Combinational Logic

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Feb. 7, 2024

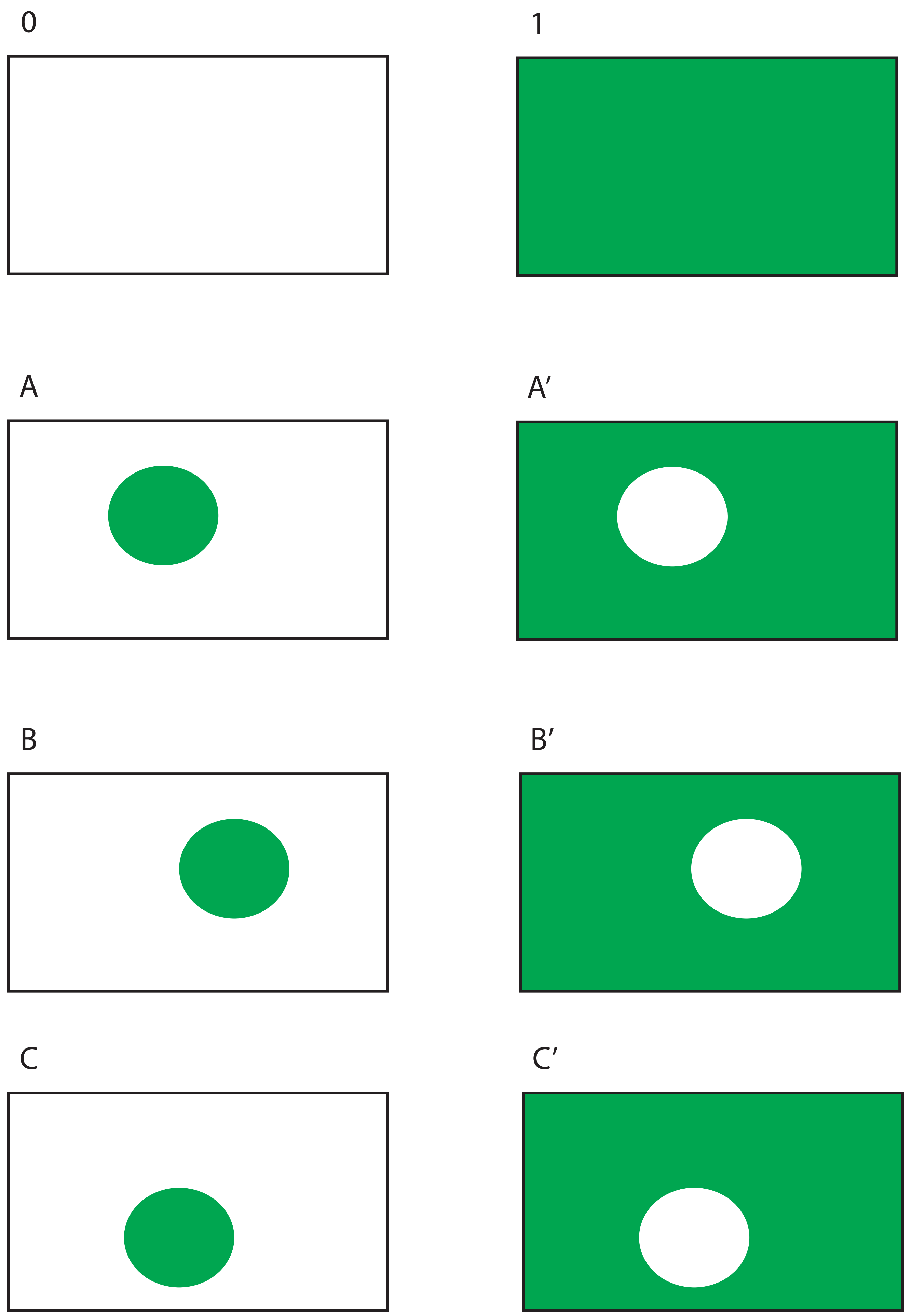
Overview

- Set Theory Review
- Algebraic Form Terminology
  - SOP, Minterm, Maxterm, Canonical Form
- Gates
- XOR Gate
- NAND Gate Representation
- Examples
- K-Maps

