



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution



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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

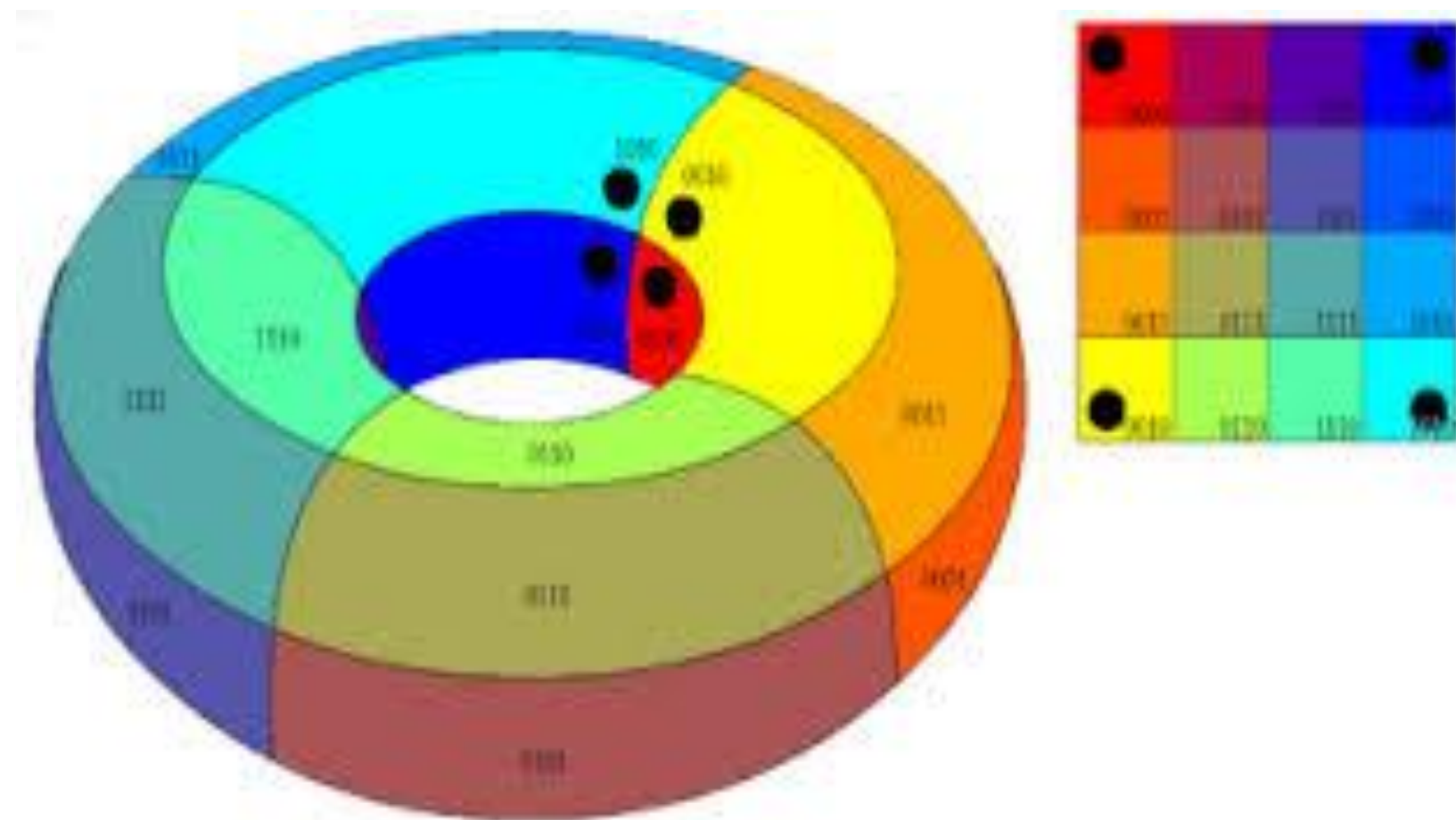
TOPIC 6 - KARNAUGH MAP MINIMIZATION



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.

