# Project 2. Find the Girth of an Undirected Graph

(Due 4/21-28/2018 Sun)

**Description:**

In this project, we will process an undirected graph, not necessarily connected. The *girth* of a graph is the *length* of a shortest cycle in this graph. After you find the girth, you also need to produce the cycle that corresponds to the girth.

**Requirements:**

1. (*Input*)   The input comes from a text file that stores the *adjacency matrix* of a graph. Your program will take the file name of an input as a command-line argument. Then your program will read the content of the file line by line, in which each row corresponds to one row of the adjacency matrix of a graph.

2. (*Validation*)   Before we process the graph, we need to validate the data to make sure that the given data corresponds to the adjacency matrix of a graph. Basically we need to check the following items:

   - (*Square Matrix*)

     Each row of the data file has a sequence of integers separated by a space character. Make sure that the number of rows equals the number of columns. Otherwise display an error message.

   - (*Bit Value Entries*)

     Check if each entry of the matrix takes the bit value: 0 or 1. If not, display an error message.

   - (*No Self-Loops*)

     Since an undirected graph cannot have any self-loop, we need to check that all the diagonal entries must be 0. Otherwise display an error message.

   - (*Valid Undirected Graph*)

     In order to make sure that this matrix corresponds to the adjacency matrix of an undirected graph, you need to check if it is *symmetric*. If not, display an error message.

3. (*Find the Girth*)　After you pass the data validation, you design an algorithm to calculate its *girth* and its corresponding shortest cycle. In this project, the performance of your algorithm is not very important, if only you get a correct answer.

   - *Hint*

     You can use the *Breadth-First Search* algorithm to calculate it. You need a way to find the length of the cycle. You may need to modify the original *Breadth-First Search*.

4. (*Output*)　After you get the answer, you need to output the *girth* of the graph. Other than that, you also need to print out this shortest cycle as a sequence of vertex numbers.

5. (*Testing*)　You need to prepare your own testing files for your project development. I will use my own testing files for grading. (I will post my testing files for your checking.)