In this thesis, the iterative simplification of complex three-dimensional triangular meshes is shown:

- The underlying theory is based on a mesh simplification algorithm using quadric error metrics.
- The Mesh is analyzed and weighted in order to find suitable collapse candidates, so that the overall shape is preserved while small details are removed.

The base algorithm is designed, implemented and enhanced for the usage in the Aardvark Rendering Framework.

There are different contraction metrics available. They differ both in speed and quality.

- **Random Edge Selection**: This technique is quite fast but rather destructive for the whole surface. The edges are being selected randomly. The lack of a qualified strategy leads to a model with irregularities and jagged surfaces.
- **Edge Length Metrics**: In contrast to the random approach, the edge length metrics offer a simple quality metric by taking the edge, its length and the angle between the normals of the adjacent faces into account.
- **Quadric Error Metrics**: The quadric error metrics are the best trade-off between quality and speed. Per vertex, the metrics of the surrounding faces are taken into account. The flatter a region, the earlier it will be contracted.

The common simplification techniques are either **view-independent** or **view-dependent**.

View-dependent simplification is commonly known as level-of-detail. Objects or regions closer to the camera are displayed with more details than objects farther away. Such steps of simplification can be computed in a preprocessing step. They can be applied in RT applications afterwards.

View-independent simplification is that an application uses a three-dimensional object as input and iteratively reduces the number of triangles along the surface without losing the representativeness of the object. The presented algorithm can not be run in real-time but produces very high quality results.

The figures below show the differences between random edge selection, edge length metrics, and quadric error metrics with a face count of 25% compared to the original mesh. The visual comparison is shown by overlaying the original mesh (red) and the reduced one (grey) simultaneously.

1. The rather jagged and huge grey patches indicate a significant loss of quality.
2. Using the edge length metrics leads to smaller grey patches and a smoother composition between the original and the reduced size model.
3. The figure shows an almost equal distribution between grey and red patches which is an evidence that only tiny details were removed.

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The leftmost version shows the original model consisting of approximately 100,000 triangles. The model on the outer right consists of only one percent (~1,000 faces) of the original model: only small details are missing, while the basic shape has been preserved. The output models of the simplification application have been rendered using Maya & MentalRay.