Computer Codes for Quine-McClusky(QM) Minimization Method

The QM method is useful in minimizing logic expressions for larger number of variables when compared with minimization by Karanugh Map or Boolean Algebra. Refer to Section 3.9 of the book Digital Principles and Applications 6e by Leach, Malvino and Saha, TMH, 2006 for details. The C source codefor QM algorithm is given in the adjoining file QMdpa6.c file. The screenshots of execution of this code after compilation in Windows VC++ are presented here for 3, 4 and 5 variable examples. You can extend it for any number of variables in a similar manner.

Three variable problem:

Refer to Truth Table of Fig. 3.36 (page 111) of the above referenced book. The truth table can be represented by minterms as

$$F(A,B,C) = \Sigma\, m(2,5,6,7)$$

The program when executed first asks no. of variables to be minimized. For this example, since 3 variables A, B, C are present, you have to write '3' and press ENTER. The program then gives how it designates input variables e.g. A will be represented as a[2], B as a[1] and C as a[0].

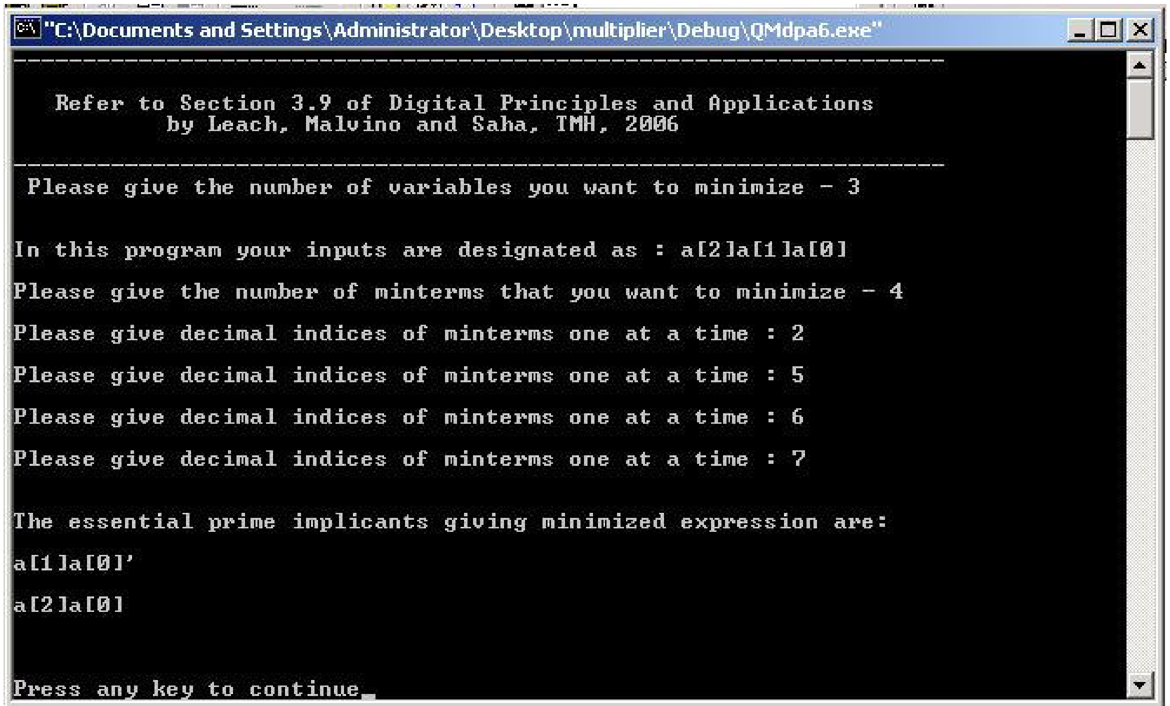
The program then asks the no. of minterms in the truth table which for this problem is to be given as '4' and then key ENTER pressed. Next, it asks you to give minterms one at a time. This you do for this problem by giving as '2' then ENTER, '5' then ENTER, '6' then ENTER and '7' followed by ENTER. At this point, the program will not ask any more minterm to be entered as all 4 are provided and essential prime implicants appear in terms of a[i] i.e. a[2], a[1] and a[0]. By reverse substitution of these to input variables A,B,C i.e. a[2] = A, a[1] = B and a[0] = C and combining we get minimized expression.

