

## Bachelor Thesis

### Topic:

### The Investigation of Methods for Optimizing the Cross-Section Representation of Voxel-Based Probabilistic Models

### Description:

Voxel-based probabilistic models are commonly used in fields such as geotechnics, medical imaging, and computational sciences to represent spatial uncertainty in 3D data. These models account for variability and data uncertainty through probabilistic distributions rather than deterministic values. However, when extracting cross-sections from such models, stair-step effects and uncertainty propagation can lead to misleading interpretations and reduced visualization quality. Effective optimization methods are required to enhance the cross-section representation while maintaining the probabilistic nature of the model.

This study aims to investigate and develop methods for optimizing the cross-section representation of voxel-based probabilistic models. The focus will be on reducing stair-step artifacts while properly incorporating and visualizing uncertainty. Additionally, different uncertainty quantification and mitigation strategies will be explored to improve the reliability of cross-section representations.

### Scope of work:

- Conduct a literature review on voxel-based probabilistic models, cross-section representation, and smoothing techniques.
- Analyse common problems such as stair-step effects and their influence on visualization and interpretation.
- Implement and compare different optimization techniques (e.g., interpolation, filtering techniques, curve fitting), investigate methods for visualizing and quantifying uncertainty in cross-section representations.
- Perform case studies using cross-section representations of subsurface probabilistic models in tunnel engineering, provided in DXF format, applying smoothing techniques based on the extracted cross-section data.
- Summarize findings and propose recommendations for future applications.

### Special requirements and comments:

The candidate should have a keen interest in programming, good spatial visualization skills.

This Bachelor Thesis will be supervised by Zentrum Geotechnik.

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