Spring 2025 COP 4516 Individual Final Contest Summary (by Arup Guha)

The first part of the summary will be a problem by problem analysis of how students did in the contest and some observations about the problems. The second part will be an analysis of the teams and how they did. Here is the first, by problem:

Problem A: Almost Magic Square
Solved by: 32 out of 55
First Solve: 26 minutes (Oliver Reinke)

This was designated to be the third easiest problem in the set after Carrying Power Strips and Which Group?, as it requires a straight-forward implementation of permutations with a fairly reasonable evaluation function for each permutation. Surprisingly, by one minute, it turned out to be the fourth unique problem solved in the contest, when Oliver Reinke got it correct on his first submission 26 minutes into the contest. The solves to this problem continued to roll in steady, fairly spaced out as for different students, permutation takes different amounts of time to implement. Halfway through the competition 16 students had solved the problem, and by the end, 32 students correctly solved the problem.

Problem B: Carrying Power Strips
Solved by: 55 out of 55
First Solve: 4 minutes (Leo Melson)

This is definitely the easiest problem in the set and was discovered quite early by several students, of which, Leo Melson submitted the first correct solution only 4 minutes into the contest. Submissions continued to flow in after that point, with 8 correct submissions in the first 10 minutes. Over the course of the first hour, a majority of students solved this problem. In fact, halfway through the competition, all but 5 students had solved it. At the 2:24 mark, the last student in the contest solved the problem, making the judges happy as they wanted all students to solve this problem!

Problem C: Which Group?
Solved by: 54 out of 55
First Solve: 5 minutes (Abraham Ng, Oliver Reinke)

This was supposed to be the second easiest problem in the set and both Abraham Ng and Oliver Reinke tied solving it first at the 5 minute mark. What made this problem harder than Carrying Power Strips is that a built in data structure was necessary to get a solution to run fast enough. Thus, a few students submitted O(nq) solutions, where n was the number of students in the class and q was the number of queries, which got the Time Limit Exceeded verdict. Most students who did this initially figured out how to improve their code and halfway through the competition only 8 students hadn't solved the problem. As the competition continued, more and more students solved this problem. In fact, a correct submissions came in 9 minutes, 1 minute before the end of the contest, so that nearly everyone in the class solved this problem as well!

Problem D: Follow the Rainbow Brick Road
Solved by: 7 out of 55
First Solve: 97 minutes (Leo Melson)

This problem turned out to be easier than it was supposed to be due to an oversight by the judges. The intended solution was to precompute all possible shortest distances, for all possible subsets of colors then answer queries in O(1) time. The goal was to make the bounds such that building each query graph individually and then running Dijkstra's on it would be too slow. Unfortunately, in their test run, the judges didn't actually try this solution against the judge to see if it would run in the designated time limit. Due to this oversight on the judges part, both students who solved this problem in the second hour, Leo Melson and Oliver Reinke, would have gotten a time limit exceeded verdict had the judges made better data. But, for the data that was made (randomly), the approach of building each query graph one by one and running Dijkstra's on every single one of them ran fast enough. The judge solutions run in about 2 seconds, but the judges wanted to be generous in terms of the time limit in allocating 8 seconds instead. In hindsight, it would have been better to either make better data or adjust the time limit to force students to make the intended optimization. Either way, the race to first place turned out to be extremely exciting, if not terribly challenging for these two competitors.

The next student to solve this problem was Colin Henkel at the 1:59 mark, right before the scoreboard freeze, followed by 4 more students who solved in the last hour, which included quite a few scoreboard shake ups.

Problem E: Divisor Series
Solved by: 4 of 55
First Solve: 25 minutes (Leo Melson)

In perhaps the biggest shock to the judges, the first correct submission to this problem was submitted only 25 minutes into the contest by Leo Melson, who decide to skip working on the Which Group? problem to see if he could conquer this one. For him, this turned out to be a good decision, but for many others it could have been a costly one. This was regarded by the judges to be the hardest problem in the set in that in required several optimizations over the typical brute force approach. In fact, the judges were so concerned that no one was going to solve this problem that they increased the time limit from 2 seconds to 10 seconds to allow for solutions that are definitely worse than optimal. Not surprisingly, no one else solved the problem in the first hour. But, in another mild surprise, Oliver Reinke submitted a correct solution just past the 1 hour mark (1:05) to pull ahead of Leo Melson by a single penalty point. Oliver had submitted previously on the problem at the 59 minute mark and gotten a time limit exceeded verdict. He fixed this by exchanging his (ordered) map object for an unordered_map object, since it's not necessary to go through the prime divisors of an integer in order for this problem. (The former technically has an O(lg n) run-time for operations while the latter has an O(1) run-time for operations.) In yet a slight surprise, the third student who solved divisor, Jacob Adams, was one who hadn't already solved Follow the Rainbow Brick Road. Jacob got Divisor at the 2:34 mark on his 7th submission. At the 2:48 mark, Juanpablo Gomez got the fourth correct submission to Divisor Series, and he only needed 2 submissions to get it correct!

