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 = A, B, …, 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

  - (B ≠ 3)
  - (C ≠ 2)
  - (A ≠ B)
  - (B ≠ C)
  - (C < D)
  - (A = D)
  - (E < A)
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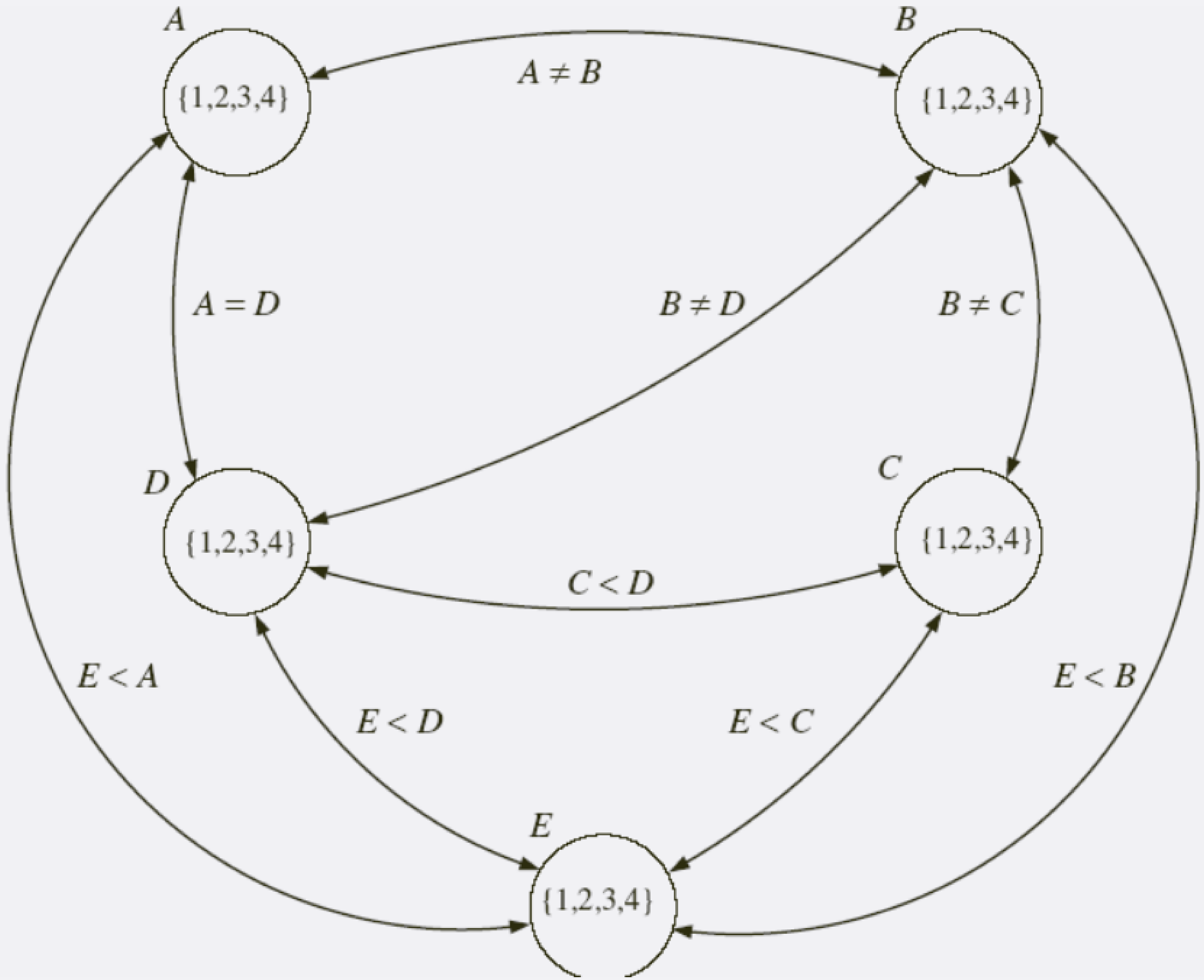
  - (B ≠ D)



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- Constraints network

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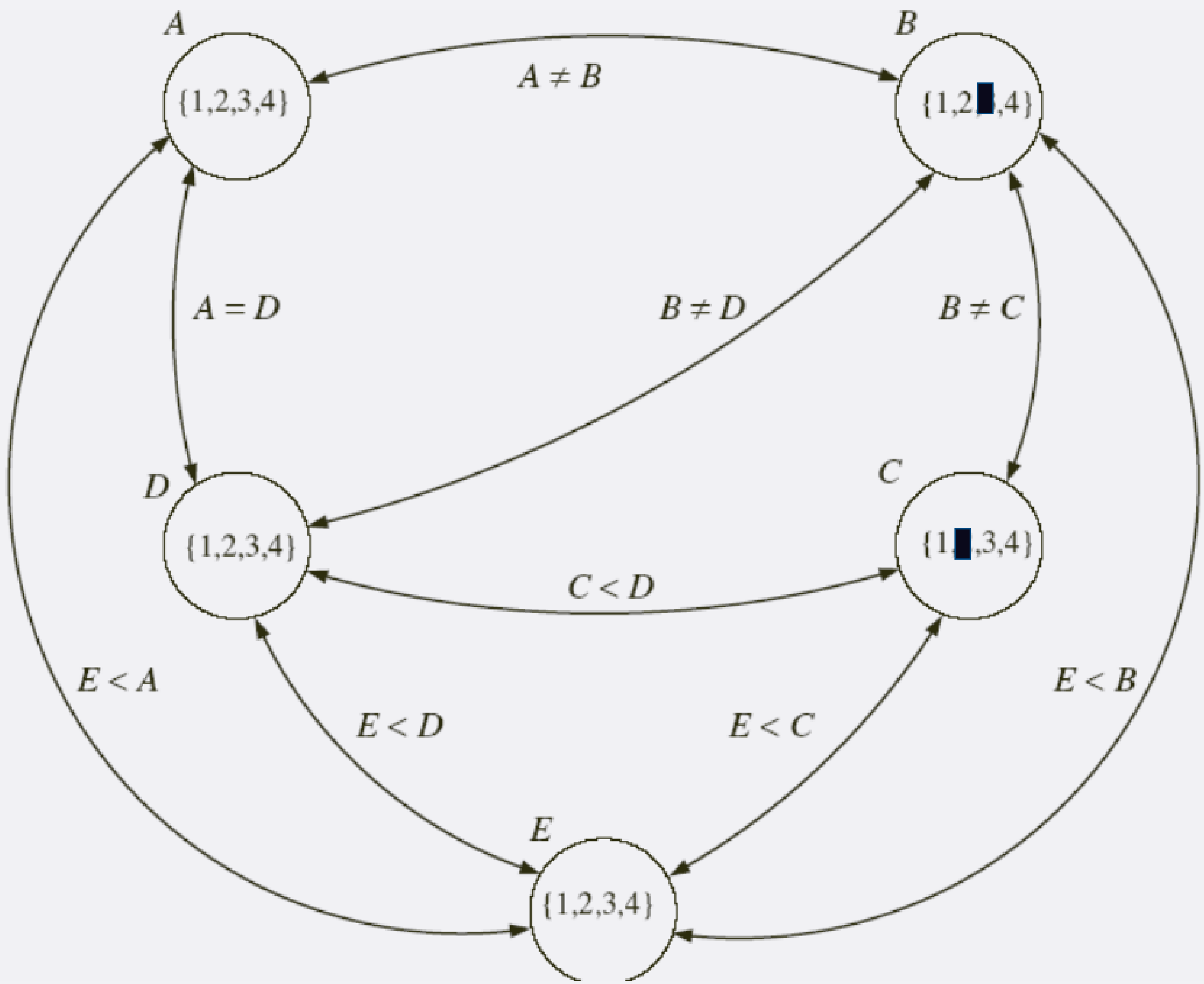

