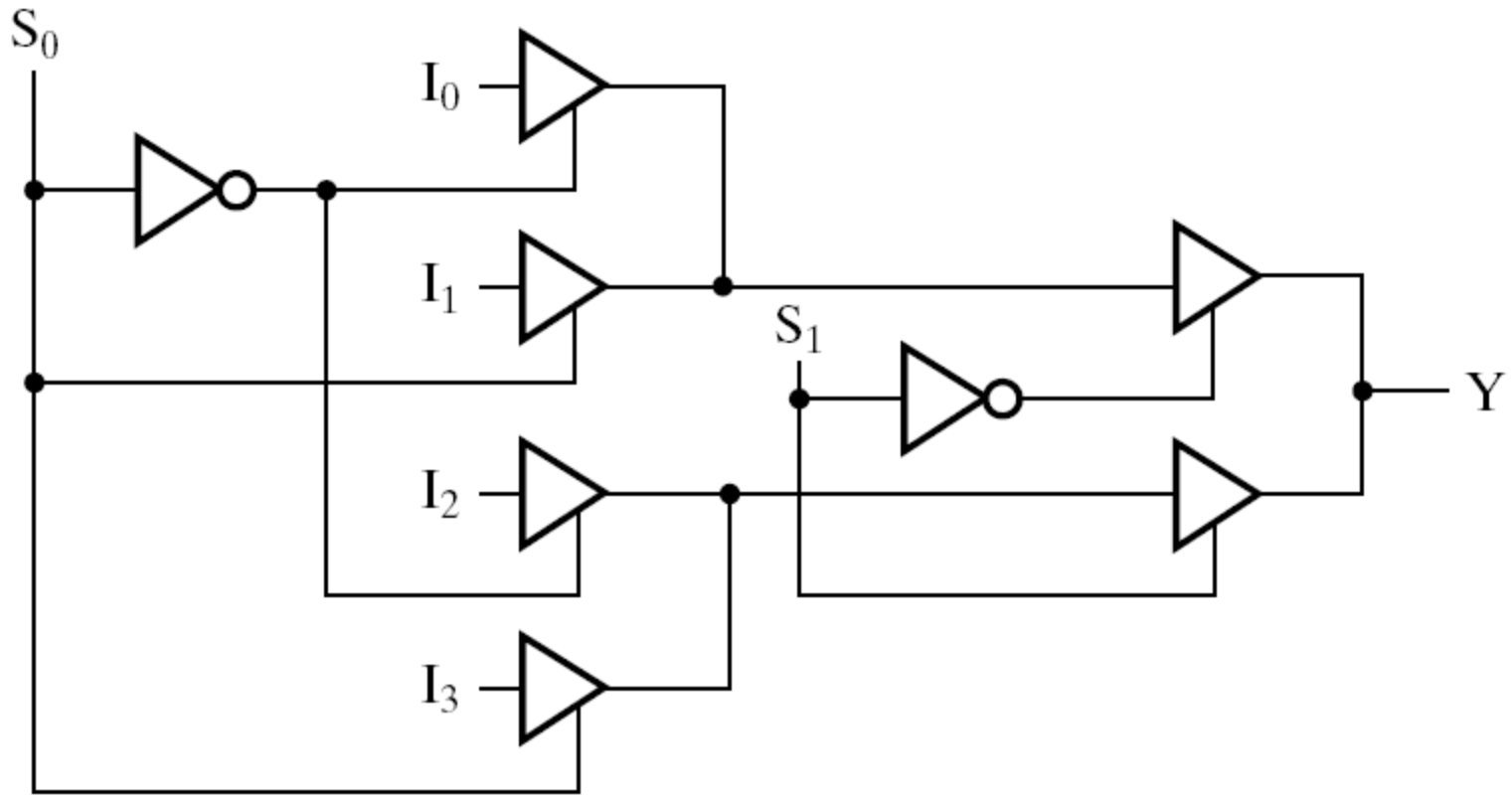
Attention Please

- Weekly Exercise (Page 105 on text book)

2-15; 2-18; 2-19; 2-22; 2-25(a)&(b)

- *U.S. News & World Report*'s annual ranking of America's Best Colleges, released today, lists SDSU at No. 68 among public universities, and No. 140 overall among national universities. There are 311 national universities in the US.
- SDSU has been gaining ground over the last five years, moving up 43 spots from No. 183 overall in 2011.
- Midterm Exam1 is scheduled on Oct. 2 in class.
- On Sept. 27, I will use one lecture to help you prepare Midterm Exam1. Don't miss it!

