CPSC424: Tutorial 7

March 3, 2025

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Credits

Tutorial this time is mostly a copy of the 2019 tutorial material prepared by Jerry.

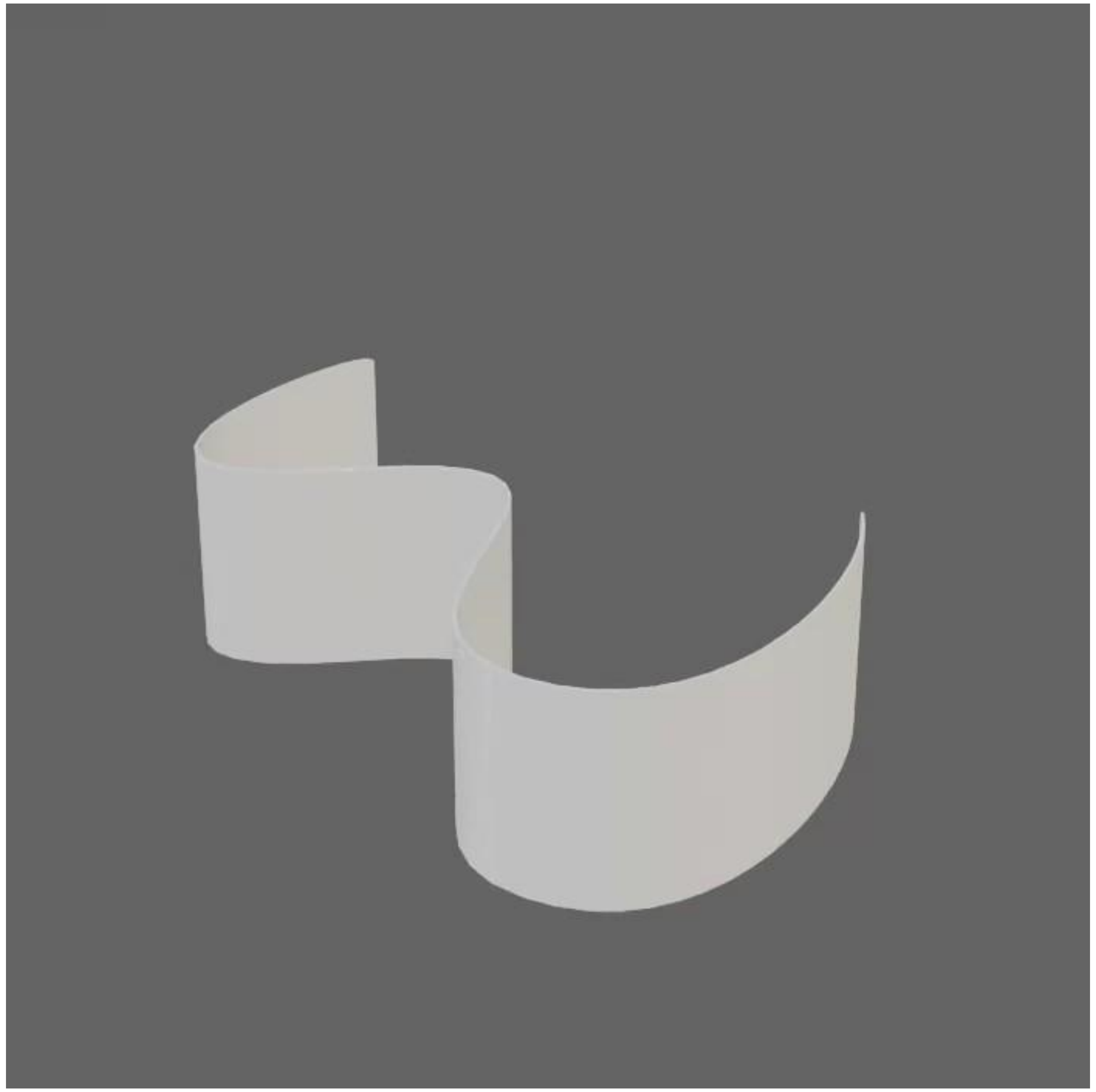
Modelling Surfaces

Surfaces can be derived from curves by simple operations:

- Extrusion
- Revolution
- Sweep
- Ruling

Modelling Surfaces

Describe the process being used to create each of the surfaces below. Be as specific as possible (*i.e.* if one process is a special case of another process, state the special case).



