Topological Data Analysis (TDA) Pipeline

- **Data Representation:** Represent the dataset as a point cloud in a high-dimensional space with a distance metric.
- **Simplicial Complex Construction:**
  - Connect points to form simplices.
  - Aggregate simplices into a complex.
- **Filtration:** Introduce a filtration parameter "t" and vary it.
- **Persistence:**
  - Track topological changes during filtration.
  - Capture birth and death of topological features.

Topological Data Analysis (TDA) Pipeline (cont.)

- **Topological Summarization:** Summarize features using barcodes or persistence diagrams.
- **Interpretation and Visualization:**
  - Interpret results in the context of the original data.
  - Visualize persistent homology using landscapes, heatmaps, etc.
- **Validation and Application:**
  - Validate results against domain knowledge.
  - Apply findings for insights into dataset structure.
- **Integration:**
  - Simplicial complex is a crucial part of the analysis.
  - Iteratively refine complex and persistent homology for multi-scale exploration.

TDA for Wave Data Pipeline

- **Data Representation:** Represent wave data as point clouds in a high-dimensional space.
- **Simplicial Complex Construction:**
  - Connect points using subsampling methods.
  - Aggregate simplices into a simplicial complex.
- **Lower Star Filtration:** Apply a lower star filtration method.
- **Persistence:**
  - Track changes during the filtration.
  - Capture birth and death of topological features using persistent homology.

TDA for Wave Data Pipeline (cont.)

- **Topological Summarization:** Summarize persistent features using persistence landscapes.
- **Interpretation and Visualization:**
  - Interpret results in the context of wave data.
  - Visualize persistent homology using barcodes, persistence diagrams, etc.
- **Validation and Application:**
  - "Persistent" topological features should correspond to wave features of high amplitude.
  - The physical reality (obstructions) of the data should be reflected in the topological features of our data.
- **Integration:**
  - Subsampling used for simplicial complex construction.
  - Incorporate in ML pipeline for obstruction / feature detection in noisy data.