

Geometric Gaussian Mixture Learning of Bernstein Polynomials

Probabilistic and uncertainty-aware geometric design

Topic

Bernstein polynomials form the foundation of Bézier curves and are widely used in Computer-Aided Geometric Design (CAGD). Their favorable geometric properties make them a standard tool for representing curves and shapes.

Modern geometric data often comes from uncertain sources such as sensors and scans. This project investigates the integration of Gaussian Mixture Models (GMMs) with Bernstein polynomial representations to combine the geometric properties of Bézier curves with probabilistic uncertainty modeling.

Problem

Gaussian Mixture Models are commonly learned from sampled data using Expectation Maximization (EM), requiring both data generation and model fitting.

The project will investigate the construction and evaluation of such a geometry-induced Gaussian mixture representation, including:

- constructing Gaussian components directly from Bernstein polynomial representations;
- exploiting the local geometry and derivatives of Bézier curves;
- developing probabilistic representations of geometric uncertainty;
- comparing the approach with conventionally fitted GMMs.

Prerequisites

- Firm grasp of Linear/Multilinear Algebra and Analysis
- Good understanding of Probability and Statistics
- PYTORCH or an equivalent NUMPY-like framework
- Some exposure to Functional Analysis and Differential Geometry is advantageous

References

- A Geometric Gaussian Mixture Representation of Plane Curves by Ali Darijani, Benedikt Stratmann, Jürgen Beyerer
- Closed-Form Gaussian Mixture Representations of d-Dimensional Triangulated Domains by Ali Darijani, Benedikt Stratmann, Uwe D. Hanebeck, Ratan Bahadur Thapa, Jürgen Beyerer, Nehal Afifi

Contact:

Ali Darijani

ali.darijani@iosb.fraunhofer.de

ali.darijani@kit.edu

ali.darijani@rwth-aachen.de

KIT/Fraunhofer Building 70.16, R124