Quine-McCluskey Logic Minimization Project

10 Test Cases

Mohamed Abbas 900211252

Mohammad Alashkar 900214276

Omar Bahgat 900211747

CSCE 2301, 02

Department of Computer Science and Engineering, AUC

Example 1: Normal Expression

```
Please enter your expression (SoP form): a`bc + ab` + bc`
```

```
Truth Table

a    b    c    F
---------------
0    0    0    0
0    0    1    0
0    1    0    1
0    1    1    1
1    0    0    1
1    0    1    1
1    1    0    1
1    1    1    0
```

```
The Canonical Sum of Products (SoP) is: (a'bc') +
    (a'bc) + (ab'c') + (ab'c) + (abc')
```

```
The Canonical Product of Sums (PoS) is: (a+b+c) *
    (a+b+c') * (a'+b'+c')
```

```
                Coverage Table

 Z        2      3      4      5      6
          ------------------------------
 01-      |x     x
 -10      |x                           x
 10-      |              x      x
 1-0      |              x             x
```

```
All Prime Implicants

   a`b : 01- : (2,3)
   bc` : -10 : (2,6)
   ab` : 10- : (4,5)
   ac` : 1-0 : (4,6)
```

```
All Essential Prime Implicants:

   a`b : 01-
   ab` : 10-
```

```
The minterms that are not covered by EPIs: (6)
```

```
Minimized Expression: a`b + ab` + ac`
```

Example 2: Minterms only (taken from slides)

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

```
Please enter the minterms: 0 2 5 6 7 8 10 12 13 14 15
```

```
Truth Table

a    b    c    d    F
--------------------
0    0    0    0    1
0    0    0    1    0
0    0    1    0    1
0    0    1    1    0
0    1    0    0    0
0    1    0    1    1
0    1    1    0    1
0    1    1    1    1
1    0    0    0    1
1    0    0    1    0
1    0    1    0    1
1    0    1    1    0
1    1    0    0    1
1    1    0    1    1
1    1    1    0    1
1    1    1    1    1
```

```
The Canonical Product of Sums (PoS) is: (a+b+c+d') * (a+b+c'+d') *
    (a+b'+c+d) * (a'+b+c+d') * (a'+b+c'+d')
```

```
The Canonical Sum of Products (SoP) is: (a'b'c'd') + (a'b'cd') +
    (a'bc'd) + (a'bcd') + (a'bcd) + (ab'c'd') + (ab'cd') + (abc'd') +
    (abc'd) + (abcd') + (abcd)
```

```
                                Coverage Table

 Z       0     2     5     6     7     8     10    12    13    14    15
        ------------------------------------------------------------------
 -0-0   |x    x                       x     x
 --10   |     x           x                 x                       x
 1--0   |                                   x     x     x           x
 -1-1   |           x           x                             x           x
 -11-   |                 x     x                                   x     x
 11--   |                                               x     x     x     x
```

```
All Prime Implicants

  b`d` : -0-0 : (0,2,8,10)
   cd` : --10 : (2,6,10,14)
   ad` : 1--0 : (8,10,12,14)
    bd : -1-1 : (5,7,13,15)
    bc : -11- : (6,7,14,15)
    ab : 11-- : (12,13,14,15)
```

```
All Essential Prime Implicants:

 b`d` : -0-0
   bd : -1-1
```

```
The minterms that are not covered by EPIs : (6, 12, 14)
```

```
Minimized Expression: b`d` + bd + ab + bc
```

Example 3: Minterms and don't cares (taken from slides)