Modelling Surfaces

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Modelling Surfaces

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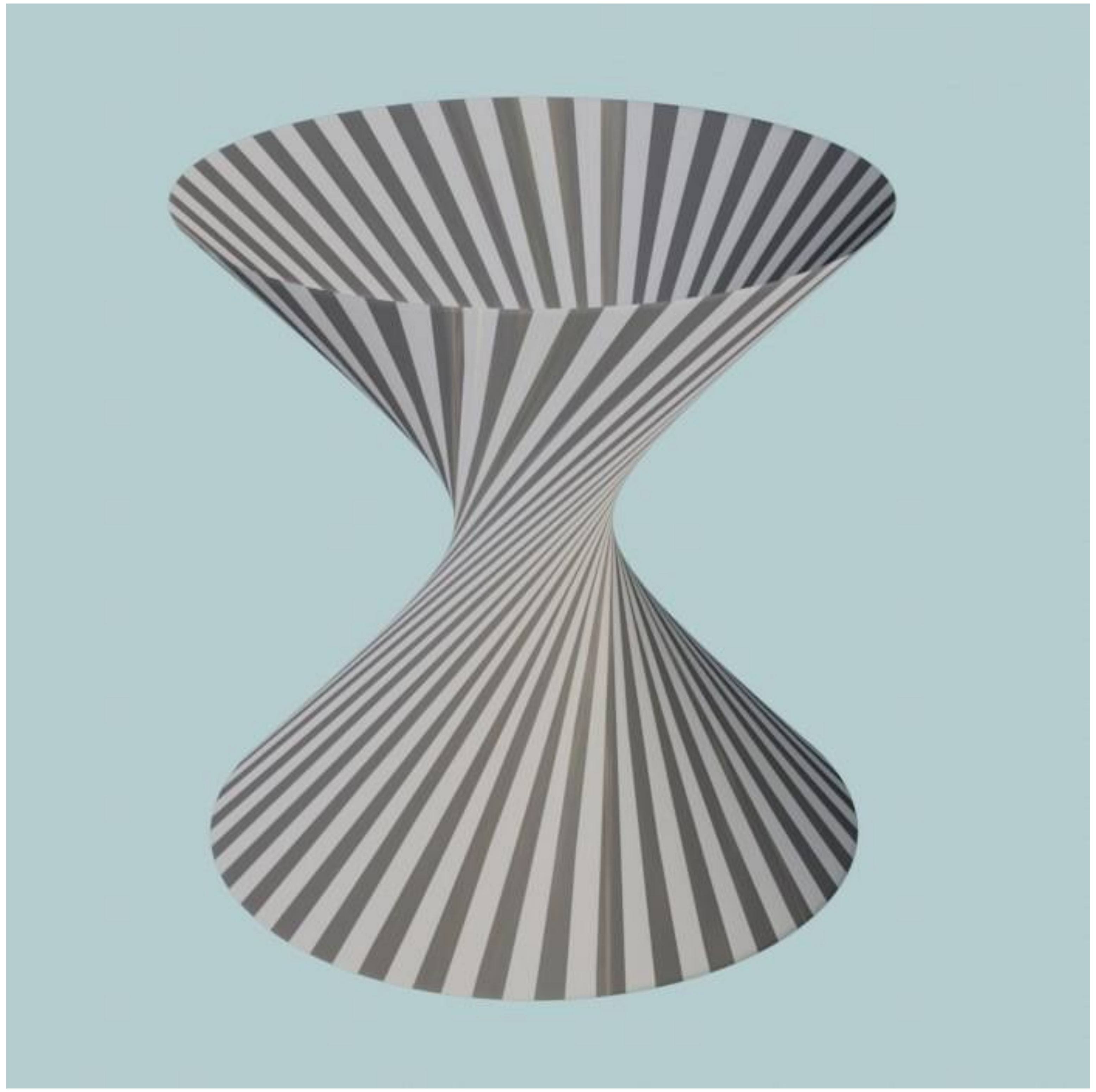
Modelling Surfaces

Describe the type of each surface below. Be as specific as possible.



