SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB204 – LINEAR AND DIGITAL CIRCUITS

II YEAR/ III SEMESTER

UNIT 3 – GATES AND MINIMIZATION TECHNIQUES
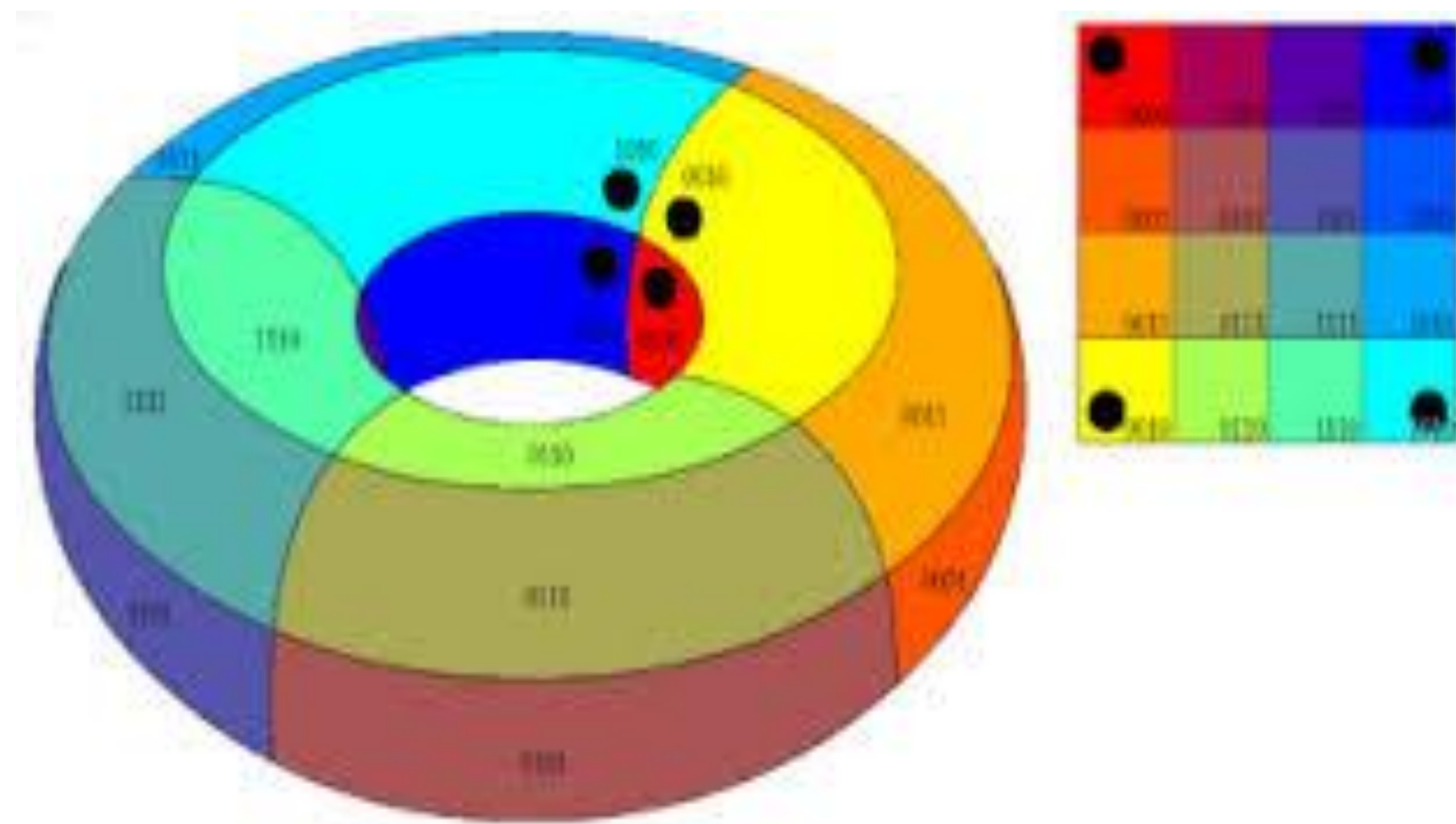
TOPIC 6 - KARNAUGH MAP MINIMIZATION

WHY KARNAUGH MAP MINIMIZATION?

➢ K-map simplification technique is simpler and less error-prone compared to the method of solving the logical expressions using Boolean laws.

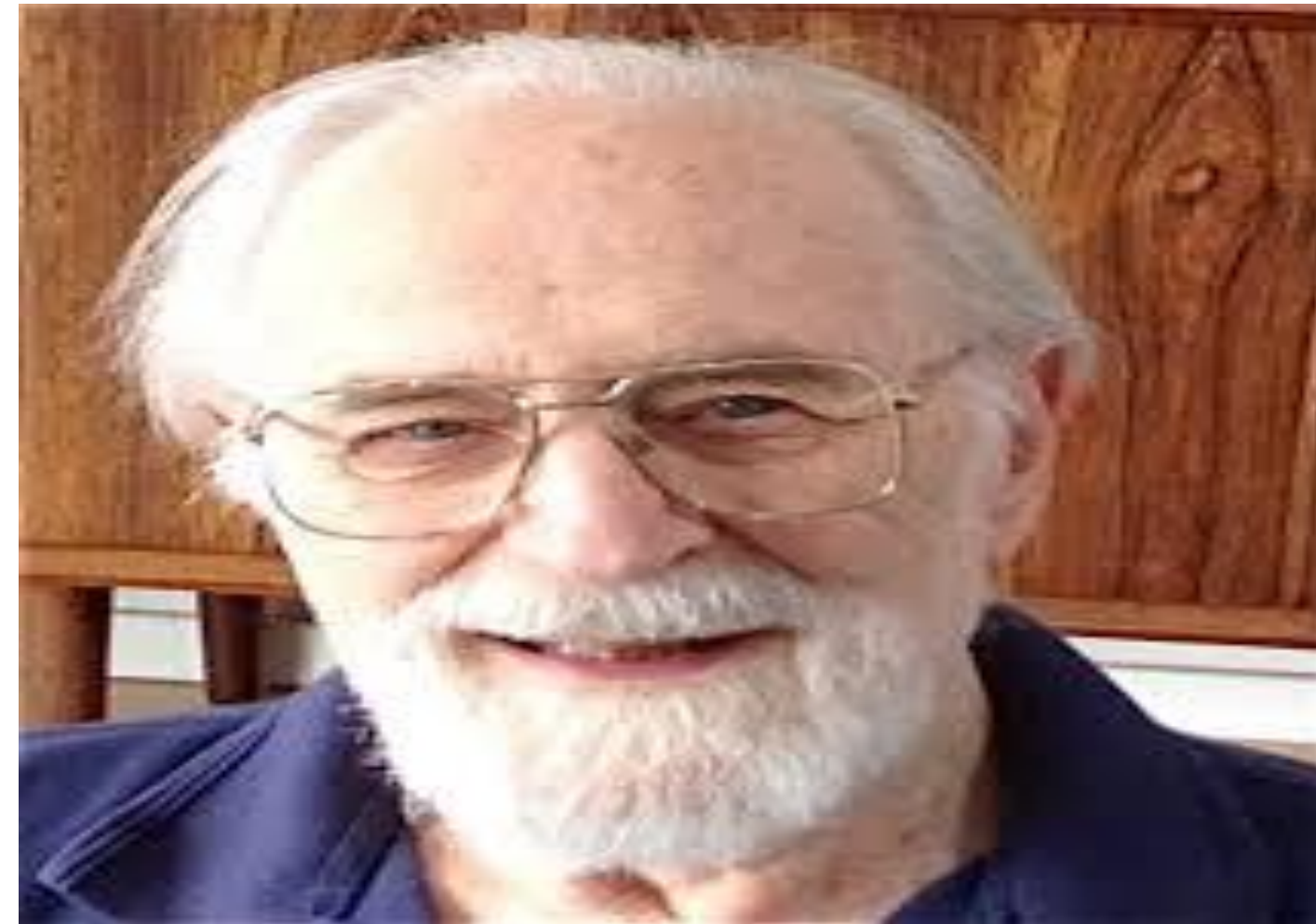➢ Its main purpose is to simplify Boolean algebraic expressions.

