Taiko Time

(20分)

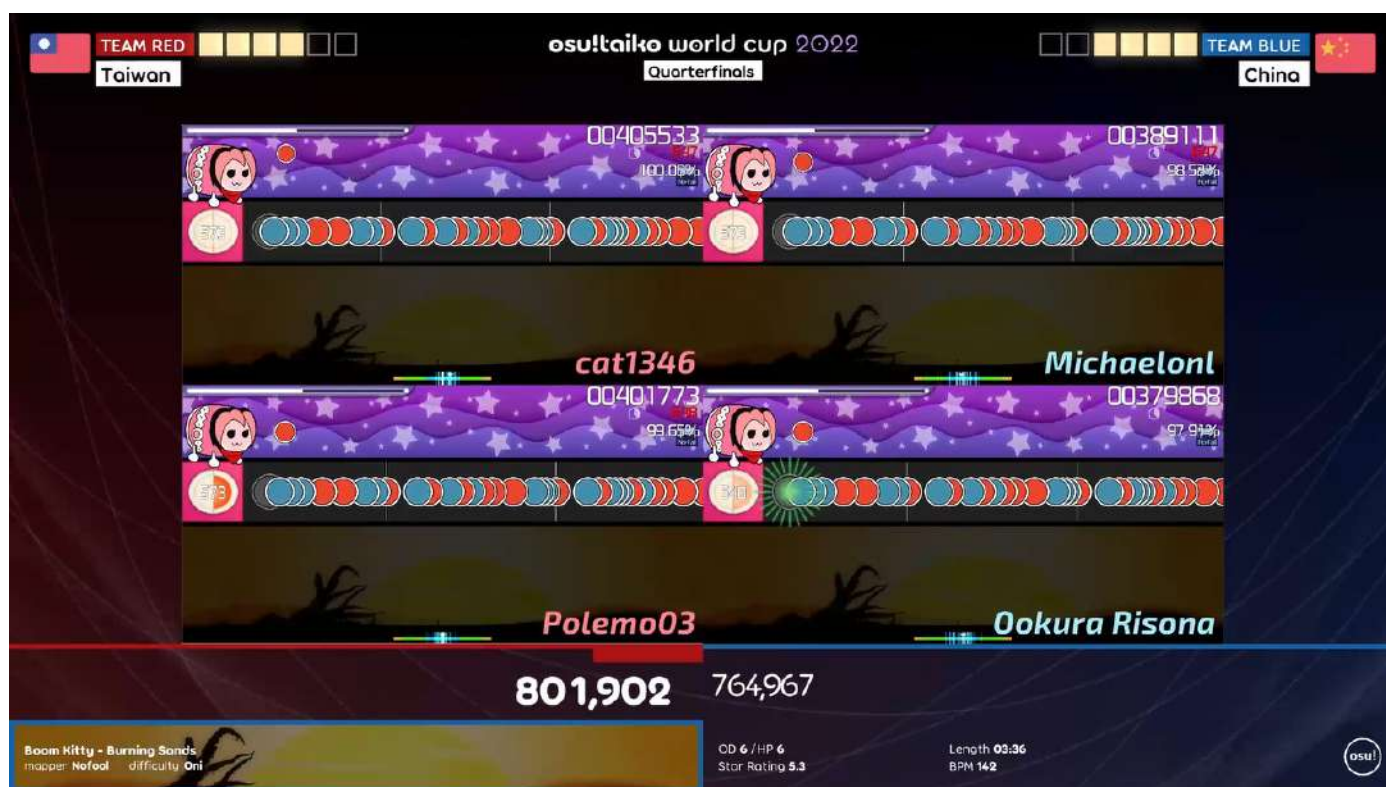## 問題敘述

「節奏躍然指上！」

osu! 是一款熱門的音樂遊戲，其目前有超過一千八百萬名玩家。osu! 一共有四種不同的遊戲模式：osu!、osu!taiko、osu!catch、osu!mania，於每年舉辦五場各模式的世界賽，並邀請知名音樂遊戲作曲家製作客製化樂曲，其冠軍賽總能吸引上千人同時觀看！

