SOP Minimization using Quine McCluskey Algorithm

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Introduction

- The Quine McCluskey Algorithm (aka tabulation method) is a method for the minimization of Boolean functions.
- Involves two steps
  - Find the prime implicants of a function and create a prime implicant chart
  - From the prime implicant chart, find the essential prime implicants as well as other prime implicants needed to cover the function

Example

$$F(A, B, C, D) = \Sigma m(0, 2, 5, 6, 7, 8, 10, 12, 13, 14, 15)$$

0	0000
2	0010
8	1000
5	0101
6	0110
10	1010
12	1100
7	0111
13	1101
14	1110
15	1111

Combine the 0-cubes to create 1-cubes, combine 1-cubes to create 2-cubes and so on

Column I			*Column II*			*Column III*	
0	0000	√	(0,2)	00-0	√	(0,2,8,10)	-0-0
2	0010	√	(0,8)	-000	√	(0,8,2,10)	-0-0
8	1000	√	(2,6)	0-10	√	(2,6,10,14)	–10
5	0101	√	(2,10)	-010	√	(2,10,6,14)	–10
6	0110	√	(8,10)	10-0	√	(8,10,12,14)	1–0
10	1010	√	(8,12)	1-00	√	(8,12,10,14)	1–0
12	1100	√	(5,7)	01-1	√	(5,7,13,15)	-1-1
7	0111	√	(5,13)	-101	√	(5,13,7,15)	-1-1
13	1101	√	(6,7)	011-	√	(6,7,14,15)	-11-
14	1110	√	(6,14)	-110	√	(6,14,7,15)	-11-
15	1111	√	(10,14)	1-10	√	(12,13,14,15)	11–
			(12,13)	110-	√	(12,14,13,15)	11–
			(12,14)	11-0	√		
			(7,15)	-111	√		
			(13,15)	11-1	√		
			(14,15)	111-	√		

Prime Implicant Chart

	E $B'D'$ (0,2,8,10)	F CD' (2,6,10,14)	G BD (5,7,13,15)	H BC (6,7,14,15)	J AD' (8,10,12,14)	K AB (12,13,14,15)
0	X					
2	X	X				
5			X			
6		X		X		
7			X	X		
8	X				X	
10	X	X			X	
12					X	X
13			X			X
14		X		X	X	X
15			X	X		X

(E)(E+F)(G)(F+H)(G+H)(E+J)(E+F+J)(J+K)(G+K)(F+H+J+K)(G+H+K)

(E)(E+F)(G)(F+H)(G+H)(E+J)(E+F+J)(J+K)(G+K)(F+H+J+K)(G+H+K)

Simplify using the rules X+XY = X; XX = X; X+X=X

= EGFJ + EGFK + EGHJ + EGHK

We can choose any one of these 4 covers. For example, EGFJ ie. B’D’ + BD + CD’ + AD’

Extension 1: Handling Don’t Cares

Include the don’t care terms in the initial list of implicants and use them while combining.

However, don’t include them in the Columns of the Prime Implicant Chart

Extension 2: Simultaneous Minimization of 2 Functions

Find the covers of the two functions.

Each function has multiple options for the cover: Eg. the function earlier had 4 options (EGFJ + EGFK + EGHJ + EGHK)

Choose the covers of each function in such a way that some product terms are shared between the two functions and the overall cost reduces.