1. Who was on the team?
   Samuel Adams and Bahdah Shin

2. For Person Shin: (2)
   a. Which number did you have?
      423

   b. What were the set of best parameters your program finds?
      roll = -24.916290268467062 in degrees
      tilt = 16.363636363636353 in degrees
      twist = -8.477221653405712 in degrees.

   c. To at least six digits past the decimal point, what was the fraction of the water you could fit into the birdbath using your numbers?
      0.4977630741037475

3. For Person Adams: (2)
   a. Which number did you have?
      452

   b. What were the set of best parameters your program finds?
      roll = -20.559829612232672 in degrees
      tilt = -7.636917225518063 in degrees
      twist = -18.78808510206095 in degrees.

   c. To at least six digits past the decimal point, what was the fraction of the water you could fit into the birdbath using your numbers?
      0.4994443180890335

4. What approach or approaches did you use? (2)
   We used the axially aligned gradient descent.

   Did you use two different methods?
      We used one method.

   Did you try other methods?
      We did not try the other methods.

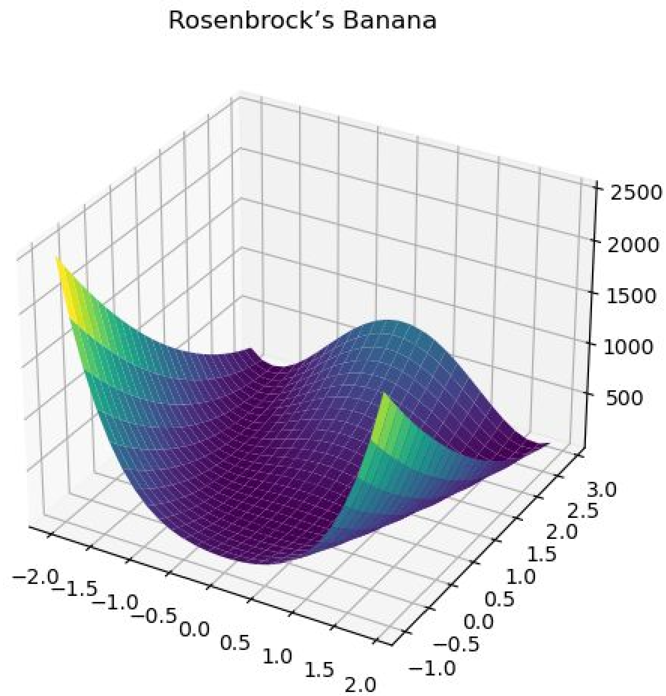
Did you have any complications along the way?
I didn't realize that the bird function was given to us in the email.
This was realized later in the day.

5. How did the work breakdown structure go with the team? (1)
Did you take the opportunity to meet someone new?
How did you assure that both of you contributed?

For this homework, Bahdah and Samuel remained a team just as with last homework. We feel as though we work together well because we balance out each other's strengths in creating a thorough solution to the problem. For this particular assignment, Samuel began with the initial layout of the given files and started to piece together a connection to axially-aligned gradient descent. Bahdah then continued to complete the function to achieve our best values. Finally, Samuel used the values to draw a conclusion and complete the assignment's documentation.

6. Is the idea of a team homework idea helping to reduce stress? (1)
With a team, we are able to fill in each other’s missing or forgotten information.
Teamup reduced stress.

7. Rosenbrock’s Banana: (1)
Look up the function called Rosenbrock’s Banana. Write three paragraphs about it. Why is it famous? How does it apply to this homework assignment? What makes it difficult? What is Nelder-Mead optimization? Can you generate a plot of this (optional).



Rosenbrock's Banana is a non-convex function introduced by Howard Rosenbrock. This function was introduced in 1960 and was used as a performance test problem for optimization algorithms. The test was that the global minimum is inside a long, narrow, parabolic shaped flat valley. FInding the valley isn't difficult, in fact it is considered trivial. The hard part is to converge to the global minimum and not some local minimum. This, in turn, tests whether an optimization function does a good job of finding the actual global minimum instead of getting caught in a local minimum.

The Rosenbrock's Banana function is called such because of the curved contours that give it the reputation of being tricky to pass. The function is defined as $f(x, y) = (1 - x)^2 + 100(y - x^2)^2$ and has a global minimum at (1, 1). The function is difficult because if an optimization methods starts at, for example, (-1.2, 1) then it will have to find its watch to the entire other side of a flat, curved valley to find the optimal point. This of course demonstrates the necessity of starting at many different, maybe even random, points to make sure that the point you found is in fact the global minimum and not a local minimum.

This relates to the homework because it reinforces that we should start at several points instead of just one. As we discussed in the lecture, there are two recommendations for ways to start our search at several different points. First, we could possibly start a grid of regular points. This is a bit more structured and a good way to test different search functions to see which performs the best. Another option is to start at a lot of random locations. While this is less structured, it is definitely effective and ensures that we are getting good coverage of starting points.

Nelder-Mead is a heuristic optimization technique that is used to find the minimum or maximum of an objective function in a multidimensional space. The method itself is a direct search method, which means based on function comparison, and is often applied to nonlinear optimization problems for which derivatives may not be known. The optimization technique, specifically, is a heuristic search method and this can converge to non-stationary points on problems that may be solved by alternate methods.

8. Conclusion and Summary: (1)
   What else did you learn along the way here? What else can you conclude?
   What did you learn about? Dr. K expects at least two solid paragraphs here.

This homework was an effective learning opportunity to understand the different convex optimization functions and how to implement them in solving real world problems like the bird bath function. Along the way, we learned about the benefits of axially-aligned gradient descent in minimizing the amount of time it took to find the local minimum and/or maximum. If we were to use a brute force approach, for example, this would take a significantly increased amount of time to find an answer. Axially-aligned gradient descent, however, is not only a more efficient approach but also is considered more effective in finding the true global minimum and/or maximum. In the context of this homework assignment, axially-aligned gradient descent saved us from having to iterate through all possible combinations for roll, tilt, and twist, as well as ensured that we were finding the actual best values for each of our given implementations.

From this assignment, we can conclude that convex optimization functions are essential to finding optimal values in our search functions. Local minimums/maximums often can confuse other search functions that get trapped while trying to find the solution as efficiently as possible. Axially-aligned gradient descent, however, expects this problem and plans for it to make sure the actual optimal values are found. Here we see the essential nature of starting at several different points, whether that be as a grid of regular points or as a lot of random locations.

9. Bonus B: (1)
   Implement a convex optimization program to find the minima of Rosenbrock’s Banana function, from methods described in class.
   Work with the function f(x,y) = (1-x)^2 + 100(y-x^2)^2