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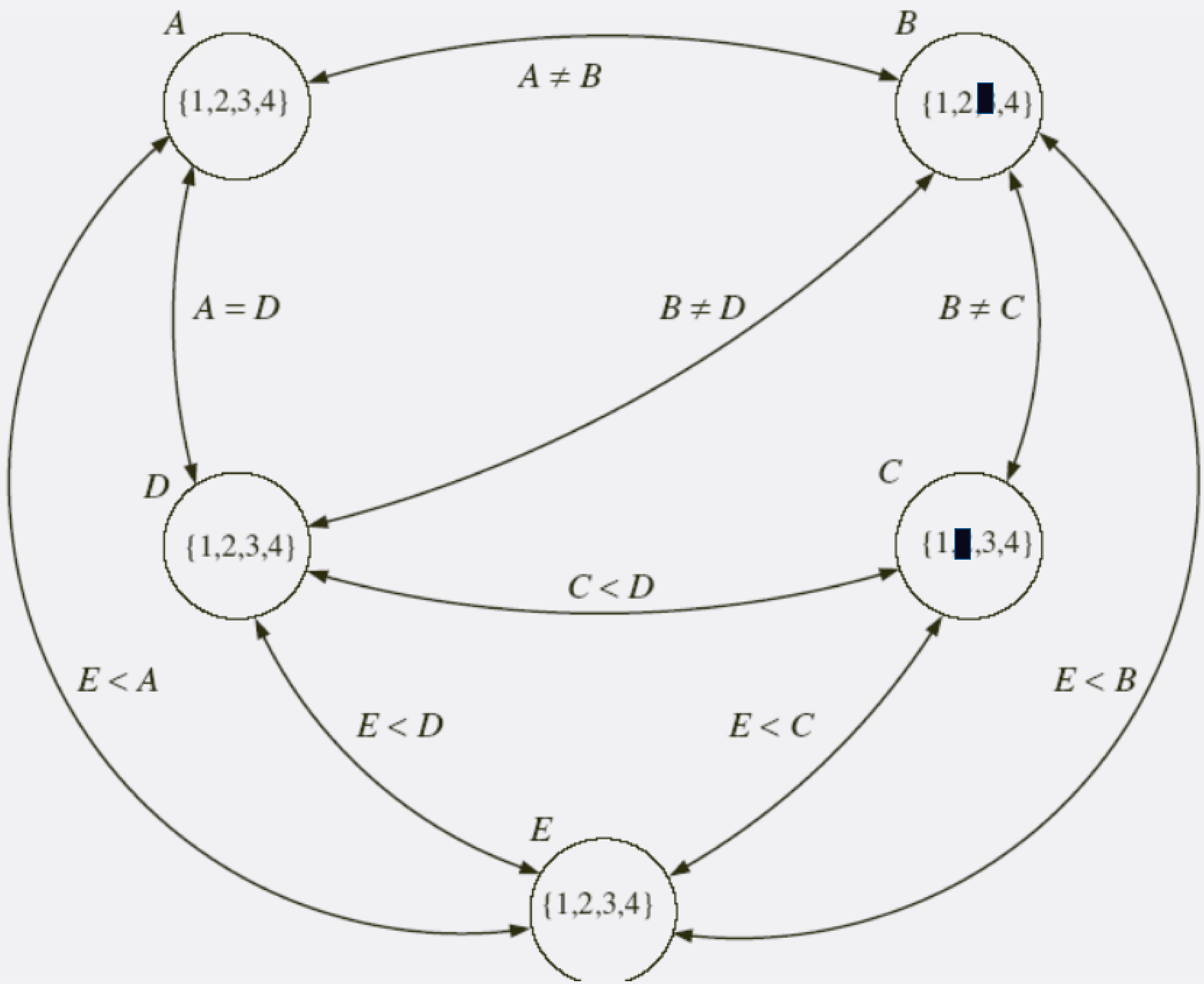

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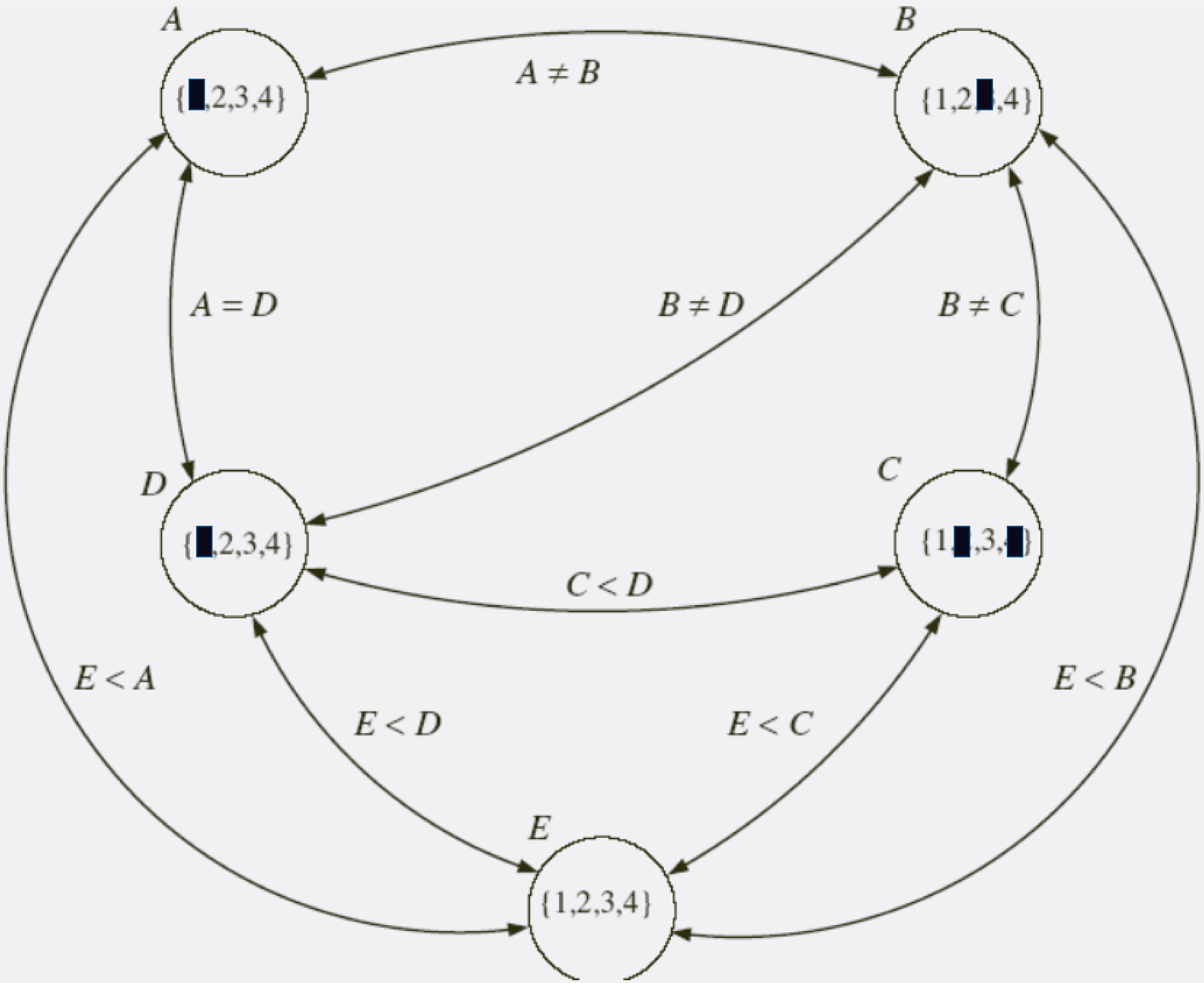