其中在 osu!taiko 的世界賽中，臺灣隊曾在 2011 與 2013 拿下冠軍，並在 2015 到 2019 年連續五年獲得亞軍，可說是臺灣人最擅長的遊戲模式！而在這道題目中，你的目標是寫一支程式進行簡化版的 osu!taiko 分數計算。若題目敘述中的內容與真實 osu!taiko 狀況不同，請以題目為準。

在 osu!taiko 模式中，各種音符會隨著音樂節奏從螢幕的右側向左移動，玩家必須在正確的時間點按下正確的按鍵以得到分數。在本題中，我們只考慮兩種音符：小的紅色音符（don，敲擊鼓面的聲音）和小的藍色音符（kat，敲擊鼓邊的聲音）。為了表示方便，玩家有時會以 D 表示紅色音符，K 表示藍色音符。

每個音符有其各自應該敲擊的時機點，設第 i 個音符的時機點為第 t_i 毫秒，且此音符的種類為 b_i。但要完美地在該時機點按下按鍵太困難了，因此在遊戲中，只要在指定的時間範圍內擊中音符即可獲得分數。此時間範圍由一個介於 $[0, 10]$ 的常數 D 決定，其計算方式如下：先計算出三個用來進行判定的常數 J_G, J_O, J_M。其中 $J_G = \lfloor 49.5 - 3D \rfloor$；$J_O = \lfloor 79.5 - 8(D - 5) \rfloor$；$J_M$ 則依 D 的大小有不同的計算方式，當 $D \le 5$ 時，$J_M = \lfloor 94.5 - 8(D - 5) \rfloor$，當 $D > 5$ 時，$J_M = \lfloor 94.5 - 5(D - 5) \rfloor$。其中，$\lfloor x \rfloor$ 表示不超過 x 的最大整數，例如 $\lfloor 7.27 \rfloor = 7$，$\lfloor 5.5 \rfloor = 5$。

假設玩家第 j 次按下按鍵的時機點為 s_j 毫秒，且敲擊的音符種類為 a_j。從第 1 個音符開始，遊戲會依序對每個音符進行判定。在判定第 i 個音符時，系統會從所有玩家按下按鍵的時間點中選出至多一個符合以下所有條件的 j 並以此作為音符 i 判定的依據：

- 時間點 j 尚未被其他音符作為判定的依據
- $t_i - J_M \leq s_j \leq t_i + J_M$

若不存在符合條件的時間點 j，則音符 i 的判定為 MISS。若有兩個或以上的 j 符合以上條件，則只選擇最小的 j 對音符 i 進行判定：若玩家敲擊的音符種類錯誤，也就是 $a_j \neq b_i$，則該音符的判定為 MISS。否則，系統將根據 $|t_i - s_j|$ 判定：若 $|t_i - s_j| \leq J_G$，則該音符的判定為 GREAT；若 $J_G < |t_i - s_j| \leq J_O$，則該音符的判定為 OK；若 $J_O < |t_i - s_j| \leq J_M$，則該音符的判定為 MISS。根據不同的判定，音符 i 會得到不同的基本分 v_i：若判定為 GREAT，則基本分 $v_i = 300$；若判定為 OK，則基本分 $v_i = 150$；若判定為 MISS，則基本分 $v_i = 0$。

在完成了各音符的判定之後，接下來便是最重要的計分環節了！不過在計算分數之前，我們還須了解兩個名詞：Combo 和 Kiai Time。

Combo，也就是連擊數，指的是玩家連續擊出的 MISS 以外的判定的音符數量。對於音符 i，若它的判定為 MISS，則它的 Combo 數 $c_i = 0$；否則，$c_i = c_{i-1} + 1$。另外，我們定義 $c_0 = 0$，也就是若第 1 個音符的判定不是 MISS，則它的 Combo 數 $c_1 = 1$。

接下來是 Kiai Time，通常 Kiai Time 用來表示樂曲想要強調的部分。在 Kiai Time 期間，得分是非 Kiai Time 的 1.2 倍！假設樂曲的第 h 段 Kiai Time 為 $[l_h, r_h]$ 毫秒，則當音符 i 位於任意一段 Kiai Time，也就是存在任意一個 h 使得 $l_h \leq t_i \leq r_h$ 時，其 $k_i = 1.2$；否則，其 $k_i = 1$。

