EXERCISES FOR INF3320

SUBDIVISION CURVES AND SURFACES

1. The four points

$$\mathbf{p}_0 = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad \mathbf{p}_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \qquad \mathbf{p}_2 = \begin{bmatrix} 2 \\ 1 \end{bmatrix} \qquad \mathbf{p}_3 = \begin{bmatrix} 3 \\ 2 \end{bmatrix}$$

   are the control points of a cubic Bézier curve. Split this curve at $t = \frac{1}{2}$, and find the control points for the two new curve segments.

2. The four points

$$\mathbf{p}_0^0 = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad \mathbf{p}_1^0 = \begin{bmatrix} 0 \\ 4 \end{bmatrix} \qquad \mathbf{p}_2^0 = \begin{bmatrix} 4 \\ 4 \end{bmatrix} \qquad \mathbf{p}_3^0 = \begin{bmatrix} 4 \\ 0 \end{bmatrix}$$

   constitute the control polygon of a subdivision curve. The curve is closed in the sense that when one runs out of control points at one end of the curve, one simply uses points from the other end.

   Use Chaikins subdivision scheme. What are the stencils and the mask for this scheme? Calculate the next level of points. What kind of curve does this scheme converge to in the limit?

3. Implement a function

```
std::vector createSplineSubdivisionMask(size_t d);
```

   that finds the subdivision mask for a C^{d-1} spline subdivision scheme for an arbitrary d.

4. Show how we can compute the four stencils for the C^2 tensor product spline subdivision scheme. Outline an algorithm which performs one subdivision step with this scheme.

5. Outline an algorithm using pseudo code that performs Catmull-Clark subdivision. What requirements do you have for the data structure?

6. Extend the source code from last weeks exercises with a new function which performs C^2 cubic spline subdivision.

   Extra: How can we handle open curves?