



# 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 ARTIFICIAL INTELLIGENCE AND MACHINE LERARNING

### 19ECB231 – DIGITAL ELECTRONICS

II YEAR<sup>1</sup>/ III SEMESTER

UNIT 1 – MINIMIZATION TECHNIQUES AND LOGIC GATES

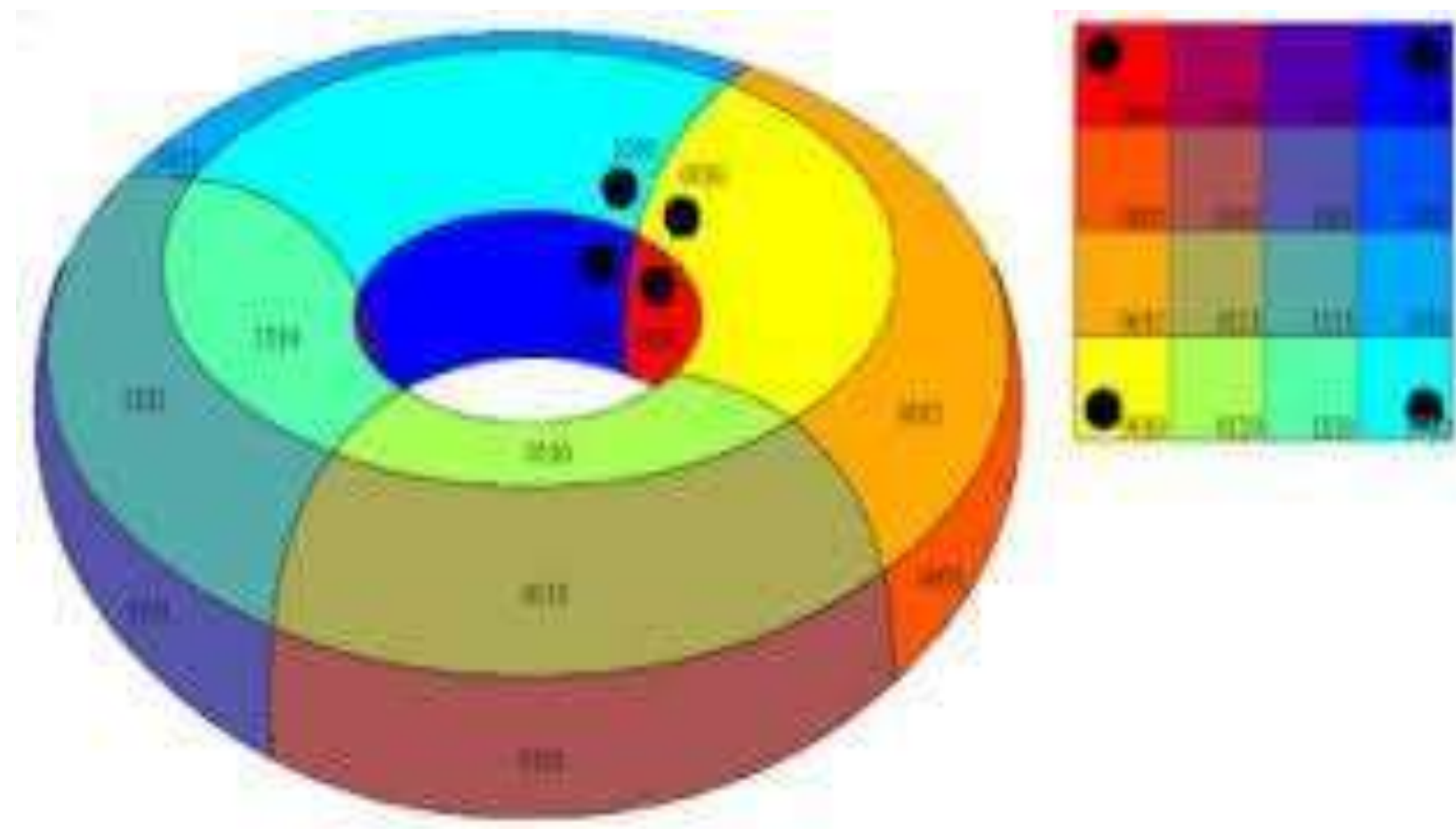
TOPIC - KARNAUGH MAP MINIMIZATION



## 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.

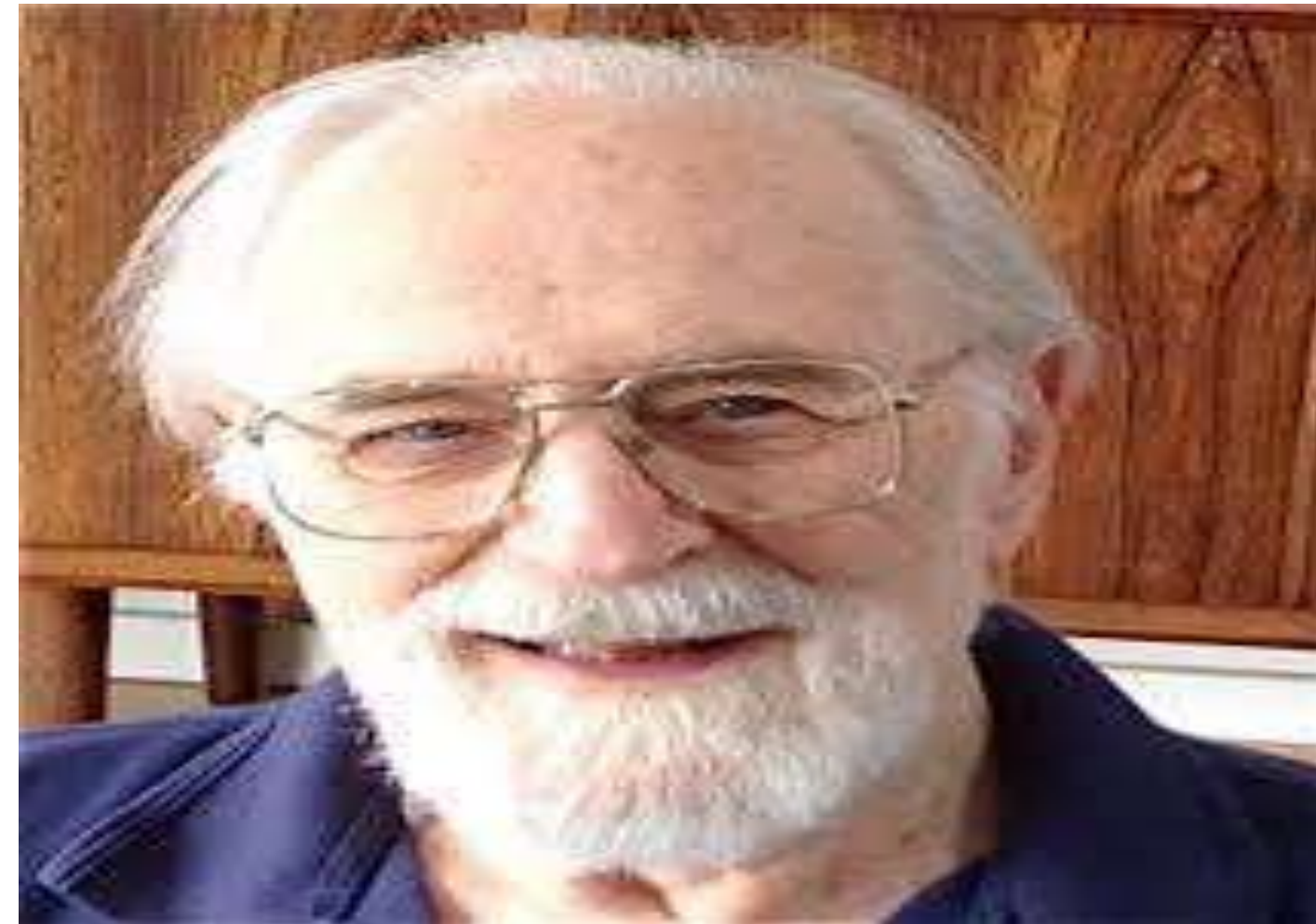