KARNAUGH MAP

➢ KARNAUGH MAP is also named as K map

➢ K map was introduced by Dr. Maurice karnaugh in the year 1953

KARNAUGH MAP - Rules

➢ Karnaugh map is a pictorial method of grouping together expressions with common factors and then eliminating unwanted variables.

➢ Karnaugh map uses the following rules for the simplification of expressions by *grouping* together adjacent cells containing *ones* .
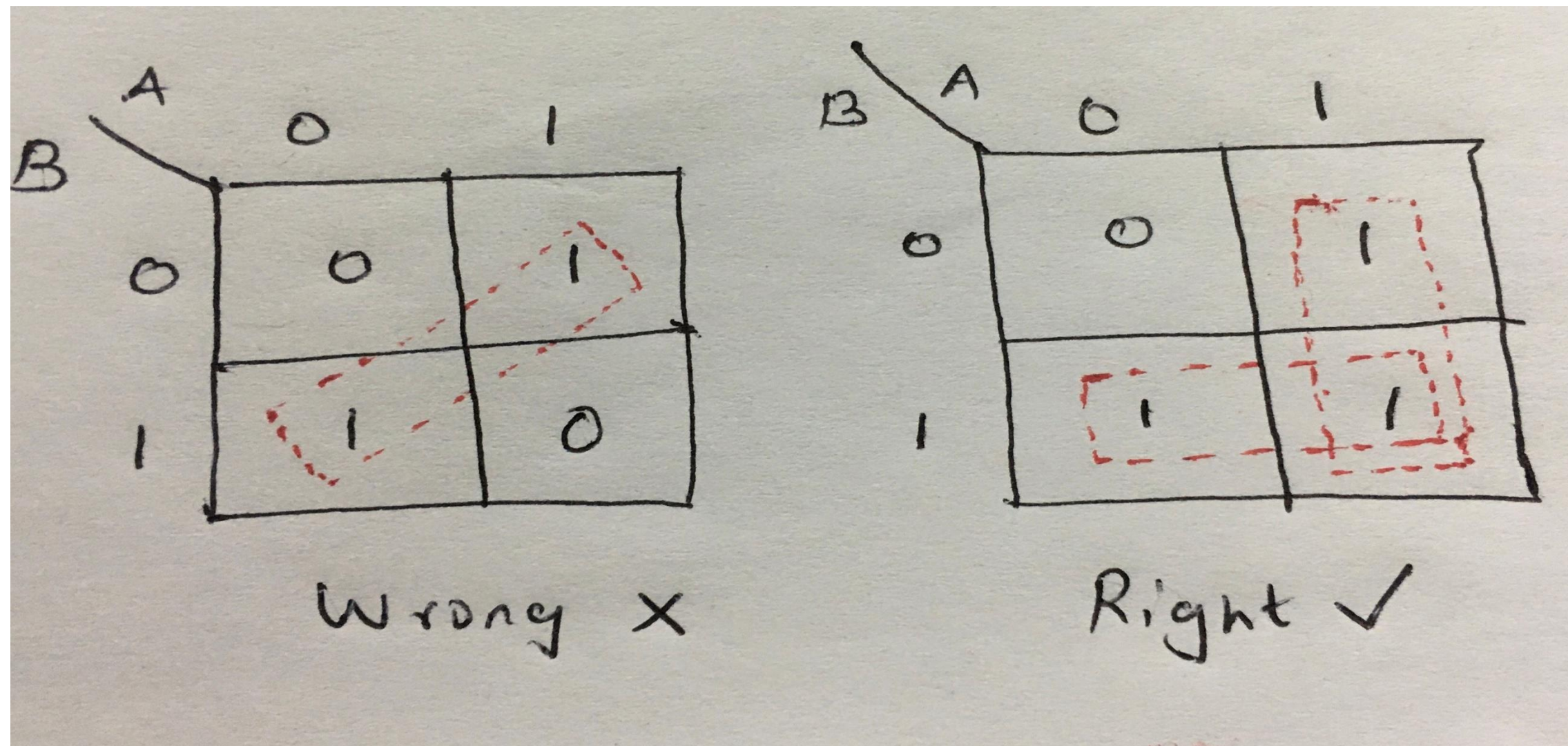
1. Groups may not include any cell containing a zero
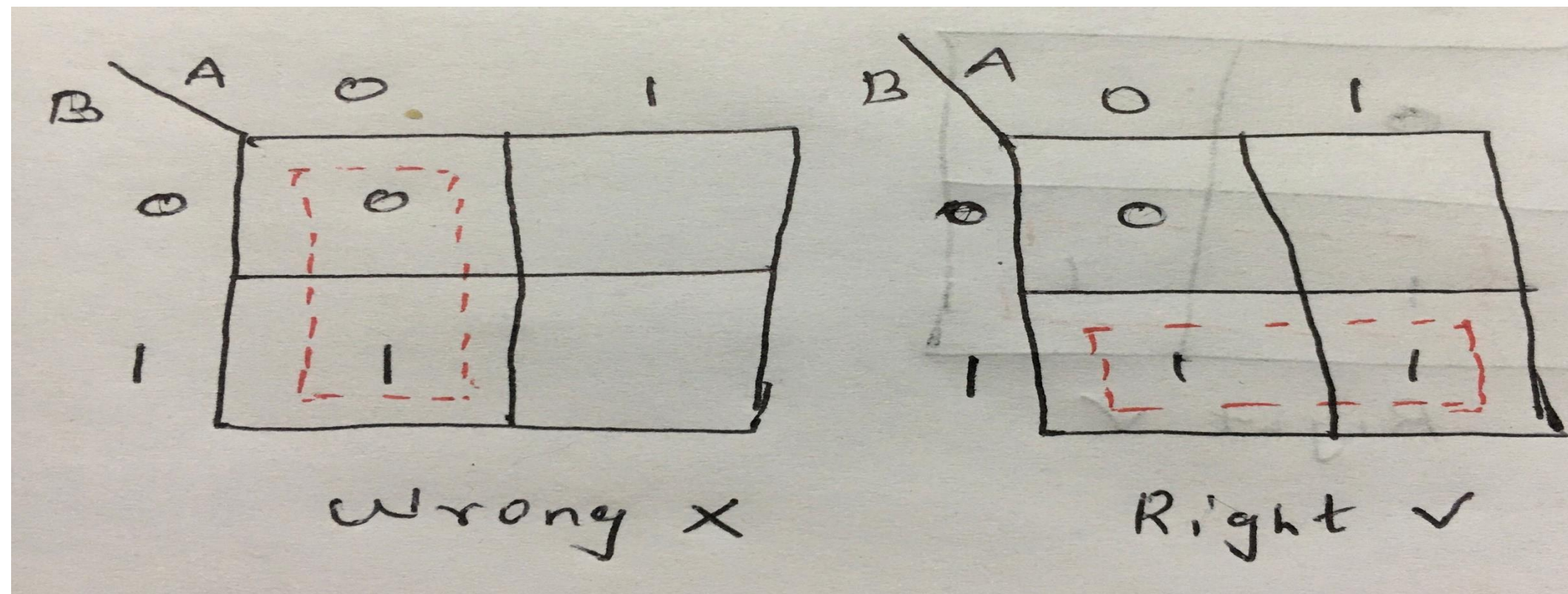
2. Groups may be horizontal or vertical, but not diagonal.