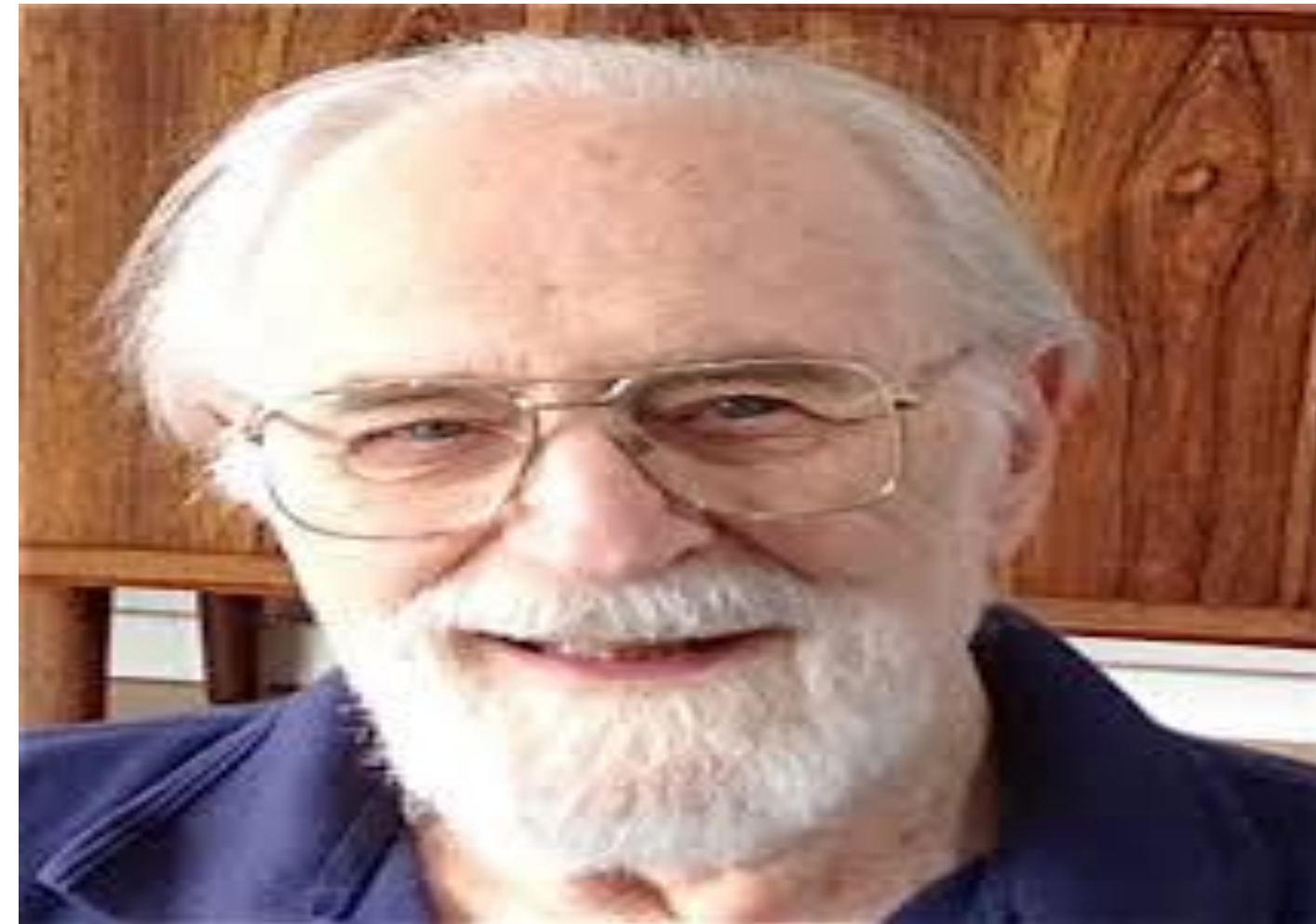




KARNAUGH MAP



- KARNAUGH MAP is also named as K map
- K map was introduced by Dr. Maurice karnaugh in the year 1953

