

Where We Are

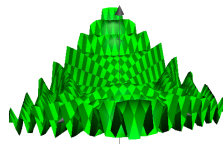
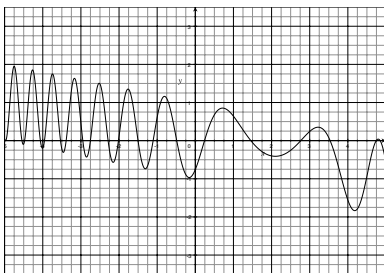
Lecture 6: Boolean Cubes and Karnaugh Maps

CSE 370, Autumn 2007
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- Last lecture: 2-level implementations and canonical forms
- This lecture: Boolean cubes and K-maps
- Next lecture: K-map minimization
- Homework 1 back today or Wed. 2 due Wed.
- Read lab 2 before the start of your session

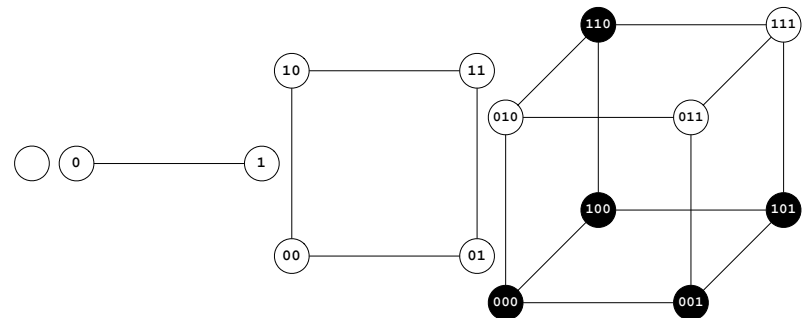
Inspiration

- Visualization of real-valued functions

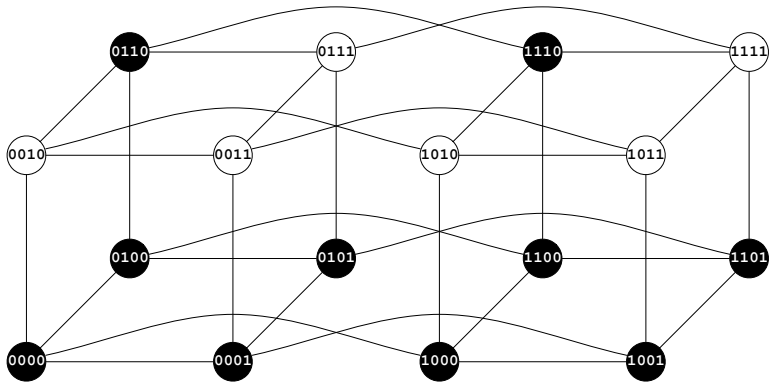


Visualizing Boolean Functions

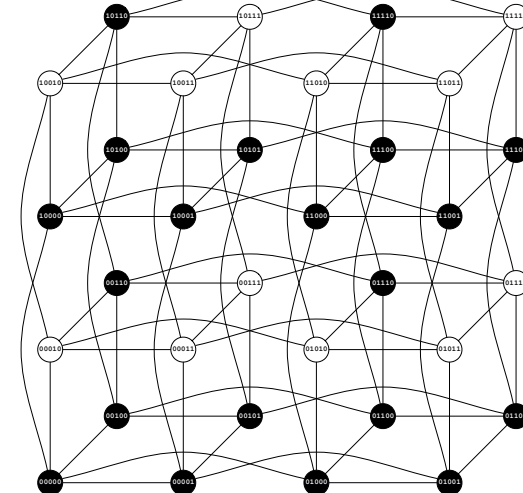
- Generally more input variables
- **Way** fewer possible values per variable



Getting a Little Ridiculous

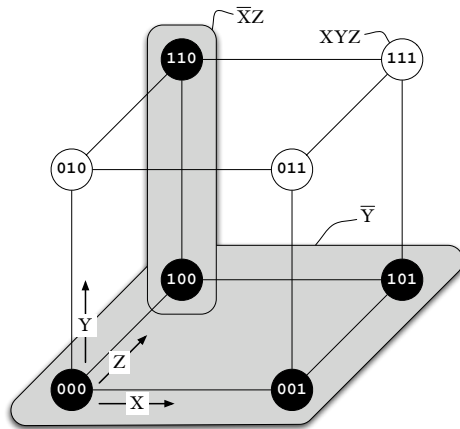


Getting a Lot Ridiculous



The Features of a Cube

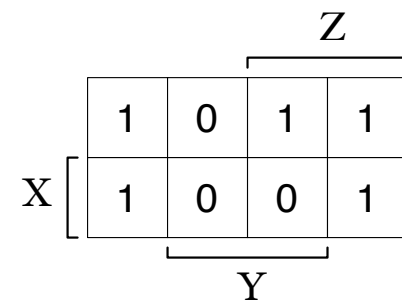
Z	Y	X	F
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0