Set Theory Properties

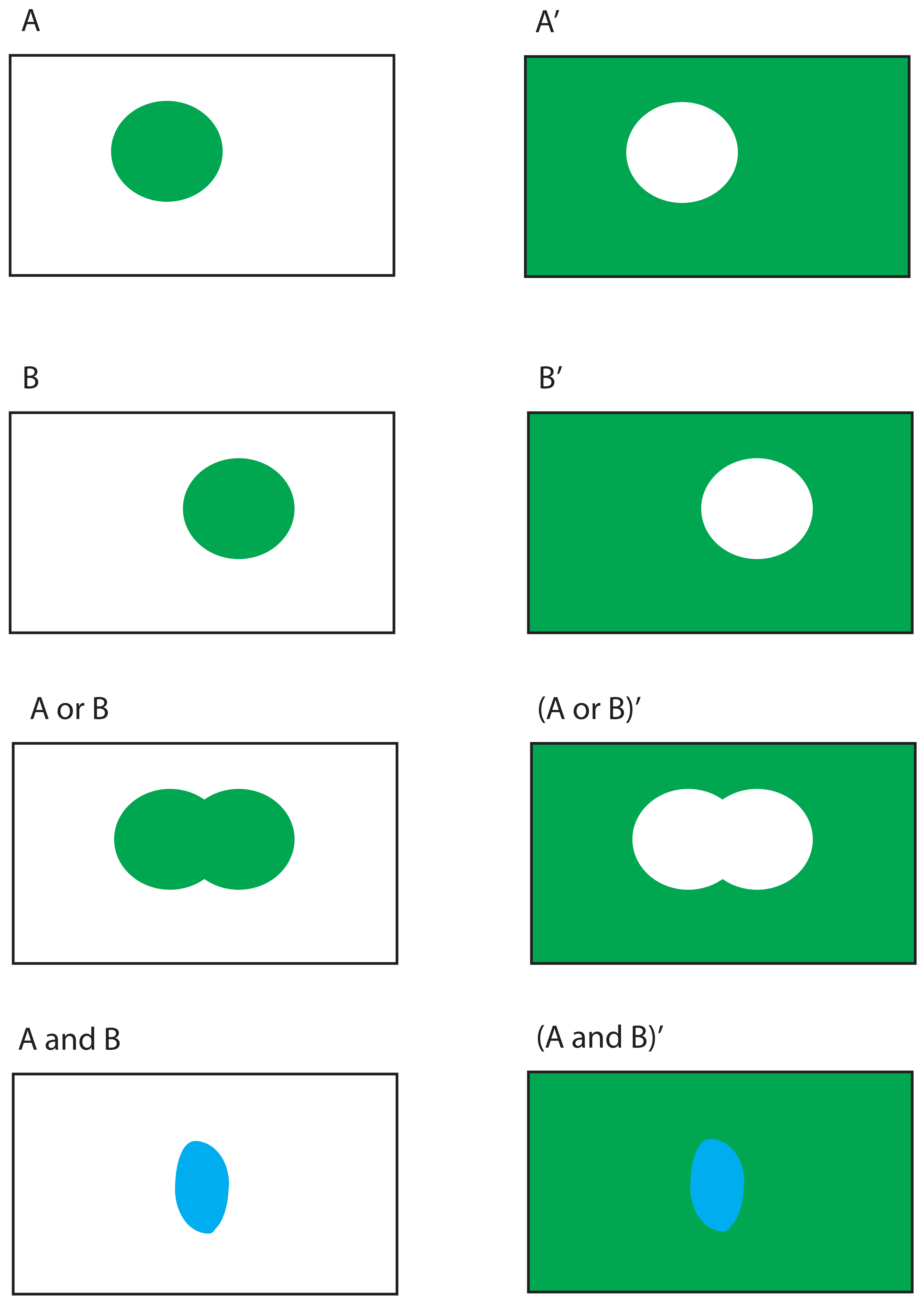
Part 2

- A or (A and B) = (A and 1) or (A and B)
  - = A and (1 or B) = A and 1 = A
- A and (A or B) = (A and A) or (A and B)
  - = A or (A and B) = A
- A or (A’ and B) = (A or (A and B)) or (A’ and B)
  - = A or (B and (A or A’)) = A or B
- (A and B) or (A and B’) = ((A and B) or A) and ((A and B) or B’)
  - = A and (B’ or A) = A
- A and (A’ or B) = (A and A’) or (A and B) = A and B
- (A or B) and (A or B’) = ((A or B) and A) or ((A or B) and B’) = A or (B’ and A) = A



DeMorgan’s Theorem

- (A or B)’ = A’ and B’
  - (A or B)’ = 1 - (A or B)
    - A region and B region should not be present
  - = (1 - A) and (1 - B) = A’ and B’
- (A and B)’ = A’ or B’
  - (A and B)’ = 1 - (A and B)
    - Only the intersection of A and B should not be present
  - = (1 - A) or (1 - B) = A’ or B'



