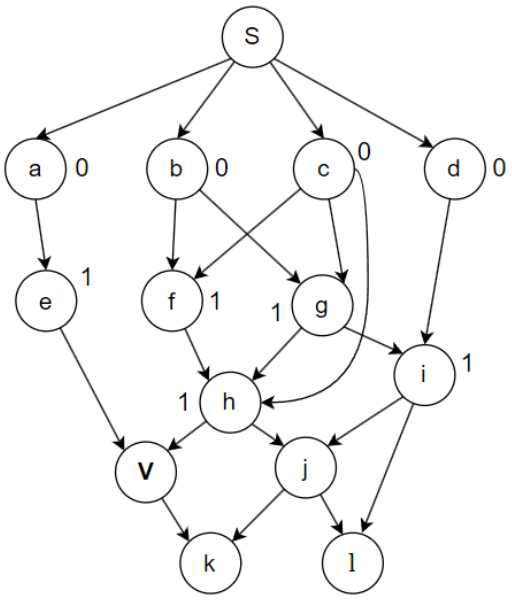
# CS 516000 FPGA Architecture & CAD

## Homework 3 (Due: 2024/11/21)

1. Given four numbers 0.88, 0.72, 0.21 and 0.36.
   (a) Use a calculator to compute the error of approximating the maximum function of the four numbers by the log-sum-exp method with $\gamma = 1$.
   (b) Use a calculator to compute the error of approximating the maximum function of the four numbers by the log-sum-exp method with $\gamma = 0.01$.
   (c) Prove that, in general, the error of approximating the maximum function of n numbers is strictly less than $\gamma \log n$ when the numbers are not all the same, and the error is exactly equal to $\gamma \log n$ when the n numbers are all the same.

2. Refer to the simulated annealing-based placement approach described on p.18 of Unit 11.
   (a) Will it be sufficient to have only the move type of exchanging locations of two randomly selected logic blocks? Why?
   (b) Will it be sufficient to have only the move type of relocating a randomly selected logic block to an empty location? Why?

3. Consider the labeling phase of FlowMap.
   (a) Suppose the labels of nodes *a* to *i* have been determined as shown below. What are the two possible values of label(*v*)?




   (b) Construct the flow network used to help verify the exact value of label(*v*). Assume we are mapping to 3-input LUTs, what is the exact value of label(*v*)?

4. (a) Map the following circuit into 4-input LUTs by applying DP Tree-map algorithm after partitioning the circuit into trees.
(b) By inspection, give an area-optimal mapping solution of the circuit into 4-input LUTs. (Duplication is allowed.)