

Exercises for Further Graphics (Lectures 1-4)

All work to be submitted by email in a single PDF, no less than 48 hours before supervision.

1. Terms and Concepts

Voronoi Diagrams

- What is *equiangularity*?
- What is the *empty circle property*?
- Describe how to use hardware acceleration to swiftly compute Voronoi diagrams. What are the limitations of this approach?

Topology

- Define the *Euler characteristic*
- Define the term *angle deficit*
- State the *Poincaré Theorem*, which links the geometry of a surface to its topology
- State Descartes' *Theorem of Total Angle Deficit*, which links angle deficit across a surface to its Euler characteristic

Curvature

- The *one-ring* of a vertex is the (usually ordered) set of vertices which lie exactly one edge away from a given vertex on a polyhedral surface. Given a vertex V with one-ring $\{v_0, \dots, v_{n-1}\}$, give a formula for the discrete curvature of the surface at V .

Monte Carlo

Define what is meant by *Monte Carlo integration* and explain its use:

- In Ambient Occlusion
- In Screen Space Ambient Occlusion
- In Photon Mapping (twice!)

2. Signed Distance Functions

Give signed distance functions for:

- A cone
- An igloo
- A tetrahedron, defined by four vec3 points
- The spiral of a corkscrew

3. Barycentric coordinates

What does it mean if one or more of the coefficients of the barycentric coordinates of a point with respect to a triangle are negative?

4. Bezier curves

- a. Why is a Bezier curve contained entirely within the convex hull of its control points?
- b. Give real-world examples of C_0 , C_1 , C_2 continuity
- c. Prove that the linear interpolation of two linear interpolations (as shown in lecture 4, slide 7) is, in fact, a Bezier quadratic.