## KARNAUGH MAP



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

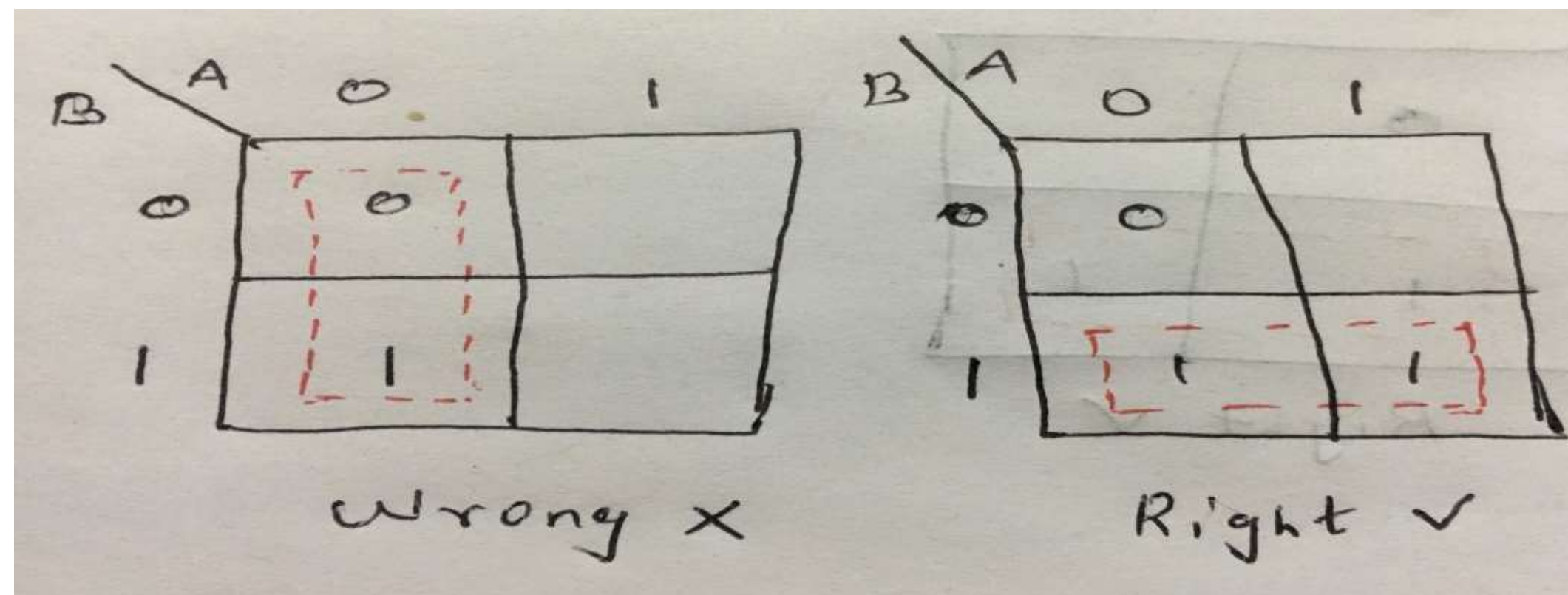




## KARNAUGH MAP - Rules

- 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

