МЕЖДУНАРОДНЫЙ УНИВЕРСИТЕТ | INTERNATIONAL UNIVERSITY | ХАЛЫҚАРАЛЫҚ УНИВЕРСИТЕТІ

Simplification

$$YX + X = X$$

$$XY + X\overline{Y} = X$$

2nd Distributive

$$(X + A)(X + B) = X + AB$$

$$(X + A)(X + B)(X + C) = X + ABC$$

Absorption

$$Y + X\overline{Y} = X + Y$$

Most Common Stupid Errors

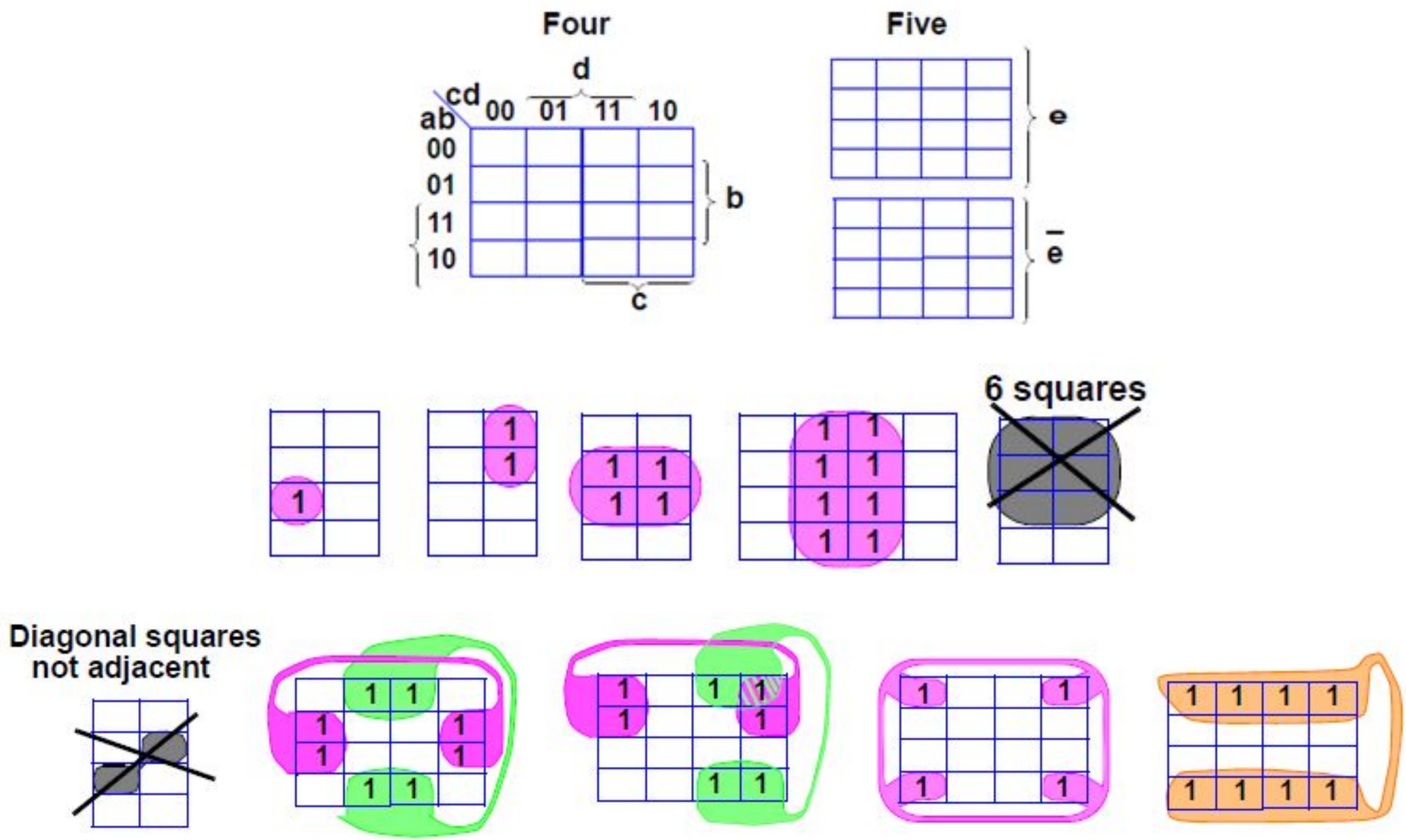
$$\cancel{\overline{X}\cdot\overline{Y} = \overline{XY}}$$

$$\cancel{X + 1 = X}$$

Lecture 4: Multiple Output Maps

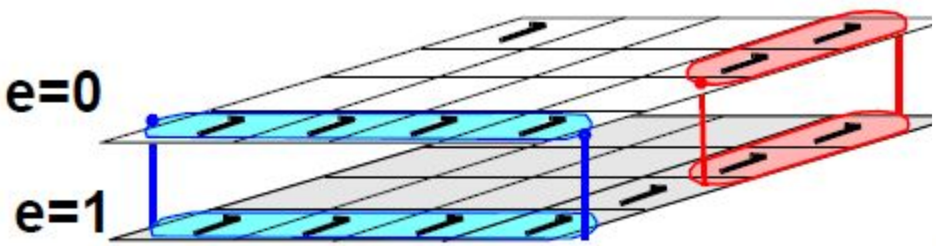
senior-lecturer Kairat Sariyev, email: ksariyev@gmail.com, room 409

