3D Point Cloud Segmentation Using Topological Persistence

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Motivation: Finding Topological Invariants in Point Clouds

Problem Statement

Let X be a topological space where $X = \{x_0, \ldots, x_k\} \in \mathbb{R}^3$ and $x_0, \ldots, x_k$ are the points in a point cloud captured by an RGB-D sensor. Our goal is to find the connected components of the space based on the zeroth homology group.

Solution

To accomplish this task, our solution comes in set of algorithms and data structures for:

- Constructing a simplical complex representation of the input space
- Using persistent homology to compute the zeroth homology group
- Extraction of the connected components in the space
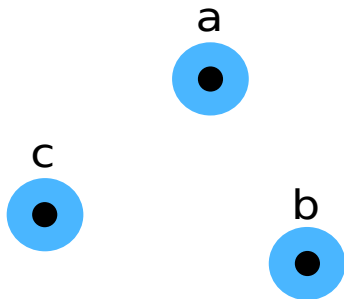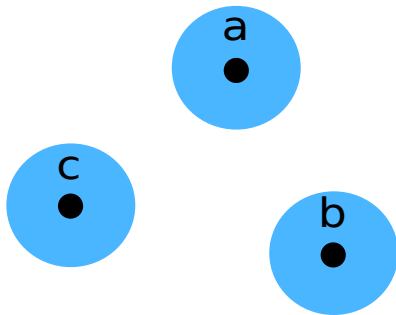
Topological Filtration

{a},{b},{c}
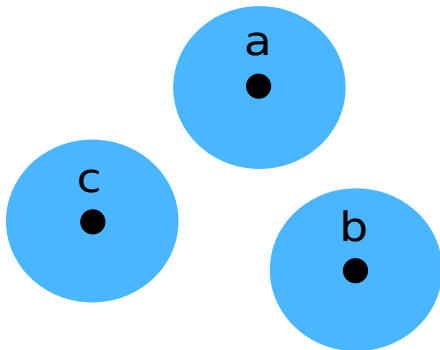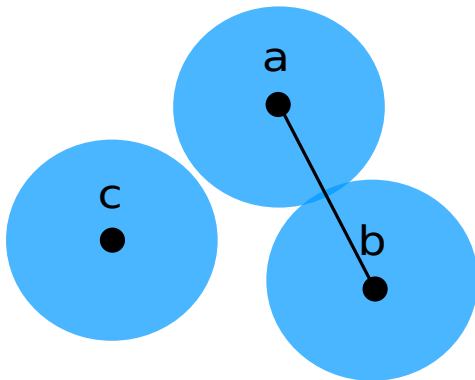
a

●

c

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b

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Topological Filtration

{a},{b},{c}

Topological Filtration

{a},{b},{c}

Topological Filtration

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{a},{b},{c}
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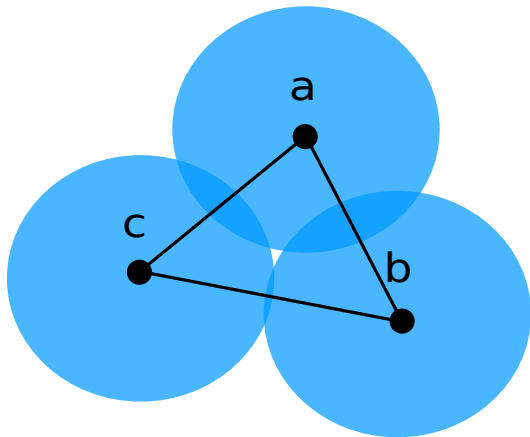# Topological Filtration

Topological Filtration

{a,b,c}
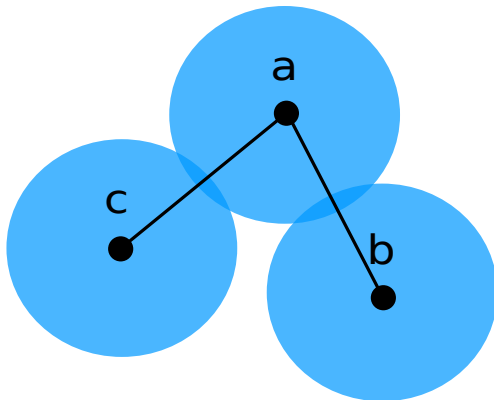
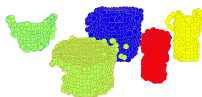## Topological Filtration
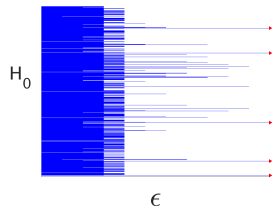
Segmentation Results

Point cloud   Segmentation   Barcode

Summary

This work implements and evaluates algorithms and data structures for segmenting point clouds based on computing topological persistence. The contributions of our work are:

- The introduction of persistent homology to the area of point cloud processing for 3D perception tasks

- A novel approach for segmenting 3D point clouds based on topological persistence

- Visualization of the segmentation process: https://www.youtube.com/user/distrob