Modelling Surfaces

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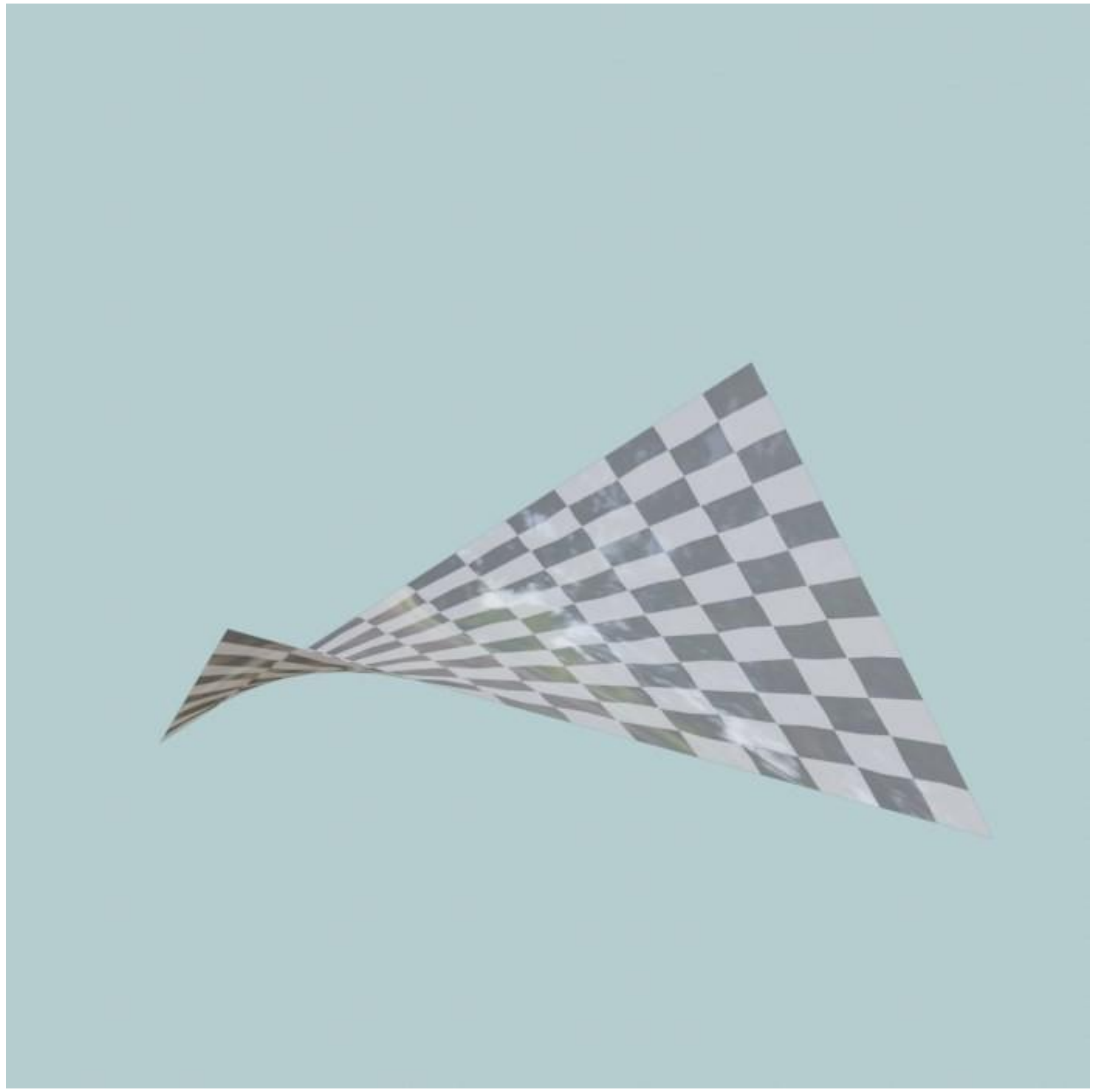


Tensor Product Surfaces

An online Bezier patch demo.