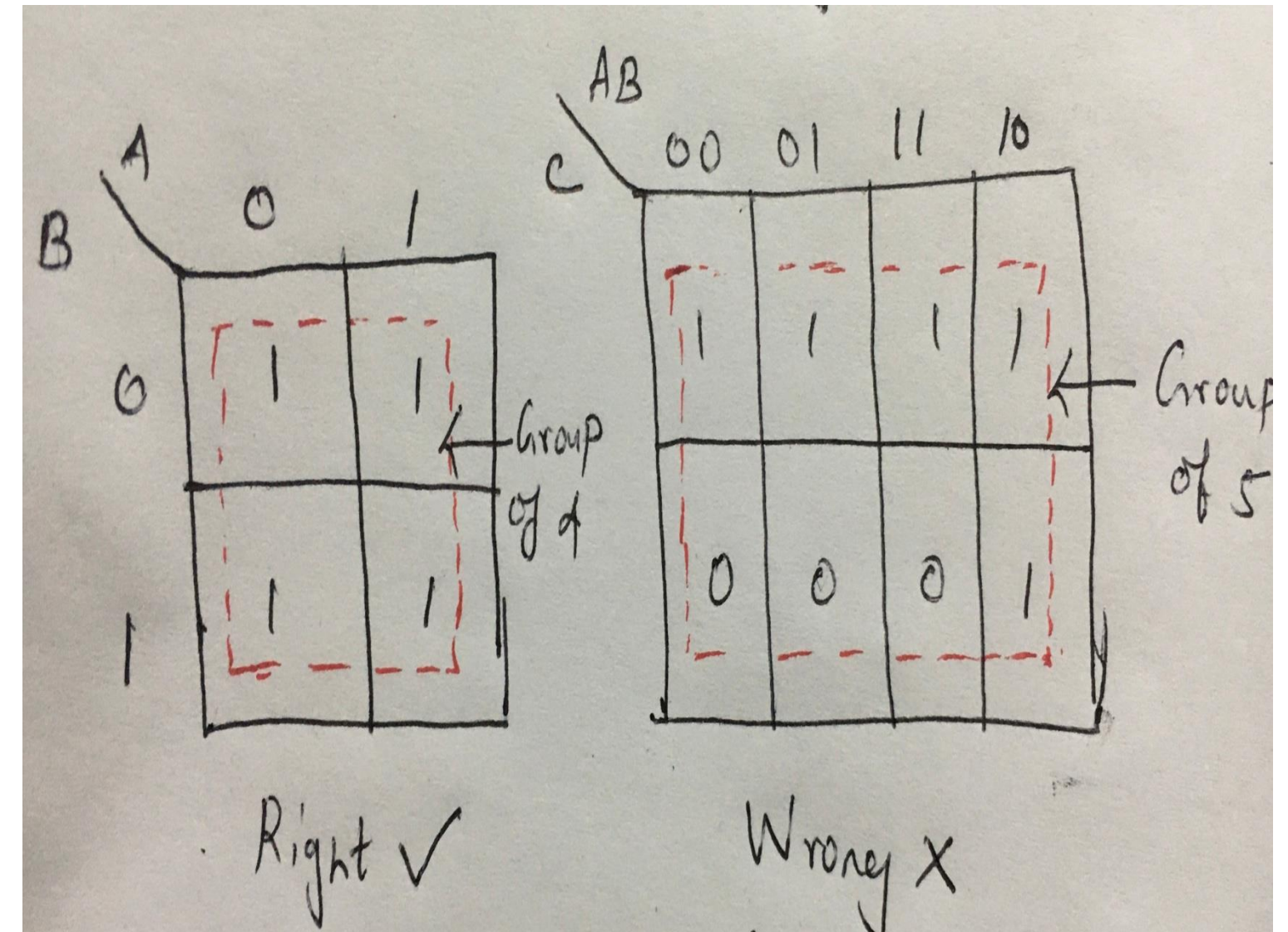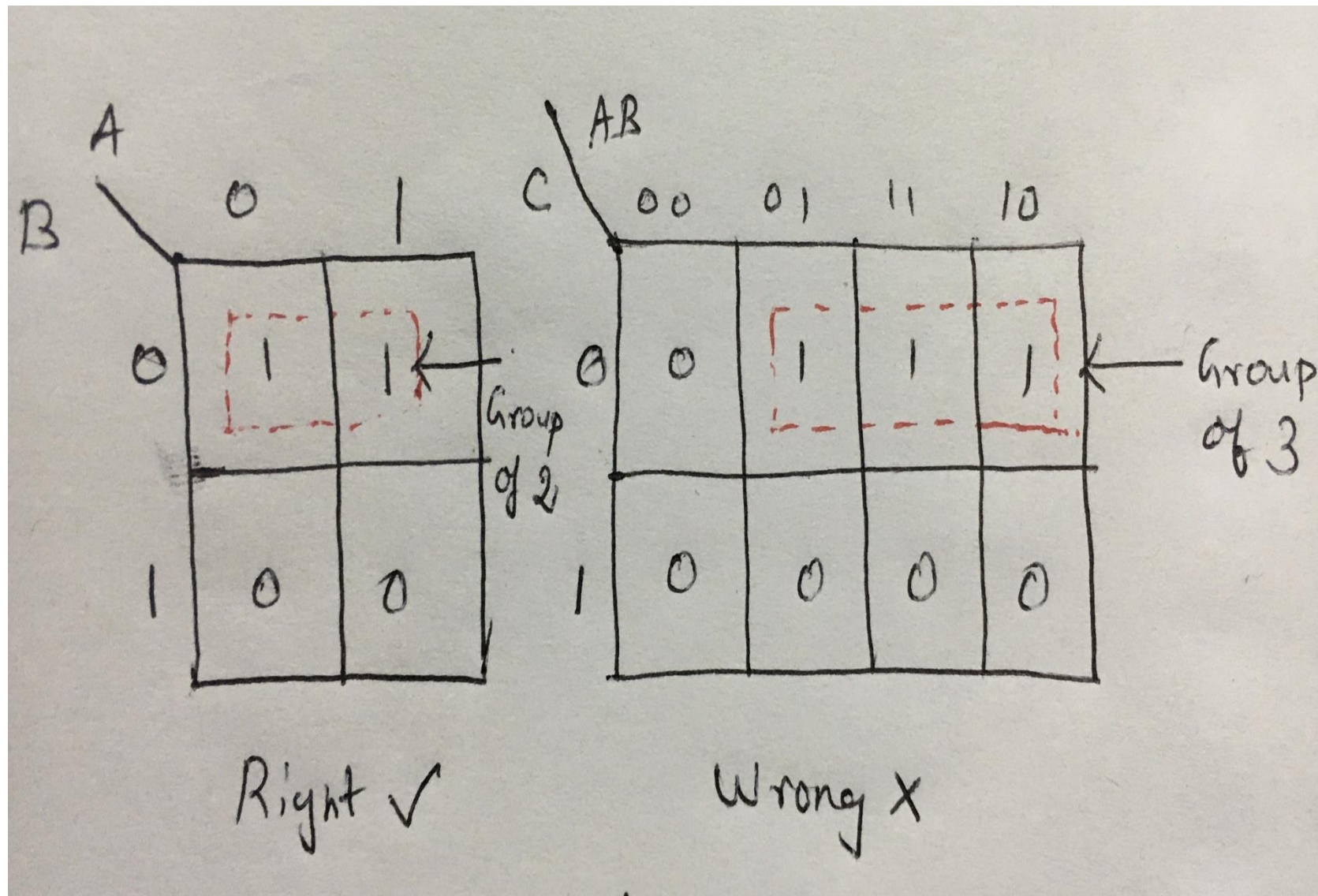3. **Groups must contain 1, 2, 4, 8, or in general 2^n cells. If n = 1, a group will contain two 1's since 2^1 = 2. If n = 2, a group will contain four 1's since 2^2 = 4.**

