

add some nice picture and/or structures, uni logos

# Topological Data Analysis in Python

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Programme

Topology in Data Analysis

The Mapper Algorithm

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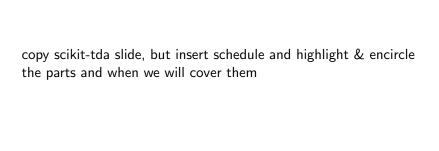
# Programme

!

#### scikit-tda

#### scikit-tda Libraries

- Ripser.py
- ► Kepler Mapper
- Persim
- CechMate
- ▶ TaDAsets



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## **Topology**

Topology is the field of mathematics that studies shapes.

Topology is "blind" to continuous deformations.

add obligatory pictures and examples that give intuition of homotopy equivalence (interval, circle, sphere, punctured sphere, torus, coffee cup)

### Königsberg Problem

"counting holes" as a way to distinguish topological spaces V - E + F = 2 introduce Graphs for later convenience

#### Data

Data = points in  $\mathbb{R}^n$ 

Challenges of data science: size, complexity, curse of dimensionality

### Topology in Data?

points are not continuous!

 $\mathbb{R}^n$  has no interesting topology!

 $\rightarrow$  where is the topology?

### Topology in Data

pictures like the ones from carlsson's talk (regression, clusters, loops, bifurcations)

### Topology in Data

noisy  $S^1$ , noisy pictures from MNIST or house numbers  $\to$  would like to have ways to extract these topological properties from the data

### Topological Data Analysis

- A lossy compressed mathematical representation of a data set. You can study the global structure of a dataset, down to the details of a single data point, without incurring a cognitive overload.
- Resistance to noise and missing data. TDA retains significant features of the data.
- ► Invariance. Only connectedness matters. The skew, size, or orientation of data does not fundamentally change that data.
- A data exploration tool. Get answers to questions you haven't even asked yet.
- ► A methodology to study the shape of data and manifolds. TDA has a solid theoretical foundation and inherits functoriality.

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#### Intro

Recall pictures from "The Shape of Data"

# Königsberg Problem (revisited)

```
sth. about traveling salesman, distances, ... such that the setup of Königsberg corresponds to a point cloud where the mapper network is interesting? idea: prepare people for mapper with the following analogy  Bridges = ways \ to \ go \ from \ one \ part \ of \ the \ city \ to \ another \ Edges = overlap
```

# Mapper

### The Mapper Algorithm (show items iteratively)

- 1. Project(Filter dependency!)
- 2. Cover (Cover dependency!)
- 3. Clustering (metric dependeny!)
- 4. Graph
  - For each **cluster** draw a **node**
  - Whenever clusters interesect draw an edge
- 5. Prettify and Analyze

Pictures corresponding to the steps

### **Examples**

some more examples to get a better feeling also hint at or state exercises

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## Kepler Mapper

#### Test

```
import kmapper

data = some_way_to_load_data()

kmapper(data, filter, bins)
```

### kmapper example

first slide: short look at Data second slide top: code second slide bottom: resulting graph maybe several instances with different filter, cover, metric ...