Logic Synthesis & Verification, Fall 2012

National Taiwan University

Problem Set 4

Due on 2012/11/28 before lecture

1 [Smallest Cube Containing]

(20%) Prove or disprove the following statements.

(a) $\mathrm{SCC}(c_1 \cdot c_2) = \mathrm{SCC}(c_1) \cdot \mathrm{SCC}(c_2)$, for any cubes c_1 and c_2.
(b) $\mathrm{SCC}(c \cdot f) = c \cdot \mathrm{SCC}(f)$, for any function f and cube c.
(c) $\mathrm{SCC}(c \cdot f_c) = c \cdot \mathrm{SCC}(f_c)$, for any function f and cube c.

2 [ESPRESSO - REDUCE]

(20%) Let

$$
\begin{aligned}
F &= w'x'z + w'x'y' + w'xz' + w'xy + wxz + wx'y, \\
D &= wxy'z' + wxyz', \text{ and} \\
R &= w'x'yz' + w'xy'z + wx'y'.
\end{aligned}
$$

be the covers of the incompletely specified function (f, d, r), don't care function d, and offset function r, respectively. Apply REDUCE based on the unate recursive paradigm as in the lecture notes on the cubes of f in order (from left to right). Show intermediate steps.

3 [ESPRESSO - EXPAND]

(20%) Apply EXPAND (using the procedure in the lecture notes) on the reduced cover derived above by REDUCE. Show intermediate steps.

4 [ESPRESSO - IRREDUNDANT]

(20%)

(a) Explain why the function $\neg g(y)$ in IRREDUNDANT can be obtained by summing over the cases of $\begin{bmatrix} F_{c_i} \\ D_{c_i} \end{bmatrix}$, for all cubes c_i of cover F.

(b) Apply IRREDUNDANT (using the procedure in the lecture notes) on the cover derived above by EXPAND. Show intermediate steps.

5 [ESPRESSO Application]

(20%) Given a graph $G = (V, E)$ with vertices V and edges E, the *graph coloring problem* asks what is the minimum number of colors needed to color the graph such that (1) any vertex in V gets one color and (2) two end vertices of any edge in E must have different colors. Given the graph as shown in Figure 1, formulate the coloring problem as a two-level minimization problem and use ESPRESSO (downloadable, e.g., from
http://diamond.gem.valpo.edu/~dhart/ece110/espresso/tutorial.html)
to solve it.

(a) Get the solution with ESPRESSO default option.
(b) Get the exact minimum solution with ESPRESSO "-Dexact" option.

How many colors are needed? Explain your formulation and attach the PLA files for the input and output of ESPRESSO.

   (Hint: Specify the onset and offset constraints related to conditions (1) and (2), respectively, using the PLA format such that after SOP minimizing the number of cubes corresponds to the number of colors. For PLA file format, see, e.g.,
http://www.engineering.uiowa.edu/~switchin/OldSwitching/espresso.5.html
In particular, you may need ".type fr" to specify the onset and offset. A detailed description of ESPRESSO usage can be found in
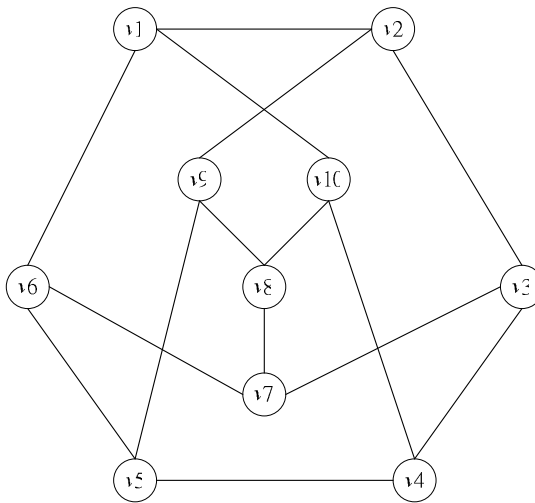http://www.engineering.uiowa.edu/~switchin/OldSwitching/espresso.1.html.)

Fig. 1. A graph to be colored.