Problem D. Tangle: A DAG for storing transactions

Input file:	`standard input`
Output file:	`standard output`
Time limit:	3 seconds
Memory limit:	1024 megabytes

In general, a tangle-based cryptocurrency works in the following way. There is a directed acyclic graph (DAG) that we call the Tangle. The network of DAG is composed of nodes, that is, nodes are entities that issue and validate transactions. The transactions issued by nodes constitute the site set of the Tangle graph, which is the ledger for storing transactions. The edge set of the Tangle is obtained in the following way: when a new transaction X arrives, it must approve two previous transactions. These approvals are represented by directed edges, as shown in Figure 4(a). If there is not a directed edge between transaction A and transaction G, but there is a directed path of length at least two from A to G, we say that A indirectly approves G. In Figure 4(a), A direct approves B and D and indirectly approves F, G, H, and I. Let us define "Tips" as unapproved transactions in the Tangle graph. In the *Tangle* snapshot of Figure 4(a), the Tips are A and C. When the new transaction X arrives and approves A and C in the Tangle snapshot of Figure 4(b), X becomes the only Tip.

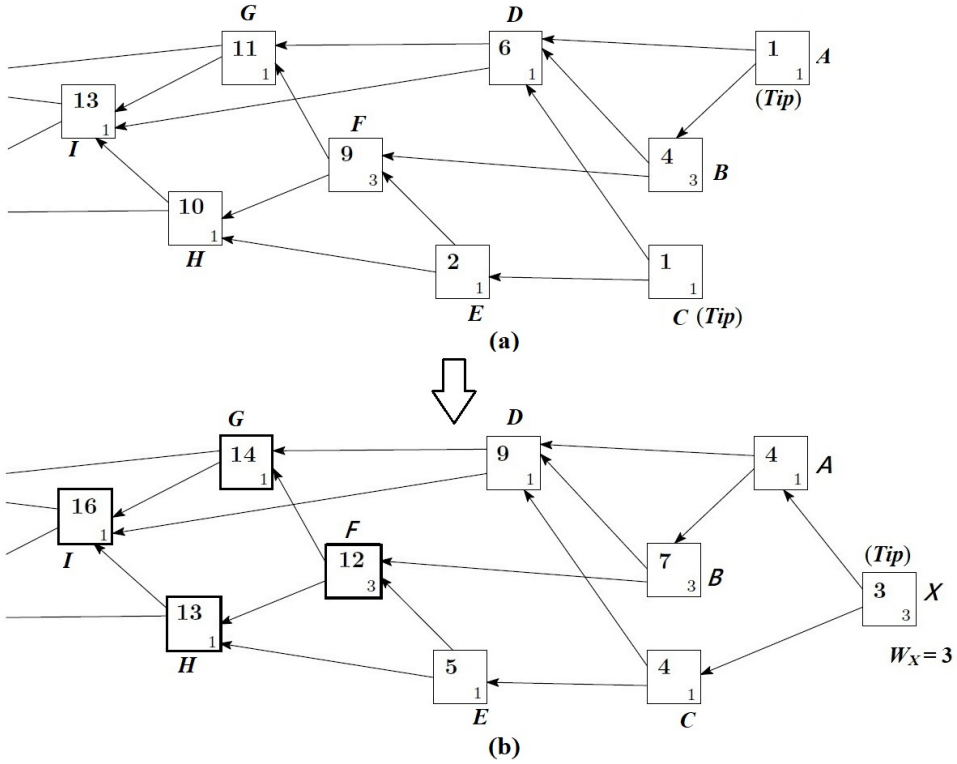

Figure 4: A *Tangle* graph with weight assignments before and after a newly issued transaction X. The boxes represent transactions, the small number in the South-East(SE) corner of each box denotes own weight, and the bold number denotes the cumulative weight.

We define the weight of a transaction, and related concepts. The weight of a transaction is proportional to the amount of work that the issuing node invested into it. It is only important that every transaction has a positive integer, its weight, attached to it. In general, the idea is that a transaction with a larger weight is more "important" than a transaction with a smaller weight. Assume that the transactions X has an own weight equal to W_X, where $1 \leq W_X \leq W_{max}$. The cumulative weight CW_X of X is the sum of its weight and weights of all transactions which directly or indirectly approves it. The calculation of cumulative weight is illustrated in Figure 4. The boxes represent transactions, the small number in the South-East corner of each box denotes own weight, and the bold number denotes the cumulative weight. For example, transaction F is directly or indirectly approved by transactions A, B, C, and E.

The cumulative weight of F is $CW_F = 3 + 1 + 3 + 1 + 1 = 9$, which is the sum of the own weight of F and the weights of A, B, C, and E, respectively. After the new transaction X ($W_X = 3$) approved, the cumulative weight of all other transactions increases by 3. The cumulative weight of a transaction is a measure of the computational effort behind it. So, once it reaches a threshold value TH, the transaction is marked as confirmed as the probability of malicious modification is low. In other words, as a transaction receives additional approvals, it is accepted by the system with a higher level of confidence. Approved transactions which have cumulative weight less than the upper limit are called unconfirmed transactions. As shown in Figure 4, transactions F, G, H, and I are confirmed, if we assume $TH = 12$. In the beginning of the *Tangle*, there was an address with a balance that contained all of the tokens. The Genesis transaction sent these tokens to several other "founder" addresses. All of the tokens were created in the Genesis transaction. Therefore, the "Genesis" transaction is approved either directly or indirectly by all other transactions (in Figure 5). Initially when a node creates a transaction, it selects two Tips (unapproved transactions) based on a Tip-selection algorithm. Each new transaction should approve two previous transactions, which are represented by directed edges. Other nodes in the network will verify the transaction and add it as a new Tip in the DAG. When a transaction is added as a Tip in the DAG, it is unapproved. When any further transactions select that Tip, it becomes approved. The cumulative weight associated with a transaction will be updated whenever a transaction approves it directly/indirectly.