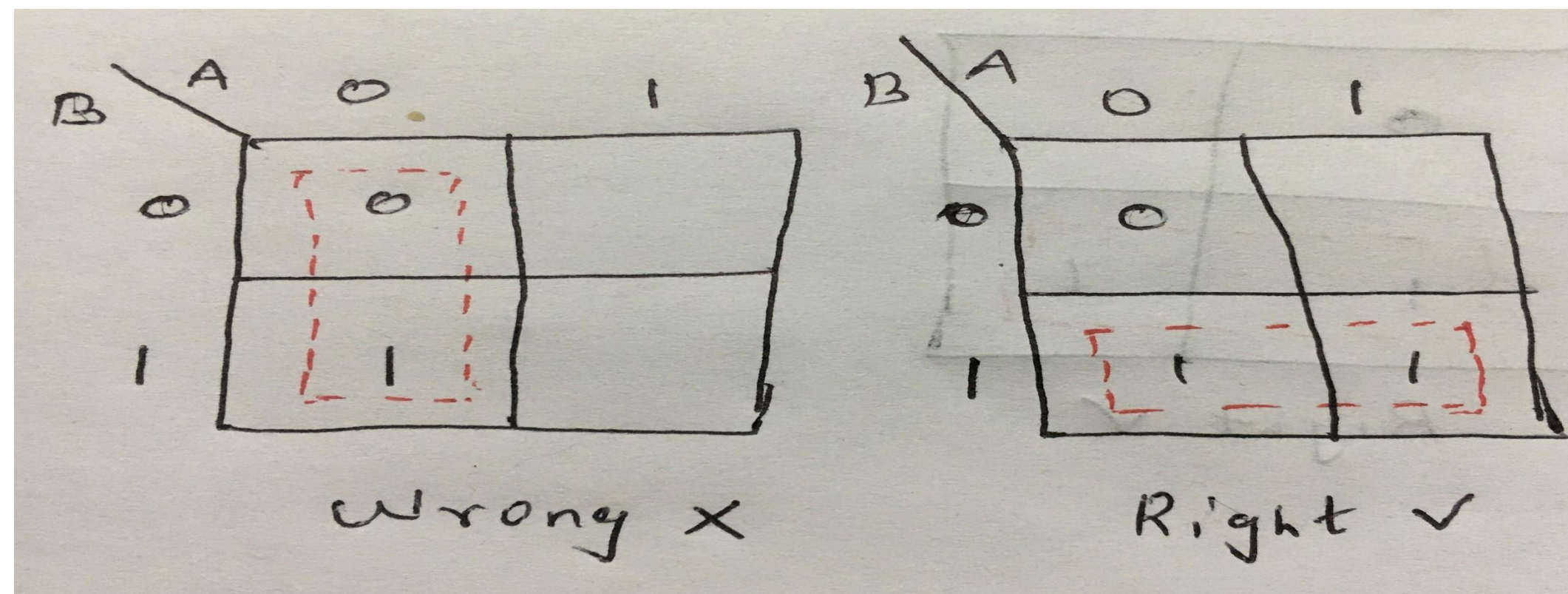




KARNAUGH MAP - Rules

- 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

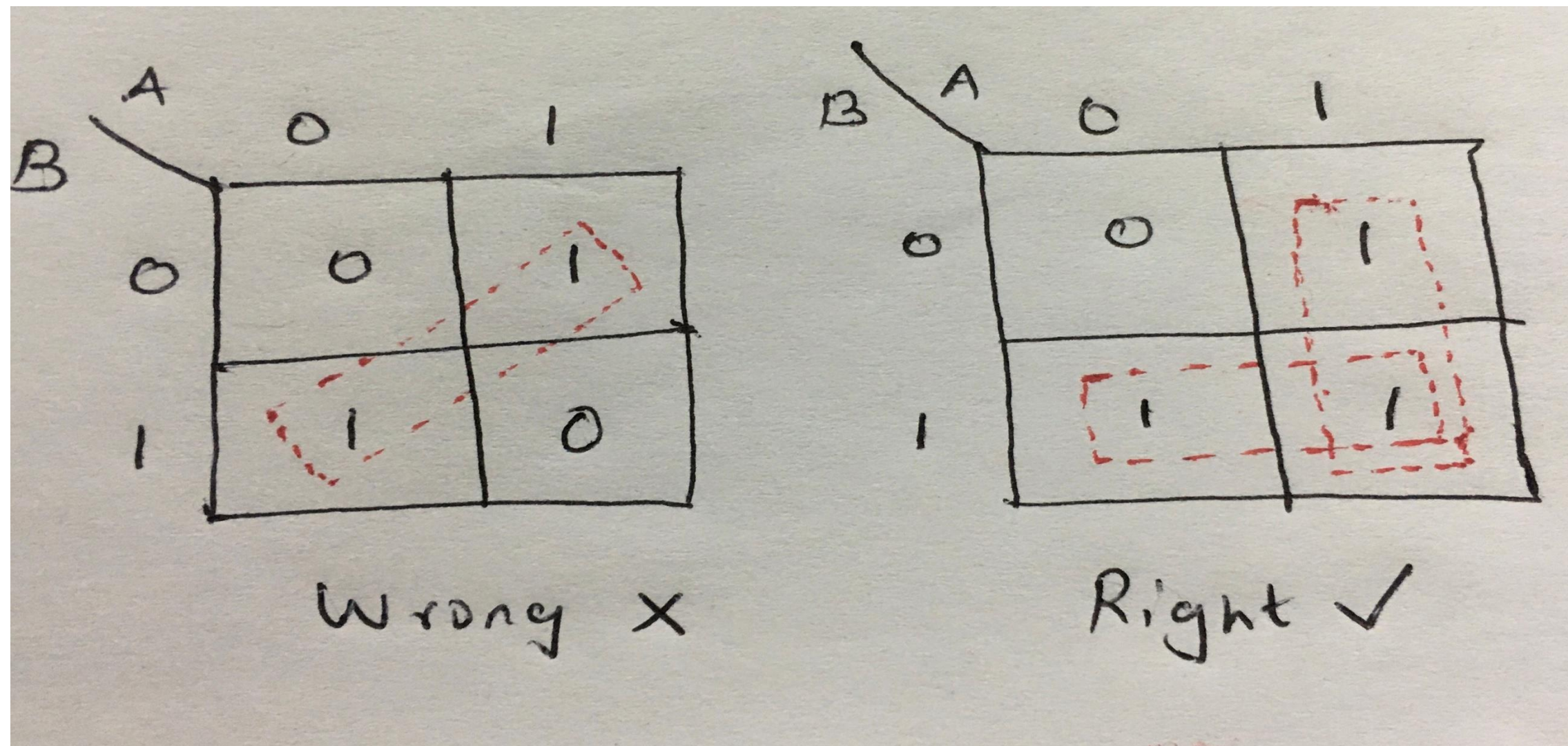




KARNAUGH MAP - Rules