MUX using Tri-State Buffers

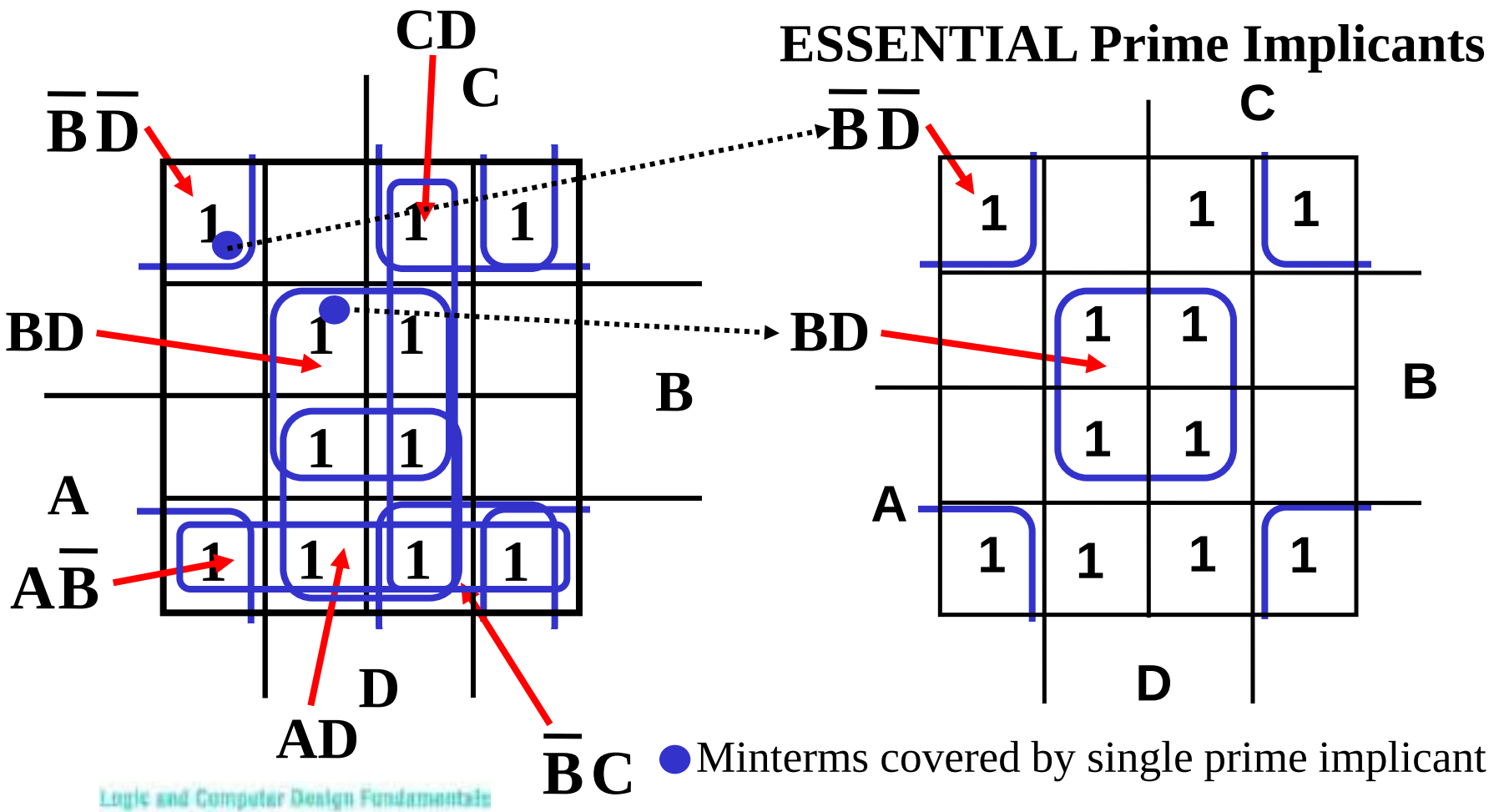


Systematic Simplification

- **A *Prime Implicant* is a product term obtained by combining the maximum possible number of adjacent squares in the map into a rectangle with the number of squares a power of 2.**
- **A prime implicant is called an *Essential Prime Implicant* if it is the only prime implicant that covers (includes) one or more minterms.**
- **Prime Implicants and Essential Prime Implicants can be determined by inspection of a K-Map.**
- **A set of prime implicants *"covers all minterms"* if, for each minterm of the function, at least one prime implicant in the set of prime implicants includes the minterm.**

Example of Prime Implicants

- **Find ALL Prime Implicants**



Prime Implicant Practice

- **Find all prime implicants for:**

$$F(A, B, C, D) = \Sigma_m(0,2,3,8,9,10,11,12,13,14,15)$$

Another Example

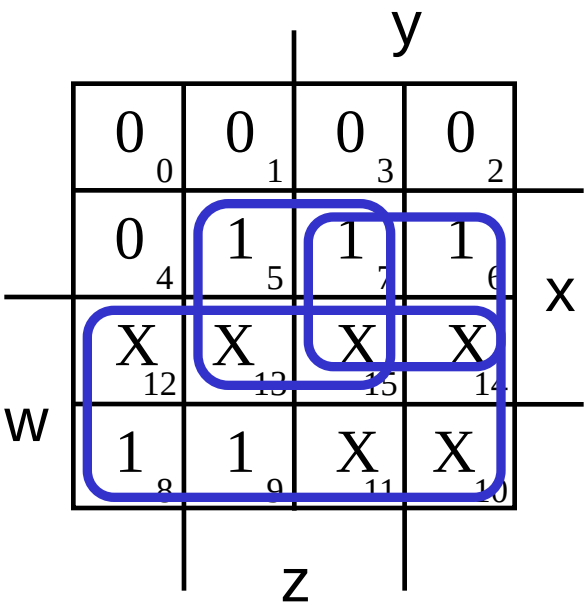
- **Find all prime implicants for:**
  $G(A, B, C, D) = \Sigma_m(0,2,3,4,7,12,13,14,15)$
  - **Hint: There are seven prime implicants!**

