Chair for Computation in Engineering
Department of Geo, Civil and Environmental Engineering
Technical University of Munich

Modeling: ★★☆☆☆
Mathematics: ★★★☆☆
Programming: ★★★★★
Science: ★★★☆☆

Software Lab:

Efficient point inclusion testing based on kd-trees

Setting

Numerical simulations can be performed accurately with FE meshes which do not need to be conforming to the boundary of the domain, for example, by using the Finite Cell Method. However, it is necessary to check on the basis of the geometric model whether an integration point is inside or outside of the domain. A common way to describe and exchange the geometry of a structure is the use of STL files. Therein, a solid is represented by its surface using planar triangles. In this case, an inside-outside test can be conducted by casting a ray from the inspected point and determining its intersections with the boundary surface. Furthermore, the number of triangles included in the test and thus the computational effort can be reduced by applying a kd-tree for spatial subdivision.

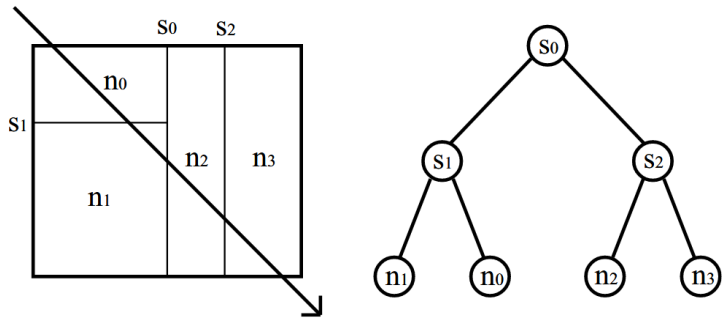

Figure 1: 2D kd tree [3]

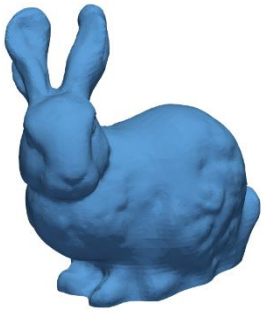

Figure 2: Tessellated model [4]

Task

Implement an efficient point inclusion test for geometric models defined by STL files. Therefore, you will:

- create an STL file reader,
- implement a point inclusion test that employs ray tracing,
- increase its efficiency by including kd-trees for spatial subdivision,
- test the implementation using exemplary STL files.

Supervisor

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References

[1] M. Hapala and V. Havran. *Review: Kd-tree Traversal Algorithms for Ray Tracing*. Computer Graphics Forum (2011)
[2] D. Horvat. *Ray-casting point-in-polyhedron test*. Proceedings of CESCG 2012
[3] T. Foley and J. Sugerman. *KD-Tree Acceleration Structures for a GPU Raytracer*. GraphicsHardware (2005)
[4] https://de.wikipedia.org/wiki/Stanford_Bunny#/media/Datei:Stanford_Bunny.stl