根據以上計算的數值，對於每個音符 i，我們可以算出其最終的分數 p_i，其計算公式如下：
$p_i = [v_i + \min(\lfloor \frac{\max(c_i - 1, 0)}{10} \rfloor, 10) \times 80)] \times k_i$，其中 $\min(x, y)$ 表示 x 和 y 之中較小的數，$\max(x, y)$ 表示 x 和 y 之中較大的數。最後，將所有 p_i 加總，即可得到本次遊玩的得分了！

在結算畫面中，除了得分以外，系統還會另外顯示一些統計。首先是三種判定的音符數量：判定為 GREAT 的音符數量 G、判定為 OK 的音符數量 O、判定為 MISS 的音符數量 M，以及 Accuracy 和 Max Combo。Accuracy 表示玩家的準確率，其計算方式為 $\frac{G + 0.5O}{G + O + M}$，Max Combo 則是玩家累積的最大 Combo 數，也就是所有音符中 c_i 最大者。

喜愛 osu! 熱愛 osu! 沒有 osu! 就吃不下飯就睡不著覺的你，為了成為 2023 年的 osu!taiko 世界賽選手，請寫一支程式進行 osu!taiko 的分數計算吧！

輸入格式

輸入的第一行包含四個數 N, H, D, K，分別表示音符數量、玩家按下按鍵的次數、決定判定時間範圍的常數、Kiai Time 的數量。其中，N, H, K 為整數，D 為實數，其小數點後至多有兩位。

第二行包含 N 個整數 t_i，表示各音符的時機點；第三行包含一個長度為 N 的字串 b，表示第 i 個音符的種類。

第四行包含 H 個整數 s_j，表示玩家按下按鍵的時機點；第五行包含一個長度為 H 的字串 a，表示玩家敲擊的第 j 個按鍵的音符種類。

接下來 K 行，每行包含兩個整數 l_h, r_h，表示第 h 段 Kiai Time 的開始與結束時間。

輸出格式

輸出的第一行包含一個整數，表示本次遊玩的得分。第二行包含三個整數 G, O, M，表示三種判定的音符數量。第三行請輸出玩家的準確率的百分比，並四捨五入至小數點後第二位。第四行請輸出一個整數，表示玩家的累積的最大 Combo 數。

資料範圍

- $1 \le N \le 65536$
- $0 \le H \le 10^5$
- $0 \le D \le 10$
- $0 \le K \le 10^5$
- $1 \le t_i, s_j \le 10^9$
- $\forall 1 < i \le N, t_{i-1} < t_i$
- $\forall 1 < j \le H, s_{j-1} < s_j$
- $a_i, b_j \in \{'D', 'K'\}$
- $1 \le l_h \le r_h \le 10^9$
- $\forall 1 < h \le K, r_{h-1} < l_h$

資料範例

輸入範例 1

```
7 8 5 1
200 400 600 1000 1100 1450 2434
DDKKDKK
100 106 200 399 650 1050 1116 1488
DDDDKKDD
400 1000
```

輸出範例 1

```
1020
2 2 3
42.86
4
```

輸入範例 2

```
16 16 9.87 2
100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600
DDKKDKDKDKDDDDDK
100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600
DKKKDKDKDKDDDDKK
200 300
1400 1600
```

輸出範例 2

```
4556
14 0 2
87.50
12
```

輸入範例 3

```
6 6 4.01 0
100 300 400 500 600 727
DDDKKK
100 200 300 400 500 600
DDDKKK
```