4. Each group should be as large as possible.
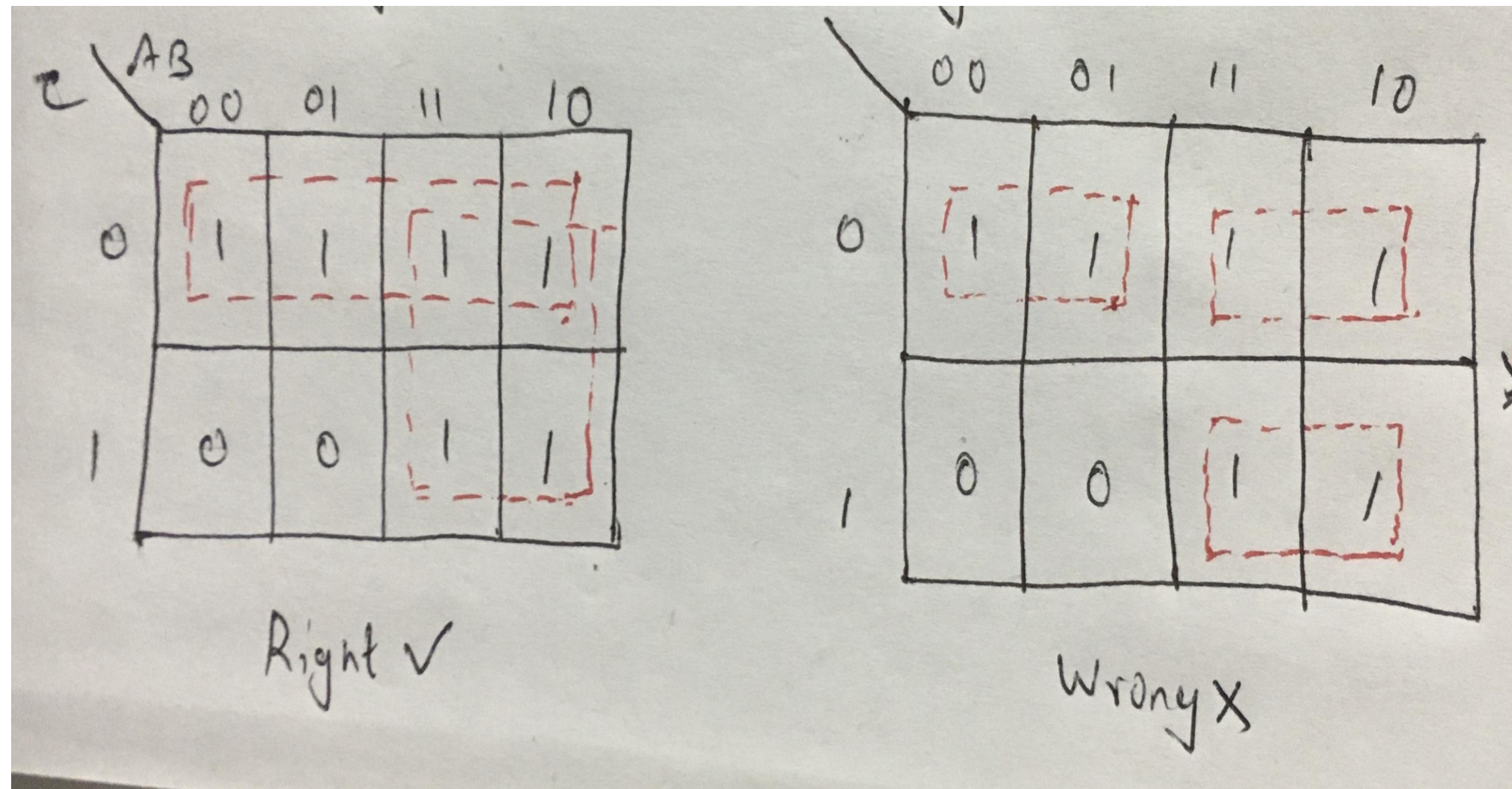
5. Each cell containing a *one* must be in at least one group.