Don't Cares in K-Maps

- **Sometimes a function table or map contains entries for which it is known:**
  - **the input values for the minterm will never occur, or**
  - **The output value for the minterm is not used**
- **In these cases, the output value need not be defined**
- **Instead, the output value is defined as a "don't care"**
- **By placing "don't cares" (an "x" entry) in the function table or map, the cost of the logic circuit may be lowered.**
- **Example 1: A logic function having the binary codes for the BCD digits as its inputs. Only the codes for 0 through 9 are used. The six codes, 1010 through 1111 never occur, so the output values for these codes are "x" to represent "don't cares."**

Example: BCD “5 or More”

- **The map below gives a function F1(w,x,y,z) which is defined as "5 or more" over BCD inputs. With the don't cares used for the 6 non-BCD combinations:**



F1 (w,x,y,z) = w + x z + x y G = 7

- **This is much lower in cost than F2 where the “don't cares” were treated as "0s."**

Optimization Algorithm

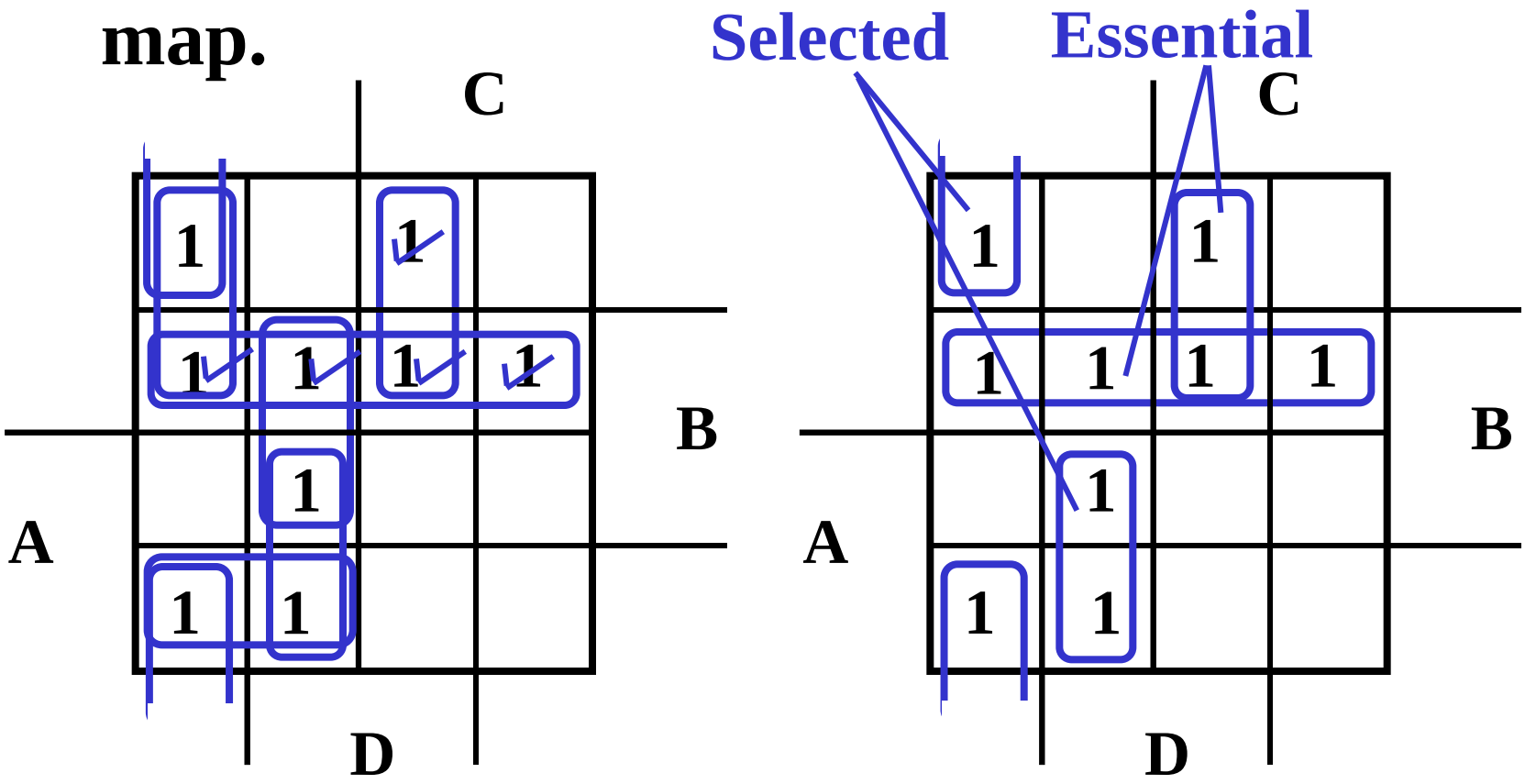
- **Find all prime implicants.**
- **Include all essential prime implicants in the solution**
- **Select a minimum cost set of non-essential prime implicants to cover all minterms not yet covered:**
  - **Obtaining an optimum solution: See Reading Supplement - More on Optimization**
  - **Obtaining a good simplified solution: Use the Selection Rule**

Prime Implicant Selection Rule

- **Minimize the overlap among prime implicants as much as possible. In particular, in the final solution, make sure that each prime implicant selected includes at least one minterm not included in any other prime implicant selected.**