$$f(A,B,C,D) = \sum m(4,5,6,8,9,10,13) + \sum d(0,7,15)$$

```
Please enter the minterms: 4 5 6 8 9 10 13
Please enter the dont care terms: 0 7 15
```

```
Truth Table

a    b    c    d    F
--------------------
0    0    0    0    0
0    0    0    1    0
0    0    1    0    0
0    0    1    1    0
0    1    0    0    1
0    1    0    1    1
0    1    1    0    1
0    1    1    1    0
1    0    0    0    1
1    0    0    1    1
1    0    1    0    1
1    0    1    1    0
1    1    0    0    0
1    1    0    1    1
1    1    1    0    0
1    1    1    1    0
```

```
The Canonical Sum of Products (SoP) is: (a'bc'd') + (a'bc'd) +
    (a'bcd') + (ab'c'd') + (ab'c'd) + (ab'cd') + (abc'd)
```

```
The Canonical Product of Sums (PoS) is: (a+b+c+d) * (a+b+c+d')
    * (a+b+c'+d) * (a+b+c'+d') * (a+b'+c'+d') * (a'+b+c'+d') *
    (a'+b'+c+d) * (a'+b'+c'+d) * (a'+b'+c'+d')
```

```
                    Coverage Table

 Z        4      5      6      8      9      10     13
        ------------------------------------------------
0-00    |x
-000    |                     x
100-    |                     x      x
10-0    |                     x             x
1-01    |                            x             x
01--    |x      x      x
-1-1    |       x                                  x
```

```
All Prime Implicants

a`c`d` : 0-00 : (0,4)
b`c`d` : -000 : (0,8)
 ab`c` : 100- : (8,9)
 ab`d` : 10-0 : (8,10)
  ac`d : 1-01 : (9,13)
   a`b : 01-- : (4,5,6,7)
    bd : -1-1 : (5,13,7,15)
```

```
All Essential Prime Implicants:

  a`b : 01--
ab`d` : 10-0
```

```
The minterms that are not covered by EPIs : (9, 13)
```

```
Minimized Expression: a`b + ab`d` + ac`d
```

Example 4: Minterms and don't cares (taken from H.W 2)

$$f(A,B,C,D) = \sum m(2,3,7,9,11,13) + \sum d(1,10,15)$$

```
Please enter the minterms: 2 3 7 9 11 13
Please enter the dont care terms: 1 10 15
```

```
Truth Table

a    b    c    d    F
--------------------
0    0    0    0    0
0    0    0    1    0
0    0    1    0    1
0    0    1    1    1
0    1    0    0    0
0    1    0    1    0
0    1    1    0    0
0    1    1    1    1
1    0    0    0    0
1    0    0    1    1
1    0    1    0    0
1    0    1    1    1
1    1    0    0    0
1    1    0    1    1
1    1    1    0    0
1    1    1    1    0
```

```
The Canonical Sum of Products (SoP) is: (a'b'cd') +
    (a'b'cd) + (a'bcd) + (ab'c'd) + (ab'cd) + (abc'd)
```

```
The Canonical Product of Sums (PoS) is: (a+b+c+d) *
    (a+b+c+d') * (a+b'+c+d) * (a+b'+c+d') *
    (a+b'+c'+d) * (a'+b+c+d) * (a'+b+c'+d) *
    (a'+b'+c+d) * (a'+b'+c'+d) * (a'+b'+c'+d')
```

```
                Coverage Table

 Z        2      3      7      9      11     13
        ------------------------------------
-01-    |x      x                     x
-0-1    |       x             x      x
--11    |       x      x              x
1--1    |                     x      x      x
```

```
All Prime Implicants

   b`c : -01- : (2,3,10,11)
   b`d : -0-1 : (1,3,9,11)
    cd : --11 : (3,7,11,15)
    ad : 1--1 : (9,11,13,15)
```

```
All Essential Prime Implicants:

    cd : --11
   b`c : -01-
    ad : 1--1
```

```
The minterms that are not covered by EPIs :
```

```
Minimized Expression: cd + b`c + ad
```

Example 5: Minterms only (taken from H.W 2)

$$f(A,B,C,D,E) = \sum m(0,2,3,5,7,9,11,13,14,16,18,24,26,28,30)$$

```
Please enter the minterms: 0 2 3 5 7 9 11 13 14 16 18 24 26 28 30
```