Now for this problem, essential prime implicants appear as a[1]a[0]' and a[2]a[0] which are BC' and AC

Hence, minimzed expression is $F(A,B,C) = BC' + AC$

Compare this with the result you get by Karnaugh Map minimization. They are same.

The screenshot of the code when executed is given next.



Will the result change if minterms are given in different order, say 6, 2, 5, 7. Of course, not. Please check yourself by running this code and giving same minterms in various order.

Four variable problem

For this let us use the truth table given in Table 3.10, page 103 of the same book. Now the minterms are

$$F(A,B,C,D) = \Sigma\, m(0,1,2,3,10,11,12,13,14,15)$$

We follow the steps given for 3-variable problem. No of variables will be ‘4’, no. of minterms ‘10’ and they are as given above.

After minimization essential prime implicants are given as a[3]’a[2]’, a[2]’a[1] and a[3]a[2].

On substitution of a[3] = A, a[2] = B, a[1] = C and a[0] = D and combining we get minimized expression as

$$F(A,B,C,D) = A'B' + B'C + AB$$

The screenshot for this is shown next.

```
"C:\Documents and Settings\Administrator\Desktop\multiplier\Debug\QMdpa6.exe"
--------------------------------------------------------------------

   Refer to Section 3.9 of Digital Principles and Applications
           by Leach, Malvino and Saha, TMH, 2006

--------------------------------------------------------------------
 Please give the number of variables you want to minimize - 4

In this program your inputs are designated as : a[3]a[2]a[1]a[0]

Please give the number of minterms that you want to minimize - 10

Please give decimal indices of minterms one at a time : 0

Please give decimal indices of minterms one at a time : 1

Please give decimal indices of minterms one at a time : 2

Please give decimal indices of minterms one at a time : 3

Please give decimal indices of minterms one at a time : 10

Please give decimal indices of minterms one at a time : 11

Please give decimal indices of minterms one at a time : 12

Please give decimal indices of minterms one at a time : 13

Please give decimal indices of minterms one at a time : 14

Please give decimal indices of minterms one at a time : 15

The essential prime implicants giving minimized expression are:

a[3]'a[2]'

a[2]'a[1]


a[3]a[2]

Press any key to continue
```

Compare this result with the one explained as example in Section 3.9. The result matches but this code gives only one set of minimized expression from probable two. Modify this code so that when there are more no. of solutions i.e. same level of minimization, all of them are displayed by the computer code.