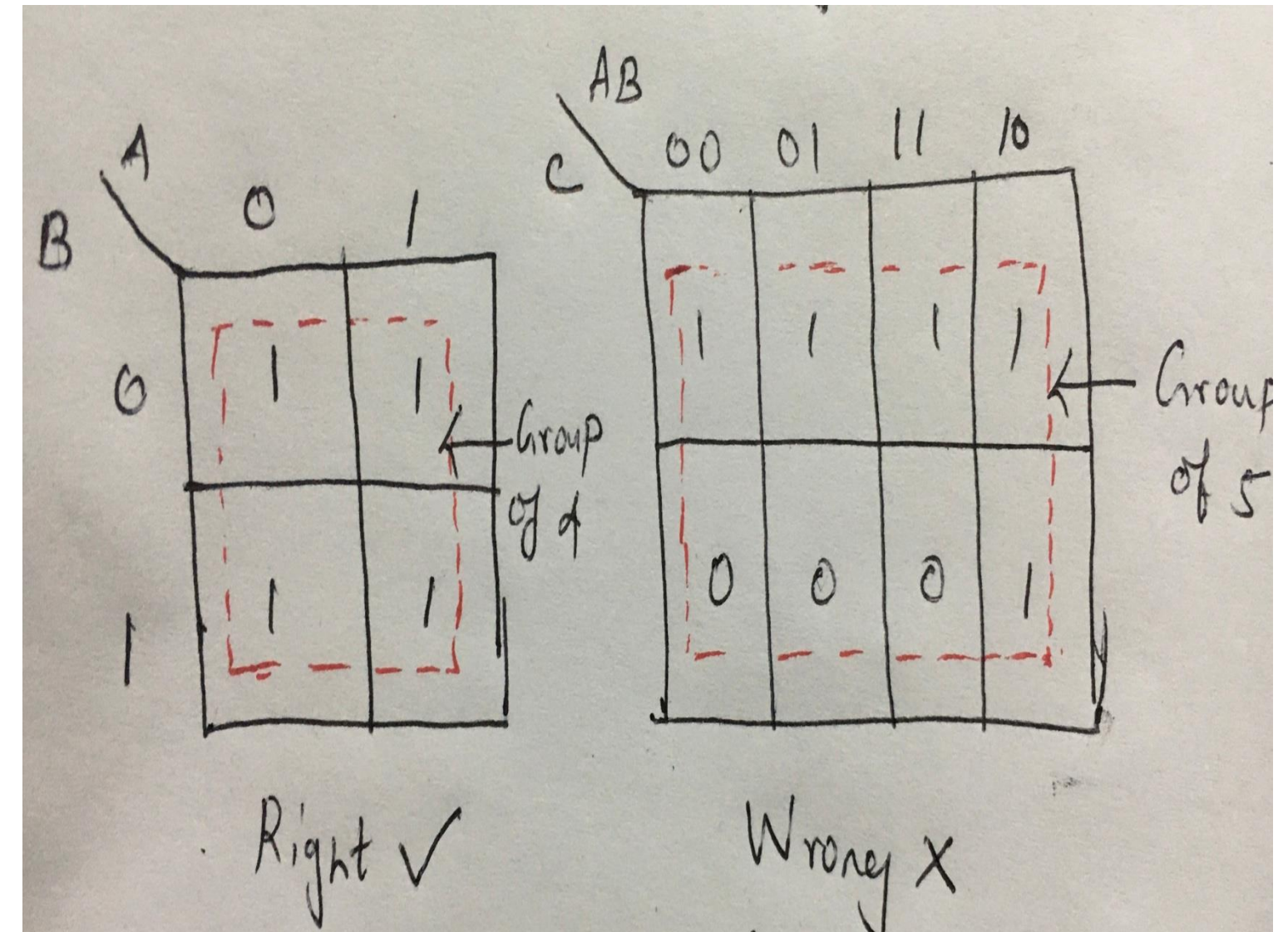
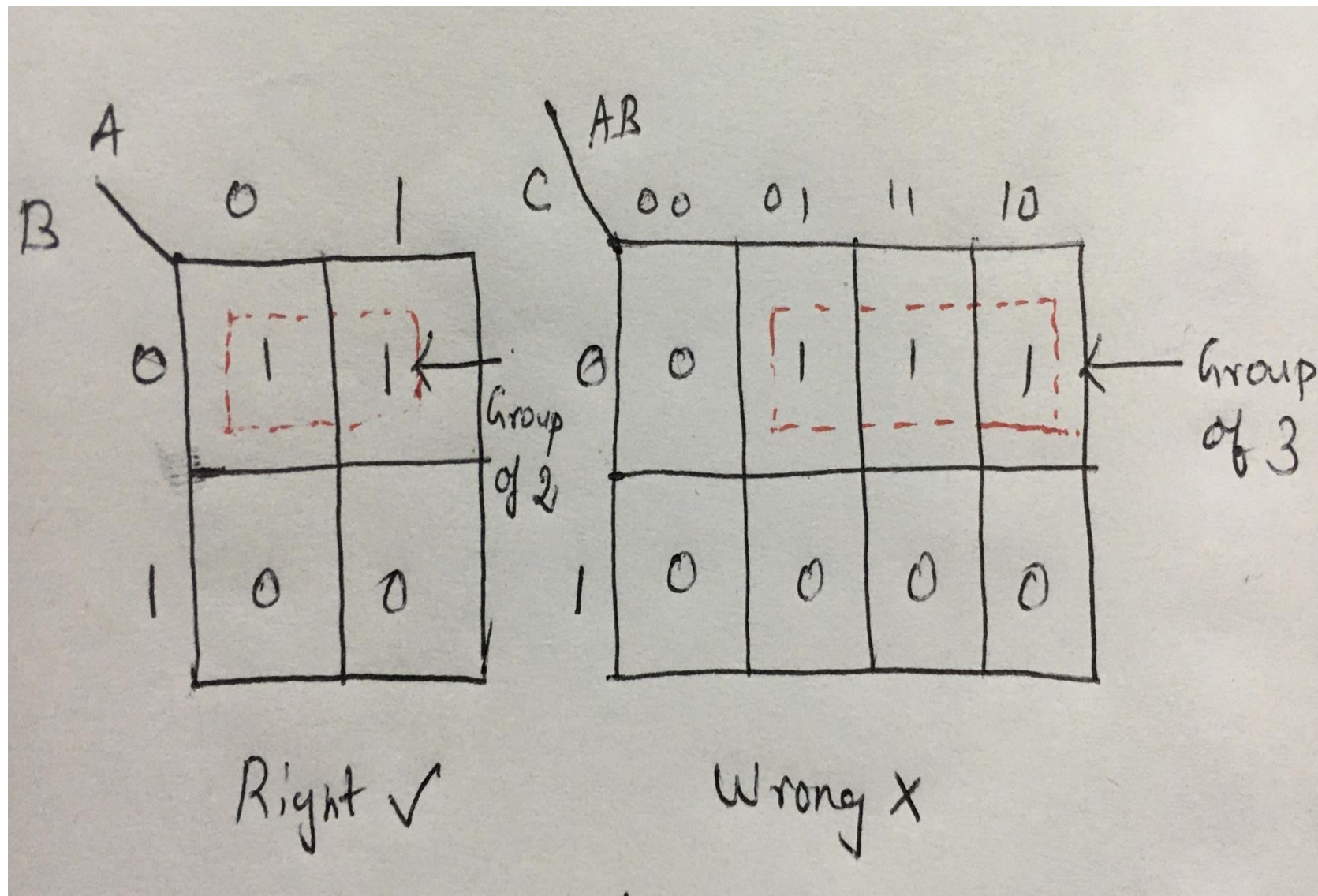
2. Groups may be horizontal or vertical, but not diagonal.





KARNAUGH MAP - Rules

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 $2^2 = 4$.