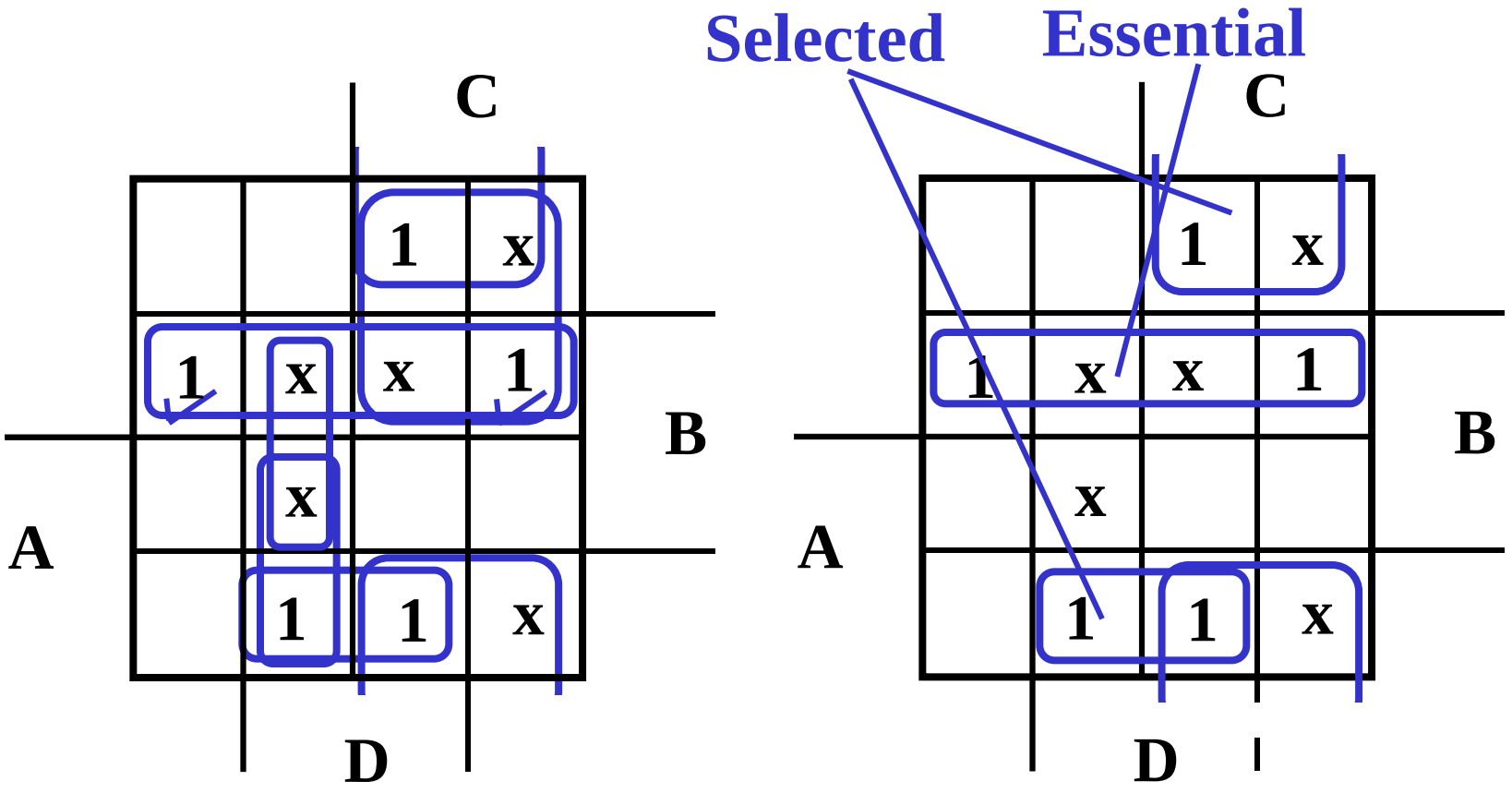
Selection Rule Example

- **Simplify F(A, B, C, D) given on the K-map.**



Selection Rule Example with Don't Cares

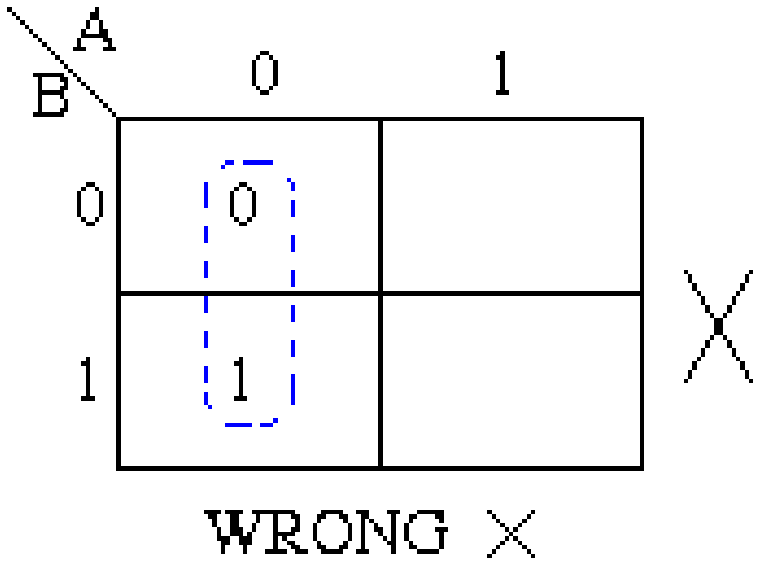
- Simplify F(A, B, C, D) given on the K-map.