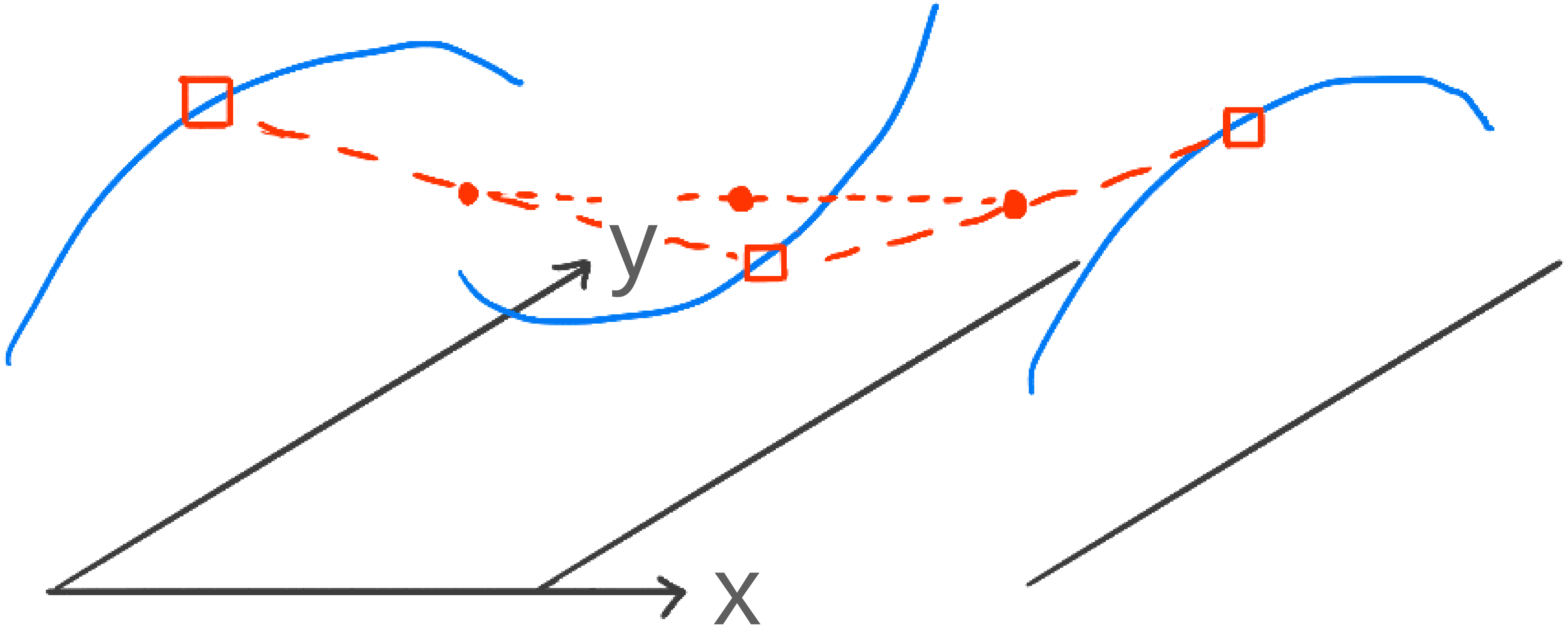
https://kovacsv.github.io/JSModeler/documentation/examples/bezier.html

Tensor Product Surfaces

Given the following nine control points which define a quadratic Bézier patch,

$$\begin{aligned}
\mathbf{b}_{0,0} &= (0, 0, 0), & \mathbf{b}_{0,1} &= (1, 0, 3), & \mathbf{b}_{0,2} &= (2, 0, 2),\\
\mathbf{b}_{1,0} &= (0, 1, 2), & \mathbf{b}_{1,1} &= (1, 1, 1), & \mathbf{b}_{1,2} &= (2, 1, 4),\\
\mathbf{b}_{2,0} &= (0, 2, 4), & \mathbf{b}_{2,1} &= (1, 2, 3), & \mathbf{b}_{2,2} &= (2, 2, 2),
\end{aligned}$$

use the de Casteljau algorithm to find the point at (s, t) = (0.5, 0.5) (the middle of the patch).