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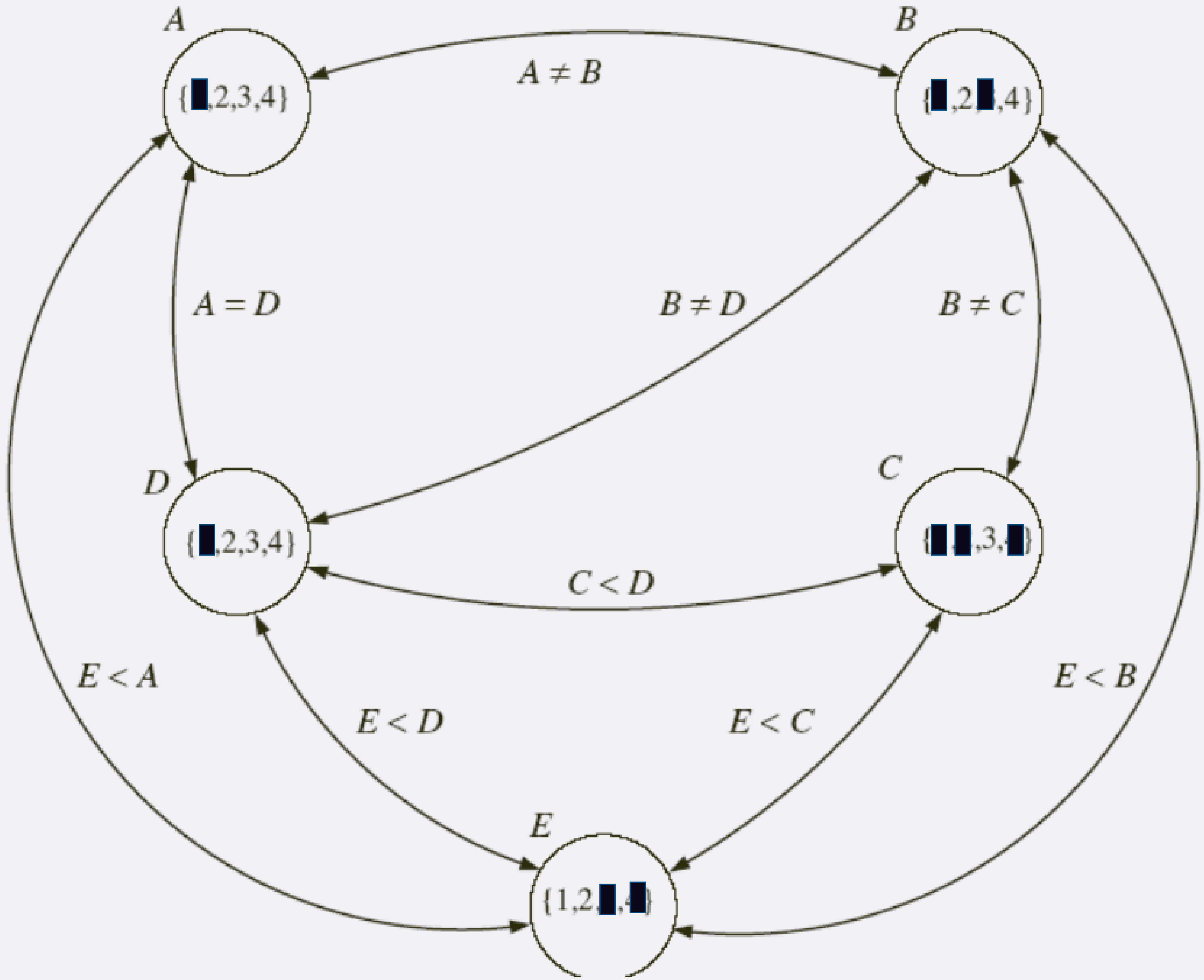