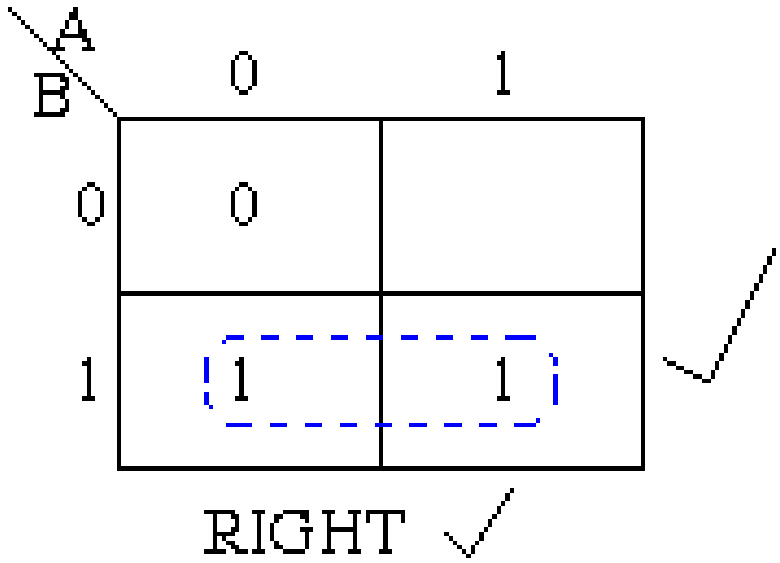


✓ Minterms covered by essential prime implicants

Common Mistakes (1)

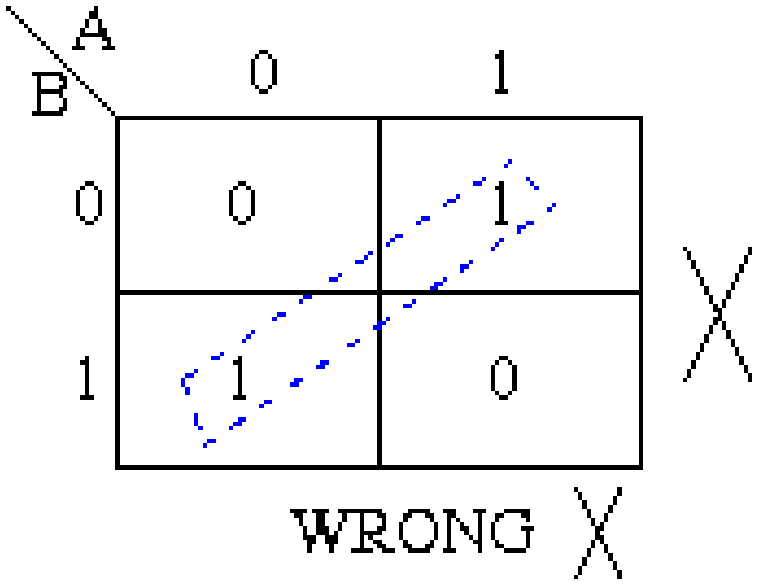
- Groups may not include any cell containing a zero.



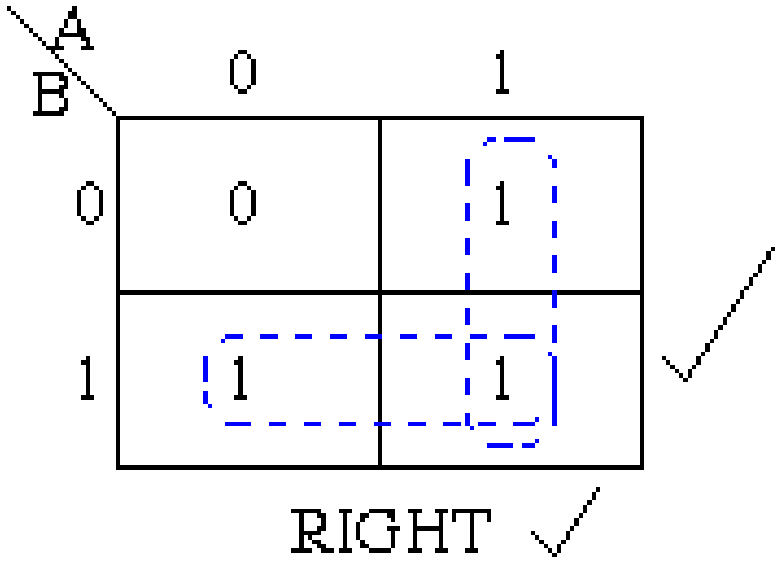


Common Mistakes (2)