Truth Table

a	b	c	d	e	F
0	0	0	0	0	1
0	0	0	0	1	0
0	0	0	1	0	1
0	0	0	1	1	1
0	0	1	0	0	0
0	0	1	0	1	1
0	0	1	1	0	0
0	0	1	1	1	1
0	1	0	0	0	0
0	1	0	0	1	1
0	1	0	1	0	0
0	1	0	1	1	1
0	1	1	0	0	0
0	1	1	0	1	1
0	1	1	1	0	1
0	1	1	1	1	0
1	0	0	0	0	1
1	0	0	0	1	0
1	0	0	1	0	1
1	0	0	1	1	0
1	0	1	0	0	0
1	0	1	0	1	0
1	0	1	1	0	0
1	0	1	1	1	0
1	1	0	0	0	1
1	1	0	0	1	0
1	1	0	1	0	1
1	1	0	1	1	0
1	1	1	0	0	1
1	1	1	0	1	0
1	1	1	1	0	1
1	1	1	1	1	0

```
The Canonical Sum of Products (SoP) is: (a'b'c'd'e') + (a'b'c'de') +
    (a'b'c'de) + (a'b'cd'e) + (a'b'cde) + (a'bc'd'e) + (a'bc'de) +
    (a'bcd'e) + (a'bcde') + (ab'c'd'e') + (ab'c'de') + (abc'd'e') +
    (abc'de') + (abcd'e') + (abcde')
```

```
The Canonical Product of Sums (PoS) is: (a+b+c+d+e') * (a+b+c'+d+e) *
    (a+b+c'+d'+e) * (a+b'+c+d+e) * (a+b'+c+d'+e) * (a+b'+c'+d+e) *
    (a+b'+c'+d'+e') * (a'+b+c+d+e') * (a'+b+c+d'+e') * (a'+b+c'+d+e) *
    (a'+b+c'+d+e') * (a'+b+c'+d'+e) * (a'+b+c'+d'+e') * (a'+b'+c+d+e')
    * (a'+b'+c+d'+e') * (a'+b'+c'+d+e') * (a'+b'+c'+d'+e')
```

```
All Prime Implicants

a`b`c`d : 0001- : (2,3)
a`b`de : 00-11 : (3,7)
a`c`de : 0-011 : (3,11)
a`b`ce : 001-1 : (5,7)
a`cd`e : 0-101 : (5,13)
a`bc`e : 010-1 : (9,11)
a`bd`e : 01-01 : (9,13)
 bcde` : -1110 : (14,30)
b`c`e` : -00-0 : (0,2,16,18)
 ac`e` : 1-0-0 : (16,18,24,26)
  abe` : 11--0 : (24,26,28,30)
```

```
All Essential Prime Implicants:

b`c`e` : -00-0
bcde` : -1110
 abe` : 11--0
```

Coverage Table

Z	0	2	3	5	7	9	11	13	14	16	18	24	26	28	30
0001-		x	x												
00-11			x		x										
0-011			x				x								
001-1				x	x										
0-101				x				x							
010-1						x	x								
01-01						x		x							
-1110									x						x
-00-0	x	x								x	x				
1-0-0										x	x	x	x		
11--0												x	x	x	x

The minterms that are not covered by EPIs : (3, 5, 7, 9, 11, 13)

Minimized Expression: b`c`e` + bcde` + abe` + a`c`de + a`bd`e + a`b`ce

Example 6: Minterms and don't cares (taken from H.W 2)

$$f(A,B,C,D) = \sum m(1,3,4,5,6,7,10,12,13) + d(2,9,15)$$

```
Please enter the minterms: 1 3 4 5 6 7 10 12 13
Please enter the dont care terms: 2 9 15
```

Truth Table

a	b	c	d	F
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	0
1	1	1	1	0

```
The Canonical Sum of Products (SoP) is: (a'b'c'd) + (a'b'cd) +
    (a'bc'd') + (a'bc'd) + (a'bcd') + (a'bcd) + (ab'cd') +
    (abc'd') + (abc'd)
```

```
The Canonical Product of Sums (PoS) is: (a+b+c+d) * (a+b+c'+d) *
    (a'+b+c+d) * (a'+b+c+d') * (a'+b+c'+d') * (a'+b'+c'+d) *
    (a'+b'+c'+d')
```