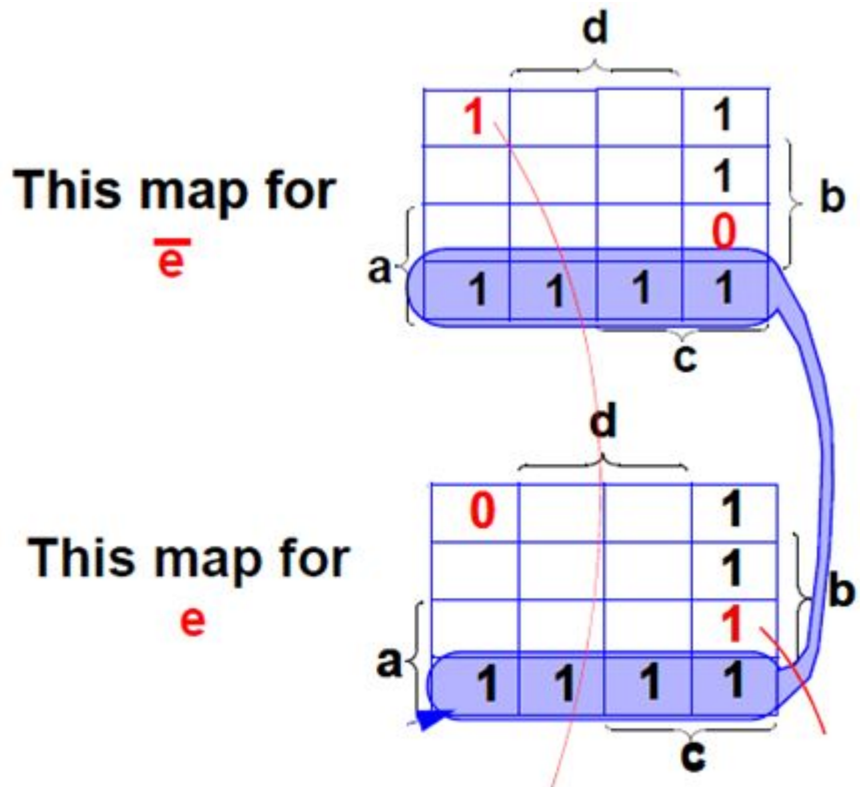
Review


Four
d
cd
ab
00
01
11
10
b
c
Five
e
$\bar{e}$
6 squares
Diagonal squares
not adjacent

Five-Variable Karnaugh Maps

Think of two maps on top of each other



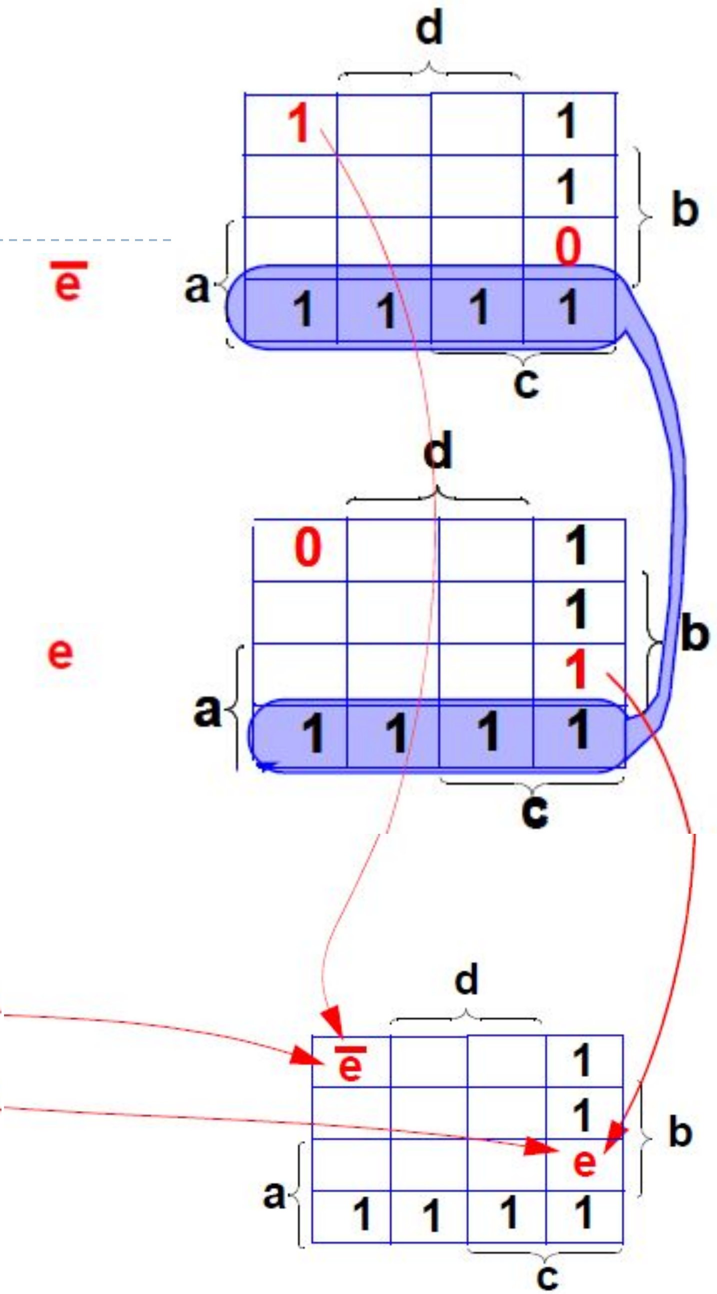


Can loop e 1 $\bar{e}$ 1   1 1

Cannot loop ~~$\bar{e}$ e~~

“e” for “1”s on top layer

“$\bar{e}$” for “1”s on bottom layer.

