Simplifying Boolean Expressions

Lab 4, due Fri Feb 21 (2400 hrs)

CS 350: Computer Organization & Assembler Language Programming

A. Why?

- Simplifying boolean expressions can make them more readable and require less hardware to implement.
- Karnaugh maps are a good way to find a simple logical expression for a truth function.

B. Outcomes

After this lab, you should be able to

- Convert a boolean expression into its full DNF equivalent.
- Simplify a truth function using a Karnaugh map.

C. Problems [100 points total]

1. [15 pts] (a) Translate $\neg(X\ \overline{Y}\ +\ Z)$ into minimal DNF (non-full DNF with a minimal set of terms). (b) Give the equivalent full DNF representation. (c) Use the full DNF representation to write a truth table for the expression.

2. [15 pts] Find a simplest boolean expression for the result R described by Table 1: (a) Write out a Karnaugh map for R; (b) Draw rectangles to indicate a set of prime implicants; and (c) Translate the prime implicants into DNF form.

Table 1

X	***Y***	***Z***	***R***
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

3. [18 pts] Repeat the previous problem on Table 2.

4. [22 pts] Repeat the previous problem on Table 3.

Table 2

V	X	Y	Z	R
0	0	0	0	1
0	0	0	1	0
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	0
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	0

Table 3

V	X	Y	Z	R
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
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

5. [30 pts] Find a simplest boolean expression equivalent to R below:
(a) Form a Karnaugh map for the expression, (b) Select prime implicants, and (c) Translate the prime implicants into DNF form.

$$R = V\,X\,\overline{(V\,X\,\overline{Y}\,Z)} + X\,\overline{Z} + V\,X\,Y + \overline{Y}\,\overline{(X\,Z)} + V\,Y\,\overline{Z} + \overline{V}\;\overline{Z}$$

(You can — but aren't required to — give a regular truth table for R before creating the Karnaugh map.)

(No programming assignment this week.)

