

```

1 //TOPO SORT
2
3 //(1,2)(1,3)(2,3)(6,9)(5,4)(3,7)(0,7)(9,8)(3,0)(5,0)(2,6)(1,8) => 5 4 1 2 ↗
   3 0 7 6 9 8
4 //(9,1)(5,6)(5,4)(4,8)(0,1)(7,2)(7,3)(9,4)(5,7)(0,2)(1,3)(0,6) => 0 5 6 7 ↗
   2 9 1 3 4 8
5
6 #include <iostream>
7 #include <fstream>
8 #include <vector>
9
10 // Forward declaration of Leader and Trailer structures
11 typedef struct Leader* lref;
12 typedef struct Trailer* tref;
13
14 // Structure representing a Leader node
15 struct Leader {
16     int key;           // Key of the leader
17     int count;         // Number of incoming precedences
18     lref next;         // Pointer to the next leader node in the list
19     tref trails;       // Pointer to the list of trailers
20 };
21
22 // Structure representing a Trailer node
23 struct Trailer {
24     lref id;           // Pointer to the leader node
25     tref next;        // Pointer to the next trailer node in the list
26 };
27
28 // Function to find the leader with key x; if not exist yet, add to the ↗
   end of the leader list
29 lref findLeader(lref& head, lref& tail, int x) {
30     lref p = head;
31
32     tail->key = x;
33
34     while (p->key != x) {
35         p = p->next;
36     }
37
38     if (p == tail) {
39         tail = new Leader;
40
41         p->count = 0;
42         p->trails = nullptr;
43         p->next = tail;
44     }
45
46     return p;

```

```
47 }
48
49 // Function to split leaders with no precedences from the leader list
50 void splitLeaderWithNoPrecedence(lref& head, lref& tail) {
51     lref p = head;
52     head = nullptr;
53
54     while (p != tail) {
55         lref tmp = p->next;
56
57         if (p->count == 0) {
58             p->next = head;
59             head = p;
60         }
61
62         p = tmp;
63     }
64 }
65
66 // Function to add a new order x < y
67 void addOrder(lref& head, lref& tail, int x, int y) {
68     lref xNode = findLeader(head, tail, x);
69     lref yNode = findLeader(head, tail, y);
70
71     tref xTrail = new Trailer{ yNode, xNode->trails };
72     xNode->trails = xTrail;
73
74     // Increase the number of precedences
75     yNode->count++;
76 }
77
78 // Function to create leaders from pairs of orders
79 void createLeadersFromPairs(lref& head, lref& tail,
80     std::vector<std::pair<int, int>> orders) {
81     head = new Leader{ -1, 0, nullptr, nullptr };
82     tail = head;
83
84     for (int i = 0; i < orders.size(); i++) {
85         addOrder(head, tail, orders[i].first, orders[i].second);
86     }
87
88 // Function to perform topological sort based on the given orders
89 void topoSort(std::vector<std::pair<int, int>> orders) {
90     lref head, tail;
91     createLeadersFromPairs(head, tail, orders);
92
93     splitLeaderWithNoPrecedence(head, tail);
94 }
```

```
95     lref p = head;
96
97     while (p) {
98         std::cout << p->key << " ";
99
100        tref t = p->trails;
101
102        p = p->next;
103
104        for (tref q = t; q; q = q->next) {
105            lref succNode = q->id;
106
107            succNode->count--;
108
109            if (succNode->count == 0) {
110                succNode->next = p;
111
112                p = succNode;
113            }
114        }
115    }
116 }
117
118 // Function to parse orders from a file and return a vector of pairs
119 std::vector<std::pair<int, int>> parseFile(std::string fileName) {
120     std::vector<std::pair<int, int>> orders;
121
122     std::pair<int, int> p;
123     char ch1, ch2, ch3;
124
125     std::ifstream inFile;
126     inFile.open(fileName);
127
128     while (!inFile.eof()) {
129         inFile >> ch1 >> p.first >> ch2 >> p.second >> ch3;
130
131         if (inFile.eof()) {
132             break;
133         }
134
135         orders.push_back(p);
136     }
137
138     inFile.close();
139
140     return orders;
141 }
142
143 // Main function
```

```
144 int main() {
145     // Parse orders from the input file
146     std::vector<std::pair<int, int>> orders = parseFile("input.txt");
147
148     // Perform topological sort and print the result
149     topoSort(orders);
150
151     return 0;
152 }
153
```