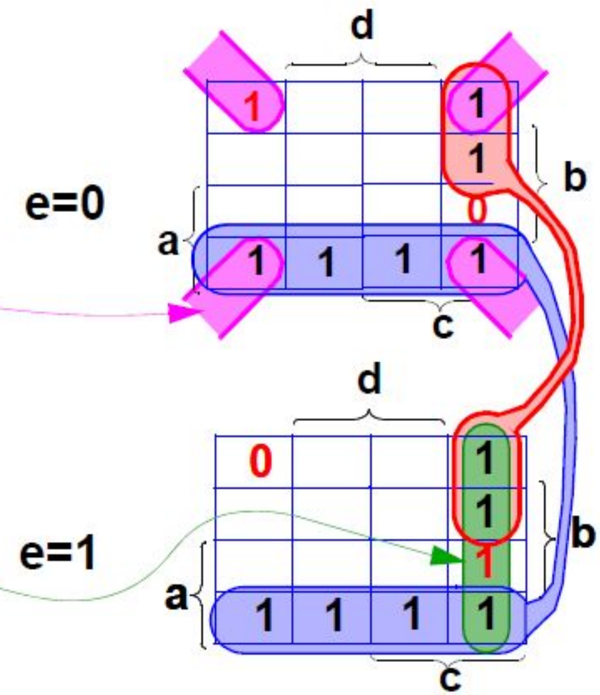


Equations From Five Variable Maps

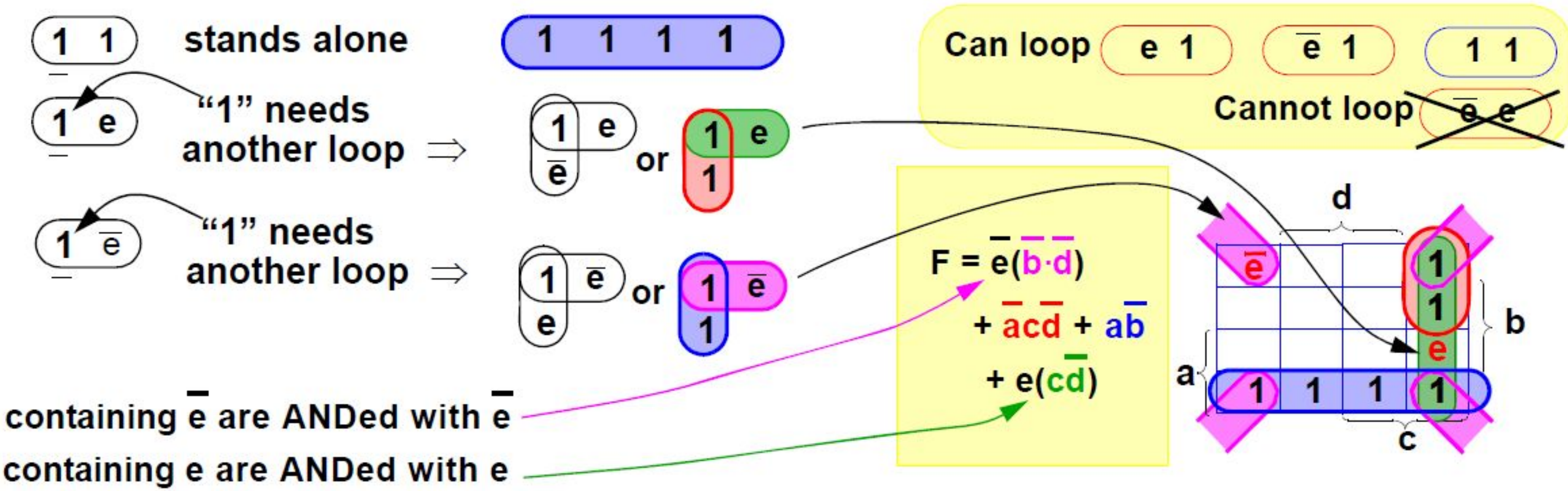
e=0 (top) map are ANDed with $\bar{e}$

e=1 (bottom) map are ANDed with e

$$F = \bar{e}(\bar{b}\cdot\bar{d}) + \bar{a}c\bar{d} + a\bar{b} + e(c\bar{d})$$



Equations From Five Variable Maps



Example: F is true when:
both A and B are off
or both C and B are off
or both A and E are on

		D	D		
	1	1	1	1	
					B
A					B
A					
			C	C	

both A and B off

		D	D		
	1	1			
					B
A					B
A	1	1			
			C	C	

both C and B off

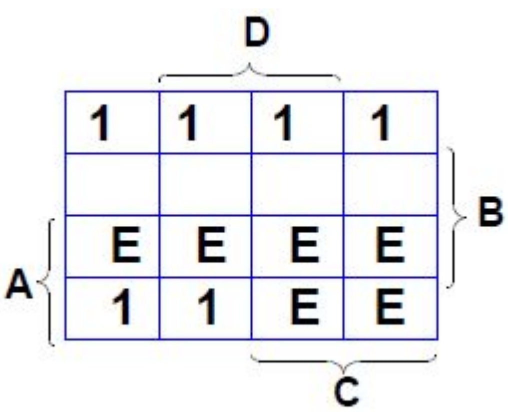
		D	D		
					B
A	E	E	E	E	B
A	E	E	E	E	
			C	C	

