ESO207: Data Structures and Algorithms

Programming Assignment 3

Due Date: 18th October 11:59pm, 2023

Total Number of Pages: 5   Total Points 100

Note :

- The questions have to be answered through a contest in Hackerrank. The contest has 3 challenges, each corresponding to a question. You have to submit your code through the contest. (Link will be circulated soon)

- Additionally you must upload your solutions on Moodle as well. You need to upload 3 files corresponding to the 3 programs.

- Your codes will be checked for possible plagiarism of any sorts. If we find such cases, then we will possibly award an F grade.

- Allowed Languages for challenge code submission : C, C++

Question 1. (25 points) Red Green Colourblind

Soham and Samarth are cycling on the Tour-de France. They are dead last. While cycling they encounter an apple tree blocking their path. The apple tree contains both Red and Green Apples. The tree additionally contains twigs between some pairs of apples. Soham is red-green colourblind. Samarth observes and claims that there is no twig between two like-coloured apples. But Soham knows that Samarth has a tendency of lying. Can you help Soham figure out if at all there is a chance Samarth is telling the truth.

- **Input**

  First line of input consists of two integers N and M, the number of apples and the number of twigs respectively.

  The following M lines contain two integers A and B which means there is a twig between apple A and apple B. There is atmost one twig between ant two apples

- **Output**

  Output YES if Samarth could be telling the truth. Then in the next line output N integers, a colouring for each apple by the numbers 1 and 2 for Red and Green respectively which satisfies Samarth's condition. Else output NO. If there are multiple solutions output any ONE.

- **Constraints**

  ○ $1 \leq N \leq 10^5$
  ○ $0 \leq M \leq min(N*(N-1)/2, 10^5)$
  ○ $1 \leq A, B \leq N$

- **Sample Input 1**

  ```
  6 6
  1 2
  3 6
  2 5
  6 4
  6 5
  2 3
  ```

Explanation of Input 1
One possible colouring so that there are no twigs between like coloured apples is as follows:

- **Sample Output 1**

  ```
  YES
  ·1 2 1 1 1 2
  ```

- **Sample Input 2**

  ```
  5 4
  3 5
  2 5
  5 4
  2 3
  ```

- **Sample Output 2**

  ```
  NO
  ```
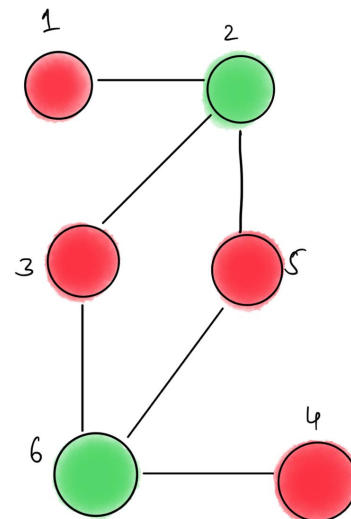
Question 2. (30 points) Cycling Frenzy

Samarth and Soham decide to have another shot at the Tour de France. This time there are various checkpoints on the roads in Paris. All the roads are 2-way. After cycling for 10 hours Samarth realizes that they have cycled past the Eiffel Tower too many times. Soham then exclaims, we have been cycling in cycles. Samarth now wants to find out which checkpoints are part of these cycles. Can you help them figure this out and reach the finish.

- **Input**
  First line of input consists of two integers N and M which denote the number of checkpoints and the number of roads respectively. The next 2 lines consist of two arrays A and B of size M, which means that there is a road between checkpoint $A[i]$ and $B[i]$ for every $1 \leq i \leq M$

- **Output**
  Output N integers which are either 1 or 0 such that 1 at i^{th} position indicates that i^{th} checkpoint is a part of one or more cycles, whereas 0 indicates that it is part of no cycles.