Coverage Table

Z	1	3	4	5	6	7	10	12	13
-010							x		
0--1	x	x		x		x			
--01	x			x					x
01--			x	x	x	x			
-10-			x	x				x	x
0-1-		x			x	x			
-1-1				x		x			x

```
All Prime Implicants

 b`cd` : -010 : (2,10)
   a`d : 0--1 : (1,3,5,7)
   c`d : --01 : (1,5,9,13)
   a`b : 01-- : (4,5,6,7)
   bc` : -10- : (4,5,12,13)
   a`c : 0-1- : (2,3,6,7)
    bd : -1-1 : (5,7,13,15)
```

```
All Essential Prime Implicants:

b`cd` : -010
  bc` : -10-
```

```
The minterms that are not covered by EPIs : (1, 3, 6, 7)
```

```
Minimized Expression: b`cd` + bc` + a`c + a`d
```

Example 7: Normal Expression (taken from H.W 2)

$$f(A,B,C) = AB + A'C + AB'C$$

```
Please enter your expression (SoP form): ab + a`c + ab`c
```

```
Truth Table

a    b    c    F
---------------
0    0    0    0
0    0    1    1
0    1    0    0
0    1    1    1
1    0    0    0
1    0    1    1
1    1    0    1
1    1    1    1
```

```
The Canonical Sum of Products (SoP) is: (a'b'c) +
    (a'bc) + (ab'c) + (abc') + (abc)
```

```
The Canonical Product of Sums (PoS) is: (a+b+c) *
    (a+b'+c) * (a'+b+c)
```

```
                Coverage Table

 Z        1      3      5      6      7
         ------------------------------
 11-     |                     x      x

 --1     |x      x      x             x
```

```
All Prime Implicants

    ab : 11- : (6,7)
     c : --1 : (1,3,5,7)
```

```
All Essential Prime Implicants:

     c : --1
    ab : 11-
```

```
The minterms that are not covered by EPIs:
```

```
Minimized Expression: c + ab
```

Example 8: Normal Expression (taken from H.W 2)

$$f(A,B,C) = A'B + c$$

```
Please enter your expression (SoP form): a`b + c
```

```
Truth Table

a     b     c     F
----------------
0     0     0     0
0     0     1     1
0     1     0     1
0     1     1     1
1     0     0     0
1     0     1     1
1     1     0     0
1     1     1     1
```

```
The Canonical Sum of Products (SoP) is: (a'b'c) +
    (a'bc') + (a'bc) + (ab'c) + (abc)
```

```
The Canonical Sum of Products (SoP) is: (a'b'c) +
    (a'bc') + (a'bc) + (ab'c) + (abc)
```

```
                Coverage Table

 Z        1      2      3      5      7
          ------------------------------
 01-      |      x      x
 --1      |x             x      x      x
```

```
All Prime Implicants

   a`b : 01- : (2,3)
     c : --1 : (1,3,5,7)
```

```
All Essential Prime Implicants:

     c : --1
   a`b : 01-
```

```
The minterms that are not covered by EPIs:
```

```
Minimized Expression: c + a`b
```

Example 9: Normal Expression (always evaluates to true)

```
Please enter your expression (SoP form): a + a`
```

```
Truth Table

a     F
------
0     1
1     1
```

```
The Canonical Sum of Products (SoP) is: (a') + (a)
```

```
The Canonical Product of Sums (PoS) is: 1
```

```
      Coverage Table

  Z          0          1
           ----------
    -       |x         x
```

```
All Prime Implicants

        : - : (0,1)
```

```
All Essential Prime Implicants:

        : -
```

```
The minterms that are not covered by EPIs:
```

```
Minimized Expression: 1
```

Example 10: Normal Expression (always evaluates as false)

```
Please enter your expression (SoP form): aa`
```

```
Truth Table

a     F
------
0     0
1     0
```

```
The Canonical Sum of Products (SoP) is: 0
```

```
The Canonical Product of Sums (PoS) is: (a) * (a')
```

```
Coverage Table

  Z
```

```
All Prime Implicants
```

```
All Essential Prime Implicants:
```

```
The minterms that are not covered by EPIs:
```

```
Minimized Expression: 0
```