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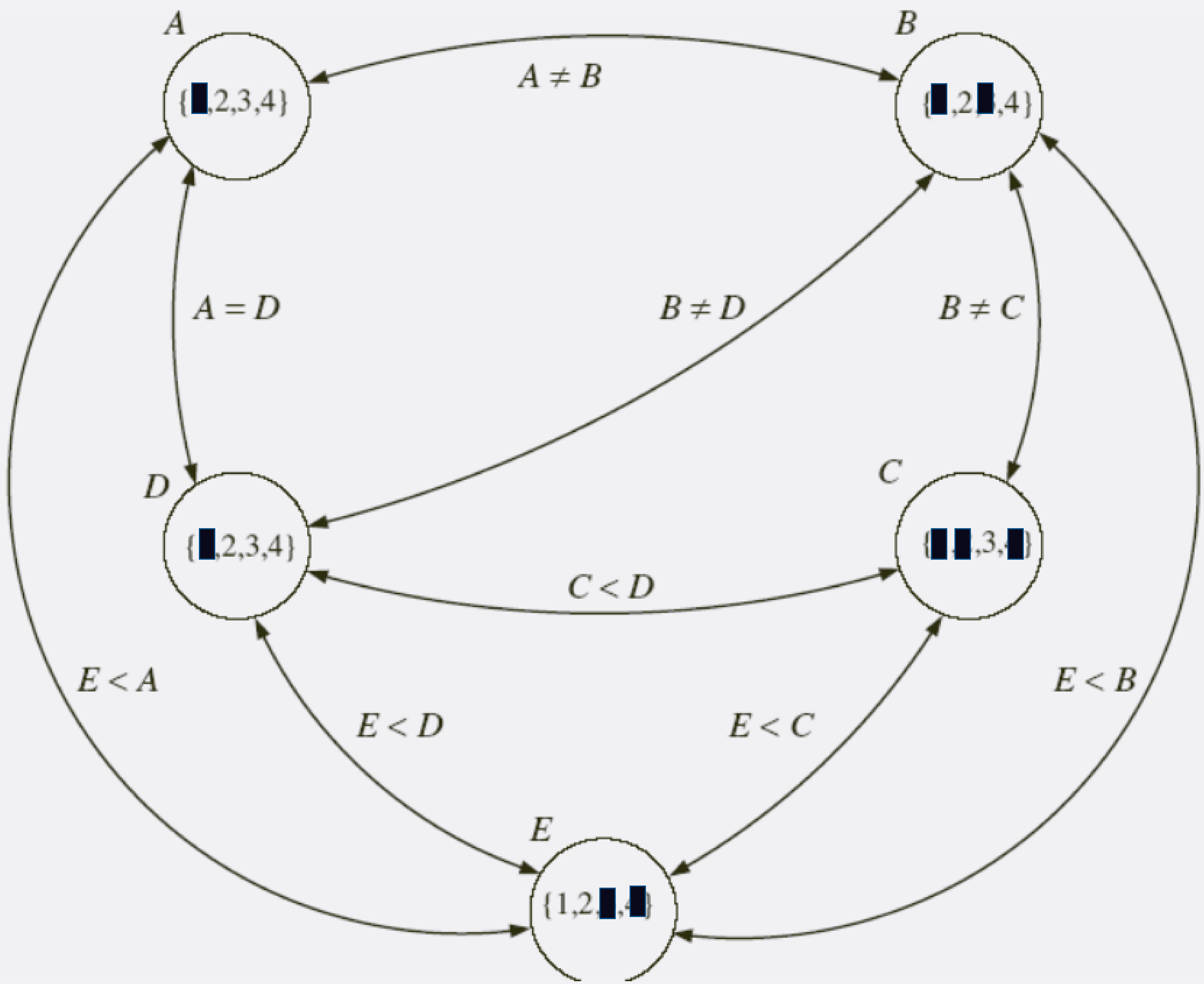

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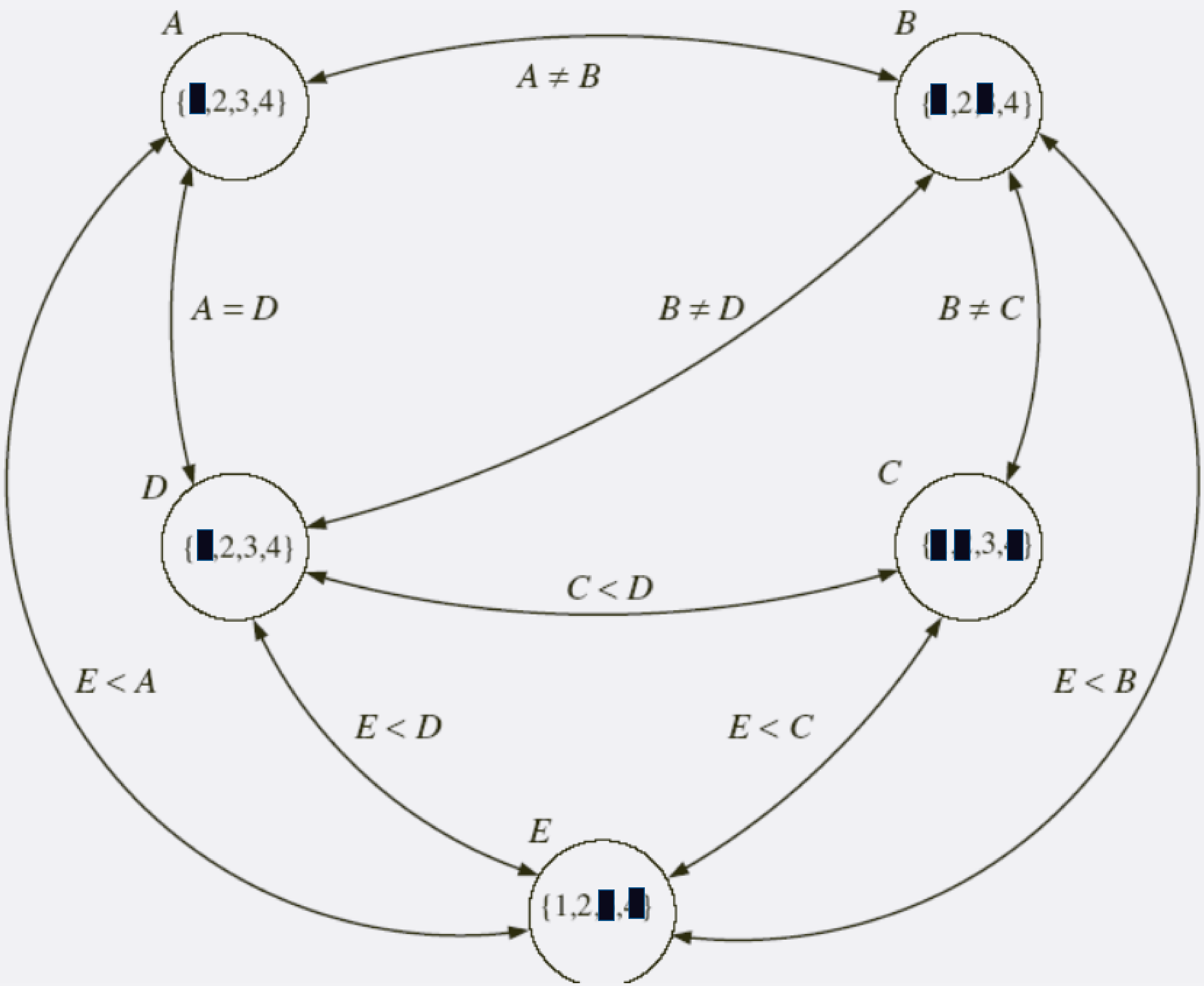

