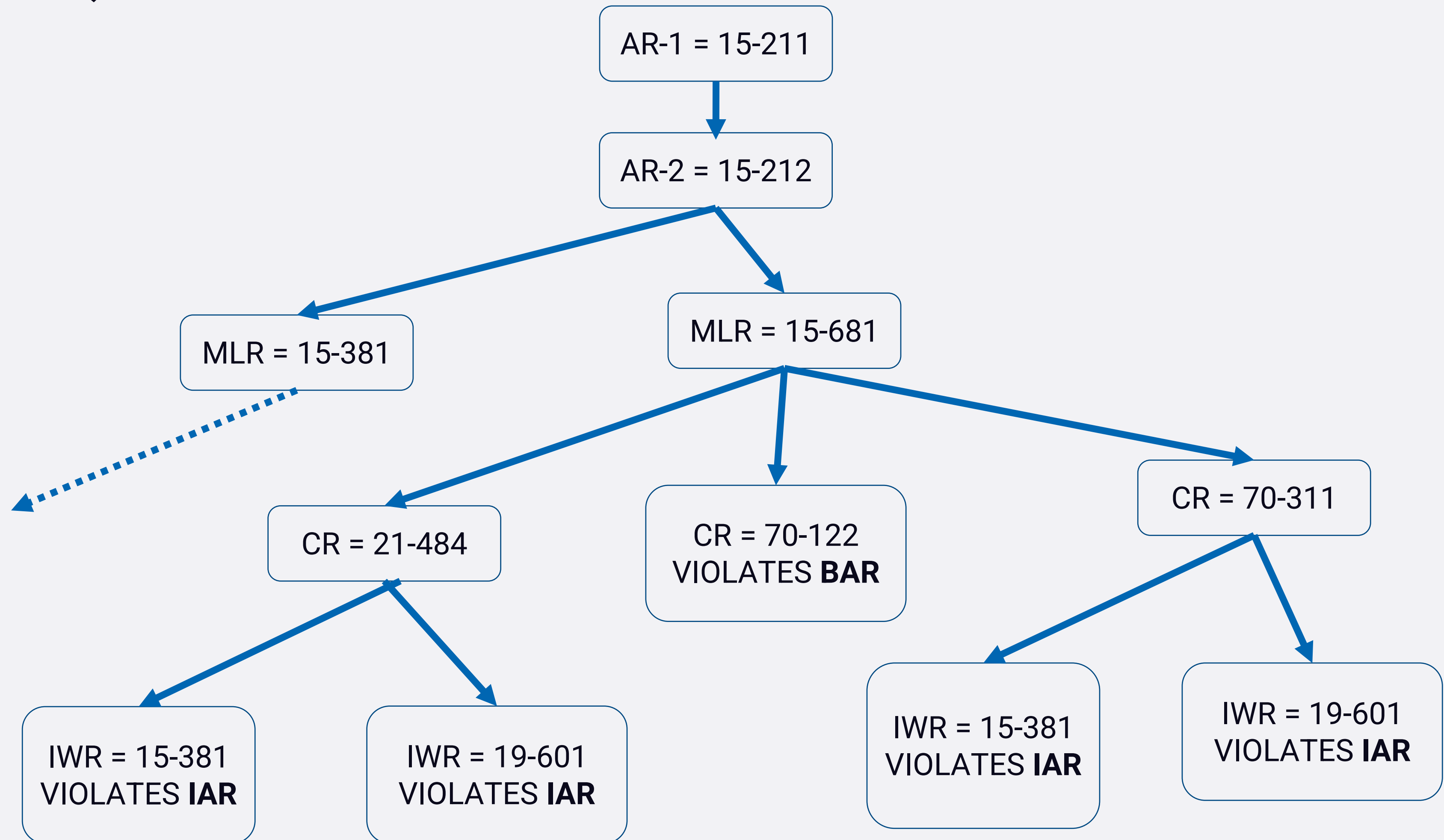
Exercise 7.5

- Question 2



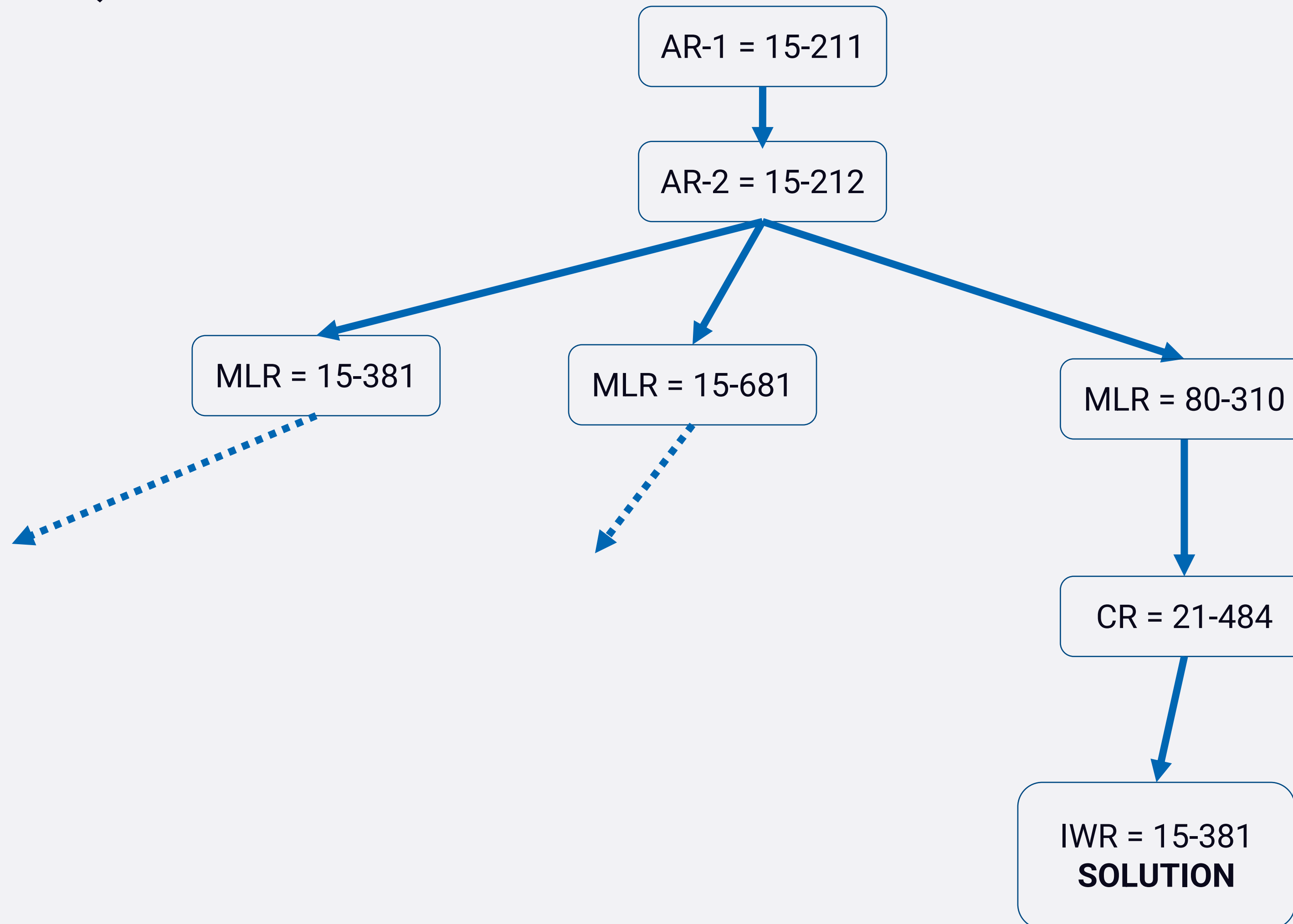
Exercise 7.5

- Question 2



Exercise 7.5

- Question 2



Exercise 7.3

- Consider the following binary constraint network:
 - There are 4 variables: X_1, X_2, X_3, X_4
 - Domains: $D_1=\{1,2,5,7\}$, $D_2=\{1,2,6,8,9\}$, $D_3=\{2,4,6,7,8,9\}$, $D_4=\{1,2,3,8,9\}$
 - The constraints are
 - $X_1=X_2$
 - $X_2 < X_3$ or $X_2 - X_3 = 3$
 - $X_3 > X_4$.

- Tasks:
 - a. Is the network arc-consistent? If not, compute the arc-consistent network. (show the whole process of enforcing arc-consistency and not just the final network)
 - b. Is the network consistent? If yes, give a solution.

Exercise 7.4

- Consider the following binary constraint network:
 - There are 5 variables: X_1, X_2, X_3, X_4, X_5
 - Domains: $D_1=\{3,4,5,7,9\}$, $D_2=\{2,4,6,8,9\}$, $D_3=\{1,2,6,8,9\}$,
 $D_4=\{1,2,3,8,9\}$, $D_5=\{2,5,6,7,8\}$
 - The constraints are
 - $X_1 > X_2$ or $X_2 - X_1 = 2$
 - $X_2 < X_3$
 - $X_2 > X_4$ or $X_2 - X_4 = 1$
 - $X_3 > X_5$.

- Tasks:
 - a. Is the network arc-consistent? If not, compute the arc-consistent network. (show the whole process of enforcing arc-consistency and not just the final network)
 - b. Is the network consistent? If yes, give a solution.

Exercise 7.6

- Consider the following binary constraint network:
 - There are 5 variables: $X1, X2, X3, X4, X5$
 - Domains: $D1=\{1,3,4,5,6,9\}$, $D2=\{3,4,5,7,8,9\}$, $D3=\{1,4,5,6,7,9\}$,
 $D4=\{1,2,3,4,6,8\}$, $D5=\{2,3,4,5,7,9\}$
 - The constraints are
 - $X1=X2$
 - $X2+X3=9$ or $X3<X2$
 - $X3\neq X4$
 - $X5>X2$.

- Tasks:
 - a. Is the network arc-consistent? If not, compute the arc-consistent network. (show the whole process of enforcing arc-consistency and not just the final network)
 - b. Is the network consistent? If yes, give a solution.