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



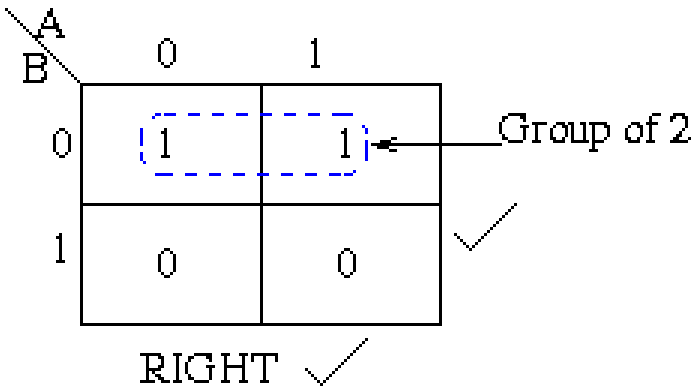
WRONG X

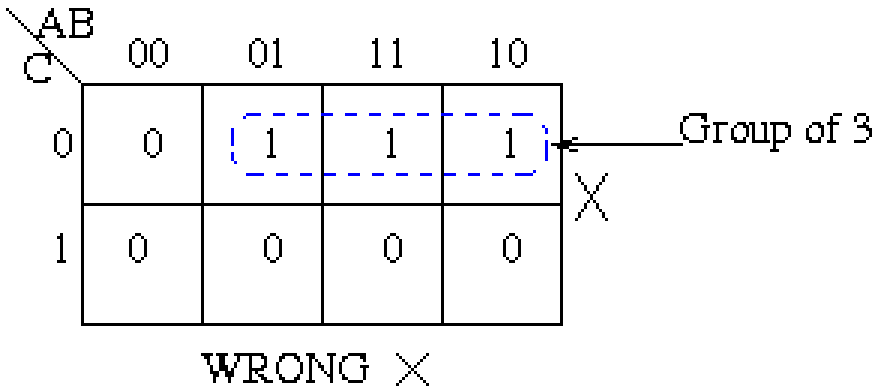


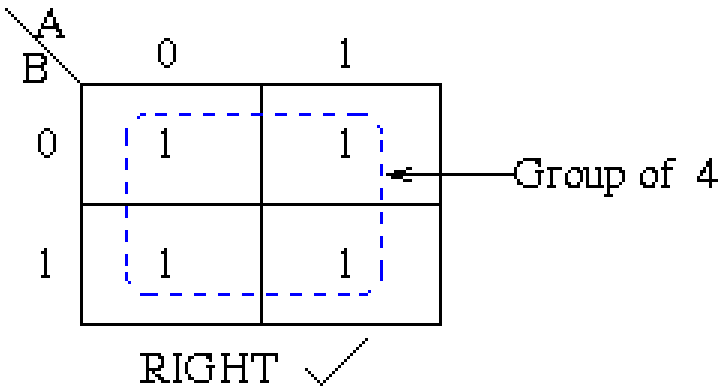
RIGHT ✓

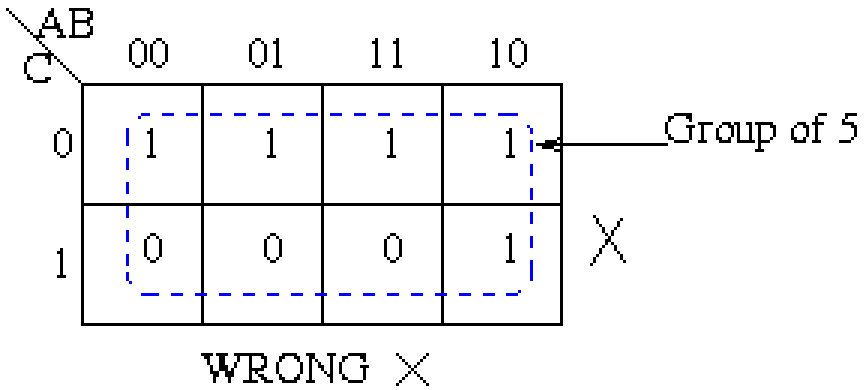
Common Mistakes (3)

- Groups must contain 1, 2, 4, 8, or in general 2n cells.



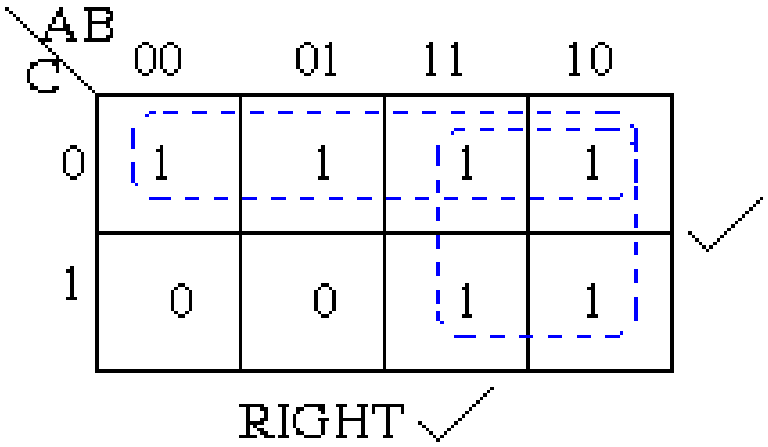




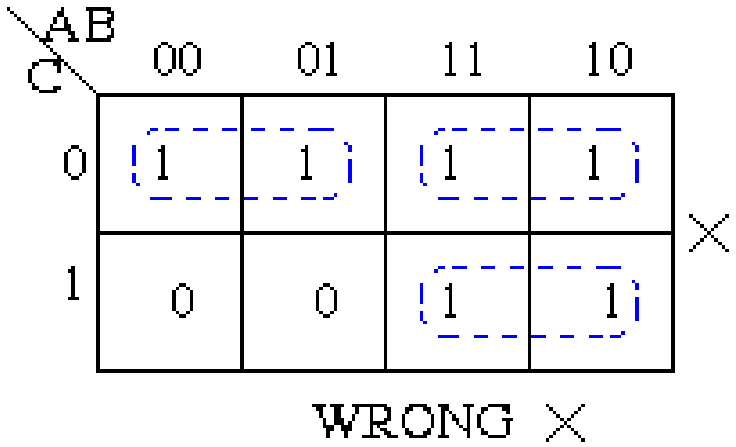


Common Mistakes (4)

- Each group should be as large as possible.