Contest Summary

The contest started off with a bang. Leo Melson got the scoring started submitting a correct solution to Problem B: Carrying Power Strips 4 minutes into the contest. Soon afterwards, Abraham Ng and Nicholas Mistry submitted correct solutions 5 minutes into the contest. Thus within the first five minutes, the two easiest problems were exposed. As a consequence, within the first ten minutes 15 students had correct solutions submitted to one of those two problems with two students, Abraham Ng and Oliver Reinke, solving both of the problems in the first ten minutes. The contest continued following this pattern of many students submitting on the two easiest problems for the first 25 minutes of the contest. Then, shockingly, at the 25th minute, Leo Melson submitted a correct solution to Divisor Series, which was regarded by the judges to be the hardest problem in the set. A single minute later, at minute 26, Oliver Reinke submitted a correct solution to Almost Perfect Square, the problem the judges deemed to be the third easiest in the set. Slightly after the half hour mark, three students, Oliver Reinke, Matthew Thomas and Leo Melson had solved 3 problems, followed by another 20 students who had solved 2 problems and 14 students who had solved 1 problem, for a total of 37 students who had solved at least 1 problem. Shortly thereafter, at the 36 minute mark. Colin Henkel submitted a correct solution to Almost Magic Square to become the fourth student with 3 problems solved.

At one point shortly after, Leo was in sixth place due to penalty points due to his decision of going after series before group and almost. While it looked like it would cost him, it didn't because he very quickly wrote a correct solution to Almost Magic Square at the 48th minute, to put himself clearly at the top of the leaderboard at that point. Now, in order to pass him, one of the seven students with 3 problems would have to get either Follow the Rainbow Brick Road or Divisor Series, the two hardest problems in the set. At the one hour mark, Leo Melson still sat atop the scoreboard with 4 problems solved (all but Rainbow…), followed by 10 students with three problems solved (all 10 of these students solved the same set of problems, the first three in the set), followed by 23 students with two problems solved, and another 17 students with 1 problem solved, leaving only 4 students without a correct solve at the end of the first hour.

The second hour started with Oliver Reinke solving Divisor Series at the 1:05 mark putting him just ever so slightly ahead of Leo Melson. In fact, only 1 penalty point separated the two, with Oliver with 127 penalty points and Leo with 128. So, more than likely, the winner of the competition will come down to who of the two can solve Follow the Rainbow Brick Roads. As the second hour continued, the scoreboard had less frequent movement at the top. In the second half of the score, more of the students with 1 problem started moving to 2 problems.

In another shock, the winner of the contest was determined well before expected, with Leo Melson first solving Follow the Rainbow Brick Road at the 1:37 mark with 1 incorrect submission followed by Oliver Reinke solving the same problem at the 1:40 mark. Both students solved the set and Leo finished with 245 penalty points while Oliver came in a very, very close second with 247 penalty points. In fact, right after Leo submitted, he noted that if Oliver submitted at the next minute, they would tie. Thus, at the 1:40 mark, both first place and second place were definitely decided, with the next 15 students with 3 solves, leaving third, fourth and fifth place wide open.

Right before the two hour mark when the scoreboard froze, Colin Henkel submitted a correct solution to Follow the Rainbow Brick Road, becoming the sole person on the scoreboard with 4 problems solved. At the two hour mark, we had two students completing the set, one student with four problems, 15 students with three problems, 31 students at two problems, 5 students with one problem and one student without any problems. Still three students hadn't solved Carrying Power Strips and 5 students hadn't solved Which Group? Hopefully, in the last hour everyone can get to at least two solves. In addition, it'll be nice to see some movement on the top of the scoreboard for fourth and fifth place.

At the beginning of the third hour as of the 2:02 mark, all students had completed a problem! In addition, two students, Daniel Landsman and Asher Watkins, solved Follow the Rainbow Brick Road, so both of those students got to four problems solved, meaning that in order to earn a trophy, 4 problems were required. Also, as the third hour continued, more correct solutions to Almost Perfect Square started trickling in. At the 2:20 mark, 24 students had correctly solved it. And at the 2:24 mark, Garrett Mosrie solved Carrying Power Strips, bringing him to three problems solved, signifying that all 55 students had solved the problem!

As the last hour progressed, more students moved from 1 problem to 2 problems, and at the 2:30 mark, only 2 students had 1 problem, and 25 students had solved Almost Magic Square. No one else moved from 3 to 4 problems by the 2:30 mark so at least for this snapshot in time, all students with 4 or more problems would receive trophies while everyone with fewer than 4 problems would not. But, if an additional student solves a fourth problem in the last half hour, then at least one of the students with four problems solved would miss out on a trophy due to penalty points. In fact, at the 2:34 mark, Jacob Adams became the third person to solve Divisor Series with four problems solved, moving into 6th place, just shy of getting a trophy. Then, at the 2:36 mark, Matthew Thomas solved Follow the Rainbow Brick Road for his fourth problem to move into fourth place, bumping Asher Watkins who had been in 5th place to 6th place, out of the trophies. At this point, all of the students in places 3 through 6 had submissions on Divisor Series that they were trying to improve. Then, Abraham Ng got a correct submission on Follow the Rainbow Brick Road, knocking Daniel Landsman out of 5th place. At this point, there were 6 student four problems solved: Colin Henkel, Matthew Thomas, Abraham Ng, Daniel Landsman, Asher Watkins, and Jacob Adams, with Jacob being the only one who had solved Divisor Series in the group, which is how the contest ended at the top.

5th Place: Abraham Ng(4 problems, 228 penalty)
4th Place: Matthew Thomas (4 problems, 210 penalty)
3rd Place: Colin Henkel (4 problems, 189 penalty)
2nd Place: Oliver Reinke (5 problems, 247 penalty)
1st Place: Leo Melson (5 problems, 245 penalty)

Great job everyone, great competition!