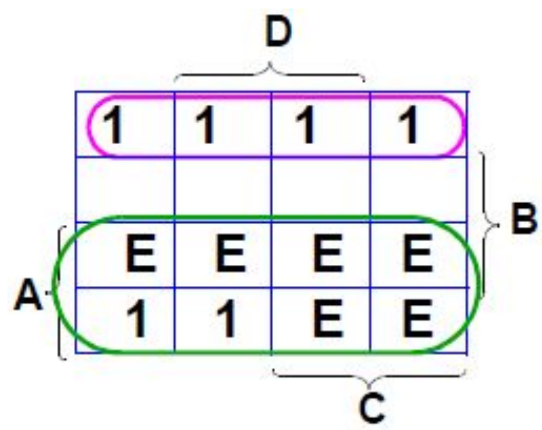
both A and E on

Combine on one map

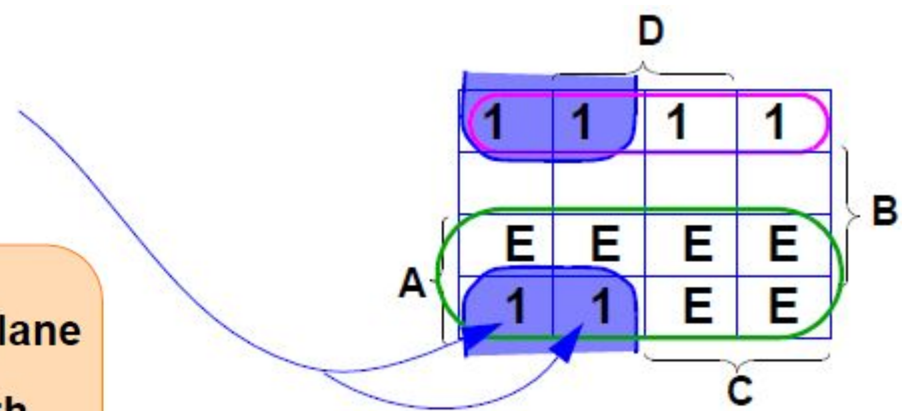
		D	D		
	1	1	1	1	
					B
A	E	E	E	E	B
A	1	1	E	E	
			C	C	

Example: F is true when:
both A and B are off
or both C and B are off
or both A and E are on



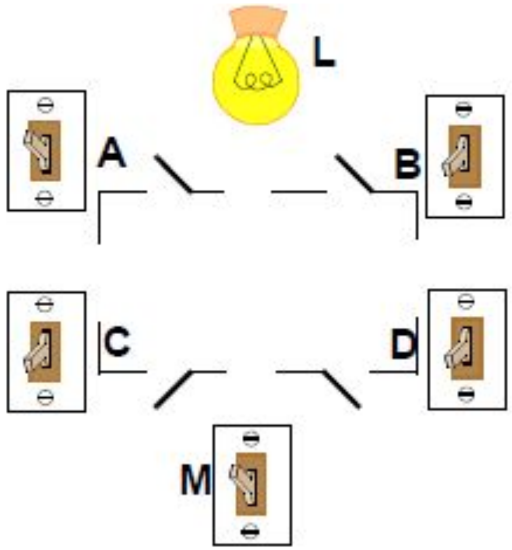


These squares not looped in $\bar{e}$ plane



F = EA +	e plane
$\bar{A} \cdot \bar{B} + \bar{C} \cdot \bar{B}$ +	both planes
0	$\bar{e}$ plane

Example: Light Control



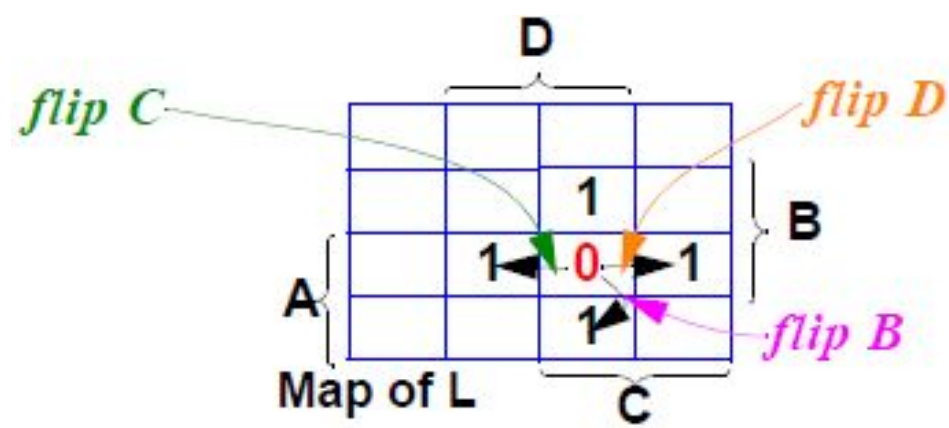
Flicking A,B,C or D
- -turns on light if it is off
- -turns off light if it is on

M turns off all lights

Start at ABCD=1111; L= 0 (off)

Flick any one switch,
one bit will change.

Move one square, get L=1



If M = 0, light is always off.
All “1”s become “0”s.

Map of L

D

	1		1
1		1	
	1		1
1		1	

B

A

C

Changing any one bit changes L

4-variable map is alternate “1”s and “0”s.