Tensor Product Surfaces

Given the following nine control points which define a quadratic Bézier patch,

$$
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\mathbf{b}_{1,0} &= (0, 1, 2), & \mathbf{b}_{1,1} &= (1, 1, 1), & \mathbf{b}_{1,2} &= (2, 1, 4), \\
\mathbf{b}_{2,0} &= (0, 2, 4), & \mathbf{b}_{2,1} &= (1, 2, 3), & \mathbf{b}_{2,2} &= (2, 2, 2),
\end{aligned}
$$

use the de Casteljau algorithm to find the point at (s, t) = (0.5, 0.5) (the middle of the patch).

First treat each column as a separate Bézier curve. We find the midpoints $\mathbf{c}_i$ of each Bézier curve as usual.

$$
\begin{aligned}
c_0 &= \frac{1}{4}(0, 0, 0) + \frac{1}{2}(0, 1, 2) + \frac{1}{4}(0, 2, 4) = (0, 1, 2) \\
c_1 &= \frac{1}{4}(1, 0, 3) + \frac{1}{2}(1, 1, 1) + \frac{1}{4}(1, 2, 3) = (1, 1, 2) \\
c_2 &= \frac{1}{4}(2, 0, 2) + \frac{1}{2}(2, 1, 4) + \frac{1}{4}(2, 2, 2) = (2, 1, 3)
\end{aligned}
$$

Tensor Product Surfaces

Given the following nine control points which define a quadratic Bézier patch,

$$
\begin{aligned}
\mathbf{b}_{0,0} &= (0, 0, 0), & \mathbf{b}_{0,1} &= (1, 0, 3), & \mathbf{b}_{0,2} &= (2, 0, 2),\\
\mathbf{b}_{1,0} &= (0, 1, 2), & \mathbf{b}_{1,1} &= (1, 1, 1), & \mathbf{b}_{1,2} &= (2, 1, 4),\\
\mathbf{b}_{2,0} &= (0, 2, 4), & \mathbf{b}_{2,1} &= (1, 2, 3), & \mathbf{b}_{2,2} &= (2, 2, 2),
\end{aligned}
$$

use the de Casteljau algorithm to find the point at (s, t) = (0.5, 0.5) (the middle of the patch).

c_0, c_1, c_2 form the control points for a Bézier curve in the other direction. Thus the middle of the patch is

$$
\begin{aligned}
F\,(0.5, 0.5) &= \frac{1}{4}c_0 + \frac{1}{2}c_1 + \frac{1}{4}c_2\\
&= \frac{1}{4}(0, 1, 2) + \frac{1}{2}(1, 1, 2) + \frac{1}{4}(2, 1, 3) = \left(1, 1, \frac{9}{4}\right).
\end{aligned}
$$

Curve Network

Flow Aligned Surfacing of Curve Networks

Hao Pan[1], Yang Liu[2], Alla Sheffer[3], Nicholas Vining[3], Changjian Li[1], Wenping Wang[1]

[1]The University of Hong Kong, [2]Microsoft Research Asia, [3]University of British Columbia

