

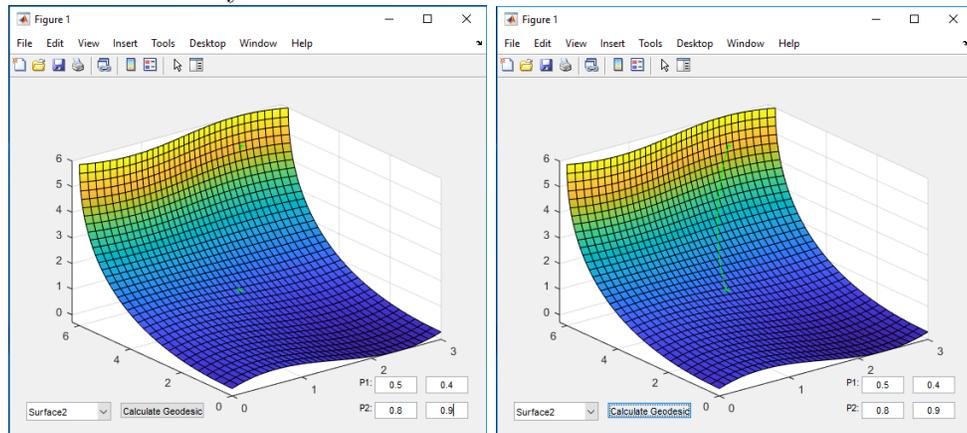
Project Update 2

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Geodesics on Tensor Product Surfaces

Summary of Work

At this point, I have completed the user interface for my project and have updated the surfaces in my code to be tensor product surfaces. Additionally, I can calculate and display paths between two points on those surfaces (these are approximate paths).

In addition to the user being able to toggle between pre-defined surfaces, the user can also update the location of the starting and ending point for the path. Because the surfaces are tensor product surfaces, the point information provided by the user is assumed to be a pair of parameter values, u and v . Finally, the user can click the "Calculate Geodesic" to compute a path between the two points. Currently, this path is simply a discrete path using evenly-spaced parameter values. The discrete points on the path are connected using a straight line, so the path is an approximate path. The path is not currently minimized.



I have also updated the surfaces in my code from placeholder surfaces to tensor product surfaces. The first surface is a flat plane, which I plan to use for debugging purposes. The second surface is the cubic Bèzier surface from Homework 4. Both surfaces are cubic Bèzier surfaces, but I plan to add additional surfaces that have varying degree and basis functions.

Finally, I have written a function to calculate the length of the path between two points on the surface. Like the plotting of the path, the length calculation estimates the path as a set of line segments. This leads to the

length of the path being approximate. Currently, the lengths of the line segments are calculated using the euclidian distance, but I might also look into using different distance metrics in the future.

Analysis of Work

My goals for this update were

1. Finish the work originally planned for the first update.
2. Define objective function(s) for the minimization problem.
3. Be able to run the minimization to get a shortest discrete path on the tensor product surface.

Goal 1. has been completed. My goals for the first update were to be able to represent tensor product surfaces and paths in the code, plot those tensor product surfaces and paths, and to develop the user interface. All three of these goals are now completed. Goal 2. has also been completed. I have written a function to calculate an approximate length of a path on a tensor product surface. I may decide later to try additional distance metrics, but for now I am considering this goal to be complete. Goal 3. is not complete. While I do have an objective function defined, it has not yet been plugged into the rest of my code. I am planning to use MATLAB's `fminunc` function to do the minimization, but I have not yet written that part of the code.

The reason for not having met Goal 3. is simply not having made enough time to work on the project. My time was spent working on other things, and I just didn't get to finishing the last goal for this update.

Plan for Completion

My goals for the final report were originally

- Adjust the output from the minimization if needed to generate a curve with points evenly spaced along the arc length.
- Be able to visualize the intermediate steps of the minimization process.
- Determine the minimization settings which give the best results.

I plan to leave the goals the same, and add the goal of finishing the work originally planned for this update. To make sure I finish all the work planned for this project, I plan to continue to try to find more time to allocate toward working on this project.

Finally, I have several stretch goals for this project:

- Utilize machine learning to speed up the calculation of the approximate geodesics.
- Investigating if any of the various methods for calculating geodesics on discrete surfaces can be used for calculating geodesics on continuous surfaces.
- Use different definitions of a geodesic to compute the objective function.

At this point, I don't think I will have the time needed to accomplish either of the first two stretch goals. However, the third one combined with the possibility of investigating different distance metrics might still be reasonable stretch goals. I plan to leave all my stretch goals as options, but to focus on the third one (and possibly distance metrics) first if time allows.