Karnaugh Maps

- Flattened Boolean cubes

Z	Y	X	F
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	1
1	1	1	0



4 Variable Example

- Inverse majority function

A	B	C	D	F	A	B	C	D	F
0	0	0	0	1	1	0	0	0	1
0	0	0	1	1	1	0	0	1	1
0	0	1	0	1	1	0	1	0	1
0	0	1	1	1	1	0	1	1	0
0	1	0	0	1	1	1	0	0	1
0	1	0	1	1	1	1	0	1	0
0	1	1	0	1	1	1	1	0	0
0	1	1	1	0	1	1	1	1	0

Different Way to Draw a K-Map

- Inverse majority function

A	B	C	D	F	A	B	C	D	F
0	0	0	0	1	1	0	0	0	1
0	0	0	1	1	1	0	0	1	1
0	0	1	0	1	1	0	1	0	1
0	0	1	1	1	1	0	1	1	0
0	1	0	0	1	1	1	0	0	1
0	1	0	1	1	1	1	0	1	0
0	1	1	0	1	1	1	1	0	0
0	1	1	1	0	1	1	1	1	0

Rectangles in K-Maps

- Always a power of 2 on a side
- Can “wrap around” the border
- Can only enclose all 1's or all 0's
 - 1's correspond to product terms
 - 0's correspond to sum terms

Individual Terms

- $\neg C \neg D$
- $\neg A \neg C$
- $\neg A + \neg B + \neg D$
- $\neg B \neg D$

Bad Rectangles

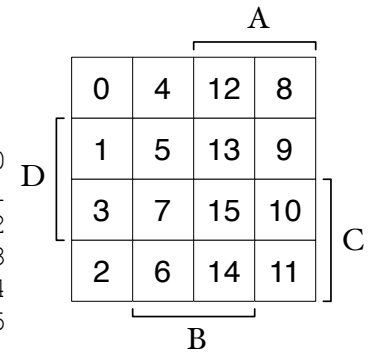
	A \ B \ C \ D	00	01	11	10
00	1	1	1	1	1
01	1	1	0	1	
11	1	0	0	0	
10	1	1	0	1	

- Non-power of 2 width (points to the red rectangle)
- Non-rectangle (points to the cyan dashed rectangle)
- Non-power of 2 height (points to the green dashed rectangle)
- Encloses both 0's and 1's (points to the blue dashed rectangle)

Numbering the Squares

- Inverse majority function

A	B	C	D	#	A	B	C	D	#
0	0	0	0	0	1	0	0	0	8
0	0	0	1	1	1	0	0	1	9
0	0	1	0	2	1	0	1	0	10
0	0	1	1	3	1	0	1	1	11
0	1	0	0	4	1	1	0	0	12
0	1	0	1	5	1	1	0	1	13
0	1	1	0	6	1	1	1	0	14
0	1	1	1	7	1	1	1	1	15



Now You Try

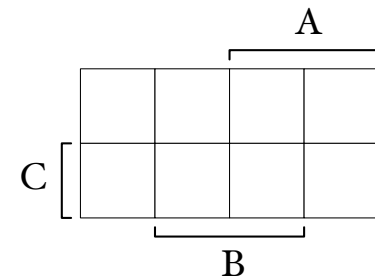
- Multiplexer

A	B	C	F
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Now You Try

- Multiplexer

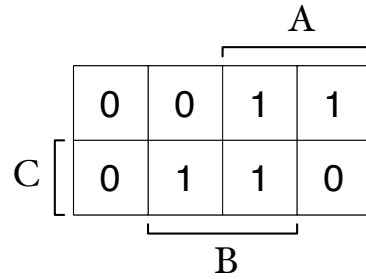
A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1



Now You Try

- Multiplexer

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1



Thank You for Your Attention

- Pick up your quiz
- Read lab 2
- Continue homework 2
- Continue reading the book