輸出範例 3

```
300
1 0 5
16.67
1
```

範例說明

範例測資 1 中，前 6 個音符對應到的玩家敲擊的時間點 j 為 $2, 4, 5, 6, 7, 8$，其中第 6 個音符對應到的敲擊種類是錯誤的，而第 7 個音符沒有對應到任何 j，判定依序為 MISS、GREAT、OK、OK、GREAT、MISS、MISS。v_i 依序為 $0, 300, 150, 150, 300, 0, 0$。第 2 到第 4 個音符在 Kiai Time 期間，故 $k_2 = k_3 = k_4 = 1.2$；其餘音符 $k_i = 1$。p_i 則依序為 $0, 360, 180, 180, 300, 0, 0$，總分為 1020。

範例輸入 2 中，第 2 和第 15 個音符判定為 MISS，其餘音符判定為 GREAT。

範例輸入 3 中，第 1 個音符判定為 GREAT，其餘音符判定為 MISS。

Taiko Time

(20 Points)

Description

"Rhythm is just a click away!"

osu! is a popular rhythm game which has over 18 million players. It consists of four different game modes: osu!, osu!taiko, osu!catch, and osu!mania. There are five world cup hosted by osu! team for these game modes each year, and many featured artists are invited to compose custom songs for the tournaments. Thousands of viewers will crowd into osu!'s official twitch channel to watch the grand finals matches!

Team Taiwan won the osu!taiko World Cup in 2011 and 2013, and they also getting the second place for five consecutive years from 2015 to 2019. osu!taiko is one of the most popular game modes in Taiwan! In this problem, you're going to write a program to simulate how osu! calculate the score in osu!taiko mode. Please follow the problem description if there are some differnces with the real osu!taiko scoring system.
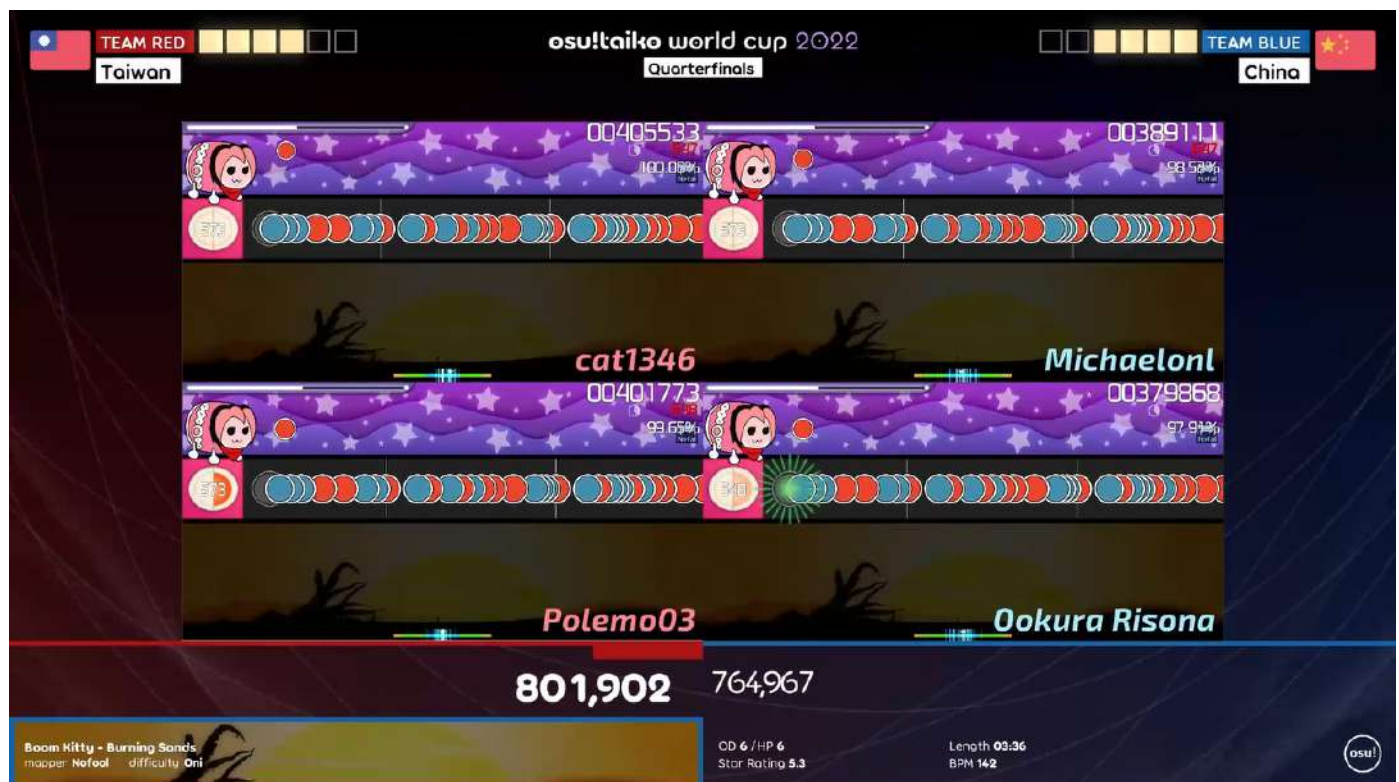
In osu!taiko, notes move leftward from the right side of the screen. Players have to press down the correct keys at the correct moment to earn scores. In this problem, we introduce only two kind of notes in the game - small red note (don, the sound of hitting the center of a drum), and small blue note (kat, the sound of hitting the edge of a drum). As a matter of convenience, letters D and K usually stand for small red notes and small blue notes respectively.

