QUINE-MCCLUSKEY METHOD

LOGIC MINIMIZATION

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TOPIC OUTLINE

The Quine-McCluskey Method

- **Minterms**
- **Prime Implicants**
- **Essential Prime Implicants**

QUINE-MCCLUSKEY METHOD

QUINE-MCCLUSKEY METHOD

The **Quine-McCluskey** method is a formal **tabular method** for applying the Boolean distributive law to various terms to find the minimum sum of products by eliminating literals that appear in two terms as complements.

Standard Minterm (SOP) Form

Group	ABC	Minterm
0	000	m_0
1	001	m_1
	010	m_2
	100	m_4
2	011	m_3
	101	m_5
	110	m_6
3	111	m_7

QUINE-MCCLUSKEY METHOD

Steps

1. Group minterm's by number of 1s.

2. If two minterms differ by only **one bit**, combine them by replacing the differing bit with "x".

Standard Minterm (SOP) Form

Group	ABC	Minterm	1st Level
1	001	m_1	(m_1, m_3)0x1 (m_1, m_5)x01
	010	m_2	(m_2, m_3)01x (m_2, m_6)x10
2	011	m_3	
	101	m_5	
	110	m_6	

$$f = \bar{A}C + \bar{B}C + \bar{A}B + B\bar{C}$$

QUINE-MCCLUSKEY METHOD

Steps

1. Group minterm's by number of 1s.
2. If two minterms differ by only **one bit**, combine them by replacing the differing bit with "x".
3. Identify prime implicants. **Prime implicants** are terms that could not be combined further in the previous step.
4. Create prime implicant chart.
5. Write the simplified Boolean expression.

Standard Minterm (SOP) Form

Group	1st Level
1	(m_1, m_3)0x1 (m_1, m_5)x01 (m_2, m_3)01x (m_2, m_6)x10

Prime Implicants	m_1	m_2	m_3	m_5	m_6
(m_1, m_3) $\bar{A}C$	✓		✓		
(m_1, m_5) $\bar{B}C$	✓			✓	
(m_2, m_3) $\bar{A}B$		✓	✓		
(m_2, m_6) $B\bar{C}$		✓			✓

$$f = \bar{A}C + \bar{B}C + B\bar{C}$$

EXCERCISE

Use the Quine-McCluskey method to minimize the given standard SOP expression.

$$f = \sum m(13, 14, 15)$$

Solution

Group	ABCD	Minterm	1st Level

Prime Implicants	m_{13}	m_{14}	m_{15}

EXCERCISE

Use the Quine-McCluskey method to minimize the given standard SOP expression.

$$f = \sum m(5, 6, 7, 12, 13, 14, 15)$$

Solution

Group	$ABCD$	Minterm	1st Level
3			
4			

EXCERCISE

Use the Quine-McCluskey method to minimize the given standard SOP expression.

$$f = \sum m(5, 6, 7, 12, 13, 14, 15)$$

Prime Implicants	m_5	m_6	m_7	m_{12}	m_{13}	m_{14}	m_{15}

Solution

Group	1st Level	2nd Level
2		
3		

EXCERCISE

Use the Quine-McCluskey method to minimize the given standard SOP expression.

$$f = \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}D$$
$$+A\bar{B}C\bar{D} + AB\bar{C}\bar{D} + AB\bar{C}D + ABCD$$

Solution

Group	$ABCD$	Minterm	1st Level
1			
2			
3			
4			

EXCERCISE

Use the Quine-McCluskey method to minimize the given standard SOP expression.

$$f = \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}D$$
$$+A\bar{B}C\bar{D} + AB\bar{C}\bar{D} + AB\bar{C}D + ABCD$$

Prime Implicants	m_1	m_3	m_4	m_5	m_{10}	m_{12}	m_{13}	m_{15}

Solution

Group	1st Level	2nd Level
1		
2		
3		

LABORATORY