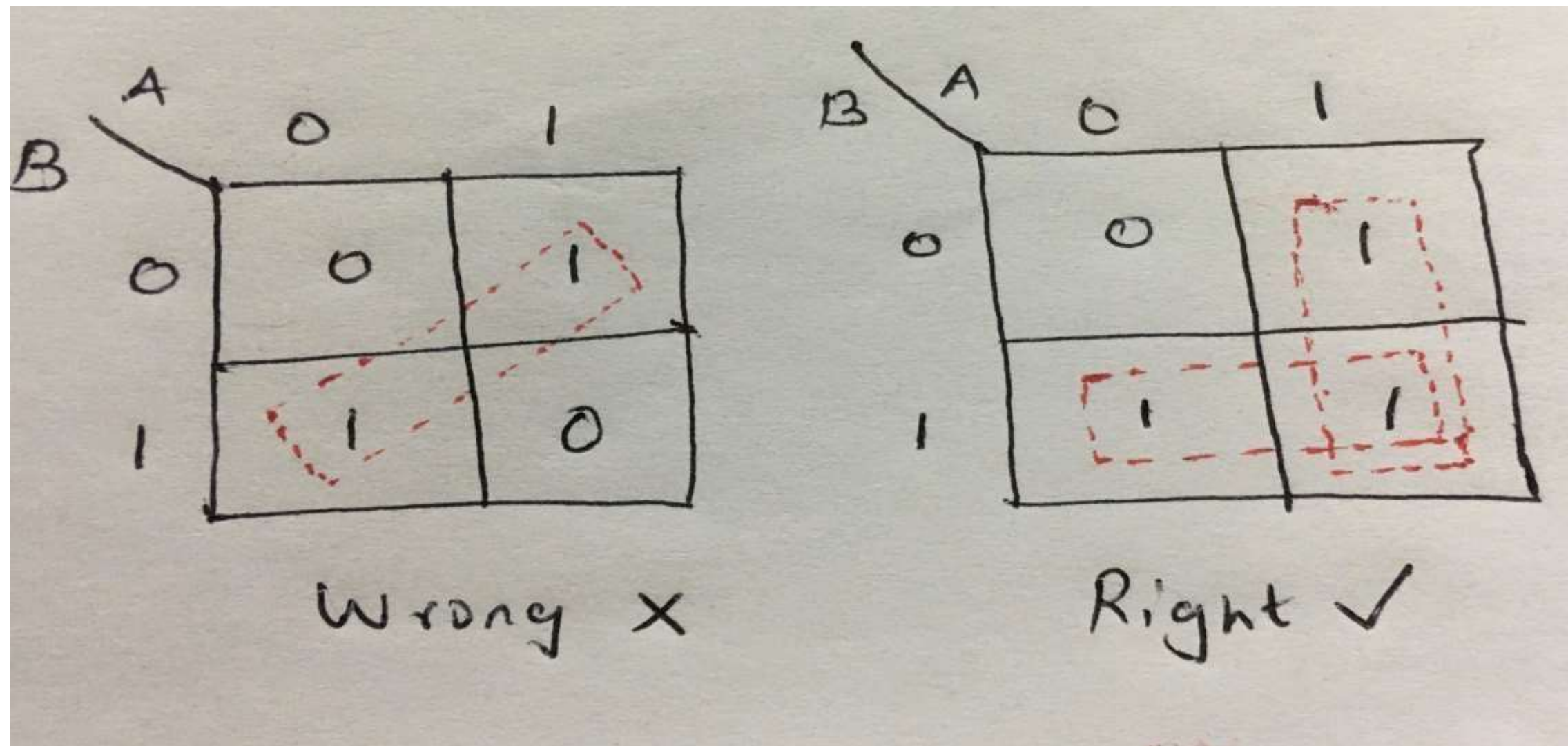




## KARNAUGH MAP - Rules



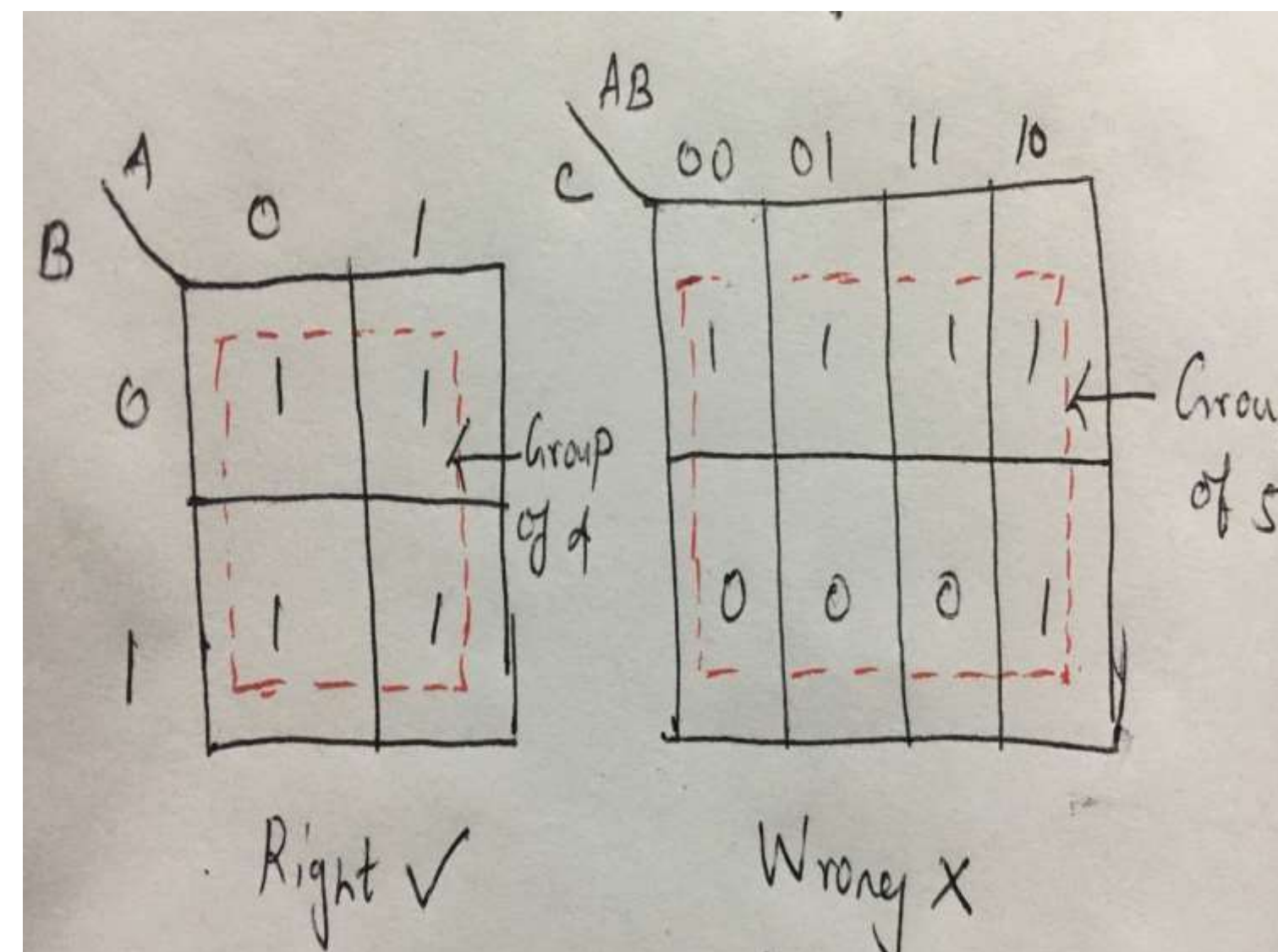
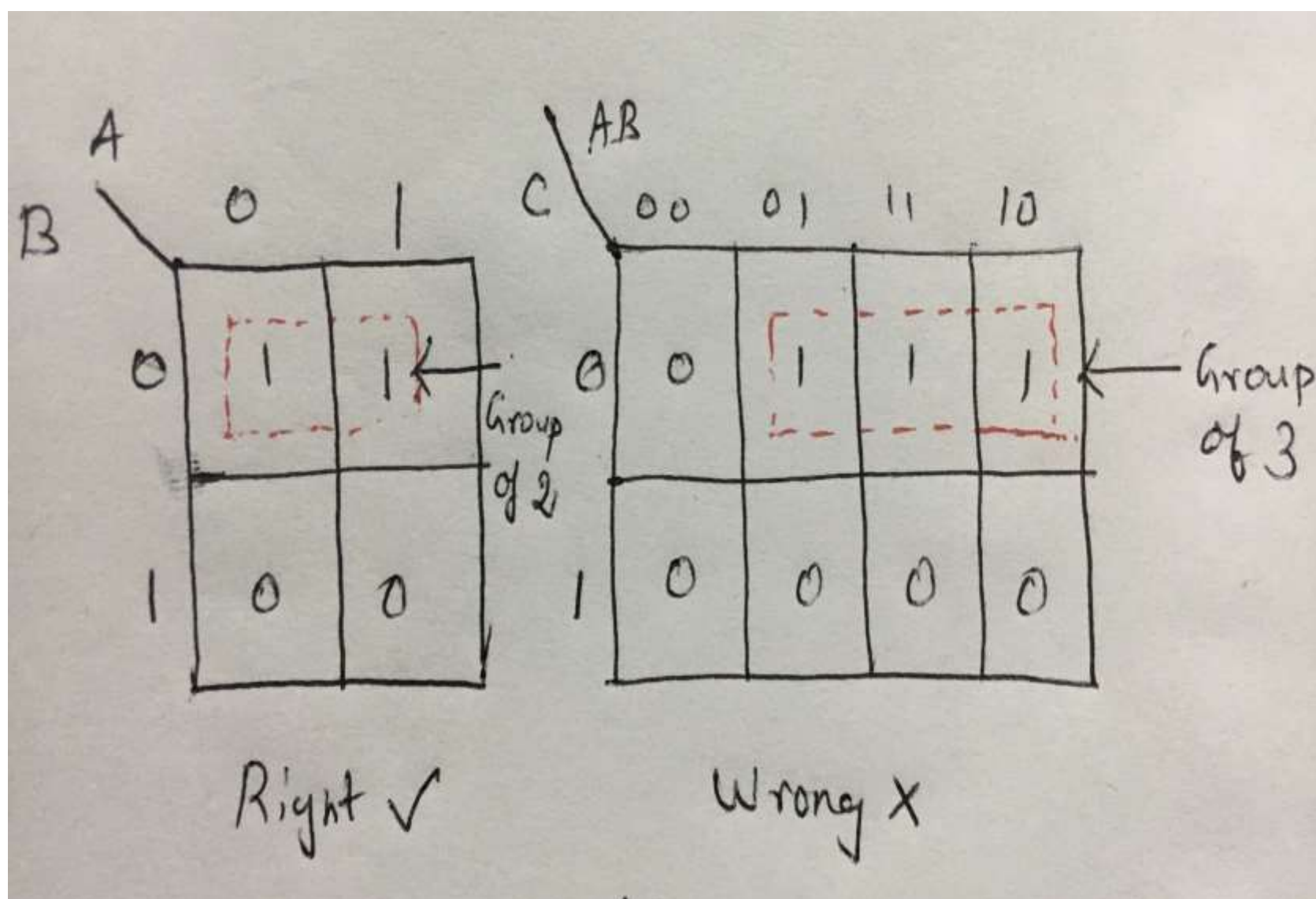
2. Groups may be horizontal or vertical, but not diagonal.





