Analyzing the Topological Properties of 3D STL Files

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January 5, 2024

Abstract

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1 Introduction

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2 Background

2.1 simplicial homology

[Hat01]

2.2 persistent homology

2.2.1 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.

2.2.2 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

2.2.3 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

2.2.4 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

2.3 Formula

3 Methods

3.1 What is an STL File?

An STL file is

3.1.1 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:

[['Face 0', [normal vector xyz], [[point 1 xyz], [point 2 xyz], [point 3 xyz]]], ['Face 1', ...]]

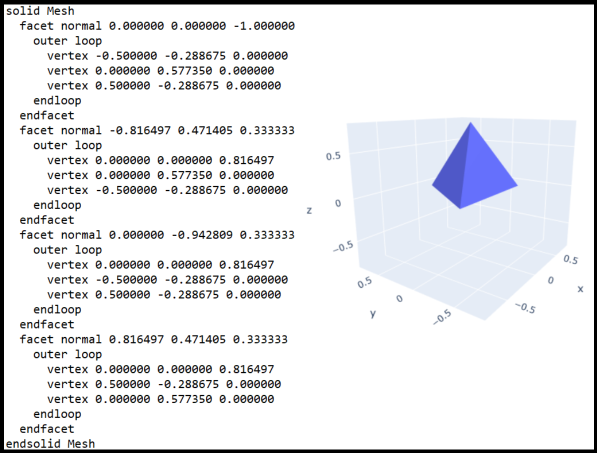

Fig. 1: The contents of a .AST file representing the tetrahedron shown on the right.

3.2 Python Libraries

3.3 Meshing

3.4 Filtration Construction

3.5 Persistence Diagram Construction

4 Results

5 Discussion

6 Conclusion

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7 Bibliography

7.1 How to add Citations and a References List

References

[Hat01] Allen Hatcher. *Algebraic topology.* Cambridge University Press, 2001.