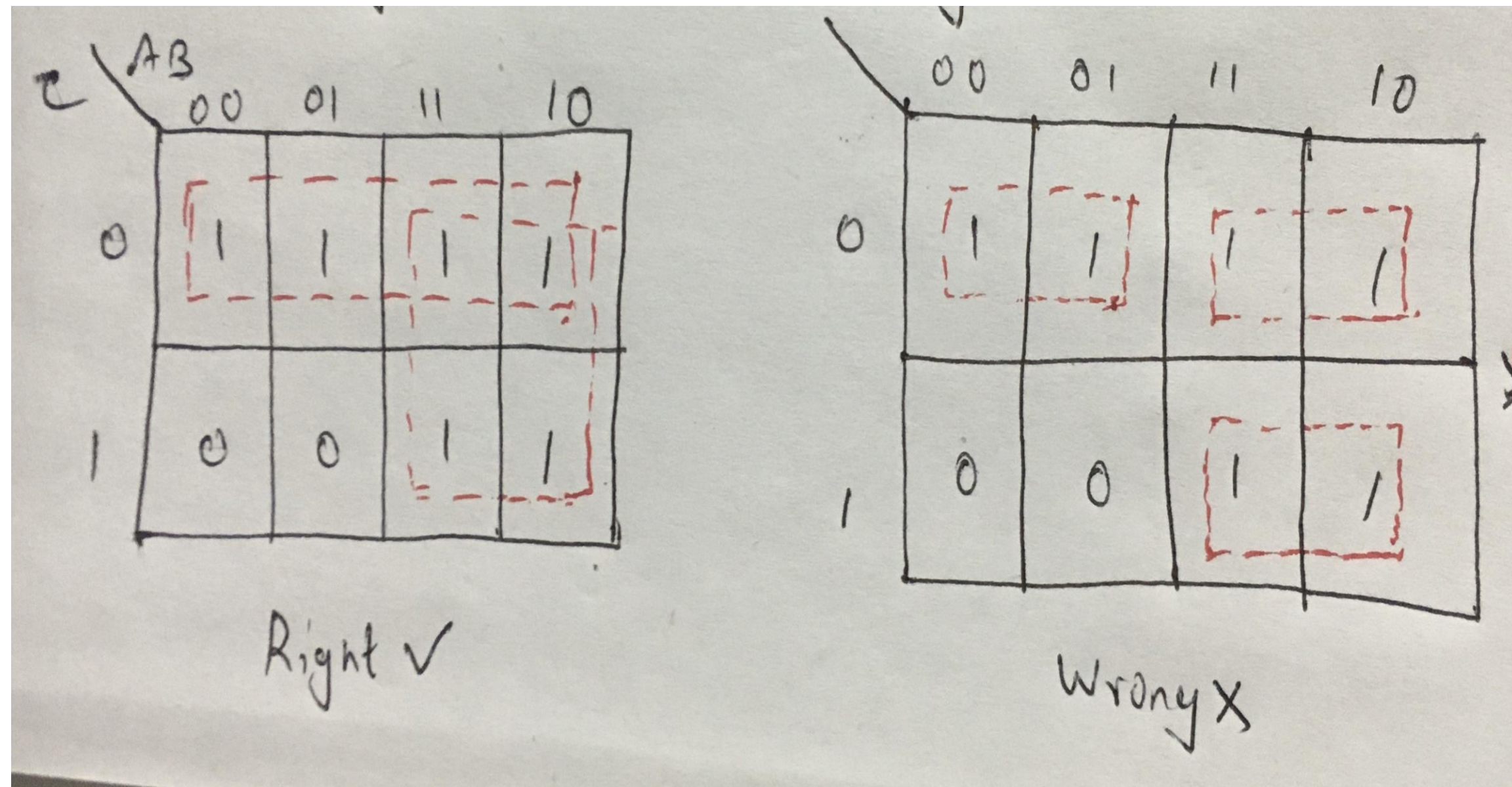




KARNAUGH MAP - Rules



4. Each group should be as large as possible.