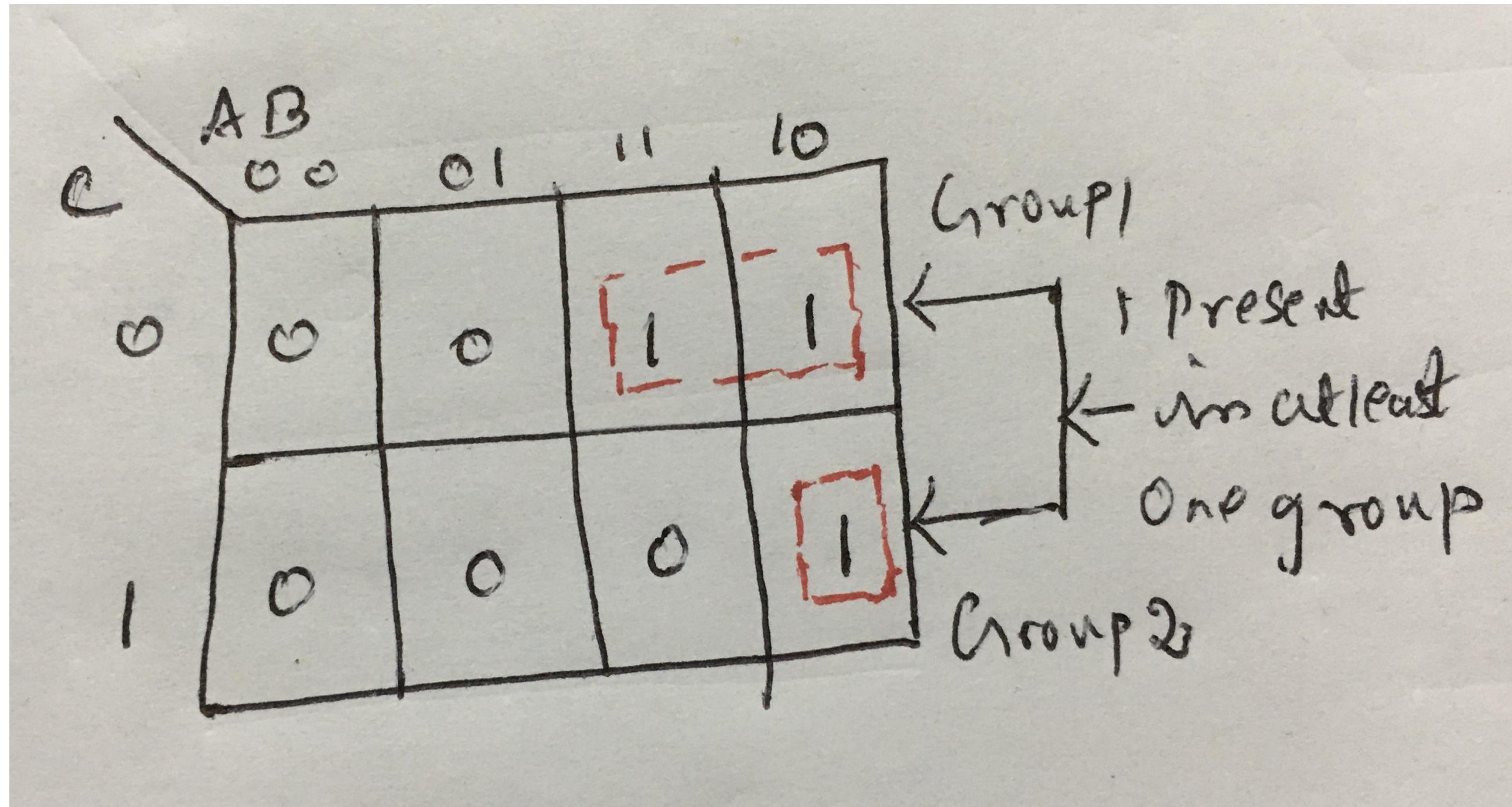
6. Groups may overlap.
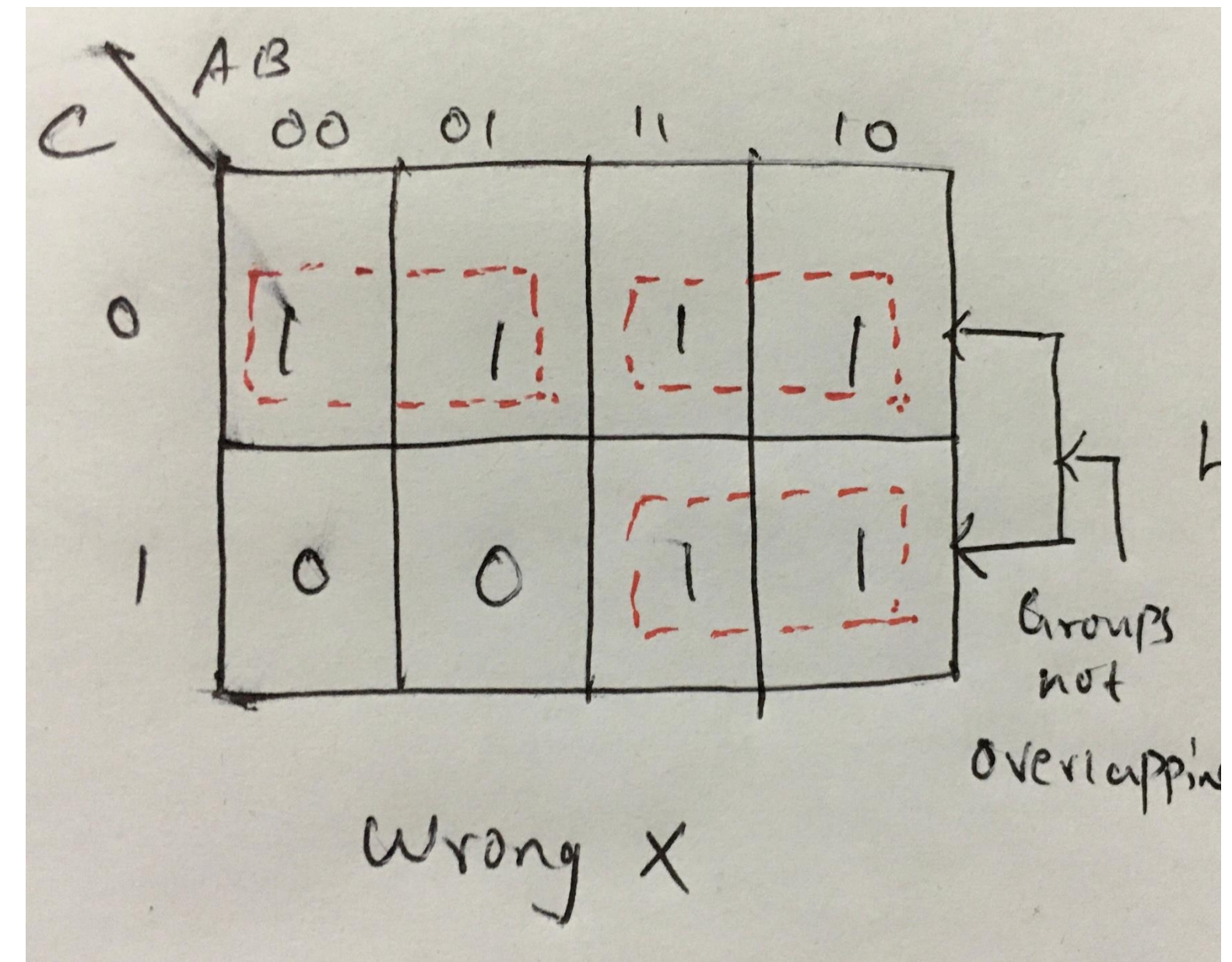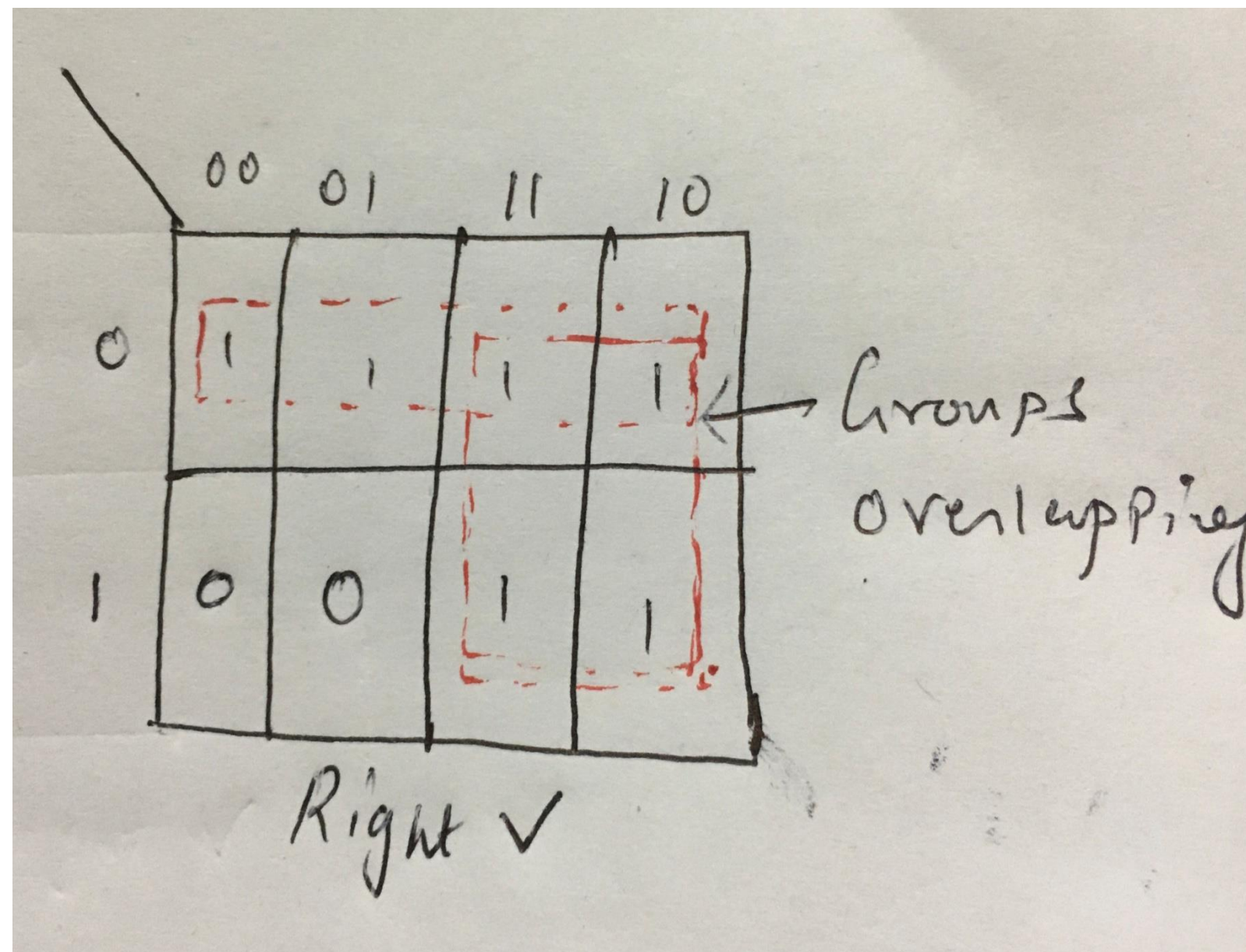
7. Groups may wrap around the table. The