$$L = A \oplus B \oplus C \oplus D$$

D

	M		M
M		M	
	M		M
M		M	

B

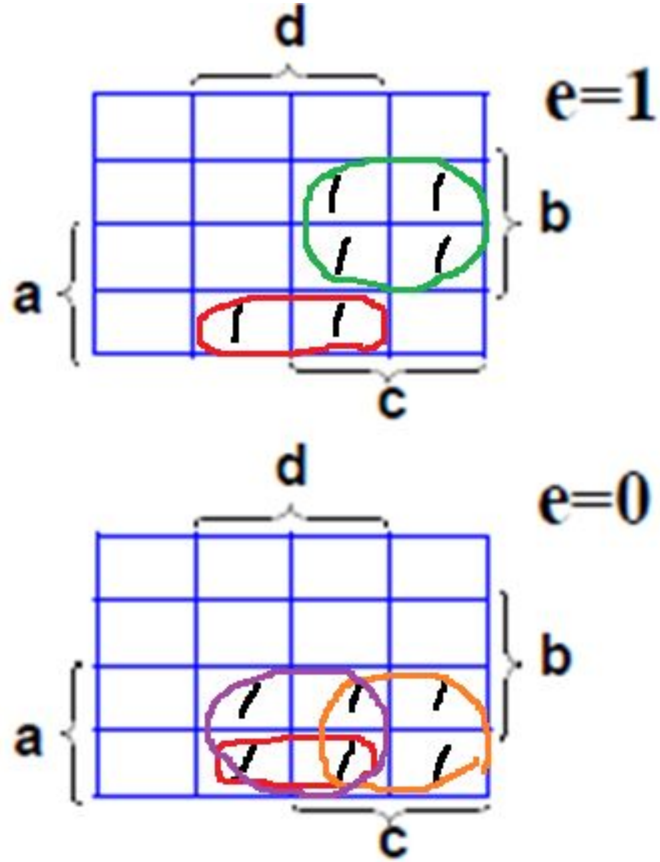
A

C

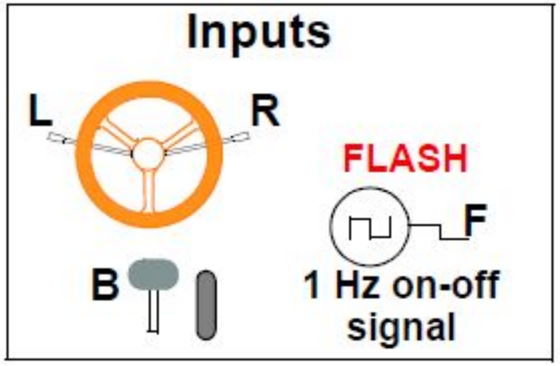
$$L = M(A \oplus B \oplus C \oplus D)$$

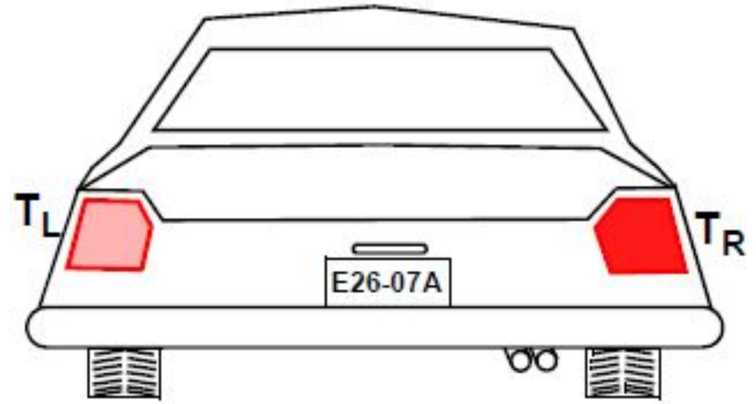
Example: $F = (abc + a\bar{b}d + cb)e + (a\bar{b}d + ac + adb)\bar{e}$

$$= (abc + cb)e + (ac + adb)\bar{e} + a\bar{b}d$$



Example: Tail Light Control





	Inputs LR B		Tail light T_L	Tail light T_R
- - -	00 0		0	0
- R -	01 0	Right turn	0	Flash
LR -	11 0	4-way,	Flash	Flash
L - -	10 0	Left turn,	Flash	0
- - B	00 1	Brake	Solid	Solid
- R B	01 1	Right turn & Brake	Solid	Flash
LR B	11 1	4-way and Brake	Flash	Flash
L - B	10 1	Left turn & Brake	Flash	Solid

LR B	T_L	T_R
00 0	0	0
01 0	0	Flash
11 0	Flash	Flash
10 0	Flash	0
00 1	Solid	Solid
01 1	Solid	Flash
11 1	Flash	Flash
10 1	Flash	Solid