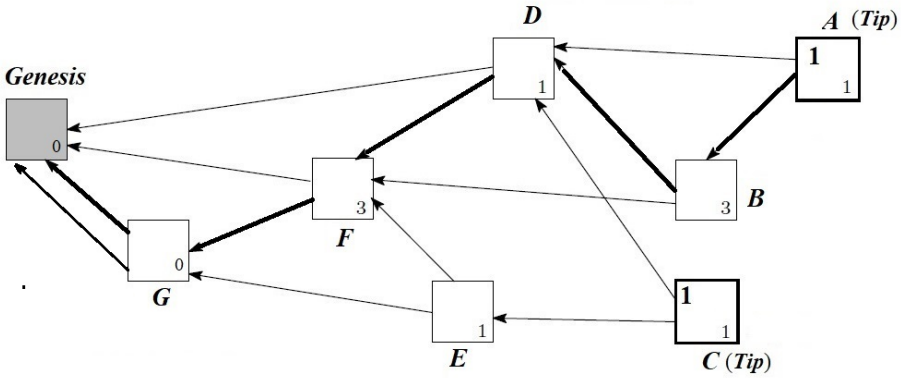

Figure 5: A Tangle graph with weight assignments to each transaction

For convenience, the initial Tangle is shown in Figure 6(a). A new created transaction X will select two Tips Y and Z (unapproved transactions) based on a Tip-selection algorithm. In Figure 6 (b) shows the notations of weights and cumulative weights for X, Y, and Z, respectively.

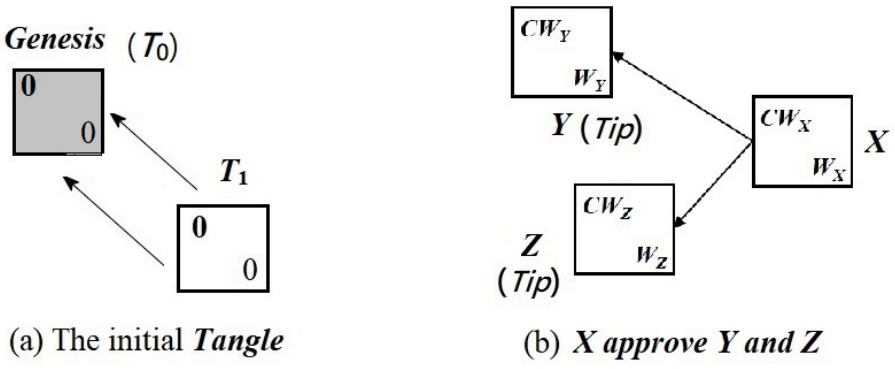

Figure 6: A Tangle graph with weight assignments to each transaction

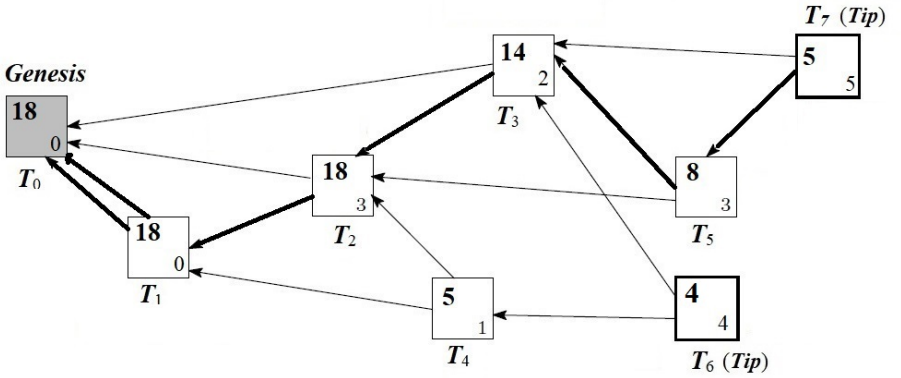

Figure 7: The Tangle graph for Sample Input 1, where $TH = 12$ ($CW_X \geq TH$ for T_2 and T_3).

Input

The first line of the input is a pair of integer n TH, where n denotes the number of transactions and TH denotes the threshold value of cumulative weight. The transactions are input in increasing order of X. Each transaction is in one line, which contains a list of integers: X Y Z W_X, where $2 \leq X \leq 10000$, $0 \leq Y, Z \leq X - 1$, $Y \neq Z$, and $1 \leq W_X \leq 5$.

Constraints

- $1 \leq n \leq 10000$
- $2 \leq X \leq n + 1$
- $0 \leq Y, Z \leq X - 1$, $Y \neq Z$

Output

After processing the n transactions, for a transaction T_X in $\{T_2, T_3 \ldots, T_n\}$ if $CW_X \geq TH$, then output the list of values: X CW_X in increasing order of X. Each line contains one transaction. Finally, output the total number of confirmed transactions.

Examples

standard input	standard output
6 12 2 0 1 3 3 0 2 2 4 1 2 1 5 2 3 3 6 3 4 4 7 3 5 5	2 18 3 14 2