CS5800: Algorithms Spring 2018
Assignment 6.4

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Algorithm:

The underlying technical problem is to do topological sorting. The subprocess can be indicative of nodes in a graph and the dependency of one on another can be represented by directed edges. So, we if can do topological sorting on the graph, it will give us the sequence in which the subprocesses should happen so that the dependencies are maintained. It will also tell us if such ordering is not possible.

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The graph is formed by maintaining array of linkedlist data structure where when a new edge is
added (i.e. the pair of dependent questions), first question is added to the array and the dep
one is added to its corresponding linkedlist.

Let result be a list to hold the final sequence of vertices.
Let indegree be an array to store indegree of a vertex.
Let queue be a queue to store the nodes to be processed.

Step 1: For every vertex v, do the following:
        Step a: Get all it's adjacent nodes.
        Step b: For all such nodes, increase corresponding count
                   in indegree array by 1.

Step 2: Add all vertices with zero indegree to the queue.

Step 3: Initialized processedNodes to 0.

Step 4: Until q is not empty, do the following:
        Step a: Remove element from the queue.
        Step b: Add to result list.
        Step c: For all it's adjacent nodes, reduce the corresponding
                 indegree by 1. If the indegree becomes zero for any
                 node, add it to the queue.
        Step d: Increament processedNodes by 1.

Step 5: If processedNodes doesn't match total number of vertices
         in the graph, then print topological order is not possible

Step 6: Print nodes from result list.
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analysis: To calculate the indegree we need to visit every vertex and for each vertex we will traverse the edges. since it is represented as adjacency list, the time taken should be $O(|V| + |E|)$ Space complexity also should be $O(|V| + |E|)$ to store the graph and additional queue of size V. so total space complexity $O(|V| + |E|)$