Alpha-shape Visualization in 3D

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1 Introduction

This project demonstrates how to visualize 3D alpha shapes from a set of points using Delaunay triangulation. The alpha shape is an intuitive way to define a boundary for a set of points, based on their spatial arrangement. The code generates a 3D plot of the Delaunay triangulation and highlights the simplices whose circumradius is less than or equal to a given value of alpha.

2 Prerequisites

To run this code, you will need to have Python 3 installed on your system. Additionally, the following libraries need to be installed:

- NumPy
- Matplotlib
- SciPy
- ipywidgets
- IPython

3 Installing the Libraries

To install the required libraries, open a terminal and run the following commands:

```
pip install numpy
pip install matplotlib
pip install scipy
pip install ipywidgets
pip install ipython
```

4 Running the Code

The code is designed to run in a Jupyter Notebook. If you don't have Jupyter Notebook installed, install it using the following command:

```
pip install notebook
```

To launch Jupyter Notebook, run the following command in your terminal:

```
jupyter notebook
```

This command will open the Jupyter Notebook interface in your default web browser.

Create a new Jupyter Notebook by clicking on the "New" button in the top right corner and selecting "Python 3" (or the appropriate Python version) under the "Notebook" section.

Copy and paste the provided code into a new cell in the Jupyter Notebook.

Run the cell by selecting it and clicking the "Run" button in the toolbar, or by pressing Shift+Enter.

The code will execute, and you should see the interactive 3D plot with the slider to adjust the alpha value.

5 Code Overview

The code is divided into several parts:

1. **Construct Delaunay Triangulation**: Given a set of points, this function constructs a Delaunay triangulation.
2. **Compute a-intervals for all simplices**: Given a Delaunay triangulation and an alpha value, this function computes the a-interval for each simplex in the triangulation.
3. **a-shape visualizer**: Given a Delaunay triangulation, a-intervals for all simplices, and an alpha value, this function visualizes the a-shape for the triangulation.
4. **Update visualization**: This function clears the current output, computes a-intervals for all simplices using the value of alpha, and visualizes the a-shape using the computed a-intervals and alpha value.

The code generates a set of random points and constructs a Delaunay triangulation. It then creates an interactive slider to change the alpha value, which updates the visualization of the a-shape accordingly.