Princeton COS Con

Princeton Computer Science Contest — Fall 2024

Problem B: Castle Invasion ($8 \times 3 = 24$ points)

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You have $N = 17$ castles, each with values $1, 2, \cdots, N$. Your task is to allocate $M = 150$ soldiers to castles. You play against an opponent. You win a castle if you allocate more soldiers to the castle than the opponent. You win a *match* if you win castles $\mathcal{N}$, your opponent wins castles $\mathcal{M}$, and $\sum_{n \in \mathcal{N}} n > \sum_{m \in \mathcal{M}} m$. For each opponent, there will be 100 simulated matches, and you win this *set* if you win more matches than your opponent. Your total score for this problem is **proportional to the number of sets you win.**

In this game, every team will play against every other team. Teams can submit multiple times, but only the last submission prior to each deadline will be counted (in particular, you may change your response type from "csv" to "py" and vice versa; only submission time is relevant). There will be three rounds, concluding at 3:00PM, 4:00PM, and 5:00PM respectively.

Response Format

For each round, teams submit files by Google Form at tinyurl.com/castle-invasion. There are two options:

1. Provide Python code using only standard libraries (ChatGPT is allowed for conversion). Specifically, define a function `allocate` which returns a (native, not numpy) list of N nonnegative integers. `allocate` should *not* take any arguments.

2. Provide a CSV file with up to 10 rows. Each row should have N columns of nonnegative integers. One row will be (uniformly) randomly selected for each new opponent. **Please note that this means that you may submit as few as 1 row.**

Note: after the end of each round, every team's Python code/CSV file ***will be made public****.*

Scoring

Scores will be assigned **each round** as follows (rounding is done to the nearest integer):

$$\text{score} = \text{round}\left(8 \times \sum \frac{(\#\text{ wins}) + 0.5 \times (\#\text{ ties})}{\#\text{ sets}}\right)$$

(Recall that the number of sets is the sum of your wins, ties, and losses.) In particular, across all three rounds, there are up to **24** points available in this problem.

Example

Team 1 submits a nonrandom distribution,

```
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 30, 30, 30, 30, 30]
```

Team 2 submits a nonrandom distribution,

```
[8, 8, 8, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9]
```

Team 1 wins castles $\mathcal{N} \equiv [13, 17]$. Team 2 wins castles $\mathcal{M} \equiv [1, 12]$. Hence

$$\sum_{n \in \mathcal{N}} n = 13 + 14 + \cdots + 17 = 75, \quad \sum_{m \in \mathcal{M}} m = 1 + 2 + \cdots + 12 = 78$$

so since $75 < 78$, Team 2 wins the match. Since both distributions are nonrandom, Team 2 wins *all 100 matches*, so Team 2 wins the set.