Logic Optimization: Graphical Method

Virendra Singh
Professor
Computer Architecture and Dependable Systems Lab
Department of Electrical Engineering
Indian Institute of Technology Bombay
http://www.ee.iitb.ac.in/~viren/
E-mail: viren@ee.iitb.ac.in

CS-226: Digital Logic Design

Lecture 14-A: 16 February 2021

CADSL

Function Minimization

① Cost/Area ② Performance (delay) ③ Testability ④ Power

SOP / POS / Truth table

Implicants

Cost $\propto$ (# literals + # product terms)

delay $\propto$ (max {# literals in individual prod. terms} + # prod. terms

Implicants

min (# prod. terms) — minimize cost & delay

min (# literals) — minimize cost

min (max {# literals in individual prod. terms}) — min delay

Function Minimization

(1) Algebraic Method (Boolean Algebra)
↳ Not SCALABILITY

(2) Algorithmic Approach
(a) Graphical Method (K-Map)
(b) Tabular Method (Q-M)

function $f(x_1 \cdots x_n)$
Truth Table → Graphical representation.

$f(a,b) = \bar{a}\bar{b} + a\bar{b} = (\bar{a}+a)\bar{b} = \bar{b}$

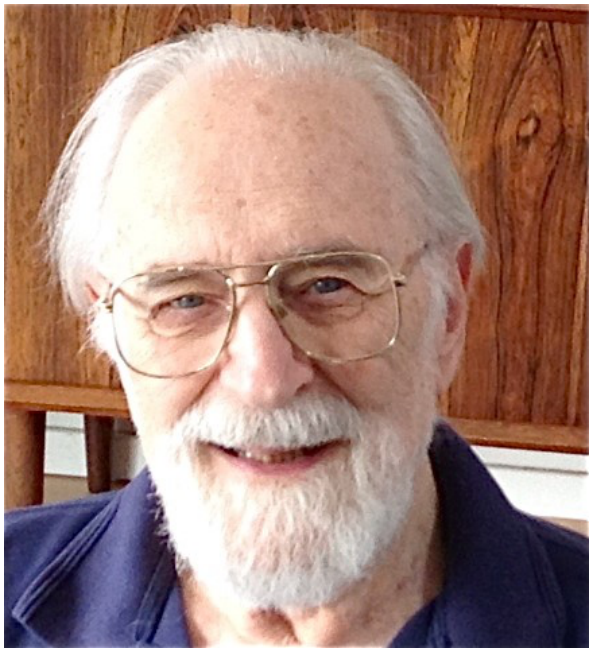
$\bar{b} \rightarrow f(a,b)$

$\bar{a}\bar{b}$: implicant; $a\bar{b}$: implicant; $\bar{b}$: Implicant

Graphical Method: Karnaugh Map

Maurice Karnaugh

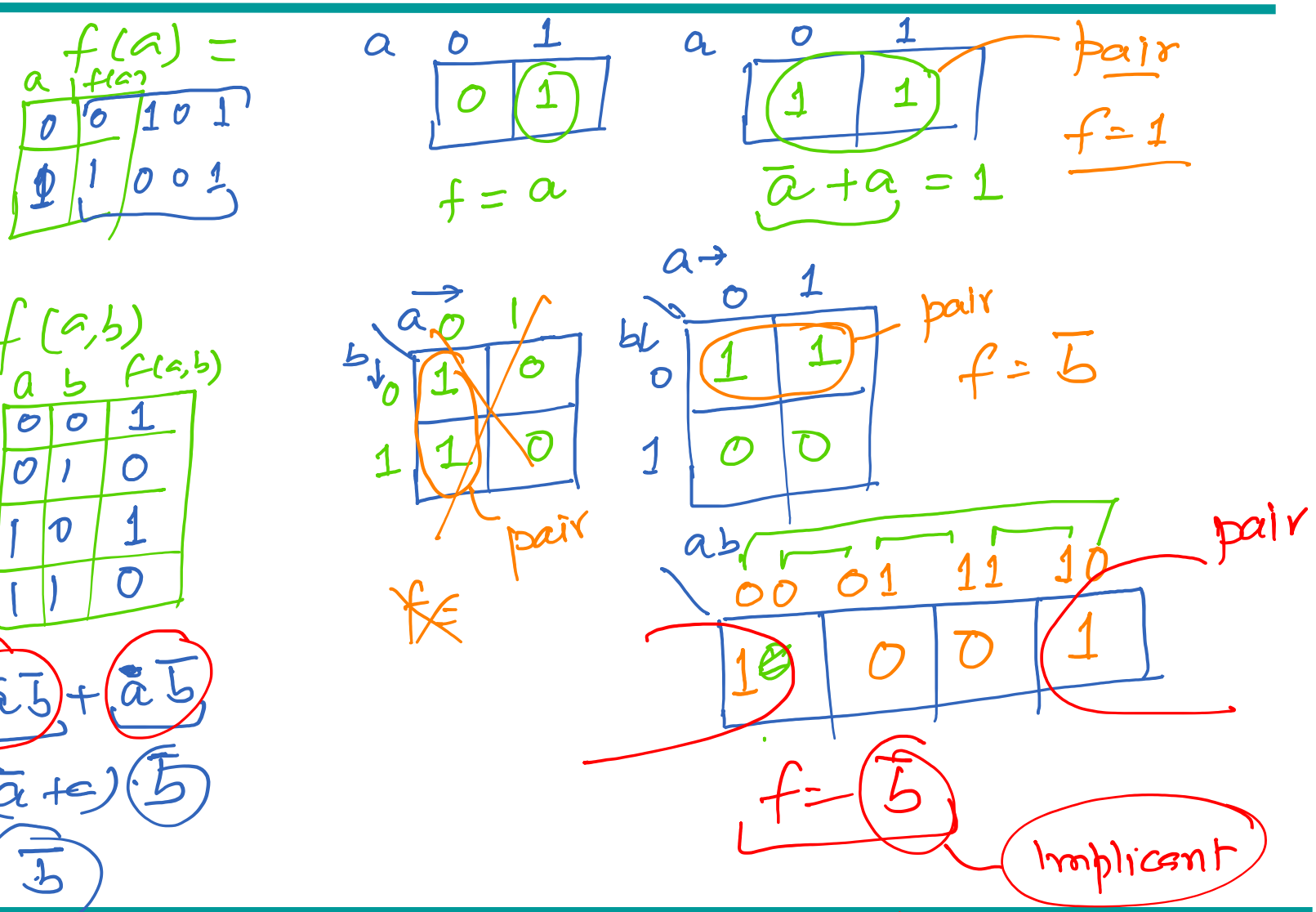
- American Physicist
- Bell Lab (1952 – 66)
- Developed K-Map in 1954