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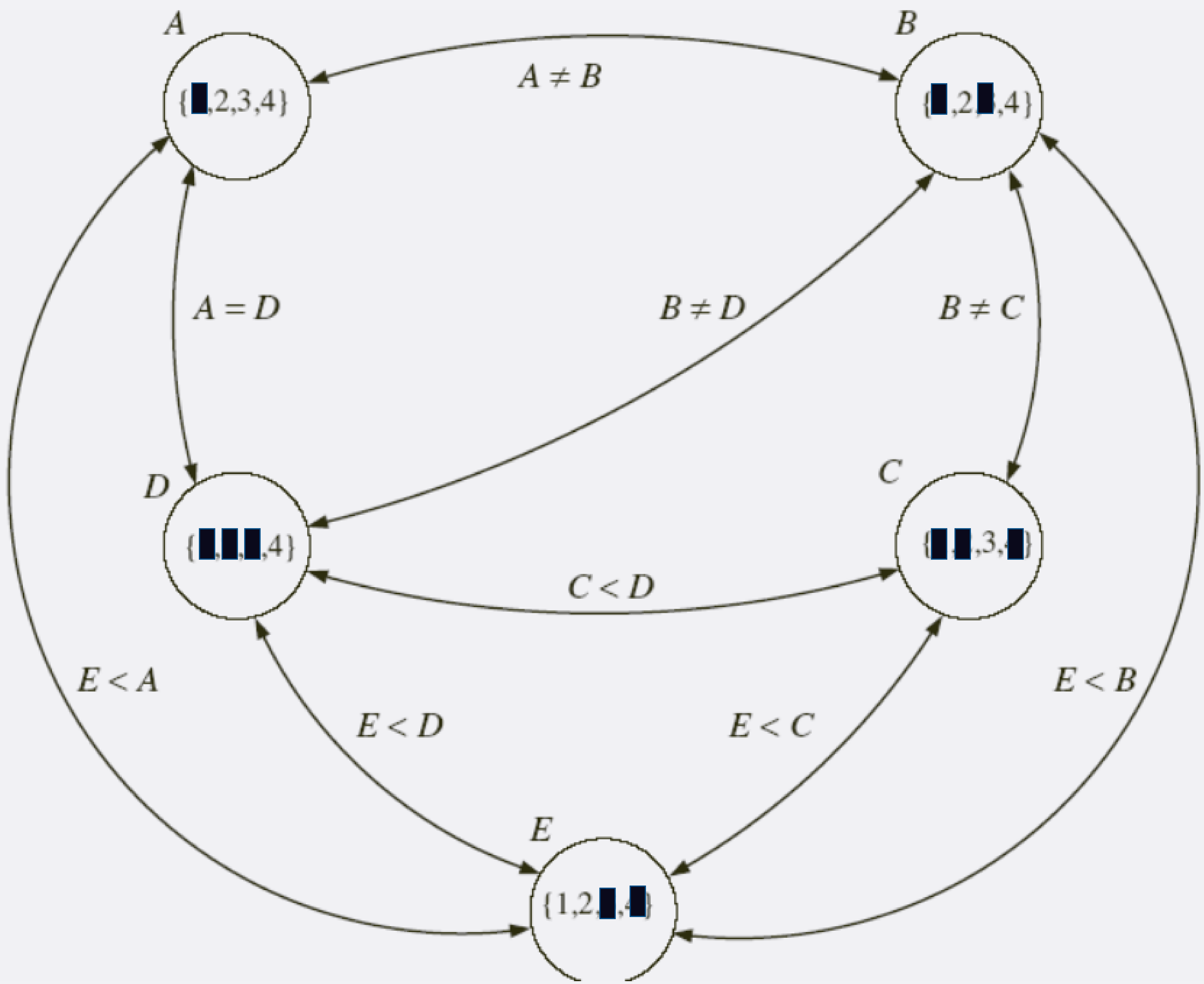

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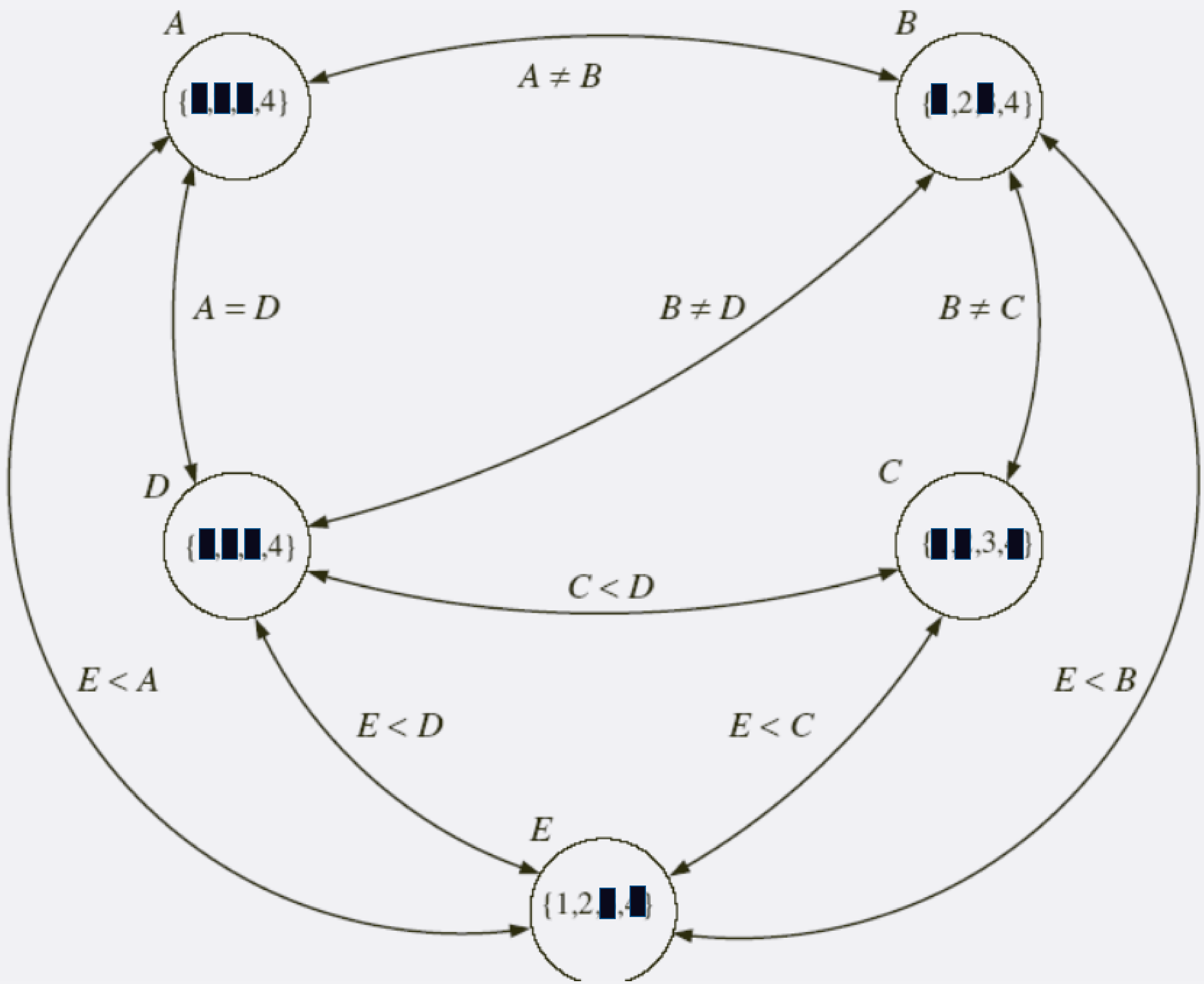