leftmost cell in a row may be grouped with the rightmost cell and the top cell in a column may be grouped with the bottom cell
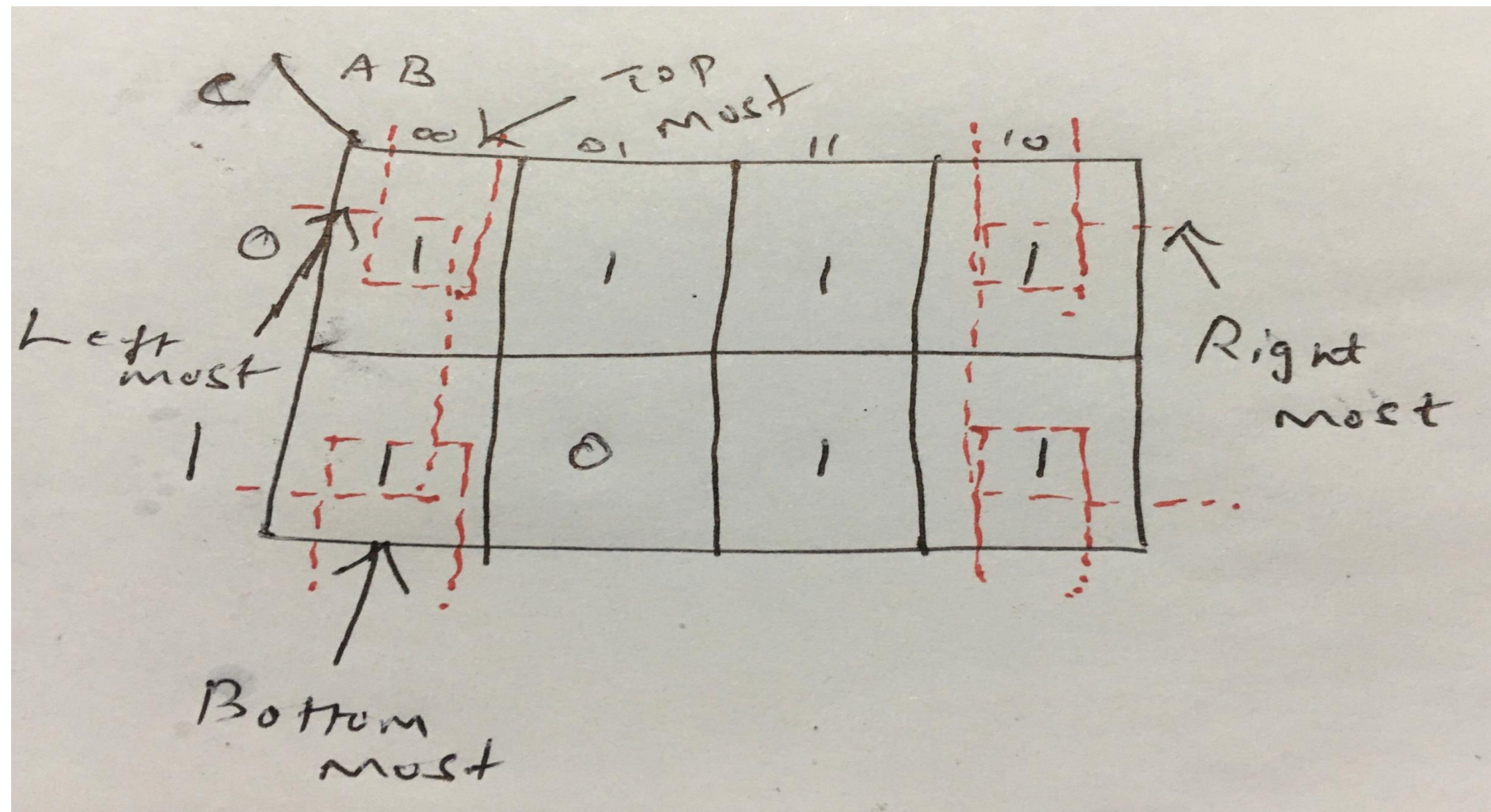