Each note has its own timing point to hit, let the i-th note's timing point be the t_i-th milisecond and its type be b_i. It is too difficult to hit the notes exactly at their timing points, therefore, players only need to hit the notes in a specific interval of time to earn scores. The interval is determined by a real number $D \in [0, 10]$. We first calculate three constants - J_G, J_O, J_M, where $J_G = \lfloor 49.5 - 3D \rfloor$, $J_O = \lfloor 79.5 - 8(D - 5) \rfloor$. The

formula for J_M varies for different D, $J_M = \lfloor 94.5 - 8(D-5) \rfloor$ when $D \leq 5$, and $J_M = \lfloor 94.5 - 5(D-5) \rfloor$ when $D > 5$. $\lfloor x \rfloor$ stands for the floor function, which returns the greatest interger less than or equal to x. For example, $\lfloor 7.27 \rfloor = 7$, $\lfloor 5.5 \rfloor = 5$.

Let the timing point of the j-th key press from the player be the s_j-th milisecond and its type be a_i. The game gives a judgement for each note chronologically from the first note. When judging the i-th note, the game select at most one key press j from the player to give a judgement that satisfies both conditions below:

- j-th key press is not used to judge any notes before
- $t_i - J_M \leq s_j \leq t_i + J_M$

If there are no key press satisfies both conditions above, the judgement of the i-th note will be a MISS. If there are two or more key presses satisfy both conditions above, the game only chooses the one with the smallest j and use it to judge the i-th note. If the player is hitting the wrong type of note, which means $a_j \neq b_i$, the judgement of the i-th note will be a MISS. Otherwise, the game judge the note by the value of $|t_i - s_j|$. If $|t_i - s_j| \leq J_G$, the judgement of the i-th note will be a GREAT. If $J_G < |t_i - s_j| \leq J_O$, the judgement of the i-th note will be an OK. If $J_O < |t_i - s_j| \leq J_M$, the judgement of the i-th note will be a MISS. The i-th note has its basic score value v_i according to its judgement. The basic score value for the i-th note v_i will be 300, 150, or 0 respectively if its judgement is GREAT, OK, or MISS.

After giving the judgement for every note, we can finally start to deal with the total score! Before kicking start to calculate, we still have to understand to special terms in osu!taiko - 'Combo' and 'Kiai Time.'

Combo means the consecutive notes that the player has hit without getting a MISS judgement. Formally, for the i-th note, let its Combo be c_i. If the judgement of the i-th note is a MISS, its Combo c_i is 0; otherwise, its Combo c_i is $c_{i-1} + 1$. Besides, we define that $c_0 = 0$, which means the Combo of the first note c_1 is 1 if its judgement is not a MISS.

Kiai Time is used to emphasize some part of the music. Players earn 20% more scores during the Kiai Time! Let the h-th Kiai Time of the music be $[l_h, r_h]$ milisecond. If the i-th note is in any of the Kiai Time, which means there exist a h such that $l_h \leq t_i \leq r_h$, the Kiai Multiplier of the i-th note k_i is 1.2; otherwise, k_i is 1.

