CPE201
Digital Design

By Benjamin Haas

Class 9: Truth Tables and Karnaugh Maps

University of Nevada, Reno

Truth Table from SOP

- A’BC + ABC + ABC’ + A’BC’ = 0’11 + 111 + 110’ + 0’10’
- The only truth table lines that gi

A	B	C	Output
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

Truth Table from POS

- (A’ + B + C) (A + B + C)(A + B + C’)(A’ + B + C’) = (1’+0+0)(0+0+0)(0+0+1’)(1’+0+1’)
- The only truth table lines that gi

A	B	C	Output
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

Converting Standard Form to the Other

- Convert the one you have to a truth table
- Find the opposite logic terms
- Write the terms out

Example

- (A + B + C′)(A′ + B′ + C′)(A + B′ + C)
- A′B′C′ + A′BC + AB′C′ + AB′C + ABC

A	B	C	Output
0	0	0	
0	0	1	0
0	1	0	0
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	0

Example

- ABC′ + A′B′C′ + AB′C

A	B	C	Output
0	0	0	1
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	1
1	1	0	1
1	1	1	

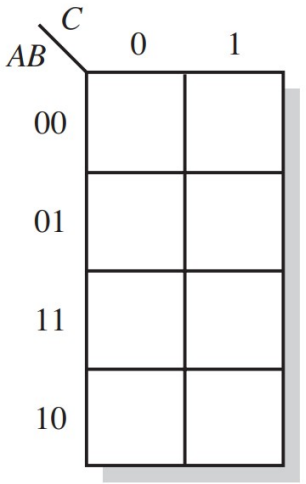
- (A+B+C′)(A+B′+C)(A+B′+C′)(A′+B+C)(A′+B′+C′)

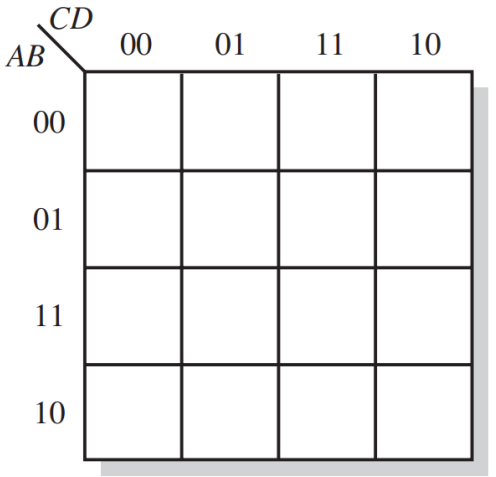
Simplification

- Boolean Algebra
- Karnaugh Maps

Karnaugh Map

- Visual way to reduce logic statements to the simplest forn
- Good for 4-5 inpu





Truth Table to Karnaugh Map

A	B	C	D	Output
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0

A	B	C	D	Output
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

AB \ CD	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	0	0	1	0

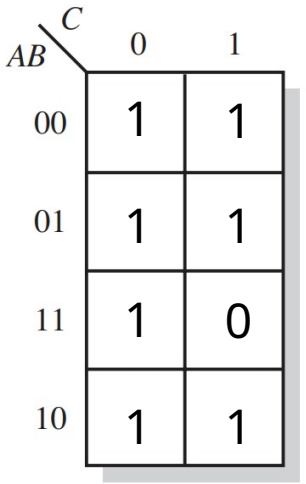
Karnaugh Map of Standard SOP

- A standard SOP gives all terms that have output of 1
- Same as converting a truth table

Karnaugh Map of Non-Standard SOP

- Terms need to be expanded to include all input options
- B’ + A’B + ABC’
- Then put into the m

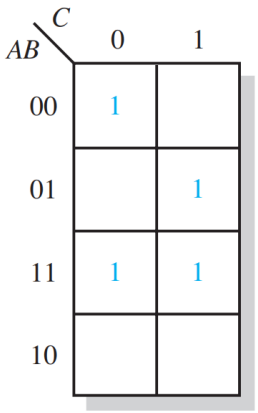
B’	A’B	ABC’
000	010	110
001	011	
100		
101		



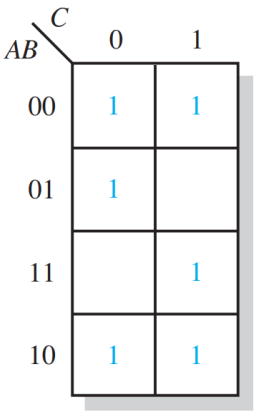
SOP Minimization

- Make groups of 1’s (by a power of 2)
  - 1’s that are adjacent
  - Groups that are squares or rectangles only
  - Make the biggest ones possible
  - Overlap is okay
  - Complete overlaps are not used