8. There should be as few groups as possible, as long as this does not contradict any of the previous rules
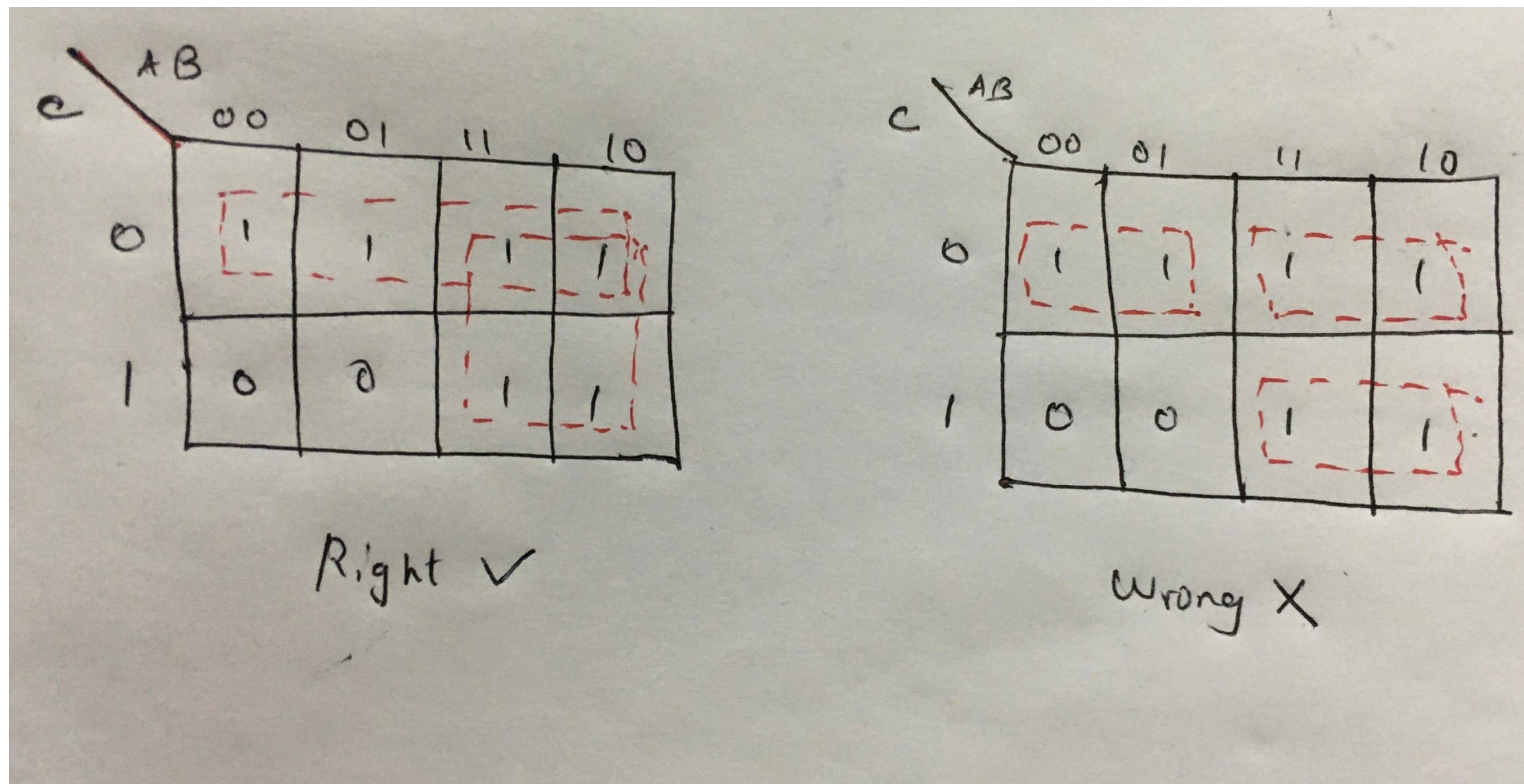
K MAP - Rules

