

Lecture 6: Boolean Cubes and Karnaugh Maps

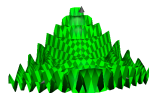
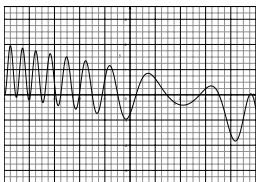
CSE 370, Autumn 2007
Benjamin Ylvisaker

Where We Are

- 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

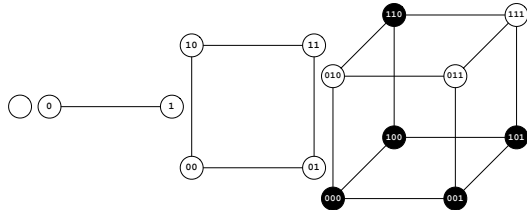
Inspiration

- Visualization of real-valued functions

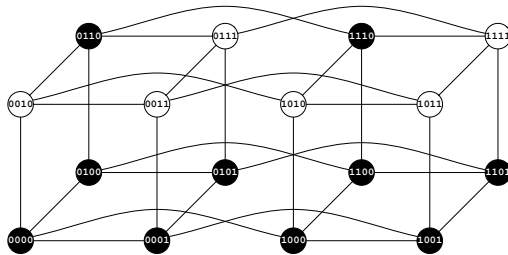


Visualizing Boolean Functions

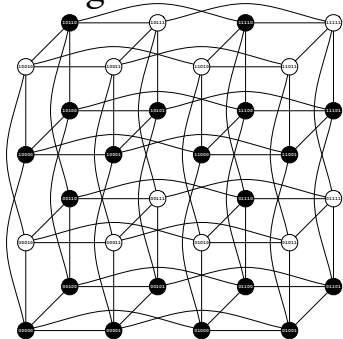
- Generally more input variables
- **Way** fewer possible values per variable



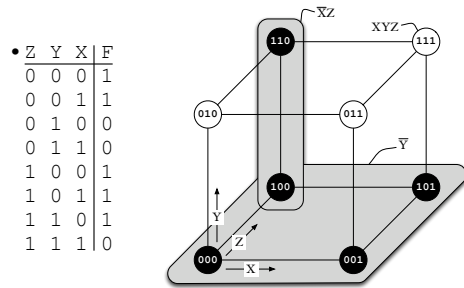
Getting a Little Ridiculous



Getting a Lot Ridiculous

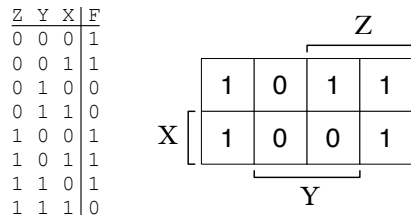


The Features of a Cube



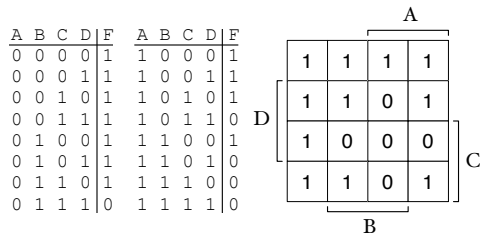
Karnaugh Maps

- Flattened Boolean cubes



4 Variable Example

- Inverse majority function



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

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

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

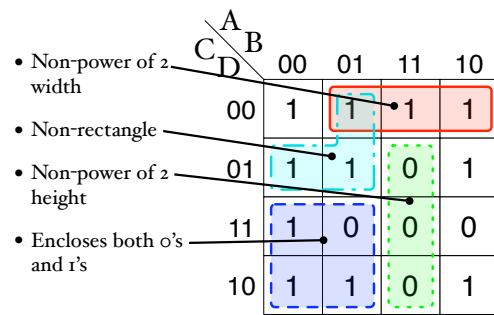
		A/B			
		00	01	11	10
C/D	00	1	1	1	1
	01	1	1	0	1
	11	1	0	0	0
	10	1	1	0	1

Individual Terms

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

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

Bad Rectangles



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

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

Now You Try

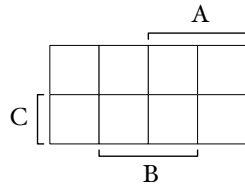
- Multiplexer

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

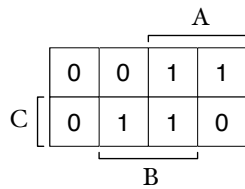
A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1



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