B: 0	B: 1
	1
	1
F	F
F	F

L, R

Tail light T_L

B: 0	B: 1
	1
F	F
F	F
	1

L, R

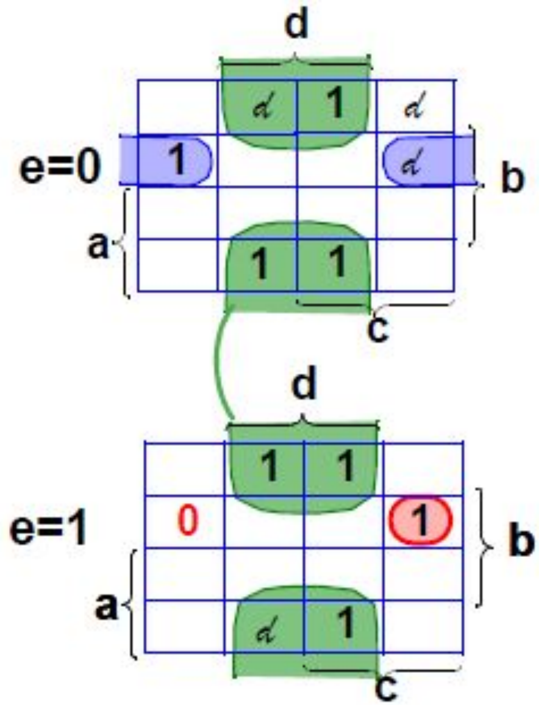
Tail light T_R

e=0

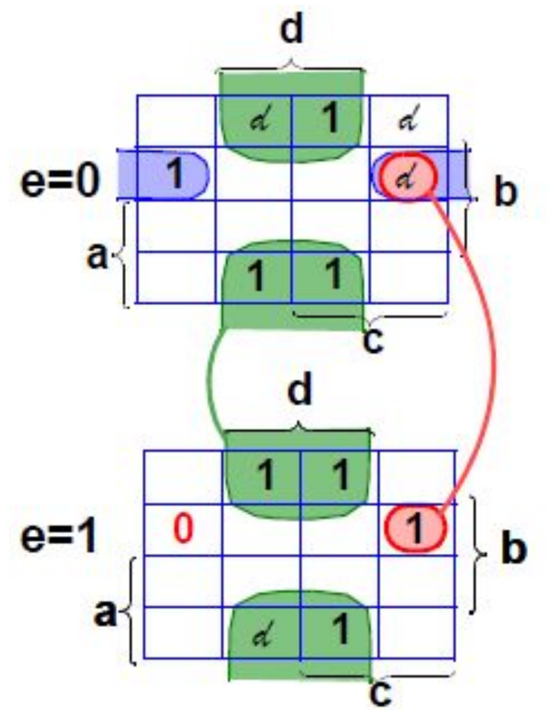
	d	1	d
1			d
	1	1	

e=1

	1	1	0
0			1
	d	1	



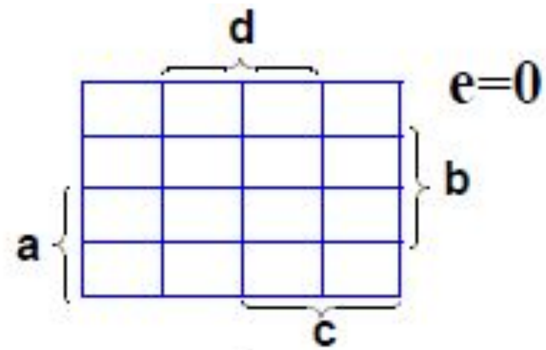
$$F = \bar{e}(\bar{a}b\bar{d}) + \bar{b}d + e(\bar{a}bc\bar{d})$$

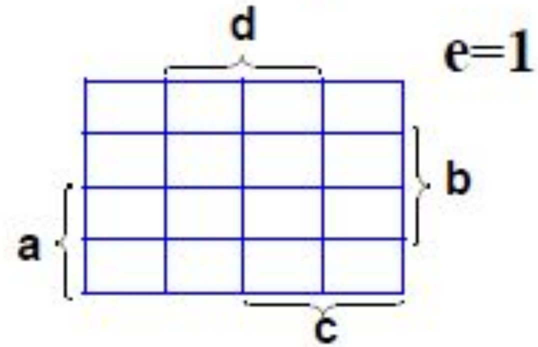


$$F = \bar{e}(\bar{a}b\bar{d}) + \bar{b}d + \bar{a}bc\bar{d}$$

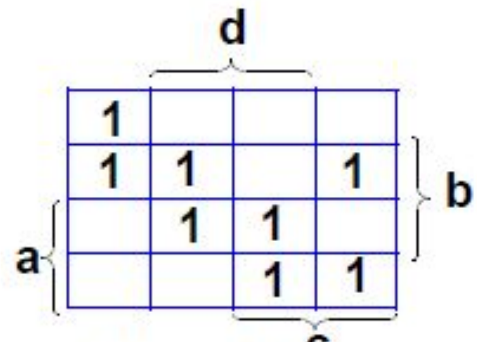
Example: $F = a\bar{b}d + \bar{b}cd + \bar{a}b\bar{c}\cdot\bar{d}\cdot\bar{e} + \bar{a}bc\bar{d}e$

Further a,c,d,e can never take on the values 0,1,0,0 $(\bar{a}c\bar{d}\cdot\bar{e})$
and a,b,c,d can never take on the values 0,0,0,1 $(\bar{a}\cdot\bar{b}\cdot\bar{c}d)$

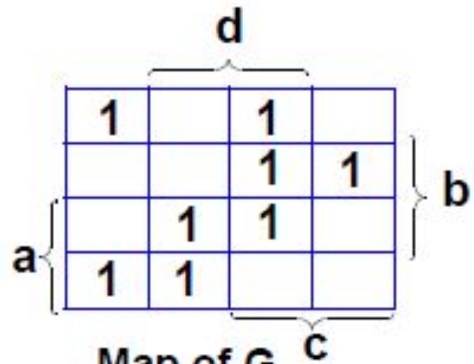




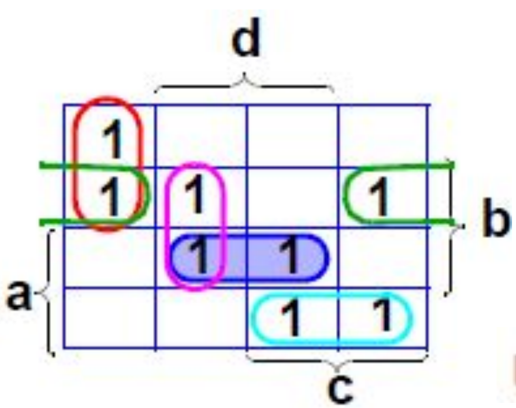
Example:



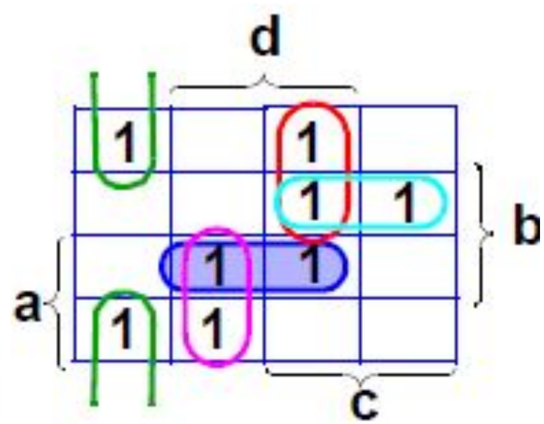
Map of F



Map of G

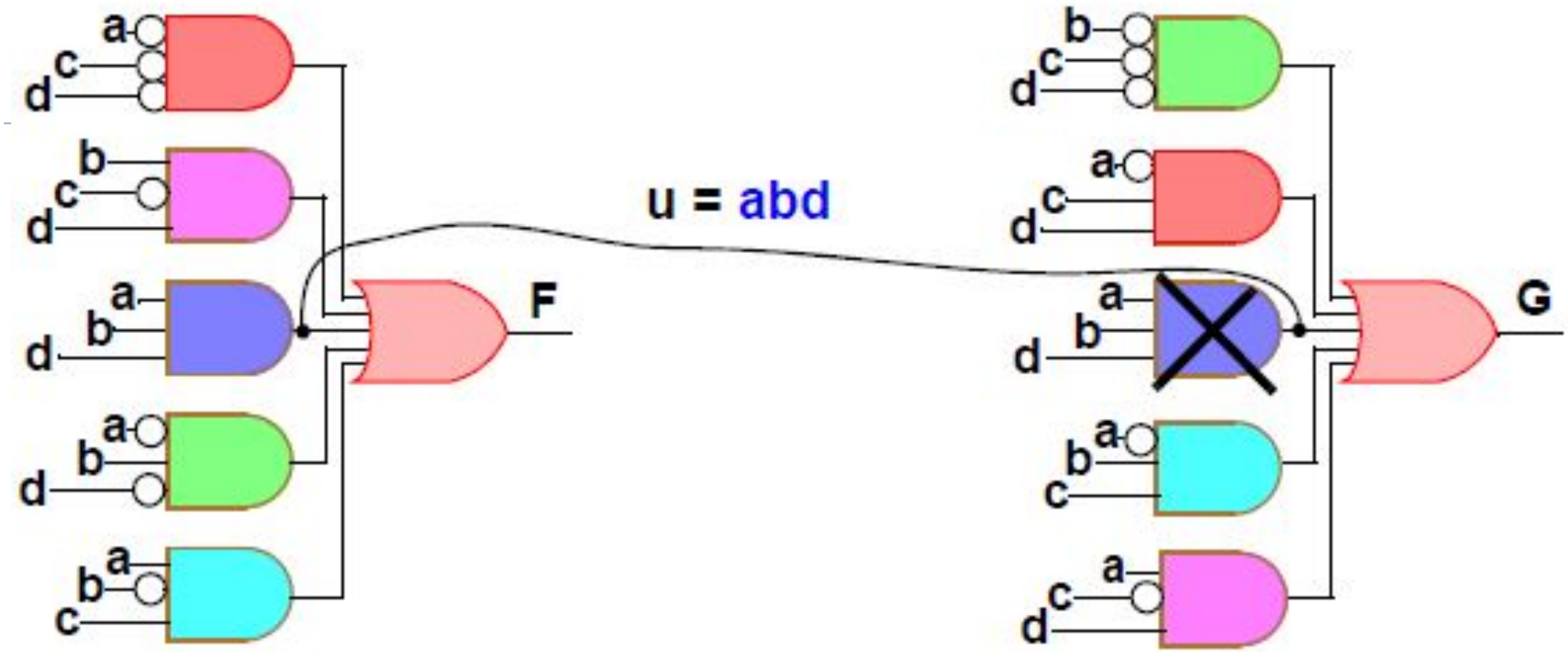


u = abd



$F = \bar{a}\cdot\bar{c}\cdot\bar{d} + b\bar{c}d + u + \bar{a}b\bar{d} + a\bar{b}c$

