**IIT Madras InstaInfluencer Fest '25**

**Background Story**

It's March 2025, and after Shaastra, an **InstaInfluencer Fest** is happening at IIT Madras for the first time! This fest is a massive gathering of GenZ influencers, content creators, and fans. Events range from viral dance-offs, meme competitions, podcast sessions, to live-streaming challenges. Each event depends on certain other events being completed first (e.g., you can't have the "Final Dance-Off" without completing the preliminary rounds).

However, drama unfolds when some influencers demand that certain events happen before others, creating complex dependencies. If there is a directed edge between event , then event must be completed before . The organizers need your help to:

1. Identify if any drama-induced cyclic dependencies exist.
2. Find groups of tightly interdependent events (**Strongly Connected Components**) and the cardinality of the group with the maximal number of events.
3. Provide a valid order of events if possible.
4. Calculate the maximum "**hype score**" (don’t worry it’s described later) achievable from attending events in a valid path.

**Problem Statement**

You're given a **directed graph** representing events at InstaInfluencer Fest:

* **Nodes** represent events.
* **Directed edges** represent dependencies (event must occur before event ).  
  - Each event has an associated "**hype score**," indicating its popularity among IIT Madras students.

You must process queries of four types:

|  |  |
| --- | --- |
| Query Type | Description |
| 1 | Check if the event schedule has any cyclic dependencies. Output "YES" if cycles exist; otherwise "NO". |
| 2 | Output the number of strongly connected components (**SCCs**) in the event dependency graph and the cardinality of the group with the maximal number of events. |
| 3 | Provide a valid topological order for the events if possible. Ensure that independent vertices are sorted **lexicographically** within their valid topological order. Incase of cycle output “NO”. |
| 4 | Compute the maximum total hype score achievable by attending events. Identify all SCCs in the graph. Condense each SCC in a single vertex, summing the hypescores of all vertices within the SCC representing the hypescore of this vertex. Now find the path with maximum total hypescore achievable in the condensed graph. |

\*A **Path**  is a sequence of vertices connected by edges connecting two consecutive vertices in the sequence, and vertices are distinct( not repeated).

**Input Format**

1. The first line contains two integers and , representing the number of events and dependencies respectively.
2. The second line contains integers , where is the hype score of event .
3. The next lines each contain two integers and , indicating that event must precede event .
4. The next line contains an integer , representing the number of queries.
5. The next lines contain one integer per line indicating query type (1, 2, 3 or 4).

**Output Format**

For each query:

* For query type 1: Output "YES" or "NO".
* For query type 2: Output two integers separated by space:
  + The number of SCCs in the graph.
  + The cardinality of the group with the maximal number of events.
* For query type 3: Output a valid topological order separated by spaces; otherwise output "NO" if no valid order exists due to cycles.
* For query type 4: Output an integer representing maximum total hype score achievable.

**Constraints**

NOTE : The vertices are numbered from 1 to N, where N is the number of vertices.

**Requirements**

**Design Requirements:**

1. Create a class GraphAlgorithm which has a pure virtual function void Query() that is overloaded by all child classes:
   * isCycle: Detects cycles in the graph.
   * indepComponent: Computes SCCs and their cardinalities.
   * validOrder: Computes a valid topological order if possible.
   * maxHype: Computes maximum hype points on DAGs.
2. Implement a **Comparator Functor** .(Not mandatory)
3. Include explanatory comments or use self-explanatory variable and function names.

**Sample Test Cases**

**Test Case 1:**

Input:

4 4

10 20 30 40

1 2

2 3

3 1

3 4

4

1

2

3

4

Output:

YES

2 3

NO

100

Explanation:

• Query Type 1: A cycle exists (1 → 2 → 3 → 1), so output "YES".

• Query Type 2: Two SCCs are found: {1,2,3} with cardinality 3, and {4} with cardinality 1. Output is 2 3.

• Query Type 3: Topological sorting is impossible due to cycles, so output "NO".

• Query Type 4: Maximum hype score comes from attending {(1->2->3)->4}, which has a hype score of 60+40=100. (1->2->3) is a SCC.

**Test Case 2:**

Input:

8 8

10 20 10 10 30 40 10 20

1 2  
1 5

2 3

3 4

5 6

5 7

7 3

7 8

4

4

3

1

2

Output:

80  
1 2 5 6 7 3 4 8  
NO

8 1

Explanation:

• Query Type 4: Maximum hype score is for the path {1-> 5-> 6} i.e. 80.

• Query Type 3: A valid topological order exists: 1-> 2-> 5-> 6-> 7-> 3-> 4-> 8. Since there is no cycle. Output is 1 2 5 6 7 3 4 8. After 1->2, there are two possible ways 3,5, but 3 cant be chosen as before 3,7 should be processed, thus will go with 5. similarly we’ll process the graph.

• Query Type 1: No cycles exist; output "NO".

• Query Type 2: All the vertices are individual SCC this number of SCC is 8 and max cardinality is 1.