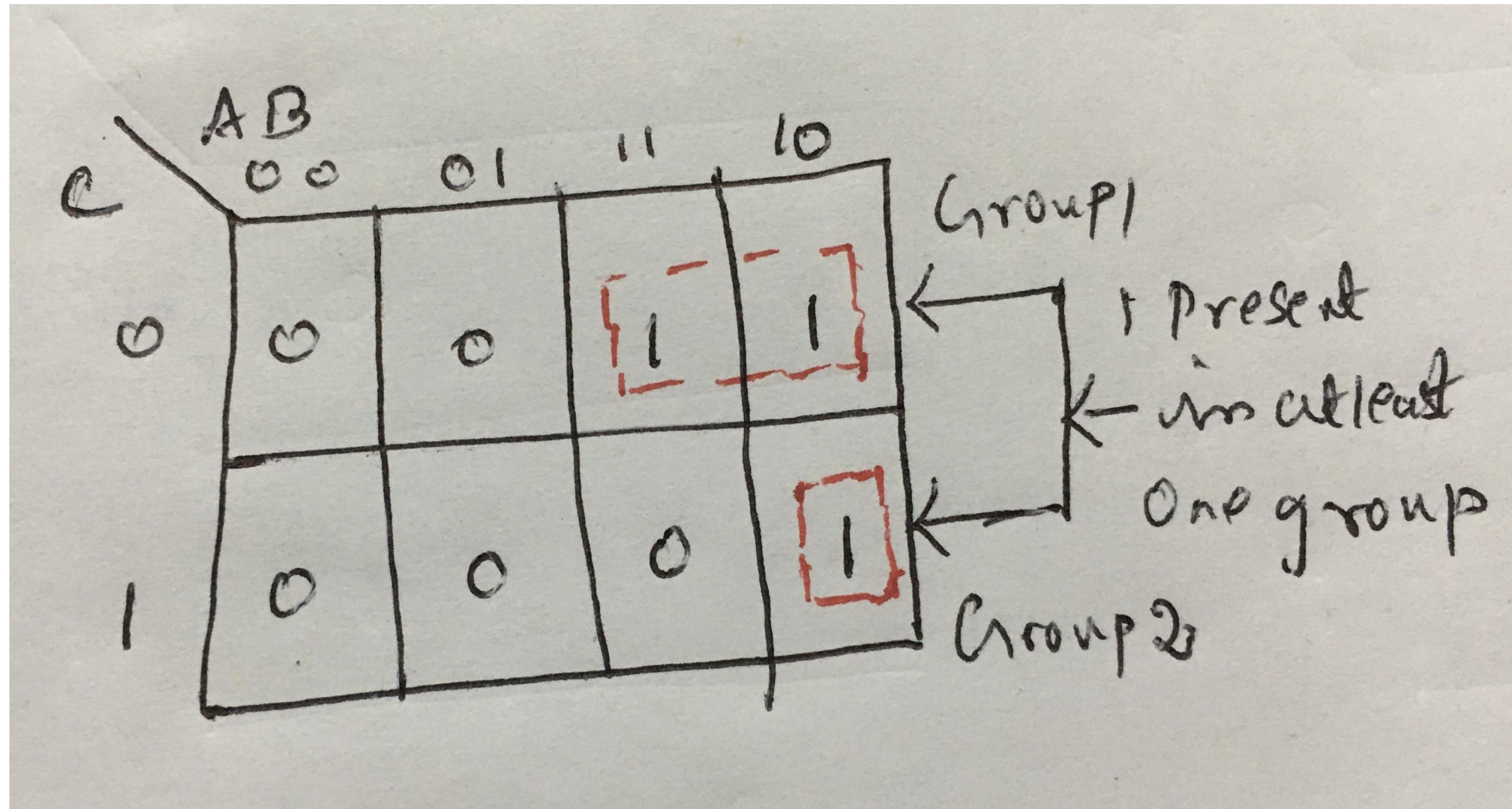




KARNAUGH MAP - Rules



5. Each cell containing a *one* must