We can calculate the final score of the i-th note by the values we obtain above. Let p_i be the final score of the i-th note, $p_i = [v_i + \min(\lfloor \frac{\max(c_i - 1, 0)}{10} \rfloor, 10) \times 80)] \times k_i$, where $\min(a, b)$ denotes the smaller number between a and b, and $\max(a, b)$ denotes the bigger number between a and b. Summing up the final score for all the notes - and that's the total score of the gameplay!

Besides the total score, the game also gives some other statistics to on the result screen. First of all, the number of notes with a GREAT judgement G, with an OK judgement O, with a MISS judgement M. Accuracy and Max Combo is also shown on the result screen. We calculate the value of Accuracy with the formula $\frac{G + 0.5O}{G + O + M}$, and the value of Max Combo is the maximal value among all c_i.

You, as an osu! enthusiast, in order to prepare to participate in osu!taiko World Cup 2023, are going to write a program to calculate the score of an osu!taiko gameplay!

Input Format

The first line contains four numbers N, H, D, K - the number of notes, the number of keypresses, the real number to determine the judgement interval, the number of Kiai Time, where N, H, K are intergers, and D is a real number with at most two decimal places.

The second line contains N integers t_i - the timing points for each note. The third line is the string b of length N - the type of each note.

The fourth line contains H integers s_j - the timing points for each key press. The fifth line is the string a of length H - the type of each key press.

Each of the next K lines contains two interger l_h, r_h - the interval of the h-th Kiai Time.

Output Format

The first line should contain an integer - the total score of the gameplay. The second line should contain three intergers G, O, M - the number of notes with a GREAT, OK, MISS judgement. The third line should contain a real number - the value of Accuracy in percantage, rounded to two decimal places. The fourth line should contain an integer - the value of Max Combo.

Constraints

- $1 \le N \le 65536$
- $0 \le H \le 10^5$
- $0 \le D \le 10$
- $0 \le K \le 10^5$
- $1 \le t_i, s_j \le 10^9$
- $\forall 1 < i \le N, t_{i-1} < t_i$
- $\forall 1 < j \le H, s_{j-1} < s_j$
- $a_i, b_j \in \{\text{'D', 'K'}\}$
- $1 \le l_h \le r_h \le 10^9$
- $\forall 1 < h \le K, r_{h-1} < l_h$

Input Example 1

```
7 8 5 1
200 400 600 1000 1100 1450 2434
DDKKDKK
100 106 200 399 650 1050 1116 1488
DDDDKKDD
400 1000
```

Output Example 1

```
1020
2 2 3
42.86
4
```

Input Example 2

```
16 16 9.87 2
100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600
DDKKDKDKDKDDDDDK
100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600
DKKKDKDKDKDDDDKK
200 300
1400 1600
```

Output Example 2

```
4556
14 0 2
87.50
12
```

Input Example 3

```
6 6 4.01 0
100 300 400 500 600 727
DDDKKK
100 200 300 400 500 600
DDDKKK
```

Output Example 3

```
300
1 0 5
16.67
1
```

Example Explanation

For sample test case 1, the key presses used to judge the first 6 note are the 2nd, 4th, 5th, 6th, 7th, 8th, respectively. The 6th note is hit with a wrong type of key press, and there's no key press to judge the 7th note. The judgement for the notes are MISS, GREAT, OK, OK, GREAT, MISS, MISS, and the basic score value v_i are $0, 300, 150, 150, 300, 0, 0$, respectively. The 2nd to the 4th note are in the Kiai Time, therefore $k_2 = k_3 = k_4 = 1.2$. All the other notes have the Kiai Multiplier $k_i = 1$. The final score of the notes p_i are $0, 360, 180, 180, 300, 0, 0$, the total score is 1020.

For sample test case 2, the 2nd and the 15th notes are judged as MISS, all the other notes are judged as GREAT.

For sample test case 3, the 1st note is judged as GREAT, all the other notes are judged as MISS.