## 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  $2^2 = 4$ .

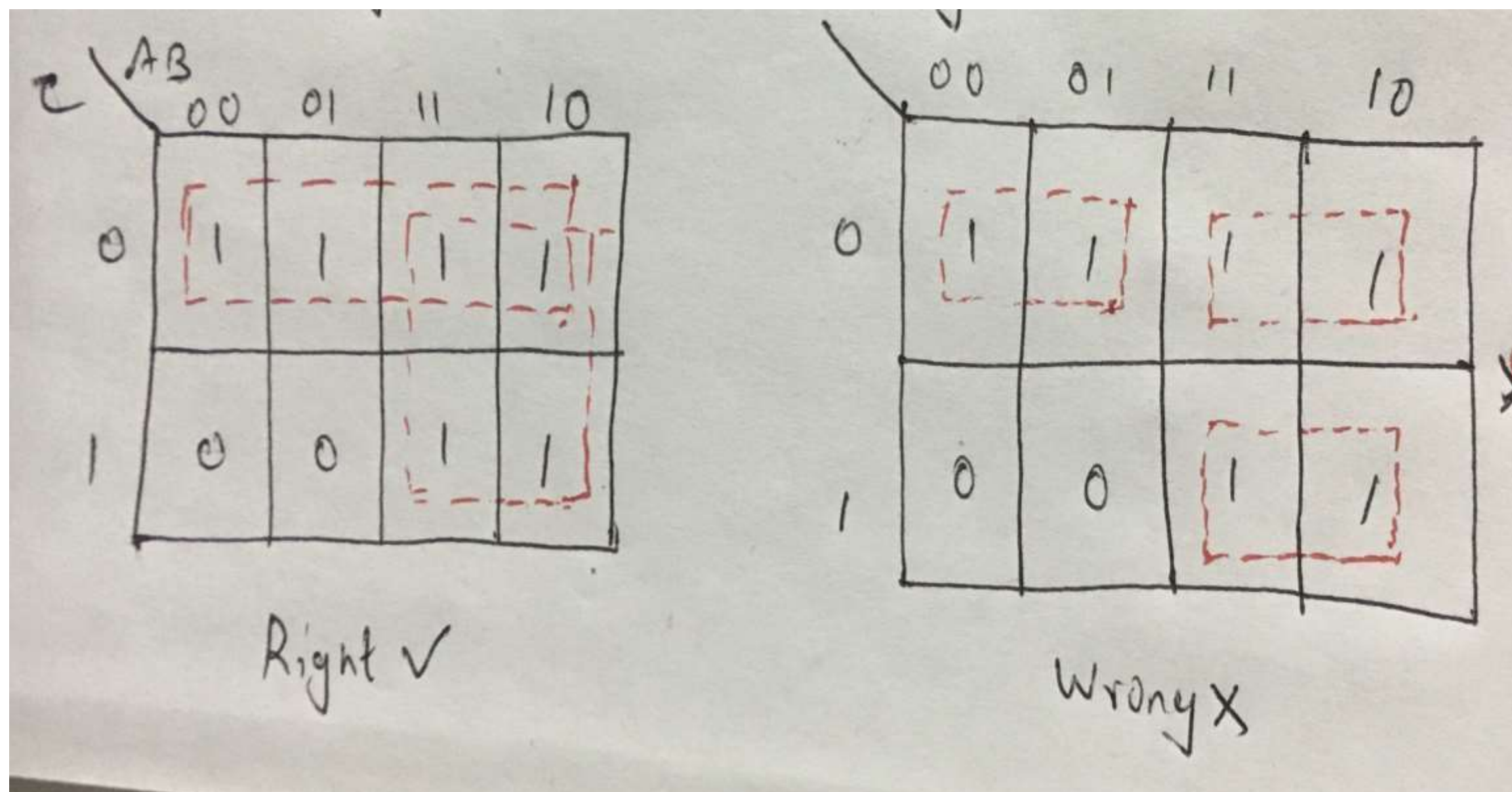




## KARNAUGH MAP - Rules



4. Each group should be as large as possible.