be in at least one group.

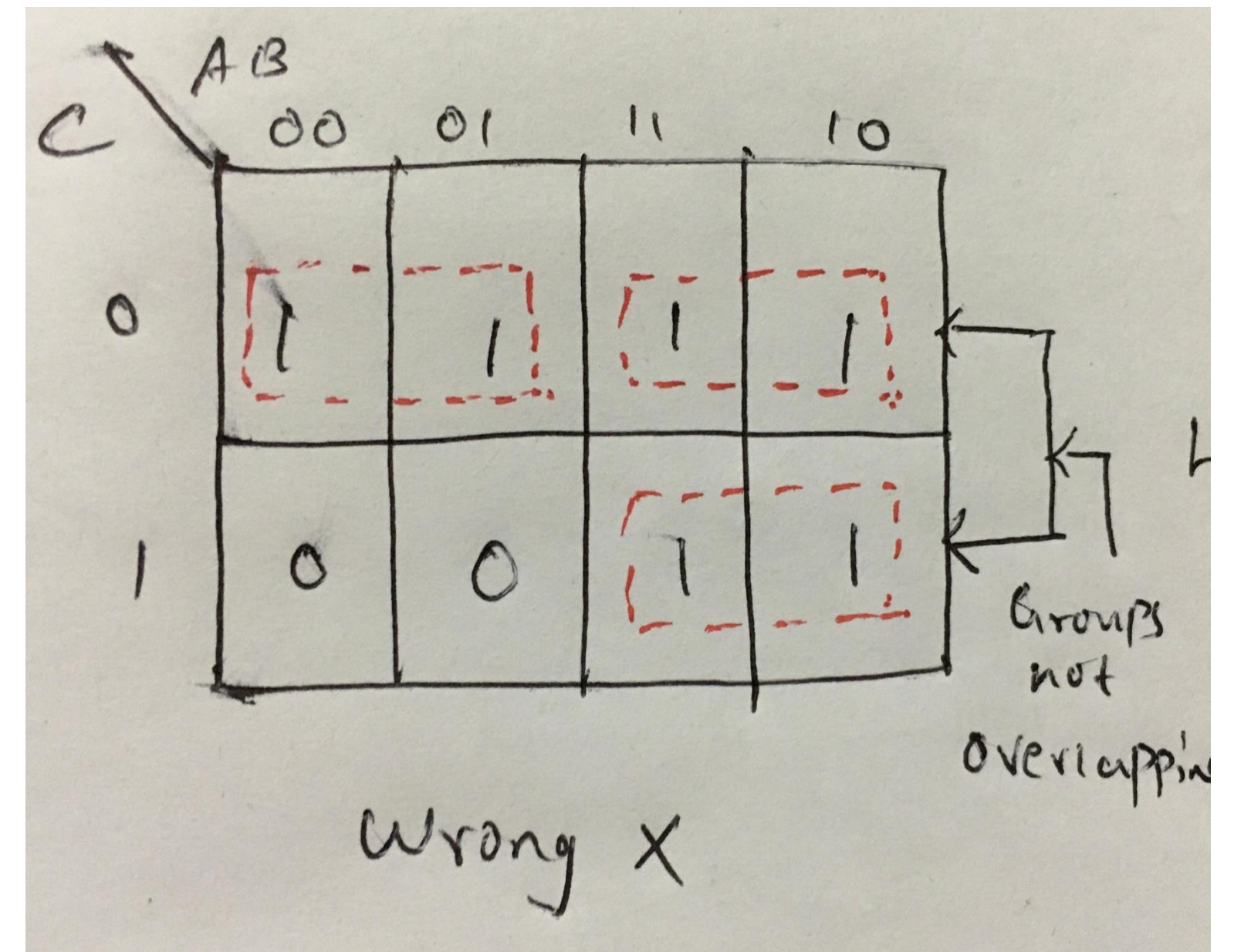
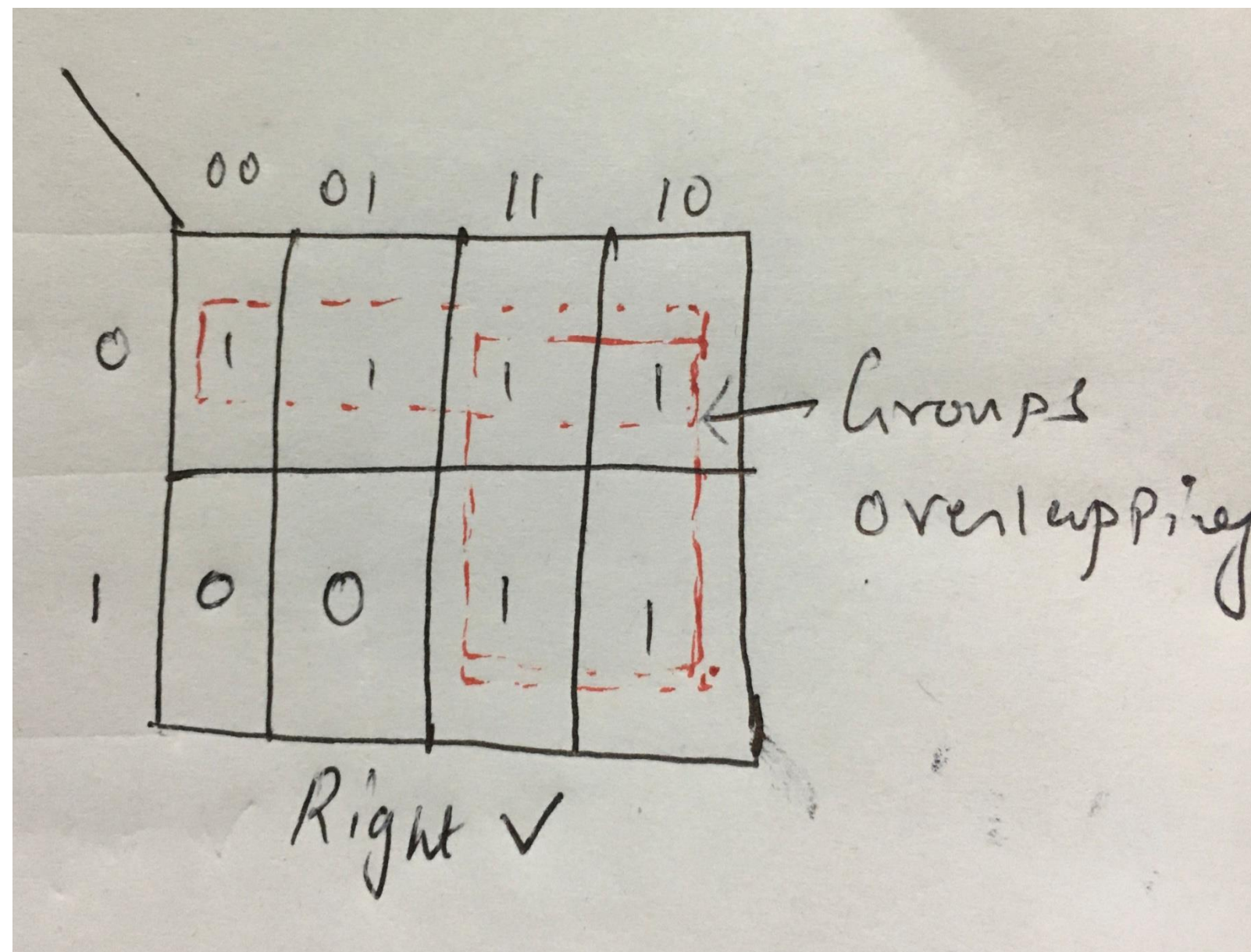




