

**Florida High School Programming Series
2019 Championship Round**

Contest Analysis by Arup Guha

Six teams competed:

Frisbee Bois, Purple Wolves, Silver Wolves, Ocean Blue, Da Bulls and “s h r o o g l e”.

The beginning of the contest saw a great deal of activity. At the 30 minute mark, the scores were as follows:

Silver Wolves 3
Purple Wolves 3
s h r o o g l e 1
Ocean Blue 1
Da Bulls 1
Frisbee Bois 1

It was great that each team had at least one correct response and the list of problems solved in less than 30 minutes was quite impressive: ab Knight, King, Move, and Queen. In particular, a five minute solution to Queen by Silver Wolves was extremely impressive as some optimization was required to get a solution to pass on time. (Trying to check each square against each queen would receive a time limit exceeded judgement.) A 21 minute solution to ab Knight by the Purple Wolves, after they had solved two other problems was quite impressive. Though the problem is a straight-forward breadth first search, taking care of all eight jumps and dealing with array out of bounds issues is certainly non-trivial work and 11 minutes of typing time (their second solution was at 10 minutes in) is quite impressive.

The second 30 minutes saw a fairly huge shift in the contest. Frisbee Bois, which had been in last place solved 4 problems to move towards the top of the scoreboard. Of particular interest was Frisbee Bois solution to “Energizer Knight” which was one of the most difficult problems in the problem set. This problem required fast matrix exponentiation with careful attention to detail in the formulation of the initial matrix as well as careful attention to detail using the mod operator. Purple Wolves kept their lead though by solving 2 problems early in the second thirty minute period. The Purple Wolves also had an impressive solve, getting “One Dimensional k-Rooks” in only 32 minutes. This problem required a custom sort and a very careful sweep of events. Both the Silver Wolves and Ocean Blue were able to add correct submissions so that the scoreboard looked like this at the end of the first hour:

Purple Wolves 5 (105 penalty points)
Frisbee Bois 5 (198 penalty points)
Silver Wolves 4 (75 penalty points)
Ocean Blue 2 (60 penalty points)
s h r o o g l e 1 (9 penalty points)
Da Bulls 1 (16 penalty points)

Frisbee Bois quickly ended up taking the lead, solving two more problems in the next 20 minutes. In that time frame only Ocean Blue added a problem as well, so after eighty minutes the totals were:

Frisbee Bois - 7 problems
 Purple Wolves - 5 problems
 Silver Wolves - 4 problems
 Ocean Blue - 3 problems
 s h r o o g l e - 1 problem
 Da Bulls - 1 problem

The seven problems that Frisbee Bois solved in the first 80 minutes were enough to ensure the victory as no other team ended up solving 7 problems. Unfortunately, from this point on, Frisbee Bois were unable to correctly solve any of the three remaining problems.

The Timber Creek teams were quite for some time until the 2:43 mark when the Silver Wolves solved Harkness with their second submission, pulling equal in problems solved with the Purple Wolves. It only took the Purple Wolves three more minutes (and three submissions) to reclaim their one problem lead over the Silver Wolves as they solved Harkness at the 2:46 mark. Thus, both Timber Creek teams had over an hour to look for their next solution.

Ocean Blue, “s h r o o g l e” and Da Bulls all solved a problem in the third hour so that Ocean Blue had four problems and both “s h r o o g l e” and Da Bulls had two problems going into the last hour.

In the last hour, the Silver Wolves finally got “One Dimensional k-Rooks” with their eighth submission, getting to their final problem total of 6. In addition, at nearly the last minute, both Da Bulls and “s h r o o g l e” added one final solution. “s h r o o g l e” took 11 submissions to finally solve Queen Coverage at the 3:55 mark and Da Bulls solved Move Notation with 3 minutes left in the contest. The final scoreboard looked like this:

Rank	Team	Problems Solved	Penalty
1	Frisbee Bois	7	445
2	Purple Wolves	6	311
3	Silver Wolves	6	607
4	Ocean Blue	4	280
5	Da Bulls	3	418
6	s h r o o g l e	3	554

Here is a list of the unsolved problems that teams made submissions on:

Frisbee Bois: Parallel Movement and Super Pawn

Purple Wolves: Energizer Knight, Parallel Movement and Super Pawn

Silver Wolves: Parallel Movement and Super Pawn

Ocean Blue: One Dimensional k-Rooks

Da Bulls: Harkness, One Dimensional k-Rooks, Queen Coverage and Super Pawn

s h r o o g l e: ab Knight, Harkness, and Super Pawn

What follows is a quick analysis of how close each team was to solving these problems:

During the contest, Frisbee Bois did not have the correct approach to Super Pawn, but roughly about an hour after the contest ended, they realized that the problem was a NIM problem and after one incorrect submission, they solved it. In contest Frisbee Bois did not have the correct approach to Parallel Movement as they tried a brute force approach that took too long. After contest, they identified the necessity to use Network Flow and correctly solved the problem.

During the contest, Purple Wolves didn't quite formalize the fast matrix exponentiation solution to Energizer Knight and created a solution that looks valid, but took too long to run. They did attempt to use the general idea behind fast exponentiation in their recursion by dividing the exponent by two at each recursive iteration. What caused the time limit exceeded was that their recursive function took in each starting and ending square, so that individual recursive calls didn't finish fast enough since they were based on recursive calls between different squares. The Purple Wolves did correctly identify the network flow solution to Parallel Movement early in the contest, but their flow code ran too slowly to pass the given time limit. The Purple Wolves approach to Super Pawn was incorrect as it just looked at the number of columns with more than 1 square of freedom.

The Silver Wolves did not have the correct approach to Parallel Movement (they were trying a greedy approach) but were fairly close to solving Super Pawn as they correctly identified that the problem was similar to NIM. Unfortunately, since their first submission was at 3:56 into the contest, they didn't have time to debug the slight issues they had with their implementation.

Ocean Blue didn't realize that the number of columns could be as large as 10^{18} in the One Dimensional k-Rooks problem. Thus, their submission produced a run-time error when trying to read in a large board size.

Da Bulls were able to fix their errors on both Harkness and Queen Coverage after the contest. During the contest they had some precision issues with Harkness and Time Limit issues with Queen Coverage.

Overall, I feel this was an excellent contest. I only wish more teams had been able to participate. Congratulations to the winners, "Frisbee Bois"!!!

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