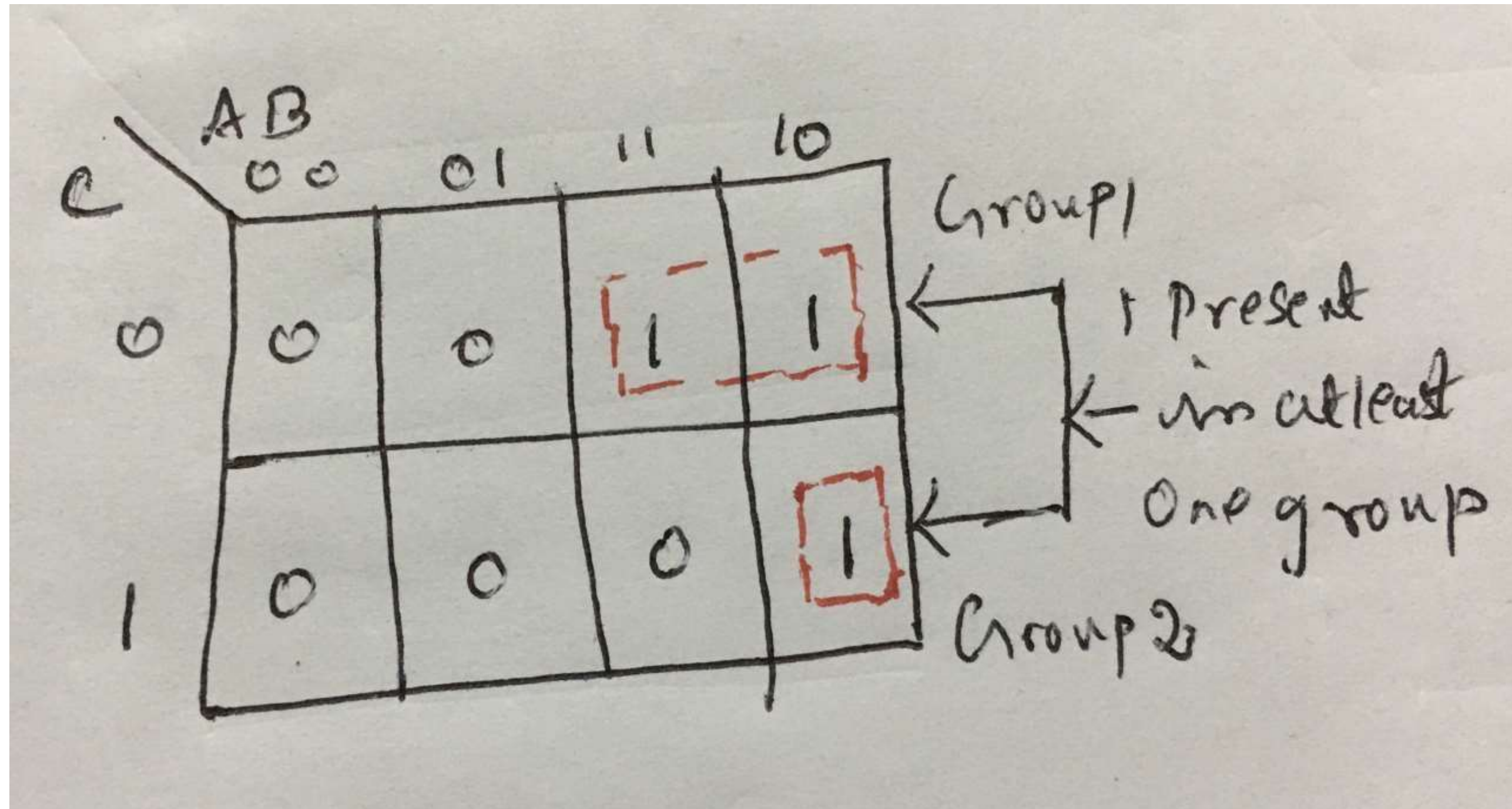




## KARNAUGH MAP - Rules



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



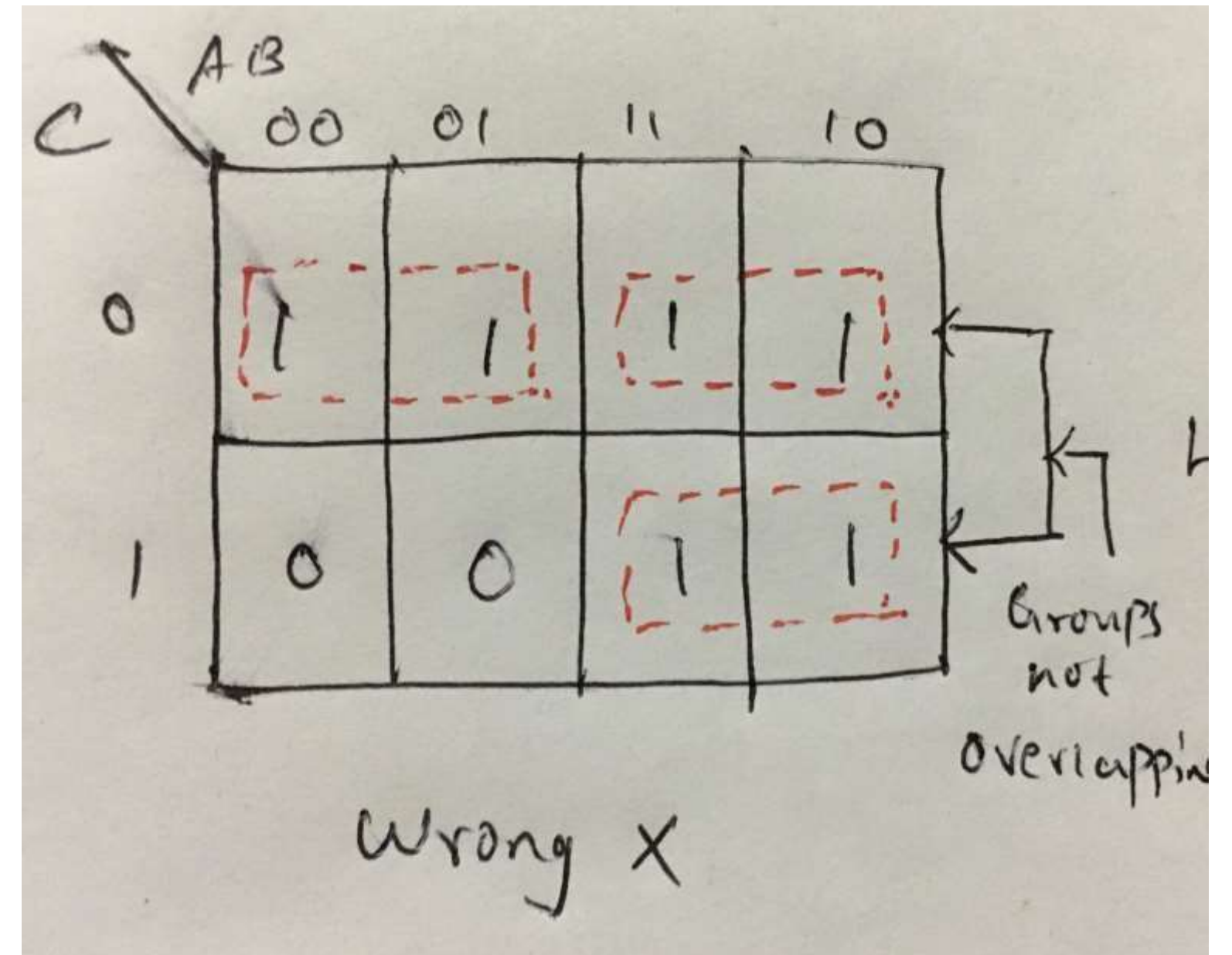
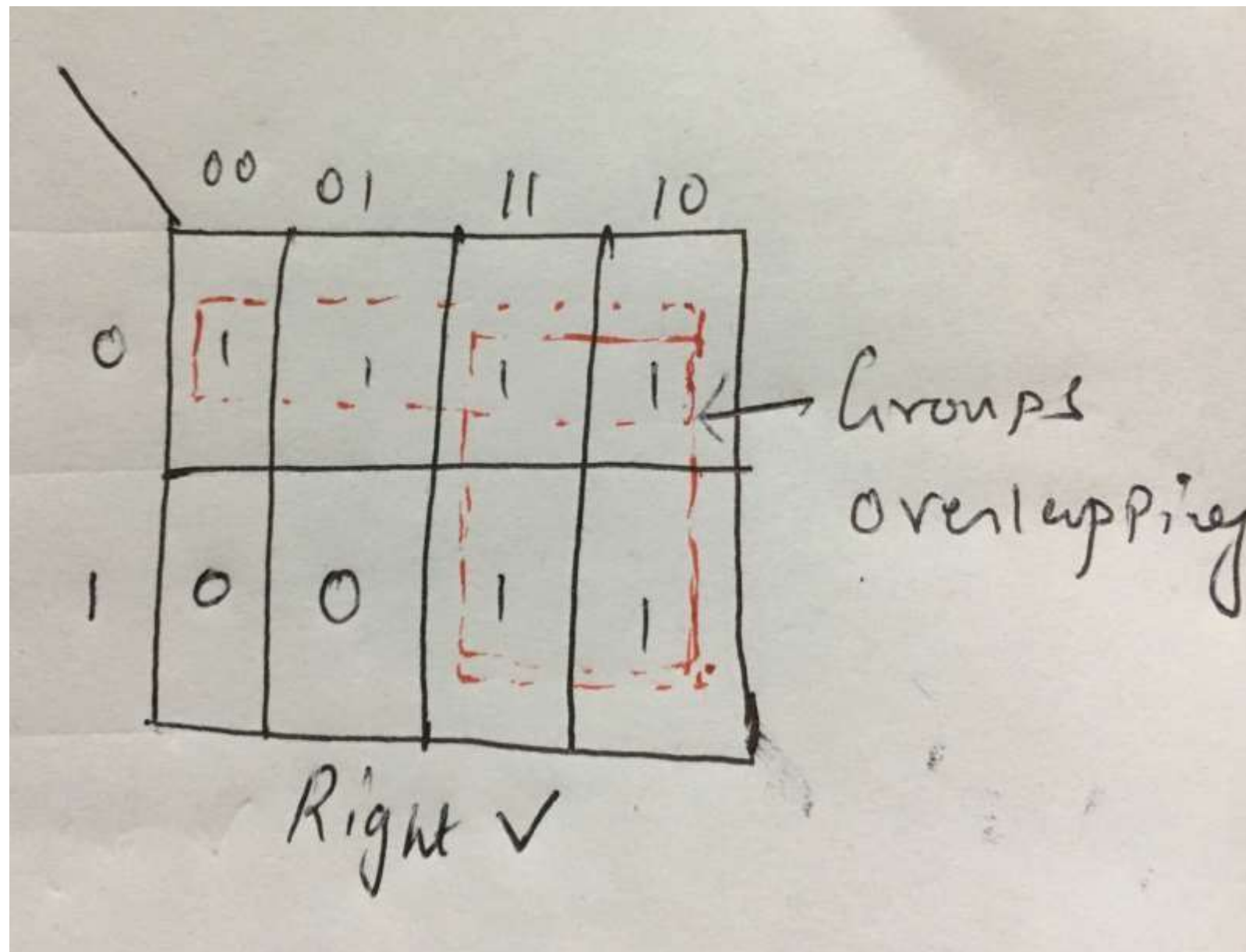