Algebraic Form Terminology

- Sum of Products: OR of AND terms
  - Z = AB + AB’C + A’BC’
- Minterm: each of the input variables present in a term
  - AB’C, A’BC’
- Minterm number: encoded value of input variable values
  - AB’C = 101_2 = 5
- Canonical Form: sum of minterms
  - Z = AB(C + C’) + AB’C + A’BC’ = ABC + ABC’ + AB’C + A’BC’

Gates

- AND
- OR
- NAND
- NOR
- NOT
  - A’ = NAND(A,A)
- XOR (Double check that 3-input xor is 1 for odd inputs)

XOR Gate

- Output is 1 if odd number of inputs are 1

A	B	C	A xor B	(A xor B) xor C
0	0	0	0	0
0	0	1	0	1
0	1	0	1	1
0	1	1	1	0
1	0	0	1	1
1	0	1	1	0
1	1	0	0	0
1	1	1	0	1

NAND gate representation

- NAND preferred over NOR for physical characteristics
- Sum-Of-Products:
  - Z = AB + AB’
    - = (AB + AB’)”
    - = ((AB)’(AB’))’
  - NAND of NAND gates (with NOT gates for inputs)

Examples

- Z = AB + A’
- Z = A + A’B’C + A’B

K-Maps

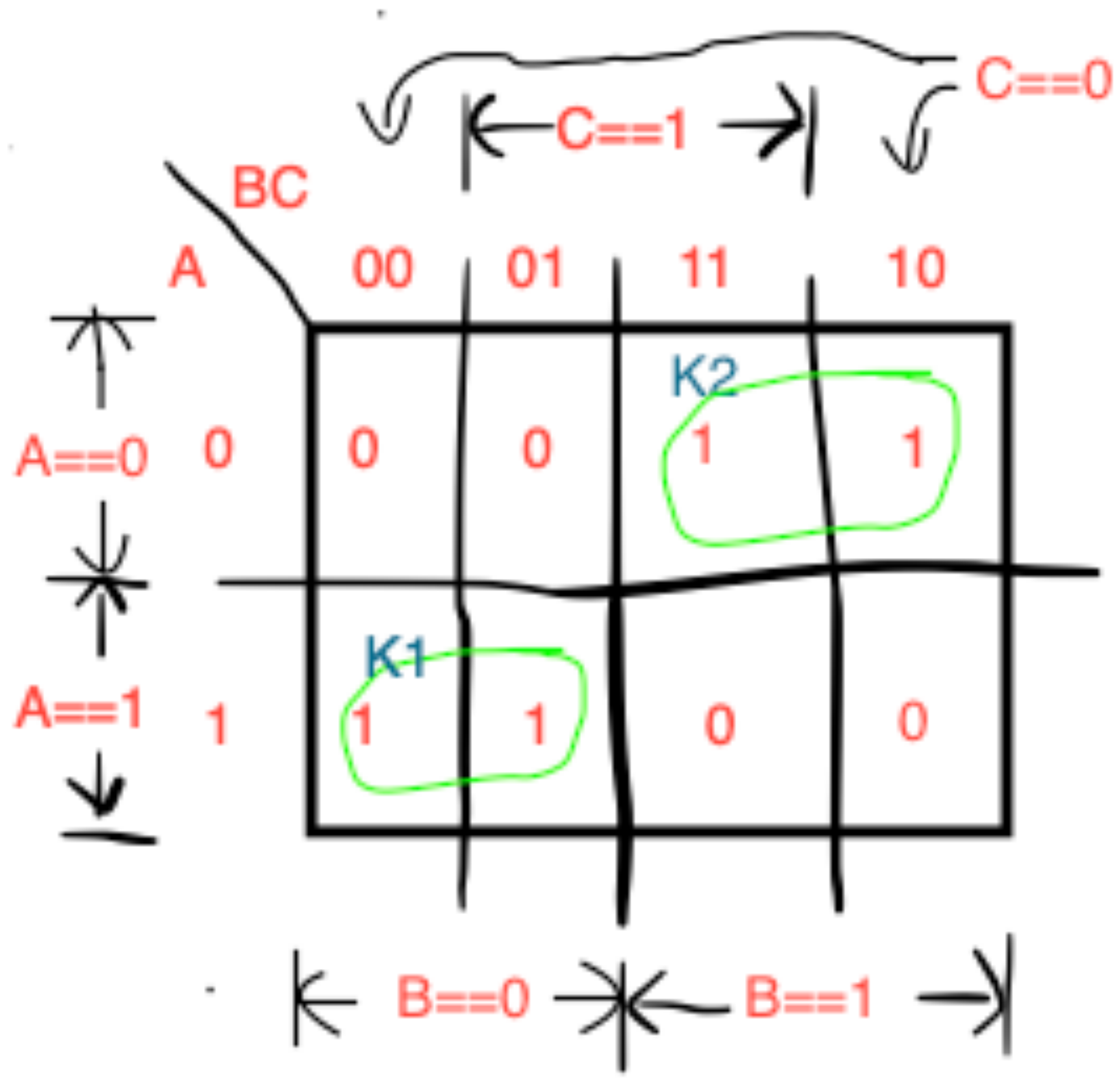
Karnaugh Maps

- 3-input minterm identification in Set Theory
  - Mapping in K-Map table
- Steps for K-Maps

K-Map Example

- Z = K1 + K2
  - = AB’ + A’B

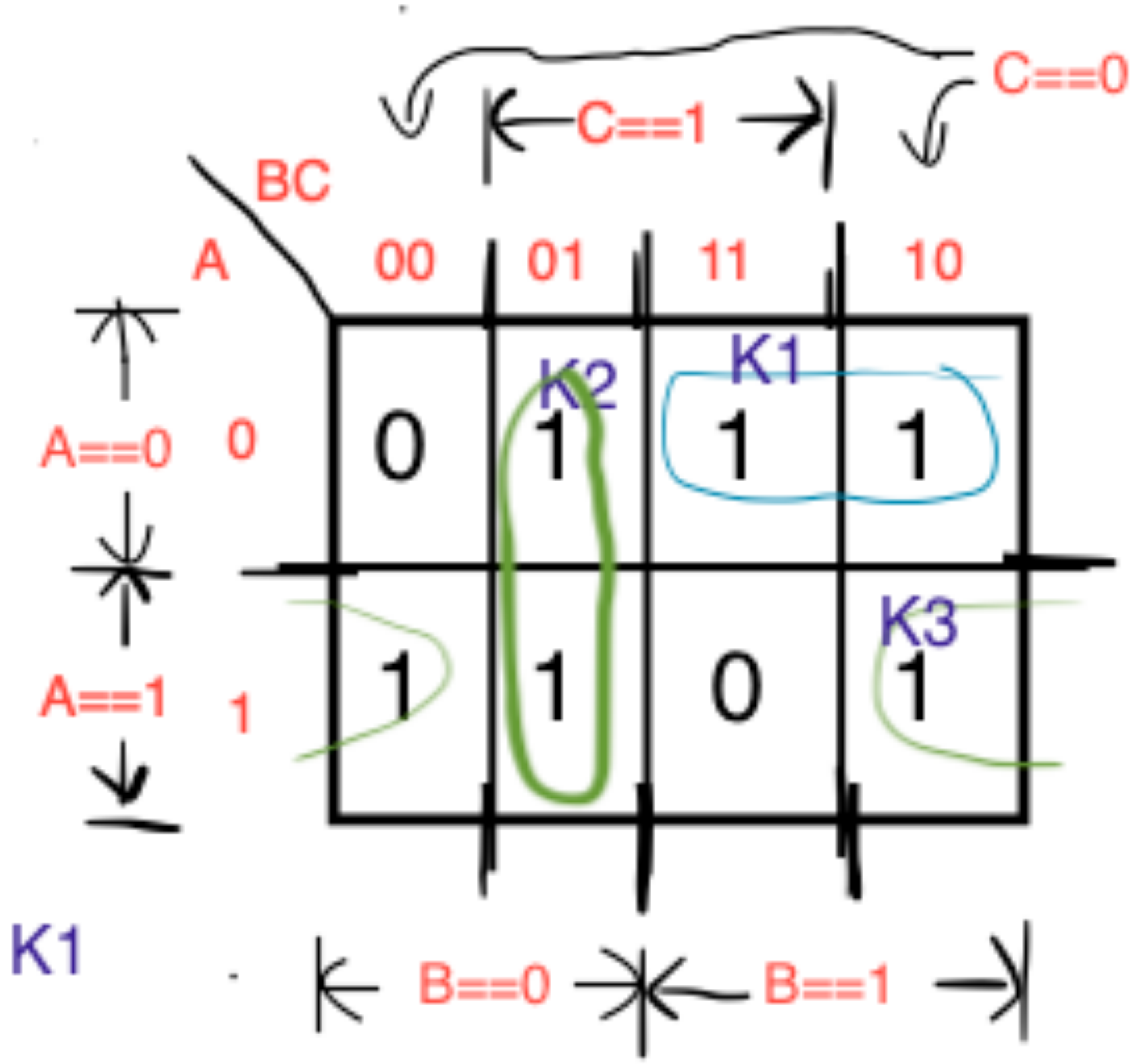
A	B	C	Z
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0