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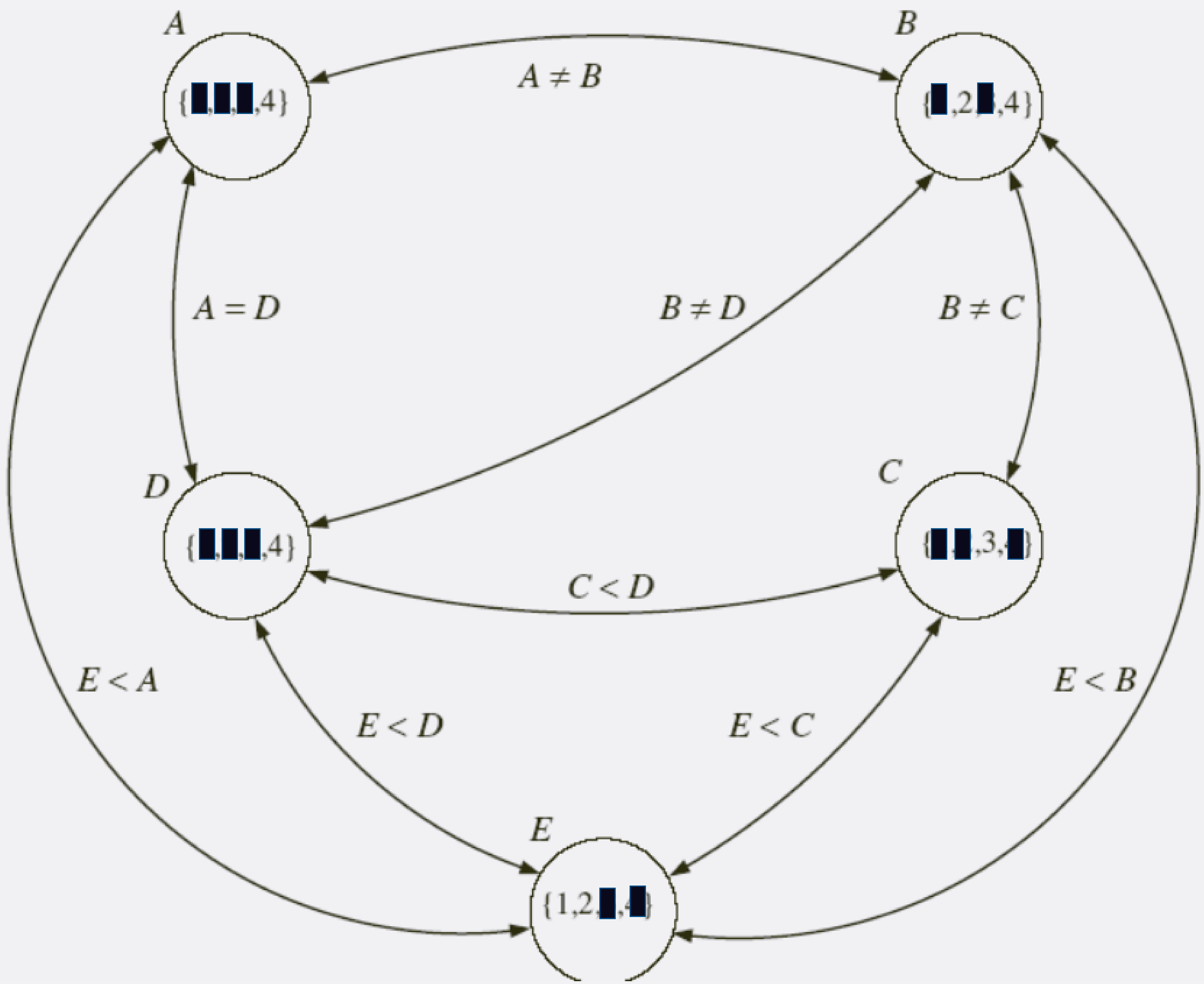

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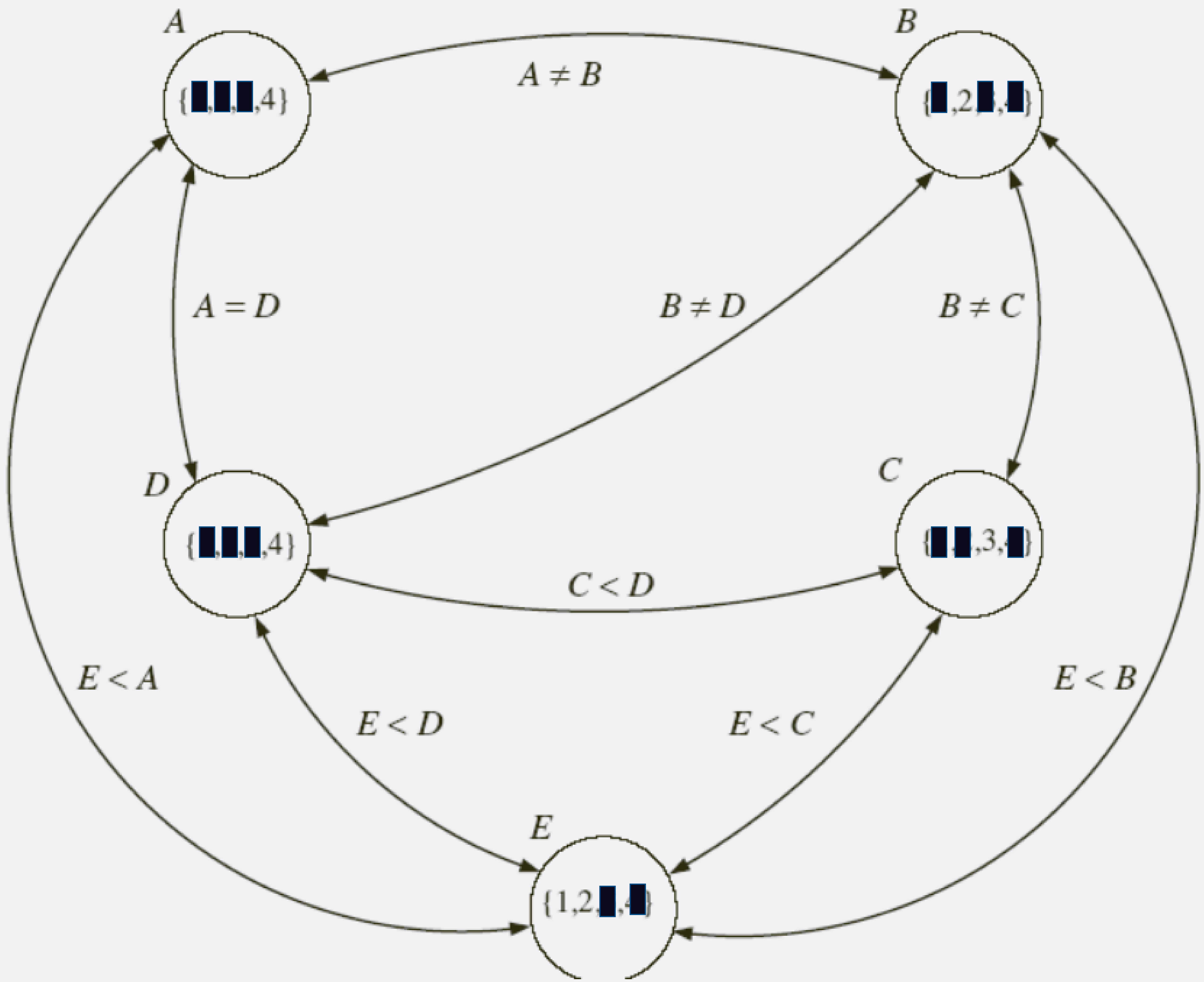