KARNAUGH MAP - Rules



6. Groups may overlap.

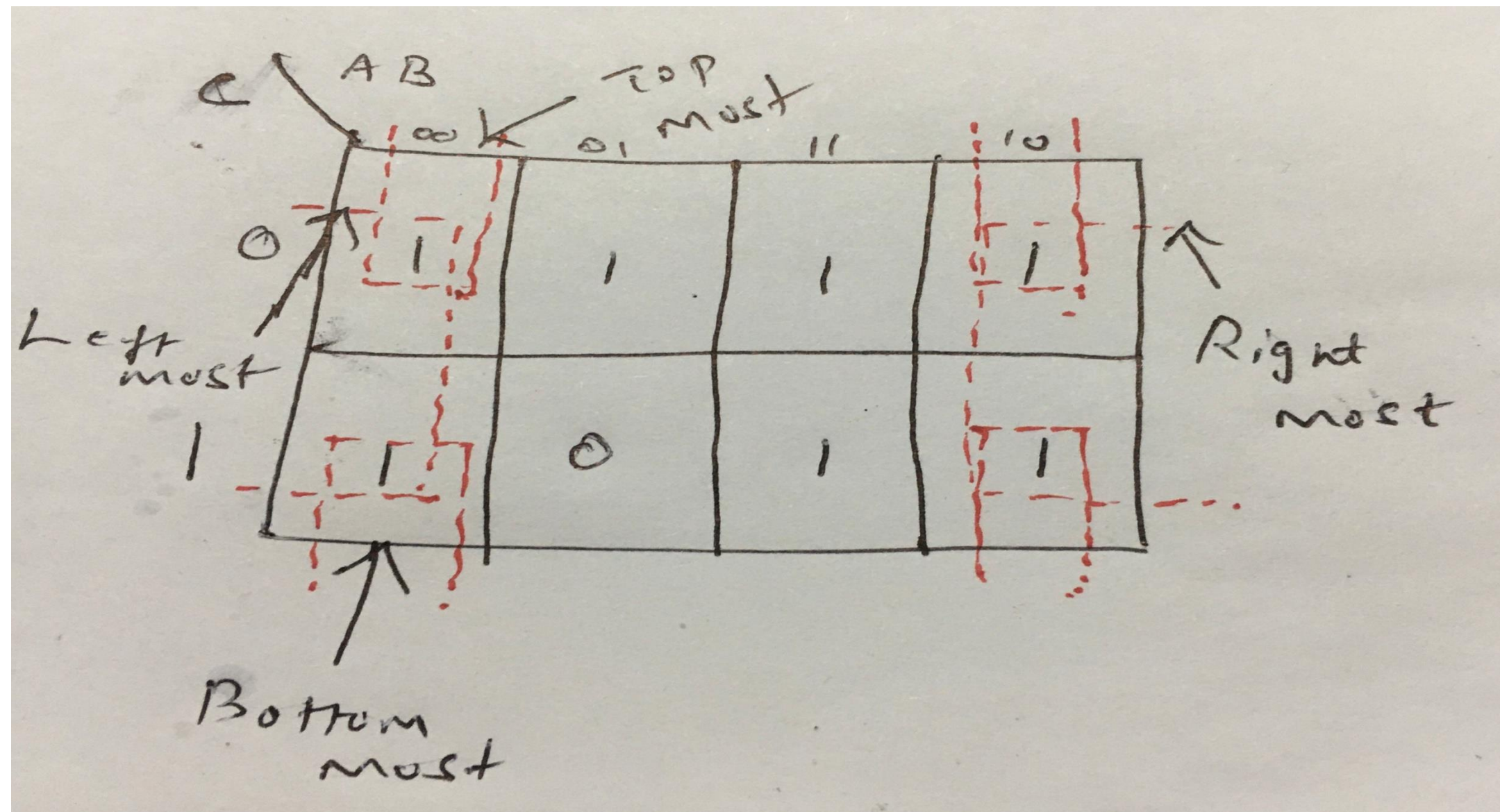




KARNAUGH MAP - Rules



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

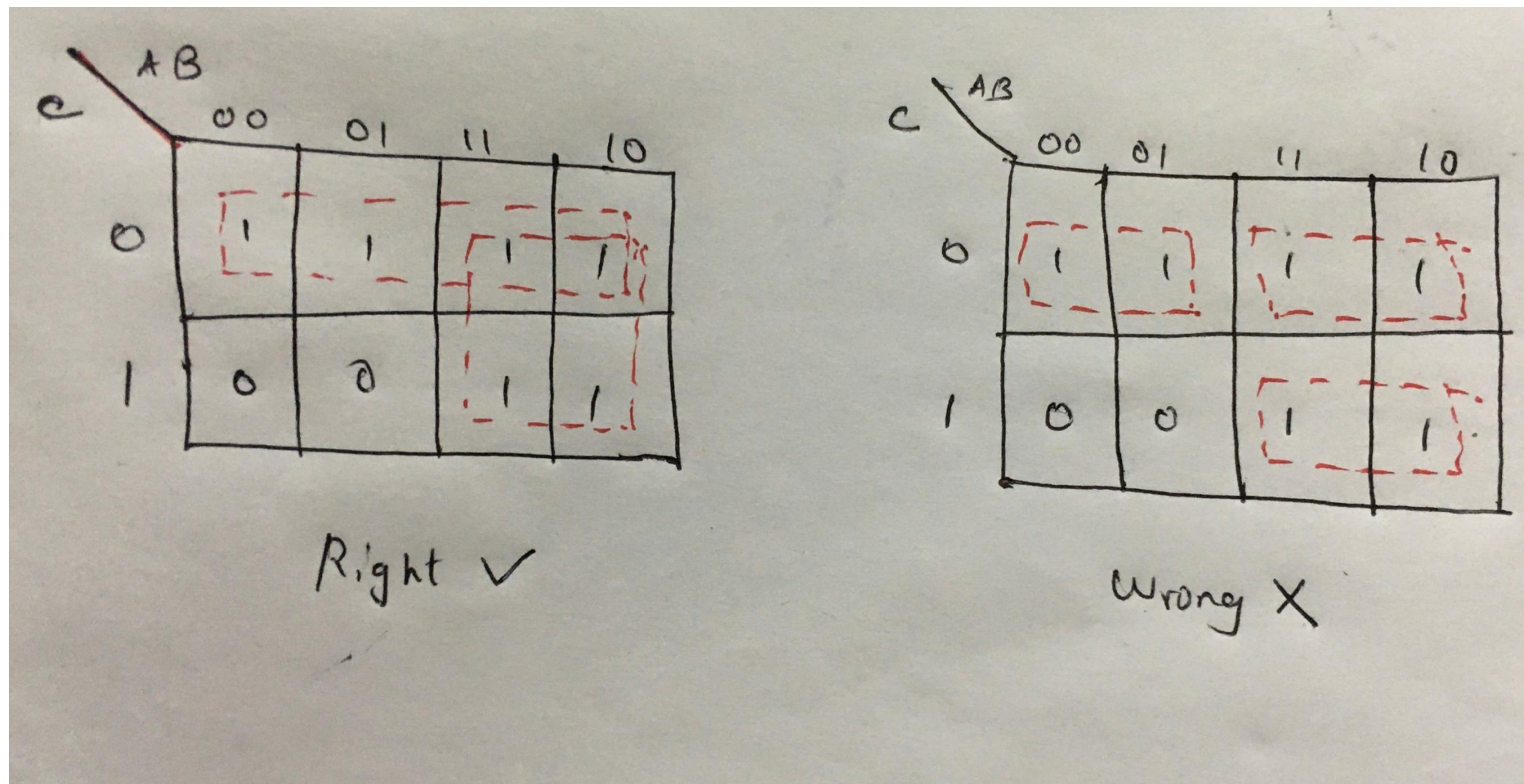




KARNAUGH MAP - Rules



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 – Types of Variables



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



KARNAUGH MAP – 2 Variable



- 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 $\{(m_0, m_1), (m_2, m_3), (m_0, m_2) \text{ and } (m_1, m_3)\}$.

Z	0	1
Y		
0	m_0	m_1
1	m_2	m_3

or

YZ	00	01	11	10
	m_0	m_1	m_3	m_2



KARNAUGH MAP – 3 Variable



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



KARNAUGH MAP – 4 Variable



- 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}



KARNAUGH MAP – 4 Variable



- 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



KARNAUGH MAP – 5 Variable



- 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