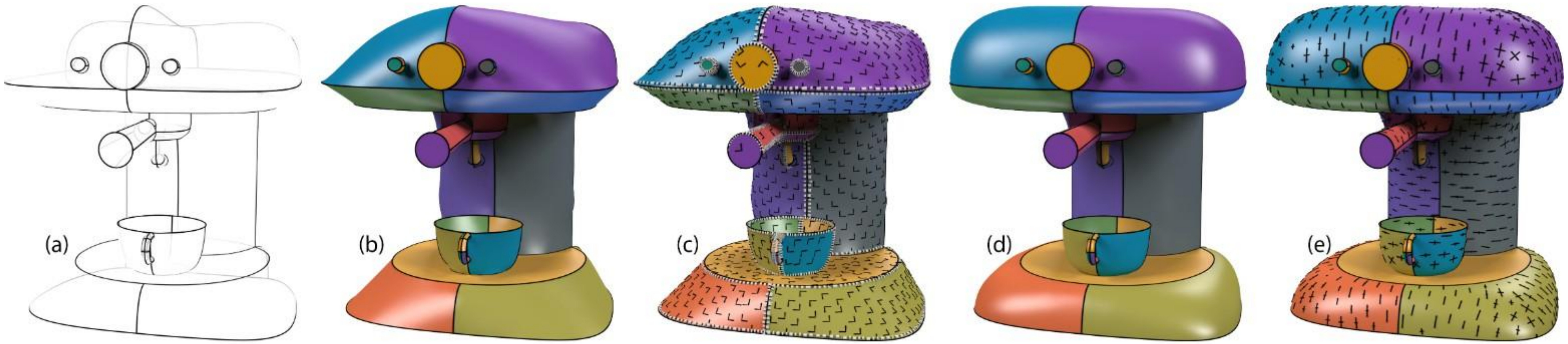

Figure 1: Surfacing an artist created curve network: (a) an input curve network of the coffee maker model; (b) initial surface; (c) the computed flow field aligned with network flow lines denoted by dashed white lines on the initial surface; (d) final surface whose curvature directions (scaled by principal curvatures) (e) are well aligned with the representative flow lines in the curve network.

Curve Network

Design-Driven Quadrangulation of Closed 3D Curves

Mikhail Bessmeltsev[1] Caoyu Wang[1] Alla Sheffer[1] Karan Singh[2]

[1]University of British Columbia [2]University of Toronto

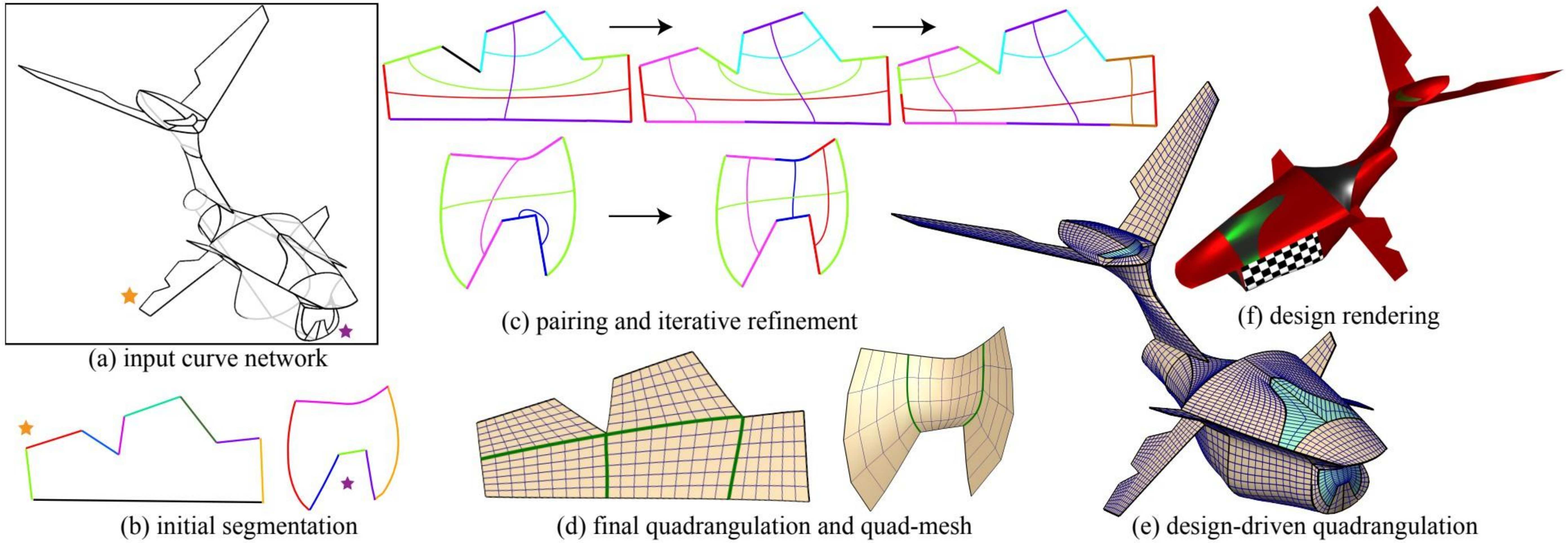

Figure 1: *Steps to quadrangulating a design network of closed 3D curves (a) : Closed curves are independently segmented (b) and iteratively paired and refined to capture dominant flow-lines as well as overall flow-line quality (c); final quadrangulation in green and dense quad-mesh (d); quadrangulations are aligned across adjacent cycles to generate a single densely sampled mesh (e), suitable for design rendering and downstream applications (f).*