➢No zeros allowed.

➢No diagonals.

➢Only power of 2 number of cells in each group.

➢Groups should be as large as possible.

➢Every one must be in at least one group.

➢Overlapping allowed.

➢Wrap around allowed.

➢Fewest number of groups possible.

➢ Karnaugh Map is most suitable for Minimizing Boolean expressions of
        2 Variable
        3 Variable
        4 Variable
        5Variable

> ➢ The number of cells in 2 variable K-map is four, since the number of variables is two.

> ➢There is only one possibility of grouping 4 adjacent min terms.

> ➢The possible combinations of grouping 2 adjacent min terms are $\{(m_0, m_1), (m_2, m_3), (m_0, m_2) \text{ and } (m_1, m_3)\}$.

➢ The number of cells in 3 variable K-map is eight, since the number of variables is three.

➢ There is only one possibility of grouping 8 adjacent min terms.

➢ The possible combinations of grouping 4 adjacent min terms are $\{(m_0, m_1, m_3, m_2), (m_4, m_5, m_7, m_6), (m_0, m_1, m_4, m_5), (m_1, m_3, m_5, m_7), (m_3, m_2, m_7, m_6)$ and $(m_2, m_0, m_6, m_4)\}$.

➢ The possible combinations of grouping 2 adjacent min terms are $\{(m_0, m_1), (m_1, m_3), (m_3, m_2), (m_2, m_0), (m_4, m_5), (m_5, m_7), (m_7, m_6), (m_6, m_4), (m_0, m_4), (m_1, m_5), (m_3, m_7)$ and $(m_2, m_6)\}$.

➢ If x=0, then 3 variable K-map becomes 2 variable K-map.

KARNAUGH MAP – 3 Variable

X \ YZ	00	01	11	10
0	m_0	m_1	m_3	m_2
1	m_4	m_5	m_7	m_6

➢ The number of cells in 4 variable K-map is sixteen, since the number of variables is four.

WX\YZ	00	01	11	10
00	m_0	m_1	m_3	m_2
01	m_4	m_5	m_7	m_6
11	m_{12}	m_{13}	m_{15}	m_{14}
10	m_8	m_9	m_{11}	m_{10}

➢ There is only one possibility of grouping 16 adjacent min terms.

➢Let R_1, R_2, R_3 and R_4 represents the min terms of first row, second row, third row and fourth row respectively. Similarly, C_1, C_2, C_3 and C_4 represents the min terms of first column, second column, third column and fourth column respectively. The possible combinations of grouping 8 adjacent min terms are {(R_1, R_2), (R_2, R_3), (R_3, R_4), (R_4, R_1), (C_1, C_2), (C_2, C_3), (C_3, C_4), (C_4, C_1)}.

➢If w=0, then 4 variable K-map becomes 3 variable K-map

KARNAUGH MAP – 5 Variable

➢ The number of cells in 5 variable K-map is thirty-two, since the number of variables is 5.

V=0

WX \ YZ	00	01	11	10
00	m_0	m_1	m_3	m_2
01	m_4	m_5	m_7	m_6
11	m_{12}	m_{13}	m_{15}	m_{14}
10	m_8	m_9	m_{11}	m_{10}

V=1

WX \ YZ	00	01	11	10
00	m_{16}	m_{17}	m_{19}	m_{18}
01	m_{20}	m_{21}	m_{23}	m_{22}
11	m_{28}	m_{29}	m_{31}	m_{30}
10	m_{24}	m_{25}	m_{27}	m_{26}

➢There is only one possibility of grouping 32 adjacent min terms.

➢There are two possibilities of grouping 16 adjacent min terms. i.e., grouping of min terms from m_0 to m_{15} and m_{16} to m_{31}.

➢If v=0, then 5 variable K-map becomes 4 variable K-map.

THANK YOU