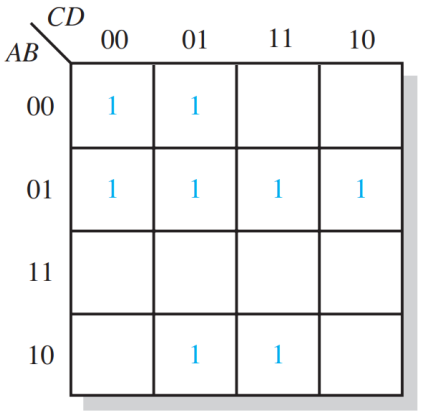
Examples



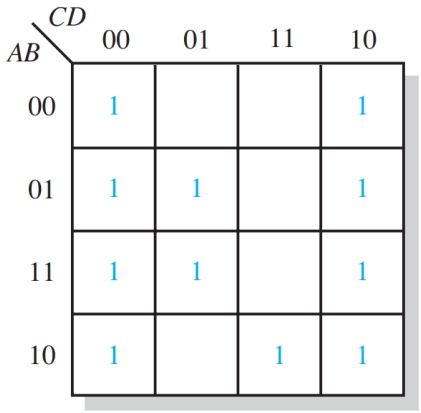
AB \ C	0	1
00	1	
01		1
11	1	1
10		



AB \ C	0	1
00	1	1
01	1	
11		1
10	1	1



AB \ CD	00	01	11	10
00	1	1		
01	1	1	1	1
11				
10		1	1	



AB \ CD	00	01	11	10
00	1			1
01	1	1		1
11	1	1		1
10	1		1	1

SOP Minimization

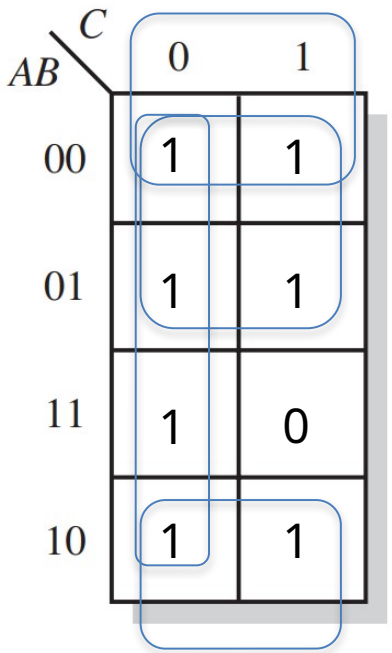
- Next make a minimum product term for the group

3 Input Variables	
1 cell	3 input product term
2 cells	2 input product term
4 cells	1 input product term
8	All terms true, F=1

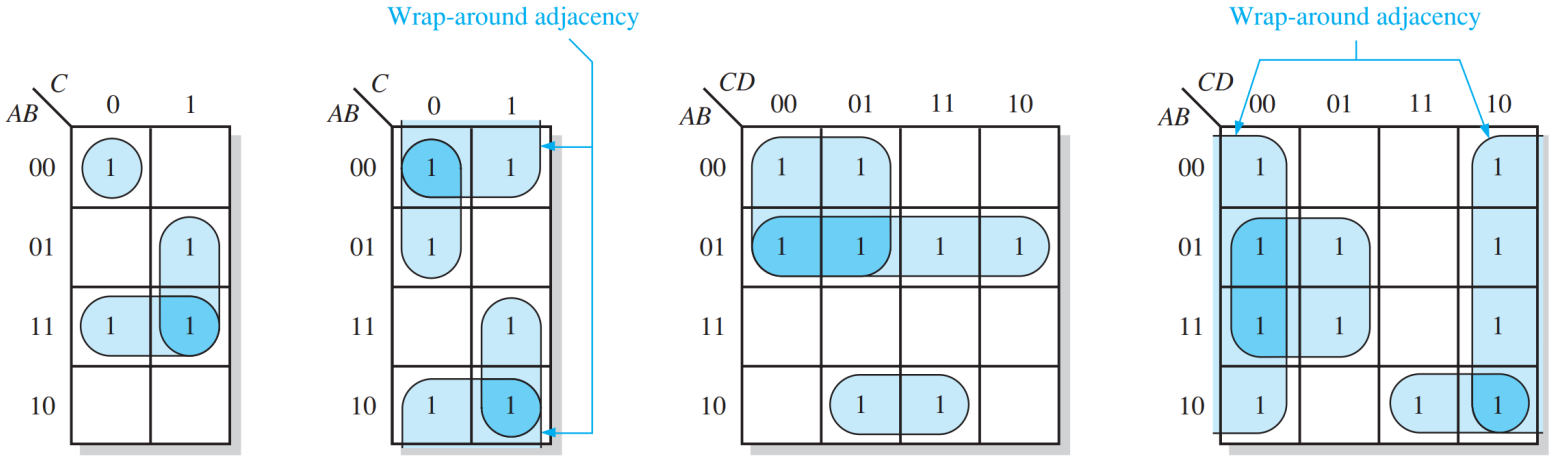
4 Input Variables	
1 cell	4 input product term
2 cells	3 input product term
4 cells	2 input product term
8 cells	1 input product term

Example

- B′ + A′B + ABC′
- 3 4-cell groups
- A′ + B′ + C′



Examples


Wrap-around adjacency
Wrap-around adjacency
C
AB
0
1
00
01
11
10
CD
00
01
11
10

Examples

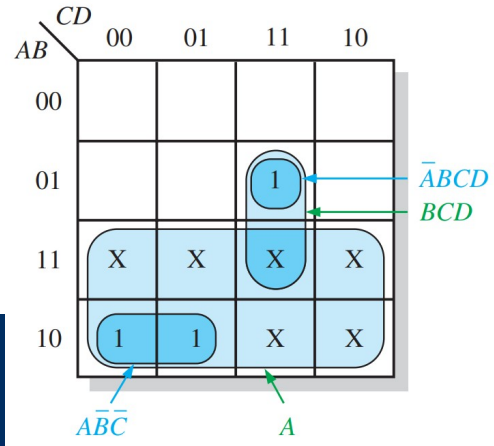
- Minimize:
- AB + AC’ + A’BC
- ABC’ + BC’ + D

Don’t Care Condition

- Used for conditions that cannot occur
- Can be used to further simplify logic

Inputs				Output
A	*B*	*C*	*D*	*Y*
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

Don’t cares



Example

- Can be used to further simplify logic

AB \ CD	00	01	11	10
00	1			
01	1	1		
11	1		X	
10	1		X	

Reading

- This lecture
  - Sections 4.7-4.9
- Next lecture
  - Sections 1.8, 3.9, 4.10-4.11, Ch4 Applied Logic