AM-MIRI: Lab 3 Exercises

Here is a list of exercises for the topics discussed in the third session of the lab. They should all be solved as separate modules (to be imported to blender). You may save time and effort reusing some of your code from Lab2.

As in Lab2, use the `Mesh` class (not the `bmesh`). You may assume that your code is executed with exactly one object selected.

The file `test-model.blend` provides a sample object for testing some of your functions. It has been used to generate `Catmull-Clark-test-model.avi`.

Also as in Lab 2, each function should additionally report the time consumed by its execution (as done for `processa_malla(mesh)` in `info_mesh.py`).

Turn in your solution to Exercise 3 and the video produced in Exercise 6 and whatever you achieve in connection with Exercise 8 via the ad-hoc "Pràctica" that you will find in the racó.

Exercise 1 — "Simple" subdivision

Write a function that modifies the mesh associated to the active object, performing one step of topological subdivision of the mesh, as defined by the Catmull-Clark subdivision, but without perturbing the positions. That is, the new vertices will be at the barycenter of each face and at the midpoint of each edge. (What blender calls "Simple" subdivision). The computation of the E:{F} relation that you did in Lab 2 might come in handy. The input mesh may contain faces of any arity. Notice that the result should be made of quads only. You may assume that the original mesh is a 2-manifold without boundary.

Exercise 2 — Catmull-Clark subdivision

Write a function that applies one step of Catmull-Clark subdivision to the active object. You may use the function in Exercise 1 to update the topology, and add code to compute the new positions of vertex-vertices and edge-vertices. Compare your results with those of the subdivision modifier in blender.

Exercise 3 — One-parameter family of surfaces

Given the results of applying the functions in Exercises 1 and 2 to the same mesh a fixed number of times n (n small, try 3 or 4), and a real number $t \in [0, 1]$, produces a new mesh with the same topology as the two input meshes, but with positions interpolated in a ratio of $t : (1 - t)$ for corresponding vertices.

Exercise 4 — Tweak parameters

Modify your solution in Ex. 2 above by varying the weights used to compute the new positions (adding "tension"). For example, you may try (refer to the slides used in class):

$$\begin{aligned} V_E &= \frac{2 \cdot V_a + 2 \cdot V_b + V_{F1} + V_{F2}}{6} \\ V_V &= \frac{F + 2 \cdot R + (2 \cdot m - 3) \cdot V}{2 \cdot m} \end{aligned}$$

Try other weightings of your own, and compare the results.

Exercise 5 — Animation

Write a callback function to use the function developed in Exercise 3 to produce an animation such that at the first frame the animation shows the result in Exerccise 1, and at the last frame it shows the result of Exercise 2 (both iterated a small fixed number of times n), interpolating linearly in between the two for the other frames of the animation. You should be able to set the start and end frames and watch the animation pressing `Alt-A`.

Exercise 6 — Make a video

Use blender and the result of Exercise 5 to make a video of the subdivision of `test-model.blend`. You may use the standard blender mechanisms to animate the camera around the object as the subdivision proceeds. The total duration of the video should be at least 30 seconds.

Exercise 7 — Catmull-Clark with borders

Modify your code so that it can handle 2-manifolds with border. You need to work out formulas adapted to the border case.

Exercise 8 — Creases

Using your insights from Ex. 7, devise a method to produce creases on the model (in correspondence to a set of edges marked as crease-edges).