COSC 121
Spring 2019
Problem Set 8
Due by class time on April 23, 2019

d-Dimensional Hypercube

A d-dimensional hypercube consists of 2^d nodes. Nodes are labeled using d-bit binary identifiers. Two nodes are connected to each other in the hypercube if and only if their binary identifiers differ in exactly 1 bit. Thus, in a d-dimensional hypercube the *degree* of each node is d. Note that the *degree* of a node is the number of other nodes that it is connected to. The neighbors of a node are the other nodes that it is connected to.

The distance between two nodes is the number of hops (or links) on the shortest path between those two nodes. In a d-dimensional hypercube the distance between two nodes is equal to the number of bits in which their identifiers differ.

Example of 4-dimensional hypercube: In a 4-dimensional hypercube (i.e., d = 4), there are 2^4 = 16 nodes, labelled 0000 through 1111 in binary. Node 0010 has neighbors 1010, 0110, 0000 and 0011. The distance between nodes 0010 and 1100 is 3, because 0010 and 1100 differ in 3 bits.

1. (20 points) Answer the following for a 4-dimensional hypercube.
   (a) List all the shortest paths between nodes 0010 and 0100.
   (b) How many different shortest paths exist between nodes 0010 and 1100? Briefly explain your answer.

2. Consider a 2-way set-associative cache consisting of a total of 64 blocks, each block containing 16 words. Determine the tag stored for each of the following addresses:
   (i) x2403
   (ii) x280A

   Show your work.

3. Consider a direct mapped cache consisting of 8 blocks, each block containing 8 words. Determine the tag stored for each of the following addresses:
   (i) x2403
   (ii) x280A

   Show your work.