RIGHT ✓

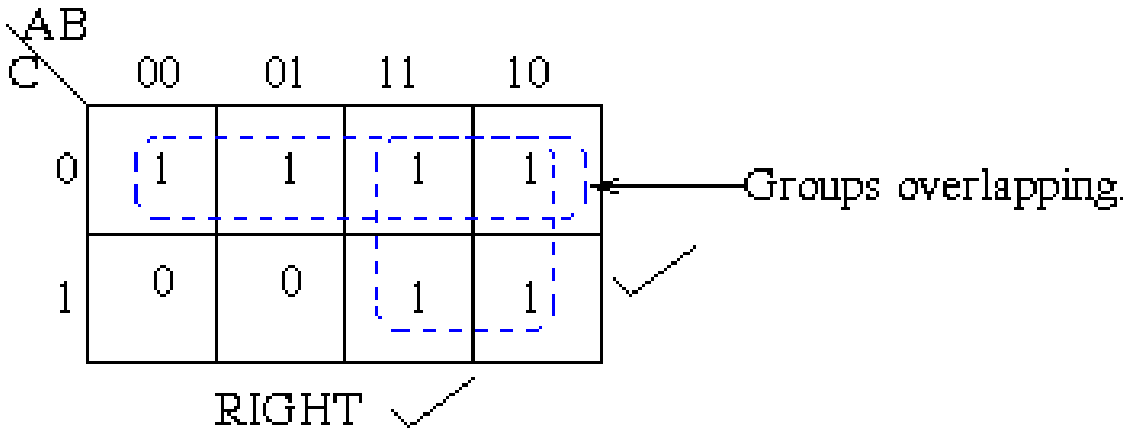


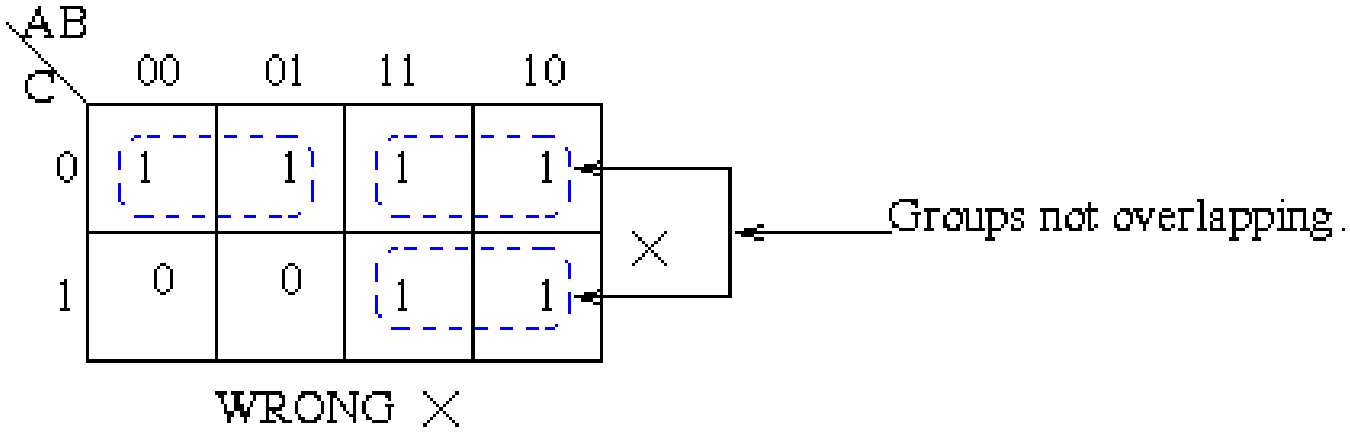
WRONG ×

(Note that no Boolean laws broken, but not sufficiently minimal)

Common Mistakes (5)

