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ABSTRACT TEXT

ANALYZING THE TOPOLOGICAL PROPERTIES OF 3D STL FILES

by

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Approved by

Committee Chair

Dedicated to my cats, Piccolo and Gohan, and my dogs, Bebe and Tilly, who I would not have been able to complete my thesis without.

APPROVAL PAGE

This thesis written by Sahil Dhawan has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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PREFACE

A preface is a statement that either explains the author's reasons for pursuing this subject matter or provides a personal comment about the subject that would not otherwise be included in the document.

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Chapter 1: Homology

1.1 Simplicial Homology

Information in this topic is from [1]

A simplex is the convex hull of (n+1) points in $\mathbb{R}^m$ in general position.

- 0-simplex: a point
- 1-simplex: an edge
- 2-sipmlex: a "filled-in" triangle, or a triangle containing all points within the boundaries of its edges.
- 3-simplex: a "filled-in/solid" tetrahedron, or a tetrahedron containing all points within the boundaries of its "filled-in" triangles.

1.2 Persistent Homology

Cech Complexes

$Cech_r(X) = \{\sigma \subseteq X \mid \cap_{x \in \sigma} B_r(X) \neq \emptyset\}$

- Balls grow around points of metric space, every time k+1 balls intersect, add a k-dimensional simplex to complex.

Vietoris-Rips Complexes

$VR_r(X) = \{\sigma \subseteq X \mid diam\sigma \leq 2r\}$

- if subsets of metric space have diameter less than or equal to 2*r, add simplex

Delaunay Complexes

$Del(X) = \{\sigma \subseteq X \mid \cap_{x \in \sigma} V_x \neq \emptyset\}$
$V_x = \{y \in \mathbb{R}^2 \mid ||y - x|| \leq ||y - z||, z \in X\}$

- Do not depend on a parameter or intersecting balls (no "time")
- Intersecting voronoi cells determine simplices in complex

Alpha Complexes

$Alpha_r(X) = \{\sigma \subseteq X \mid \cap_{x \in \sigma} (B_r(X) \cap V_x) \neq \emptyset\}$

- in-between cech and delauney complexes: to construct, take into account both voronoi cell-associated points in metric spce and growing balls around these points

Chapter 2: Methods

2.1 What is an STL File?

An STL file is

2.1.1 Converting the .ast File to a Data Structure

The .ast file was parsed for four strings which are used to denote the beginning and end of the description of faces and vertices: "facet normal", "end facet", "outer loop", and "end loop", respectively. The data was then converted into tuple with python.

```
solid Mesh
  facet normal 0.000000 0.000000 -1.000000
    outer loop
      vertex 4.500000 -0.288675 0.000000
      vertex 5.000000 0.577350 0.000000
      vertex 5.500000 -0.288675 0.000000
    endloop
  endfacet
  facet normal -0.816497 0.471405 0.333333
    outer loop
      vertex 5.000000 0.000000 0.816497
      vertex 5.000000 0.577350 0.000000
      vertex 4.500000 -0.288675 0.000000
    endloop
  endfacet
  facet normal 0.000000 -0.942809 0.333333
    outer loop
      vertex 5.000000 0.000000 0.816497
      vertex 4.500000 -0.288675 0.000000
      vertex 5.500000 -0.288675 0.000000
    endloop
  endfacet
  facet normal 0.816497 0.471405 0.333333
    outer loop
      vertex 5.000000 0.000000 0.816497
      vertex 5.500000 -0.288675 0.000000
      vertex 5.000000 0.577350 0.000000
    endloop
  endfacet
endsolid Mesh
```

Figure 2.1. The contents of an ASCII STL file representing a tetrahedron.

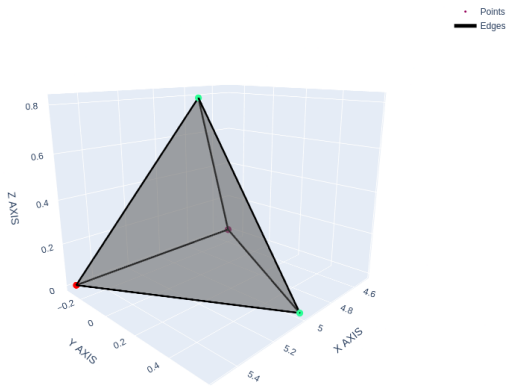

Figure 2.2. An ASCII STL file representing a tetrahedron plotted with Plotly.

2.2 Python Libraries

2.3 Meshing

2.4 Filtration Construction

2.5 Persistence Diagram Construction

Chapter 3: Results

Chapter 4: Discussion

Bibliography

[1] Allen Hatcher. *Algebraic topology*. Cambridge University Press, 2001.

Chapter A: Appendix