$G = \bar{b}\cdot\bar{c}\cdot\bar{d} + \bar{a}cd + u + \bar{a}bc + a\bar{c}d$

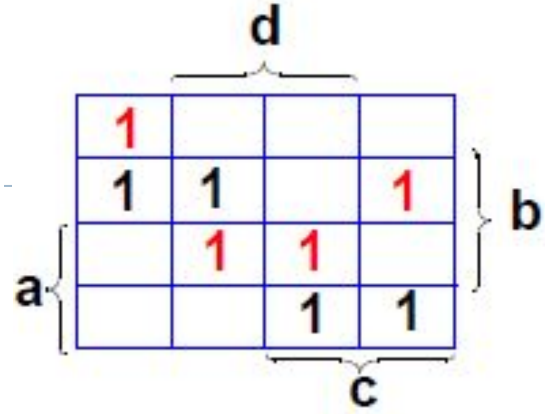


circuit size estimates

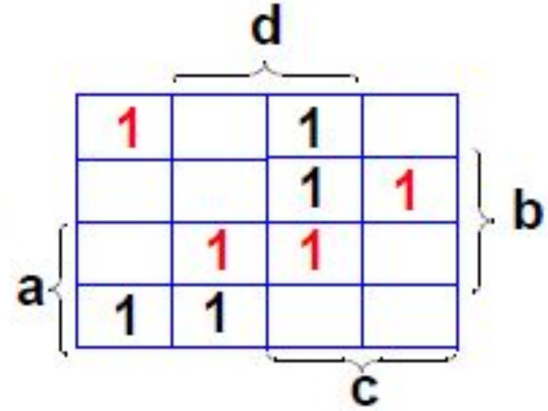
29 letters (literals) 13+13+3

37 gate inputs 15+5+12+5

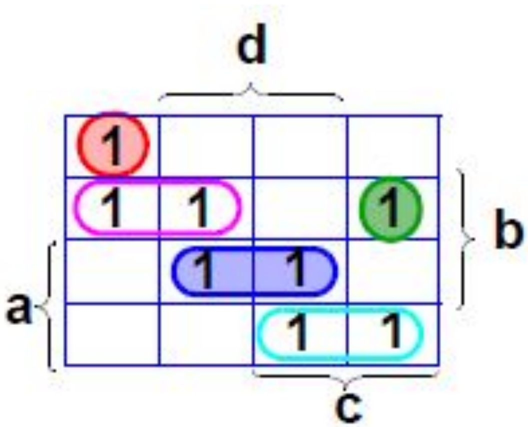
11 gates



Map of F



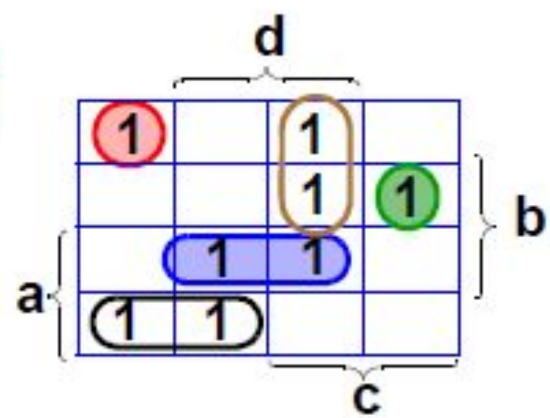
Map of G



$v = \bar{a} \cdot \bar{b} \cdot \bar{c} \cdot \bar{d}$

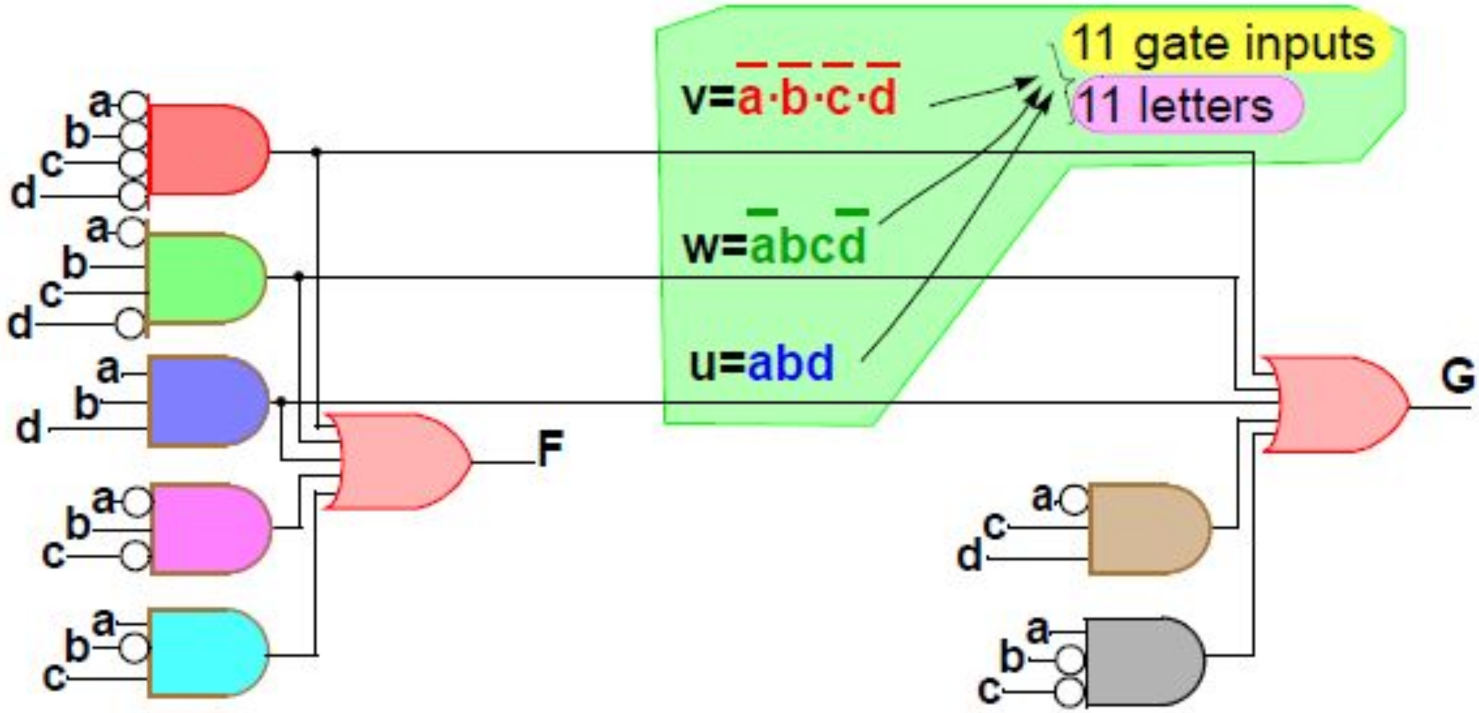
$w = \bar{a} b c \bar{d}$

$u = abd$



$F = v + w + u + \bar{a} b \bar{c} + a \bar{b} c$

$G = v + w + u + \bar{a} c d + a \bar{b} \cdot \bar{c}$



<u>size measures</u>

Prev slide	This slide	
29	29	letters (literals)
37	33	gate inputs
11	9	gates