Prof. Dr. Konrad Polthier
Eric Zimmermann
Version: 2

Scientific Visualization
Summer Semester 2023
Freie Universität Berlin

Exercise Sheet 2

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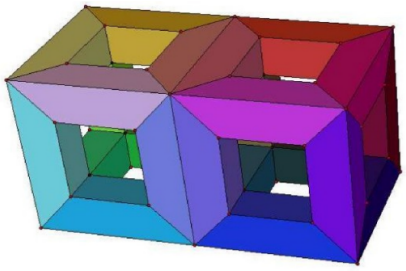
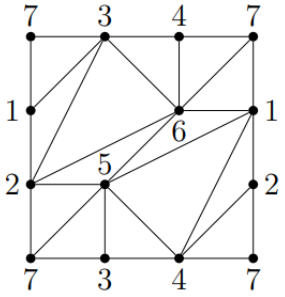


(a)



(b)

Figure 1: Left: Quadrilateral surface. Right: Drawing of *Császár torus*.

Exercise 1. (12 points)

i) Determine the genus of a closed simplicial surface with 20 triangles and 12 vertices.

ii) Sketch[1] two nonisomorphic examples of a closed simplicial surface with 20 triangles and 12 vertices which are both not the icosahedron. Why are your examples nonisomorphic?

iii) How many edges does a simplicial double torus with 1200 vertices have?

iv) Let Q be a quadrilateral surface (see Figure 1a for an example) and v, e, f, g, and χ denote the number of vertices, number of edges, number of faces, genus, and Euler characteristic of Q.

   a) Show that $\chi = v - e + f$ still holds.

   b) Determine v, e, f, g, and χ for the example shown in Figure 1a.

v) Give three examples for simplicial complexes having the same Euler characteristic but which are not simplicially isomorphic[2]. Justify your choice.

Exercise 2. (4 points) The *Császár torus*[3] is a two-dimensional simplicial complex consisting of 7 vertices, 21 edges, and 14 triangles, cf. Figure 1b. Vertices labeled with the same index are identified and the edges are identified accordingly. Determine

- star([2]), star([3,4]), star([1,5,6]),
- link([2]), link([3,4]), and link([1,5,6]).

Please use the definition of a star stated in the script.

[1] Think of an appropriate representation.
[2] They are not isomorphic as simplicial complexes.
[3] A model of the *Császár torus* can be found in JavaView, i.e. in File - Open - JavaView Models in the category Polytope.