## KARNAUGH MAP - Rules



### 6. Groups may overlap.

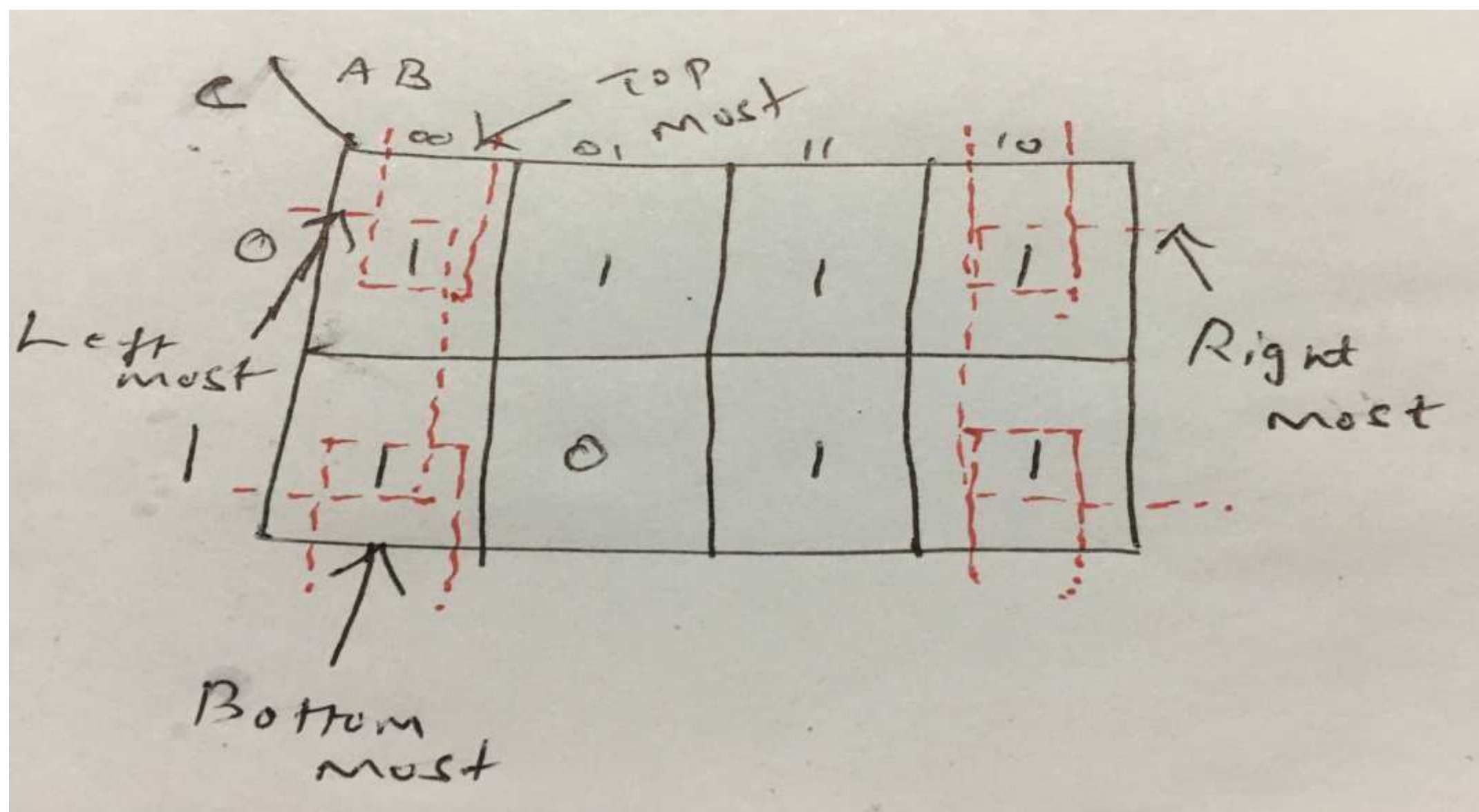




## KARNAUGH MAP - Rules



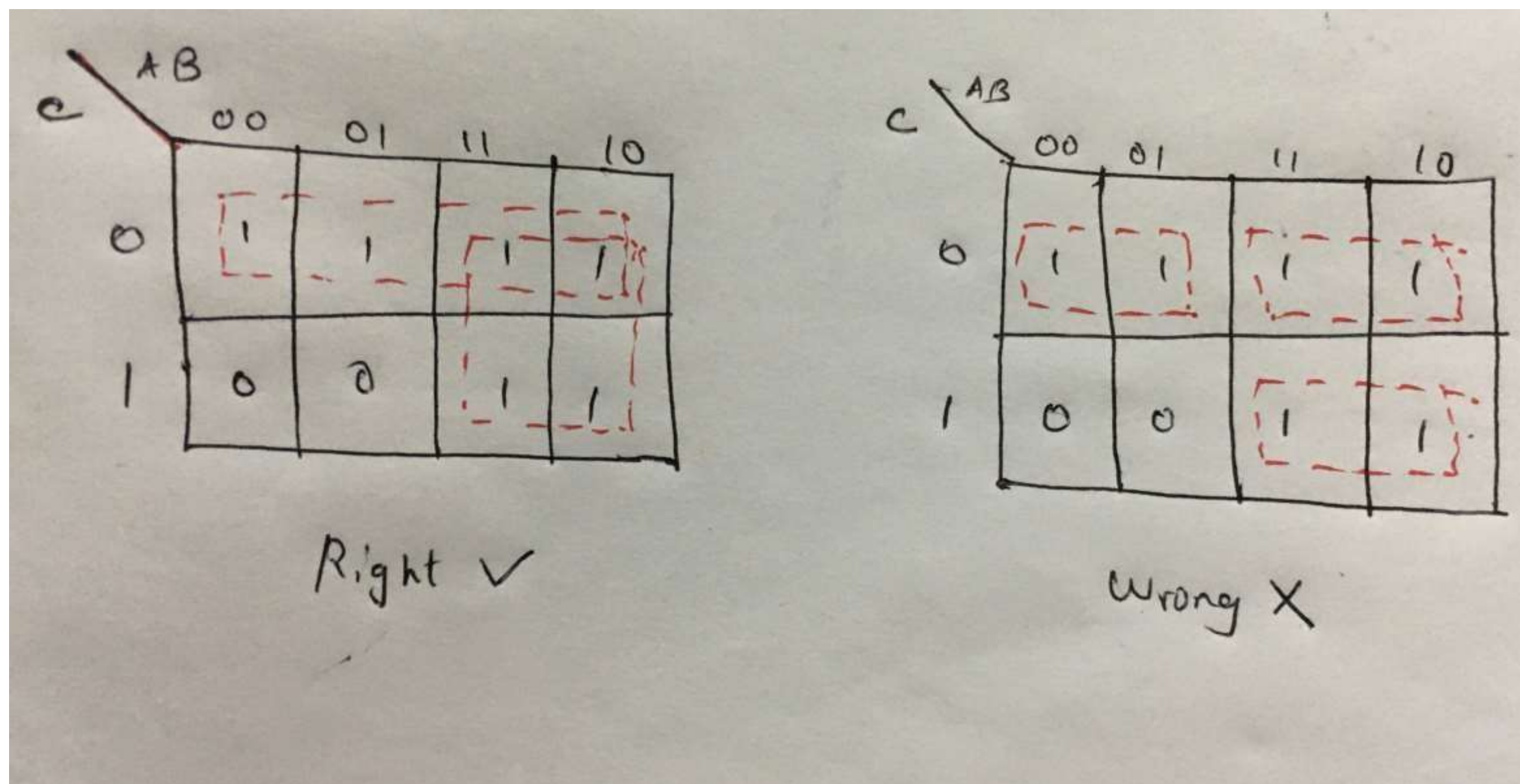
7. Groups may wrap around the table. The leftmost cell in a row may be grouped with the rightmost cell and the top cell in a column may be grouped with the bottom cell





## KARNAUGH MAP - Rules

8. There should be as few groups as possible, as long as this does not contradict any of the previous rules





# KARNAUGH MAP-RULES-SUMMARY



- 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



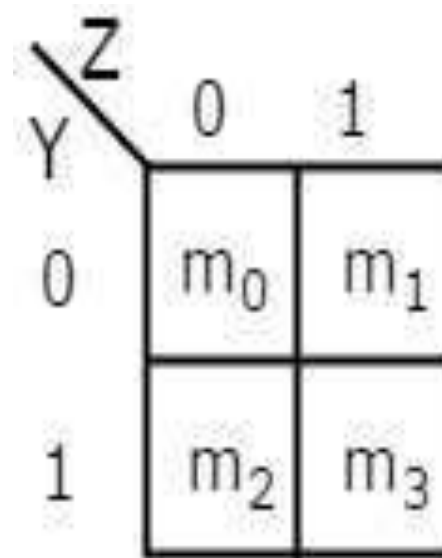
- Karnaugh Map is most suitable for Minimizing Boolean expressions of
  - 2 Variable
  - 3 Variable
  - 4 Variable
  - 5 Variable



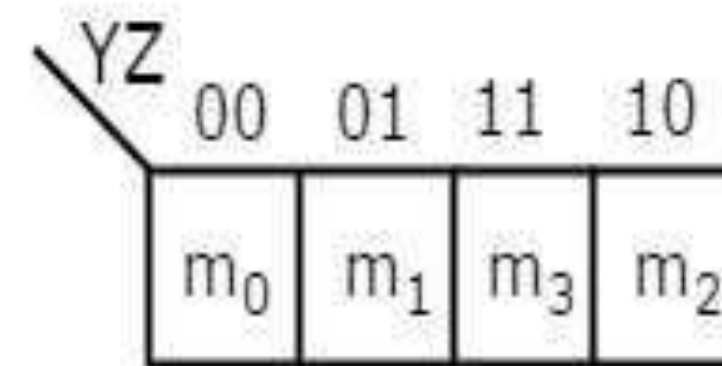
## KARNAUGH MAP – 2 Variable



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



or





## 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 <sub>0</sub>  | m <sub>1</sub>  | m <sub>3</sub>  | m <sub>2</sub>  |
| 01      | m <sub>4</sub>  | m <sub>5</sub>  | m <sub>7</sub>  | m <sub>6</sub>  |