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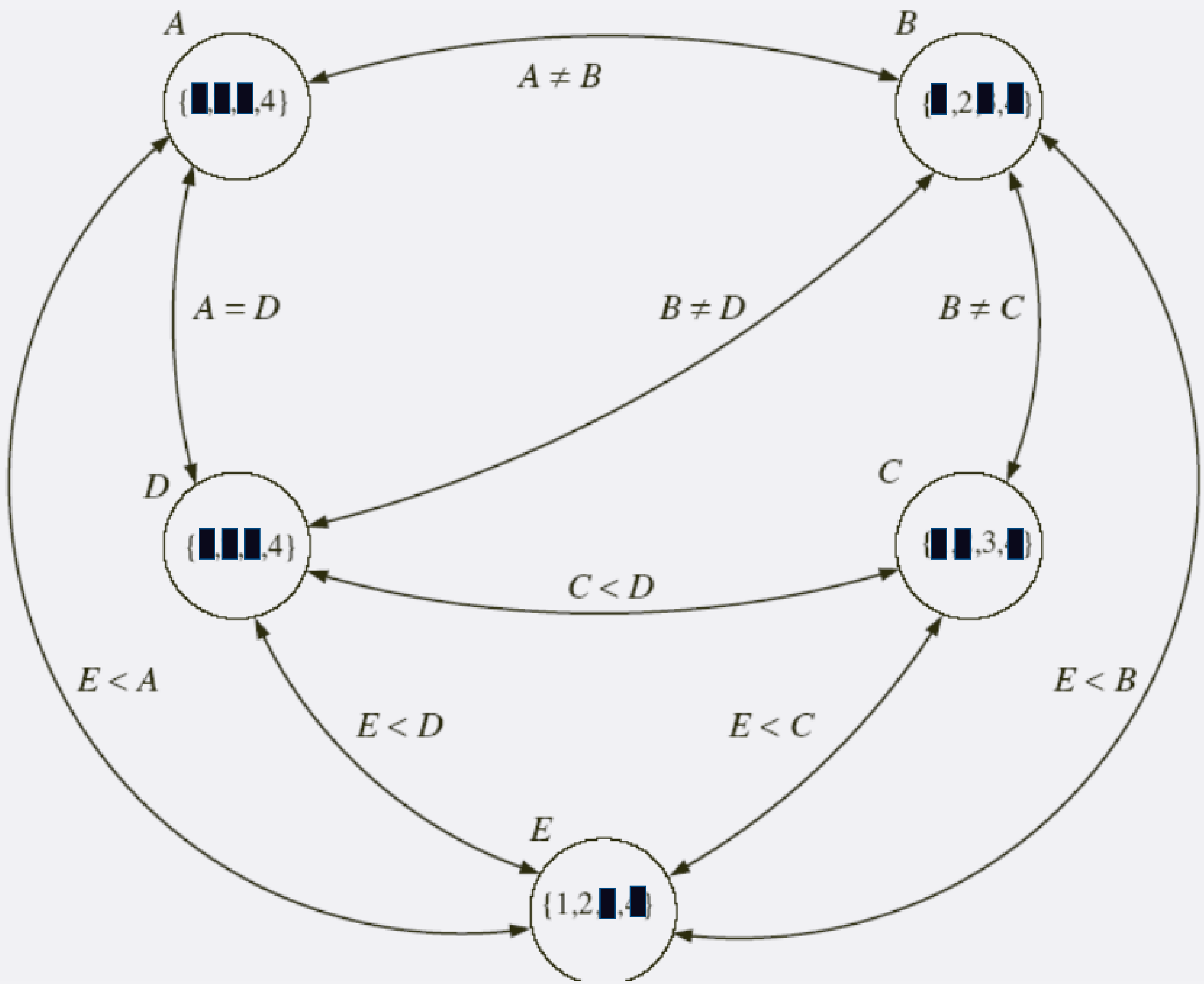


Exercise 7.2

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

- 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 7.3

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

- 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: X1, X2, X3, X4, X5
  - Domains: D1={3,4,5,7,9}, D2={2,4,6,8,9}, D3={1,2,6,8,9},
    D4={1,2,3,8,9}, D5={2,5,6,7,8}
  - The constraints are
    - X1>X2 or X2-X1=2
    - X2<X3
    - X2>X4 or X2-X4=1
    - X3>X5.