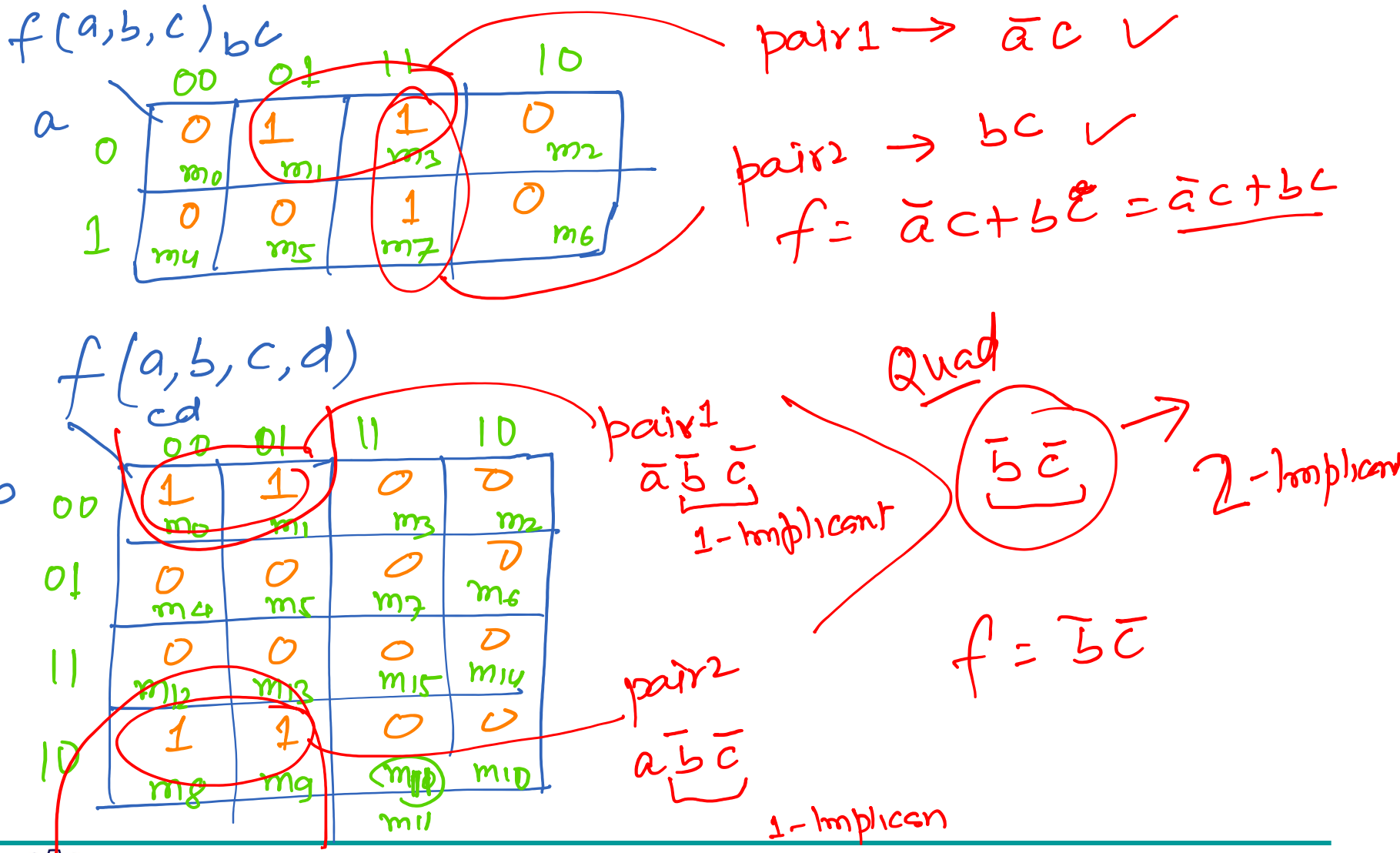
Maurice Karnaugh
Born: 4 October 1924

Karnaugh, Maurice (November 1953), "The Map Method for Synthesis of Combinational Logic Circuits" . *Transactions of the American Institute of Electrical Engineers, Part I: Communication and Electronics*. **72**(5): 593–599

Function Minimization: K-Map



Function Minimization: K-Map



Function Minimization: K-Map

2-terms ⟶ pair
2 (0-Implicants) (1-Implicant)

2 pairs ⟶ Quad.
(4 terms) (2-Implicant)

2 Quads → Octet
(2-Implicant (3-Implicant)

Prime Implicant

Largest Implicant
(Cover Largest no. of Min terms)

Objective = Min (# Prime Implicants)

Function Minimization: K-Map

m- Implicant

$f(x_1 \ldots x_n)$

n-Variable.

literals in Implicant = $n - m$

Thank You