| 11      | m <sub>12</sub> | m <sub>13</sub> | m <sub>15</sub> | m <sub>14</sub> |
| 10      | m <sub>8</sub>  | m <sub>9</sub>  | m <sub>11</sub> | m <sub>10</sub> |

V=1

| WX \ YZ | 00              | 01              | 11              | 10              |
|---------|-----------------|-----------------|-----------------|-----------------|
| 00      | m <sub>16</sub> | m <sub>17</sub> | m <sub>19</sub> | m <sub>18</sub> |
| 01      | m <sub>20</sub> | m <sub>21</sub> | m <sub>23</sub> | m <sub>22</sub> |
| 11      | m <sub>28</sub> | m <sub>29</sub> | m <sub>31</sub> | m <sub>30</sub> |
| 10      | m <sub>24</sub> | m <sub>25</sub> | m <sub>27</sub> | m <sub>26</sub> |



## 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.



1. Who introduced k map?
2. A K map is an abstract form of \_\_\_\_\_ diagram organized as a matrix of squares.
  - a) Venn Diagram
  - b) Cycle Diagram
  - c) Block diagram
  - d) Triangular Diagram
3. There are \_\_\_\_\_ cells in a 4-variable K-map.
4. Summarize the rules of k map.
5. Plot a 4 variable k map
6. Explain the K-Map using 2,3 and 4 variables.



**THANK YOU**