- 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 7.5

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

Exercise 7.5

- Question 1

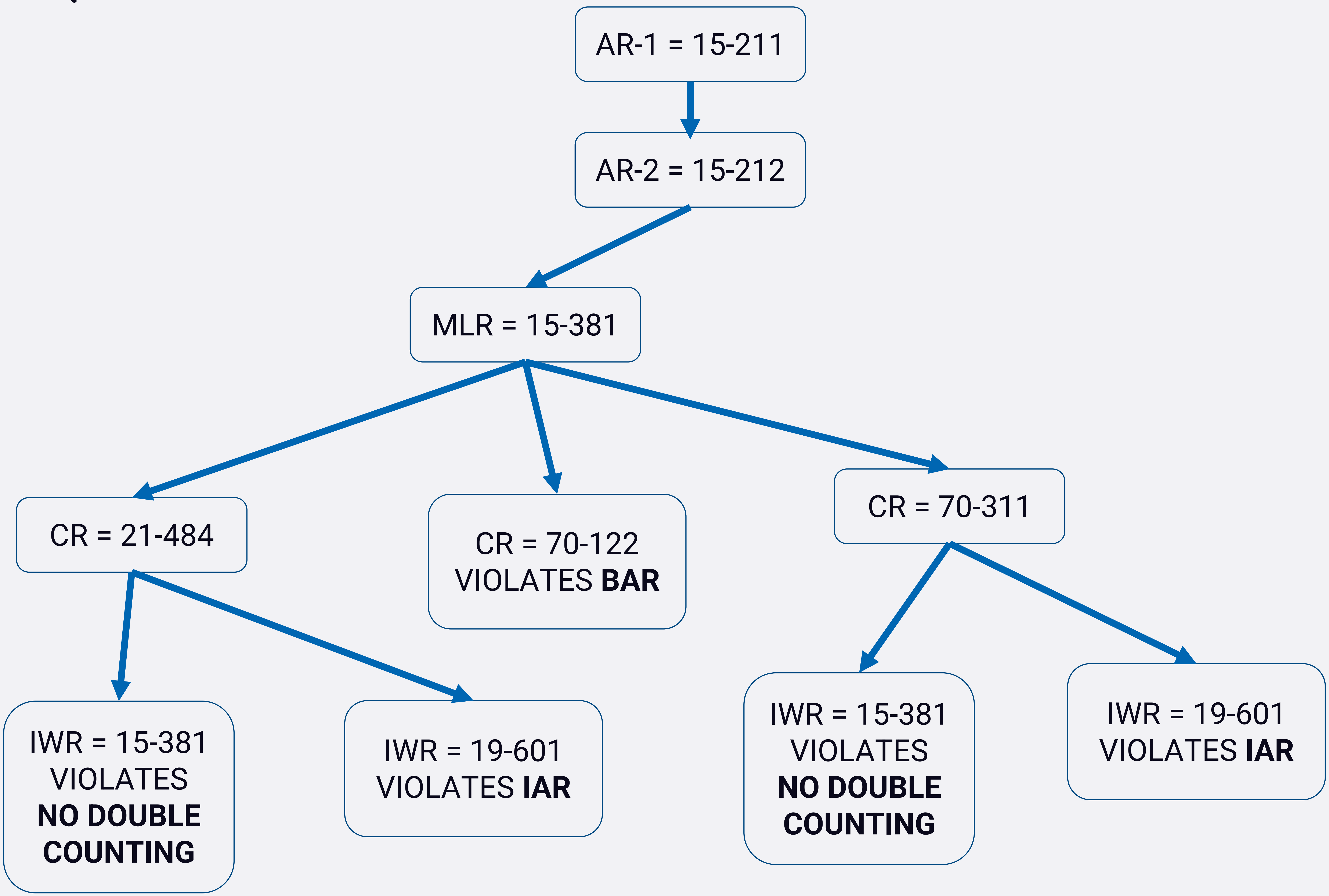
5 variables: AR-1, AR-2, MLR, CR, IWR

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

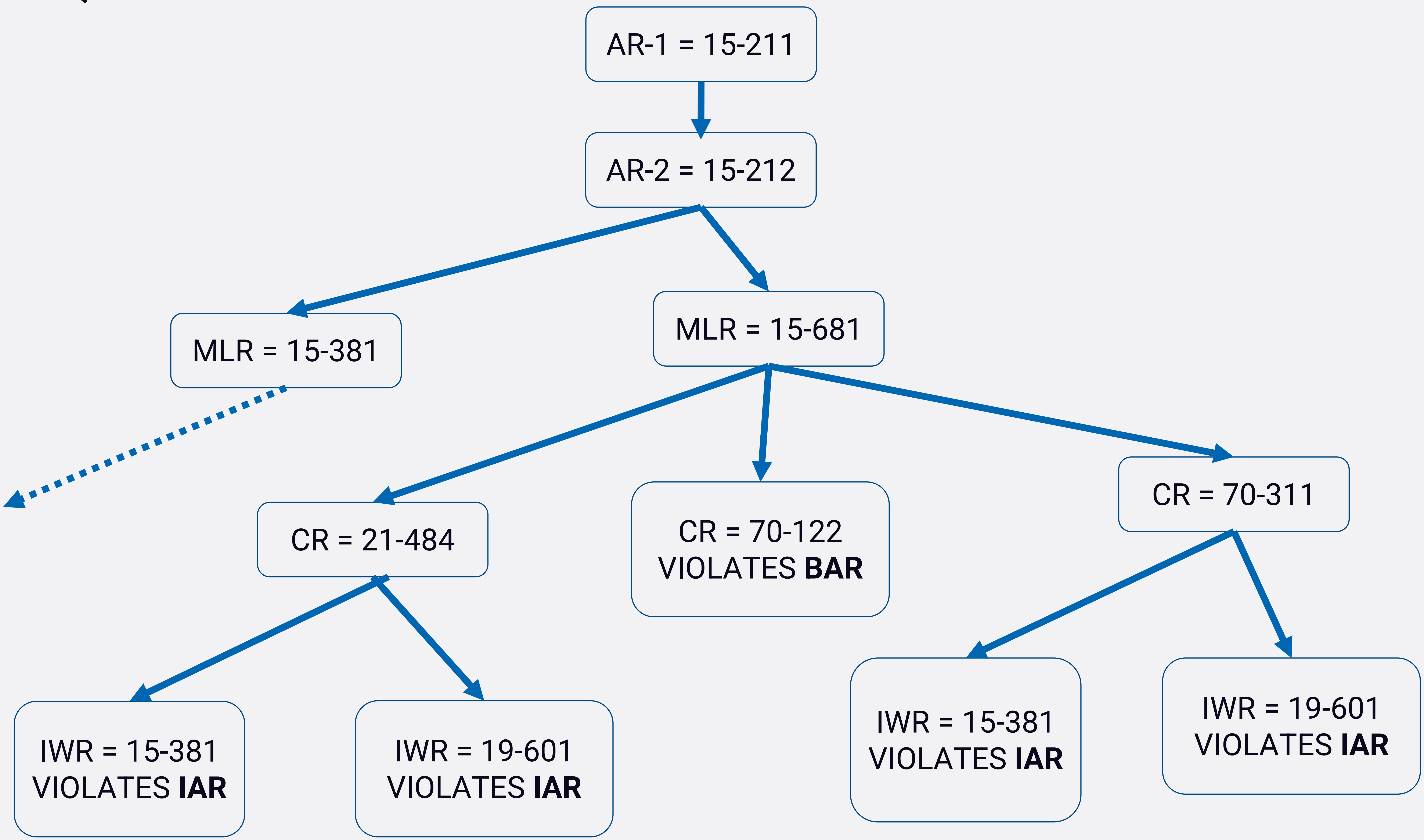
Exercise 7.5

- Question 2



Exercise 7.5

- Question 2



Exercise 7.5

- Question 2