Task: Prize

"*Život na ivici!*" je novi TV kviz čija su glavna publika ljubitelji teorije grafova. Tijekom svake epizode, voditelj predstavlja novi zadatak natjecatelju kojeg on treba riješiti. Natjecatelj koji riješi zadatak osvaja putovanje na hrvatsku obalu, uključujući (Eulerovu) turu po poznatim Dubrovačkim zidinama kao glavnu nagradu.

Gospodin Malnar je ~~potplatio~~ imao dovoljno sreće da bude prihvaćen kao natjecatelj u sljedećoj epizodi te se odmah počeo pripremati. Potrošio je nebrojene noći u knjižnici čitajući o najnepoznatijim teoremima. Jedne noći slučajno je zaspao te je počeo sanjati o njegovom nastupu na kvizu. Nakon buđenja, jasno se sjećao zadanog zadatka i njegove nemogućnosti da ga riješi. Zadatak je glasio kako slijedi.

Voditelj kviza nacrtao je dva ukorijenjena *stabla*[1], koja su se oba sastojala od N čvorova označenih prirodnim brojevima od 1 do N. Sama stabla bila su označena brojevima 1 i 2. Zatim je rekao da su stabla težinska s pozitivnim težinama, ali težine namjerno nisu dane. Nakon toga, gospodin Malnar je dobio priliku da izabere bilo koji podskup oznaka čvorova dok god je veličina tog podskupa točno K.

Nakon što je gospodin Malnar izabrao opisani podskup, smio je postaviti najviše Q pitanja oblika (a, b), gdje su a i b oznake čvorova. Za svako pitanje, voditelj je odgovorio s uređenom četvorkom $(d_1(l_1, a), d_1(l_1, b), d_2(l_2, a), d_2(l_2, b))$, gdje $d_t(x, y)$ predstavlja *udaljenost*[2] između čvorova označenih s x i y u stablu t, a l_t predstavlja oznaku *najnižeg zajedničkog pretka*[3] čvorova s oznakama a i b u stablu t.

Kako bi osvojio nagradu, gospodin Malnar trebao je odgovoriti na mnogo sličnih pitanja koja je postavio voditelj kviza. Preciznije, trebao je odgovoriti na točno T pitanja oblika (p, q), gdje su p i q oznake čvorova **koje pripadaju izabranom podskupu gospodina Malnara**. Za svako pitanje, gospodin Malnar trebao je odgovoriti s udaljenošću između čvorova p i q u oba stabla, tj. trebao je odgovoriti s uređenim parom $(d_1(p, q), d_2(p, q))$.

Tvoj zadatak je pomoći gospodinu Malnaru s njegovim pripremama na način da napišeš program koji rješava zadatak zadan u njegovom snu.

Interaction

This is an interactive task. Your program must communicate with a program made by the organizers which takes the role of the game show host. Of course, your program should take the role of Tomislav and ensure he wins the grand prize.

Your program should first read the parameters N, K, Q and T from the task description. These are given as four space-separated integers in the first line of the standard input.

Your program should proceed to read the description of two trees from the task statement. These descriptions are given in two lines, where the first line describes the first tree, while the second line describes the second tree.

Each tree is given as a sequence of N space-separated integers $p_1, p_2, \ldots, p_N$, where $p_i \in \{-1, 1, 2, \ldots, N\}$ represents the parent of node labelled i in the tree, or is equal to -1 if the tree is rooted in the node labelled i.

Your program should then output K different space-separated integers $x_1, x_2, \ldots, x_K$ $(1 \leq x_i \leq N)$, representing the subset of node labels Tomislav should choose, and *flush* the output afterwards.

Your program may now ask up to Q questions by writing `'? a b'` $(1 \leq a, b \leq N)$ to the standard output. When your program has finished asking the questions, it should write a single character `'!'` in its own line, and *flush* the output.

[1] jednostavni, povezani, aciklični grafovi
[2] zbroj težina veza na jedinstvenom putu između ta dva čvora
[3] čvor najudaljeniji od korijena kojem su i a i b (ne nužno neposredni) nasljednici

After that, your program may obtain the answers to the posed queries by repeatedly reading a line consisting of four space-separated integers $d_1(l_1, a)$, $d_1(l_1, b)$, $d_2(l_2, a)$ and $d_2(l_2, b)$ from the task description.

Your program should proceed by reading all T of the host's questions from the standard input. Each question is given in a single line by two space-separated integers p and q (where $p, q \in \{x_1, x_2, \ldots, x_K\}$) from the task description.

After your program has read all T questions, it should answer each of them by outputting two space-separated integers $d_1(p, q)$, and $d_2(p, q)$ in one line. After printing all of the answers, your program should *flush* the output one last time.

Note: You can download the sample source code from the judging system that correctly interacts with the program made by the organizers (including the output *flush*), and solves the first example.

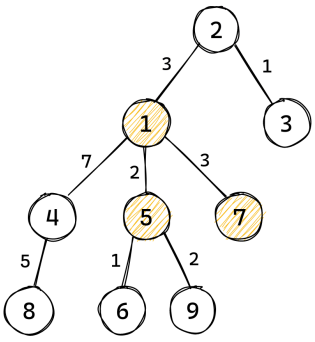
Scoring

It is guaranteed that the hidden edge weights are positive integers not greater than 2 000. Also, in all subtasks it holds that $2 \leq K \leq 100\,000$ and $1 \leq T \leq \min(K^2, 100\,000)$.

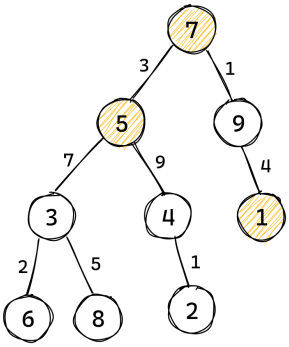
Subtask	Score	Constraints
1	10	$N = 500\,000$, $Q = K - 1$, trees are identical (including hidden edge weights)
2	25	$N = 500\,000$, $Q = 2K - 2$
3	19	$N = 500\,000$, $K = 200$, $Q = K - 1$
4	22	$N = 1\,000\,000$, $K = 1\,000$, $Q = K - 1$
5	24	$N = 1\,000\,000$, $Q = K - 1$

Example

Output	Input
	9 3 2 3 2 -1 2 1 1 5 1 4 5 9 4 5 5 7 3 -1 3 7
1 5 7 ? 1 5 ? 1 7 !	
	0 2 5 3 0 3 5 0 1 7 7 5 5 1
3 5 5 3 2 8	



1



2

Clarification: In this example, the progam choose the subset $\{1, 5, 7\}$. Then, it asked questions $(1, 5)$ and $(1, 7)$. For the first question, the lowest common ancestors of 1 and 5 are $l_1 = 1$ and $l_2 = 7$, and the answer is $(d_1(1, 1) = 0, d_1(1, 5) = 2, d_2(7, 1) = 5, d_2(7, 5) = 3)$. For the second question, the lowest common ancestors of 1 and 7 are $l_1 = 1$ and $l_2 = 7$, and the answer is $(d_1(1, 1) = 0, d_1(1, 7) = 3, d_2(7, 1) = 5, d_2(7, 7) = 0)$. Finally, the program was asked questions $(1, 7)$, $(7, 5)$, and $(5, 1)$. The answers to these questions are $(d_1(1, 7) = 3, d_2(1, 7) = 5)$, $(d_1(7, 5) = 5, d_2(7, 5) = 3)$, and $(d_1(5, 1) = 2, d_2(5, 1) = 8)$.