- **Constraints**
  - $1 \leq N \leq 10^5$
  - $0 \leq M \leq min(N*(N-1)/2, 10^5)$
  - $1 \leq A[i], B[i] \leq N \ \forall i \in [1, N]$

Explanation of Input 1
The map of Paris of Input 1 looks as follows

- **Sample Input 1**

  ```
  8 10
  1 1 1 7 7 5 8 2 2 6
  2 3 4 1 5 6 4 3 7 7
  ```

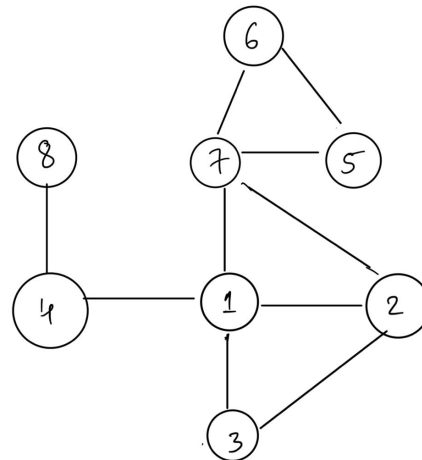- **Sample Output 1**

  ```
  1 1 1 0 1 1 1 0
  ```

- **Sample Input 2**

  ```
  7 7
  1 3 3 2 6 5 2
  2 2 4 5 5 7 4
  ```

- **Sample Output 2**

  ```
  0 1 1 1 0 0 0
  ```


Here all checkpoints except 4 and 8 are part of cycles

Question 3. (45 points) **Hansel and Gretel**

Soham won the previous Tour de France, so this time his friend Sarthak dares him to find and mark the roads belonging to the **ideal tree** of the map of Paris with his trusty Magic Marker. Soham is able to do it.

Post the race Sharma wants to walk around Paris. He repeatedly chooses two checkpoints and travels between them through only the **ideal tree** marked by Soham. He also leaves breadcrumbs on the checkpoints of the paths so that Samarth can find him, since his new iPhone runs out of battery very quick.

Samarth visits all checkpoints and keeps an array of the number of breadcrumbs retrieved at each checkpoint, but clumsy him, he lost it during customs. Can you help him get the array again.

- **Input**

  First line of input contains two integers N and K which denote the number of checkpoints on the map of paris and number of paths that Sharma chooses post the race

  The next 2 lines consist of two arrays A, B of size $N - 1$, which means that there is a road on the ideal tree between $A[i]$ and $B[i]$ for every $1 \leq i \leq N - 1$

  The next K lines consist of three integers C and D which means Sharma leaves breadcrumbs on the checkpoints when he travels from C to D through the roads marked by Soham.

- **Output**

  For each checkpoint output number of breadcrumbs retrieved by Samarth. (Note: Sharma drops only one breadcrumb on a checkpoint on a single journey)

- **Constraints**

  - $1 \leq N \leq 10^5$
  - $1 \leq A[i], B[i] \leq N \ \forall i \in [1, N-1]$
  - $1 \leq K \leq 10^5$
  - $1 \leq C, D \leq N$

- **Sample Input**

  ```
  8 5
  1 4 5 6 6 3 3
  2 1 8 5 7 5 4
  8 4
  1 6
  5 7
  3 4
  2 8
  ```
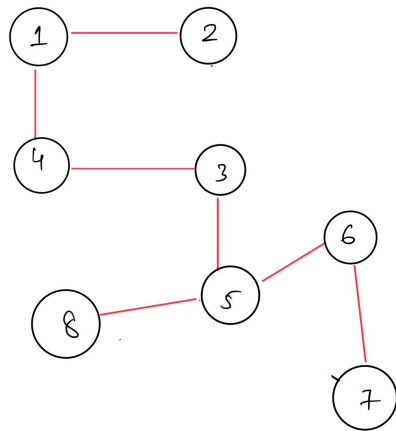
- **Sample Output**

  ```
  2 1 4 4 4 2 1 2
  ```

- **Explanation of Input**

  The ideal tree of Paris

The paths Sharma walks on are marked in blue