Solution for Carnival Tickets

Observe that the special card pulled by the game master is always equal to the median of the input.

Since n is even, we may assume that the value of each prize is given by the sum of the top half values, minus the sum of the bottom values.

We can now change the rules as follows(*):

- On each round, 1 ticket of each color is chosen.
- These n tickets are split into two piles labeled '+' and '-'.
- Each pile consists of exactly $n/2$ tickets
- The value of the prize is given by the sum of all tickets labeled '+', minus the sum of all tickets labeled '-'.

It is easy to see that a player who wishes to maximize the value of his prize will choose to put the tickets of larger value into the `+' pile. By doing so, the value of the prize remains the same as compared to the original version.

It is in fact convenient to relax the rules even further and combine the k rounds into a single round(**):

- These kn tickets are split into two piles labeled '+' and '-', each pile consisting of $kn/2$ tickets
- The value of the prize is given by the sum of all tickets labeled '+', minus the sum of all tickets labeled '-'.

It is clear that the maximal attainable value using the rules in (**) is at least as large the maximal value attainable in (*): this is because we can simply merge the '+' and '-' piles.

We claim that they are in fact equal (this would solve subtask 4).

To show that they are equal, we need a method for `splitting' up these tickets back into k piles. Starting with the $kn/2$ tickets, we proceed as follows until all the tickets are split into k rounds:

- Sort the colors by the total number of '+' in each pile.
- For each of the $n/2$ colors with the most total number of '+', take 1 ticket with a '+' label from each of them. For the remaining $n/2$ numbers, take 1 ticket with a '-' label.
- Collect the tickets from the previous step, and form 1 round with it.

It remains to solve the problem using the rules in (**).

We proceed using a greedy approach. Initially, the k smallest tickets of each color is assigned '-'. A step consisting of removing one of these '-' and replacing it with a '+' from the same color. We proceed to greedily maximize the sum of all '+' minus the sum of all '-' at each step.

To execute this greedy algorithm, we record down the largest ticket in the '-' pile of that color and the largest unused ticket of that color. The increase in score is given by the sum of these two numbers, therefore we can choose the color which corresponds to the largest value.

If we do so naively, the running time is $O(n^2m)$. We can speed this up by using a priority queue.