K-Map Example

- Z = K1 + K2 + K3
    - = A’B + B’C + AC’

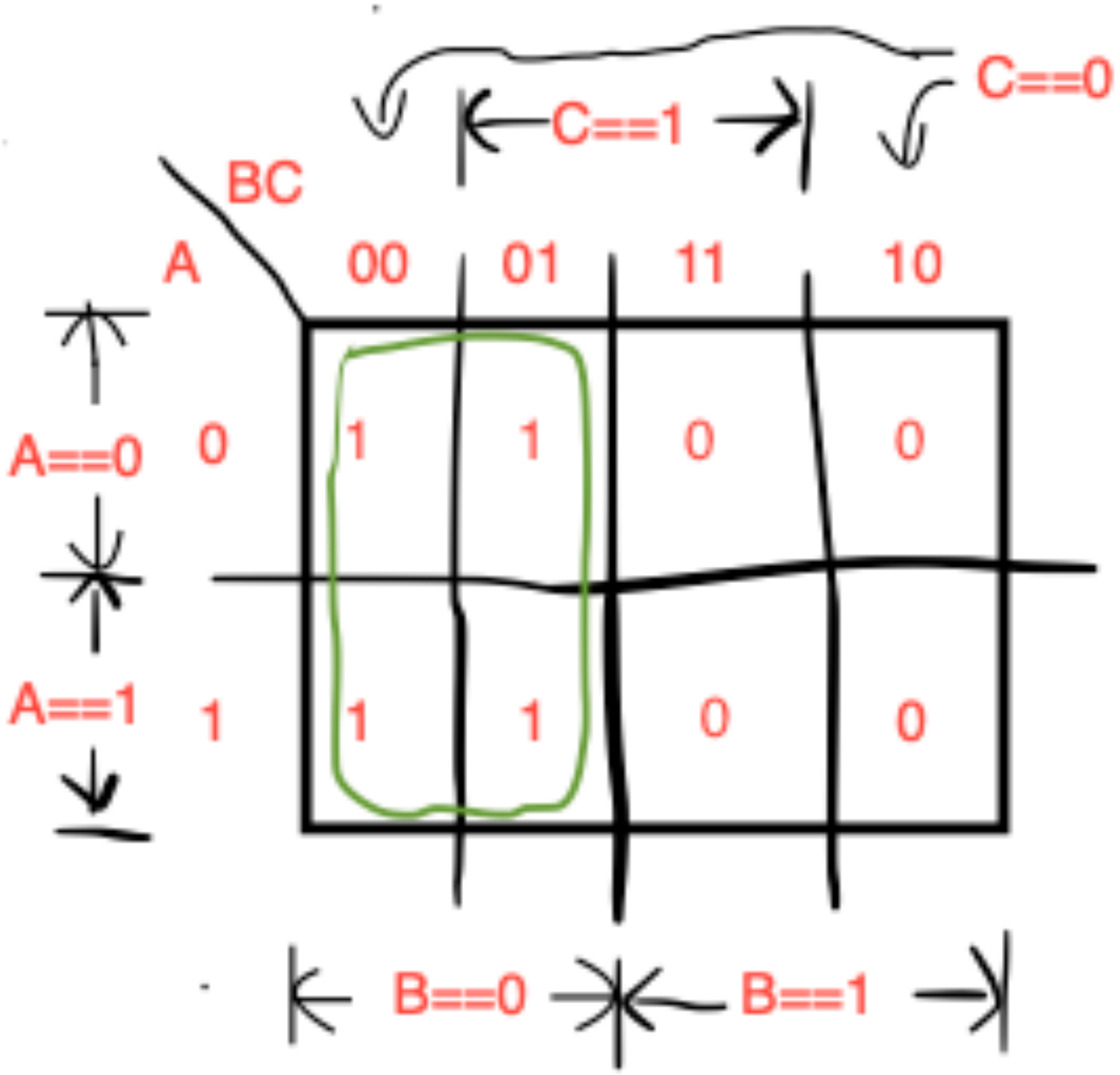
A	B	C	Z
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0



K-Map Example

- Z = B'

A	B	C	Z
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0



K-Map Example

- Z = K1 + K2
  - = A'B'C + AB'C'

A	B	C	Z
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	0