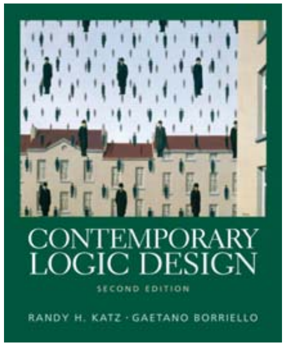
CSE 370 Spring 2006
Introduction to Digital Design

Lecture 6: Karnaugh Maps



Last Lecture
- Canonical Forms
- Sume of Products
- Product of Sums
- Boolean Cubes

Today
- Karnaugh Maps

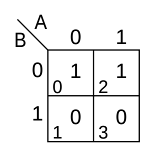
Administrivia

- Turn in Homework #2.
- Homework #3 available this afternoon on website.
- Office Hours: Firat Kiyak, Th 10-12am, in CSE 003
- Lab 3 available on website.
- Reading: Reading: pp. 93-114, 139-145, Verilog Reference (on website, see master calendar)

QUIZ #1

Karnaugh Maps

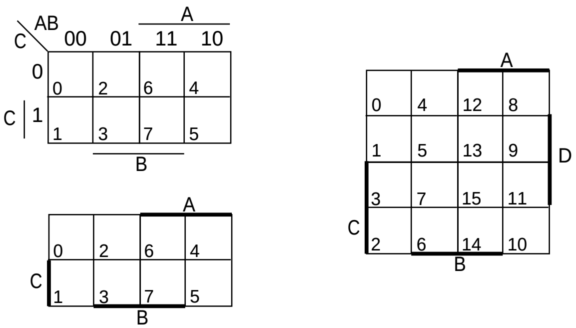
- Flat map of Boolean cube
  - wrap–around at edges
  - hard to draw and visualize for more than 4 dimensions
  - virtually impossible for more than 6 dimensions
- Alternative to truth-tables to help visualize adjacencies
  - guide to applying the uniting theorem
  - on-set elements with only one variable changing value are adjacent unlike the situation in a linear truth-table



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

Karnaugh Maps Continued

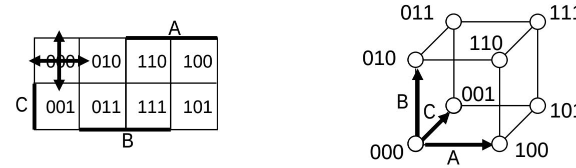
- Numbering scheme based on Gray–code
  - e.g., 00, 01, 11, 10
  - only a single bit changes in code for adjacent map cells



13 = 1101= ABC'D

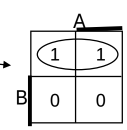
Adjacencies in Karnaugh Maps

- Wrap from first to last column
- Wrap top row to bottom row

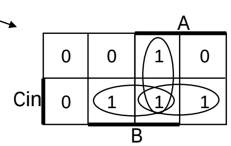


Karnaugh Map Examples

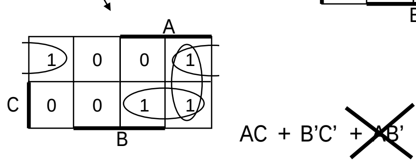
- F =
- Cout =
- f(A,B,C) = Σm(0,4,5,7)



B'



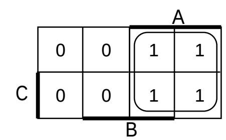
AB + ACin + BCin



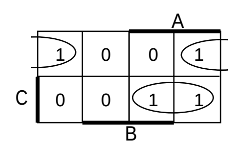
AC + B'C' + AB'

obtain the complement of the function by covering 0s with subcubes

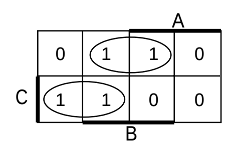
More Karnaugh Map Examples



G(A,B,C) = A



F(A,B,C) = Σm(0,4,5,7) = AC + B'C'

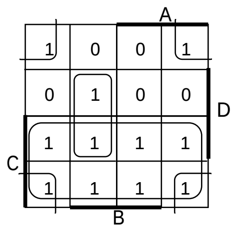


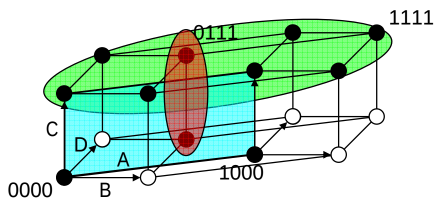
F' simply replace 1's with 0's and vice versa
F'(A,B,C) = Σ m(1,2,3,6) = BC' + A'C

A Four Variable Example

- F(A,B,C,D) = Σm(0,2,3,5,6,7,8,10,11,14,15)

F = C + A'BD + B'D'

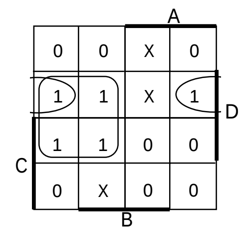




find the smallest number of the largest possible subcubes to cover the ON-set (fewer terms with fewer inputs per term)

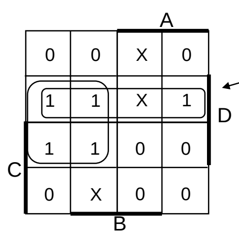
Karnaugh Map Don't Cares

- f(A,B,C,D) = Σ m(1,3,5,7,9) + d(6,12,13)
  - without don't cares
    - f = A'D + B'C'D



Karnaugh Map Don't Cares

- f(A,B,C,D) = Σ m(1,3,5,7,9) + d(6,12,13)
  - f = A'D + B'C'D without don't cares
  - f = A'D + C'D with don't cares



by using don't care as a "1" a 2-cube can be formed rather than a 1-cube to cover this node

don't cares can be treated as 1s or 0s depending on which is more advantageous

Exercise

- Minimize the function F = Σ m(0, 2, 7, 8, 14, 15) + d(3, 6, 9, 12, 13)