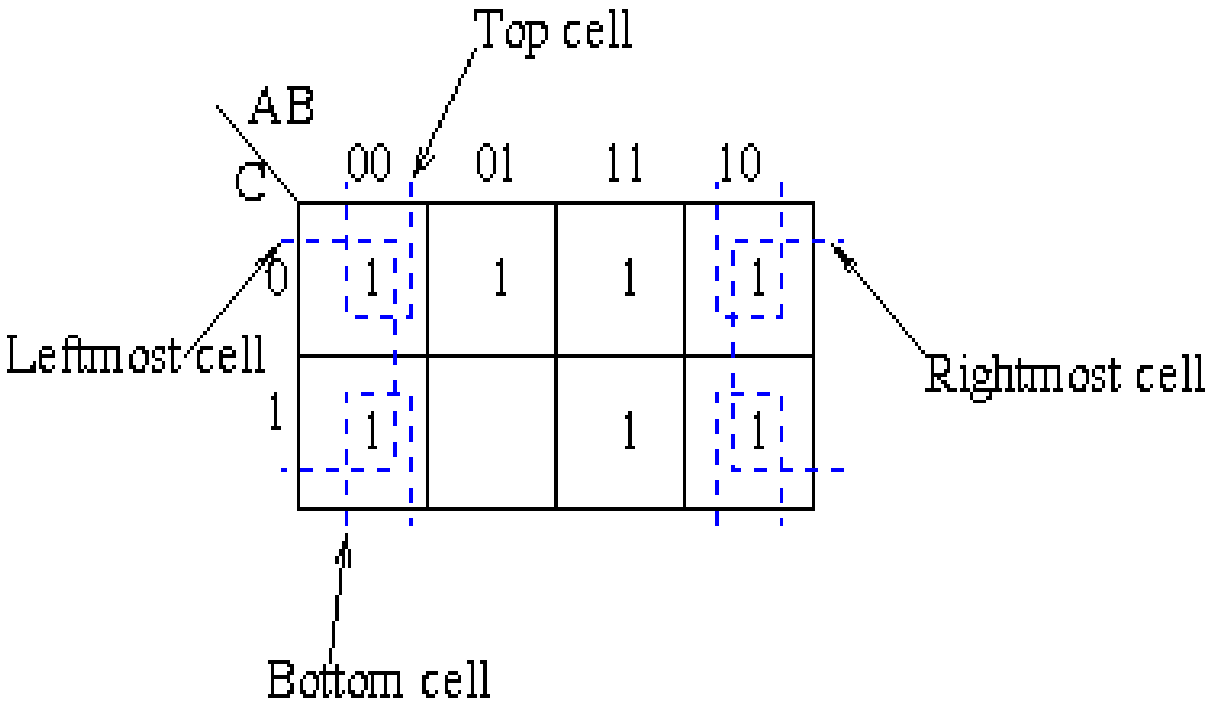
- Groups may overlap.





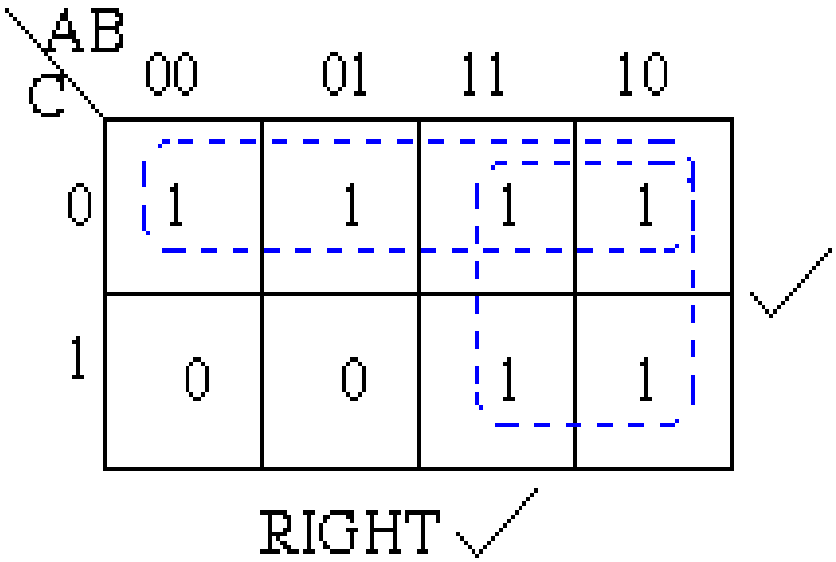
Common Mistakes (6)

- 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.

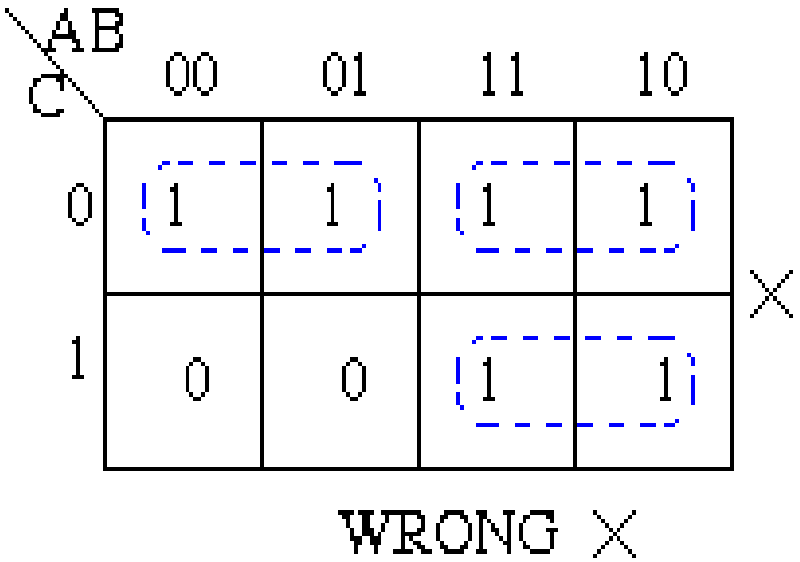


Common Mistakes (7)

- There should be as few groups as possible.



RIGHT ✓



WRONG ✗

Avoid Common Mistakes

- 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.

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How a CPU Works

- A very good video about CPU
- https://youtu.be/cNN_tTXABUA
- Rebecca Schiele found this video, thank you!