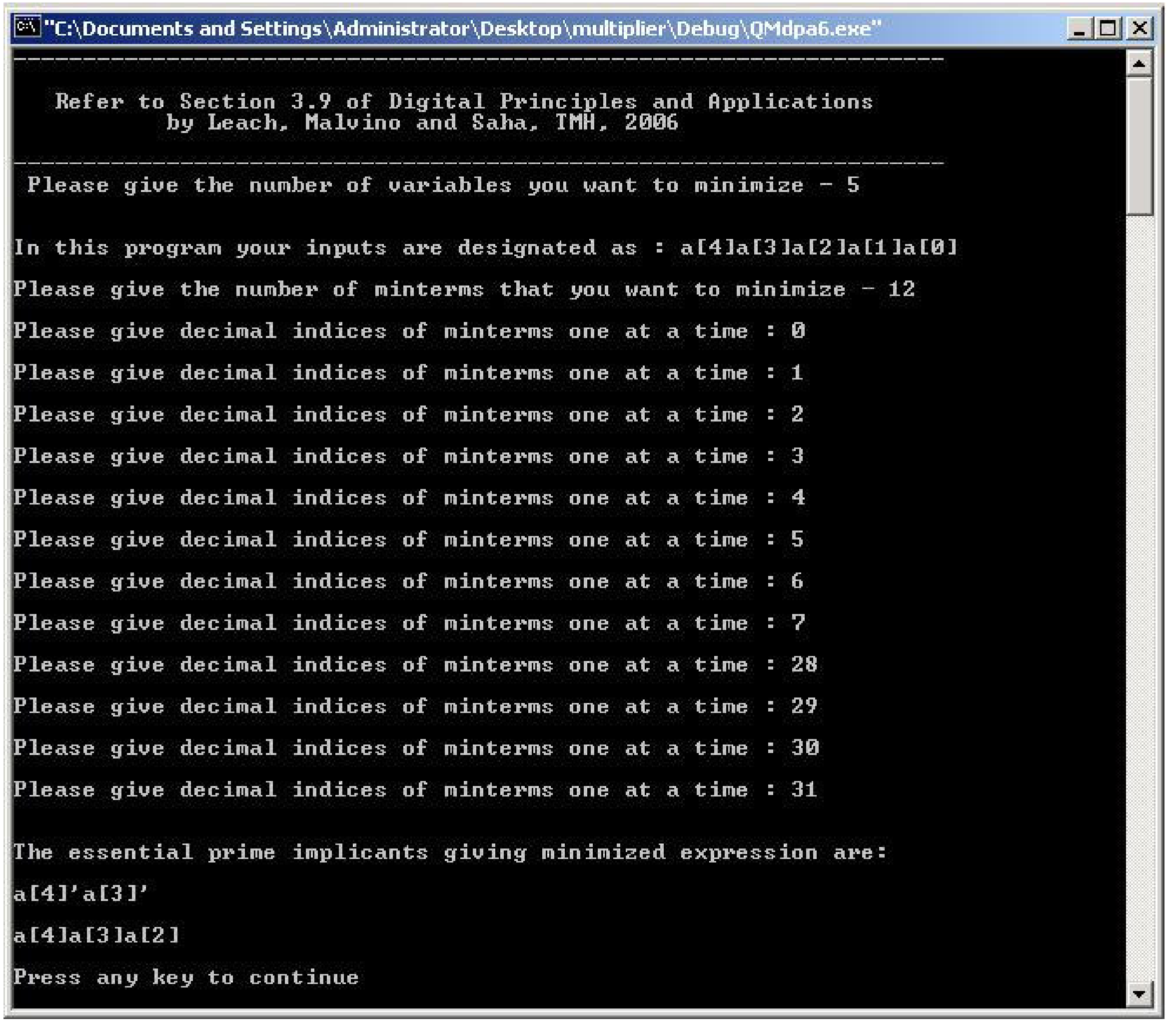
Five variable problem:

Minimization by Karnaugh Map method is difficult for 5 or more variables. Let us take one example of a 5 variable minimization problem truth table of which can be represented by minterms as follows

$$F(A,B,C,D,E) = \Sigma\, m(0,1,2,3,4,5,6,7,28,29,30,31)$$

The essential prime implicants by the given code are given as a[4]'a[3]' and a[4]a[3]a[2].

The minimized expresiion from previous discussion $F(A,B,C,D,E) = A'B' + ABC$. The screenshot for this example is given next.



```
"C:\Documents and Settings\Administrator\Desktop\multiplier\Debug\QMdpa6.exe"
------------------------------------------------------------------

   Refer to Section 3.9 of Digital Principles and Applications
           by Leach, Malvino and Saha, TMH, 2006

------------------------------------------------------------------
 Please give the number of variables you want to minimize - 5

In this program your inputs are designated as : a[4]a[3]a[2]a[1]a[0]

Please give the number of minterms that you want to minimize - 12

Please give decimal indices of minterms one at a time : 0

Please give decimal indices of minterms one at a time : 1

Please give decimal indices of minterms one at a time : 2

Please give decimal indices of minterms one at a time : 3

Please give decimal indices of minterms one at a time : 4

Please give decimal indices of minterms one at a time : 5

Please give decimal indices of minterms one at a time : 6

Please give decimal indices of minterms one at a time : 7

Please give decimal indices of minterms one at a time : 28

Please give decimal indices of minterms one at a time : 29

Please give decimal indices of minterms one at a time : 30

Please give decimal indices of minterms one at a time : 31

The essential prime implicants giving minimized expression are:

a[4]'a[3]'

a[4]a[3]a[2]

Press any key to continue
```

It is left to the reader to find out if the above relation is correct and also use this code to minimize truth tables of 6 or more variables.