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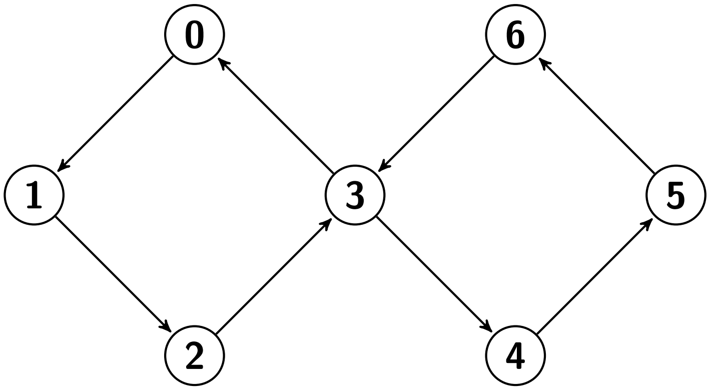
CS 405: Algorithm Analysis II
Homework Problems 2: Graph Cycles

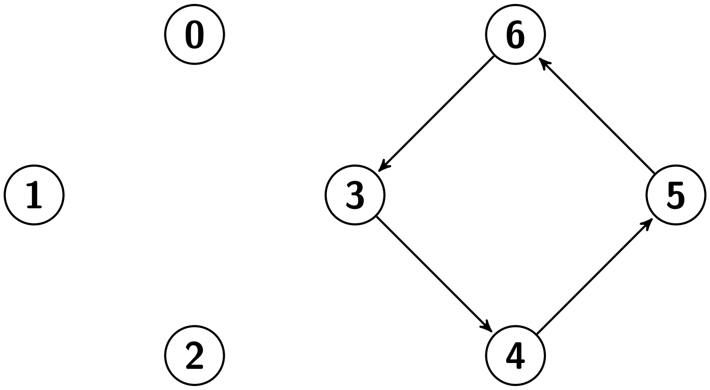
The Java project determines if the directed graph contains a cycle. The program will output the pathway to go through the graph's edges at most once. The program will start at vertex 0 as the source, then determines which path to take next based off the greatest out degree of the next edge. Taking the edge with the greatest out degree will give the program more options to go through the graph without being trapped at a dead end edge. Additionally, this method will minimize the pathways directed to the edge which will help traverse through the graph smoothly.

As the program traverse through the graph, once it reaches the edge with no more edges it will return to the main function to update the final graph. The final graph is an ArrayList of integers that represents the pathway it took. After the final graph has been updated, it will check if the graph has been fully traversed or if it missed a possible cycle. When the program determines that there are additional edges, it will start in a vertex and traverse through the updated graph to find the new cycle. After a new cycle has been found, the graph will update the final graph to merge the newly discovered cycle. Below is an image that displays the example of this scenario.

Given the graph.



One possible cycle is (0, 1, 2, 3, 0) which will remove the edges that were used as a pathway after the traversal and result in the new graph.



However, we can see that there is another cycle in the graph. In order to track the next cycle, we will start in vertex 3 and traverse the graph but only go to the directed pathway that hasn't been used. This will result with another cycle (3, 4, 5, 6, 3). We can then merge both cycles by taking the first cycle that started with vertex 0 and find the index when the program got to the beginning vertex of the other graph, which is vertex 3. Once the index for vertex 3 has been found, include the other cycle that started with vertex 3. This will result with the complete merged cycle of (0, 1, 2, 3, 4, 5, 6, 3, 0). The completity is $\Theta(V + E)$ since we will be removing the edges that has been already used to minimize the pathways. This is also linear as we will not reuse the same edges for each vertex and will use each edge for every vertex at most once.