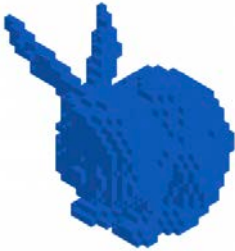


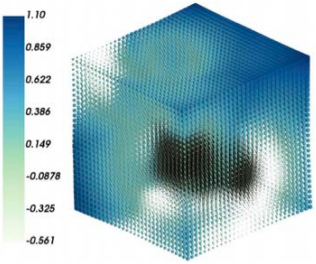


3D Surface Representations

	Voxels	Explicit surface mesh	Point sets	Continuous implicit fields
				
High frequency details?	--	++	+	++
Arbitrary topology?	+	-	+	++
Regularity?	+	+	-	++

There are many applications at which explicit representations excel:

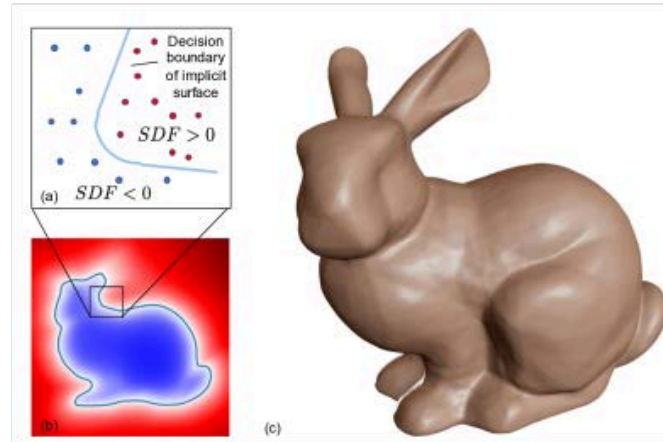
- High-quality rendering in computer graphics.
- Precise modeling of biological structures from biomedical data.
- Computational fluid dynamics in computer assisted design.

But:

- Their topology is fixed.
- They are not particularly deep learning friendly.

—> Implicit Surface Representations

Signed Distance Fields (SDF)



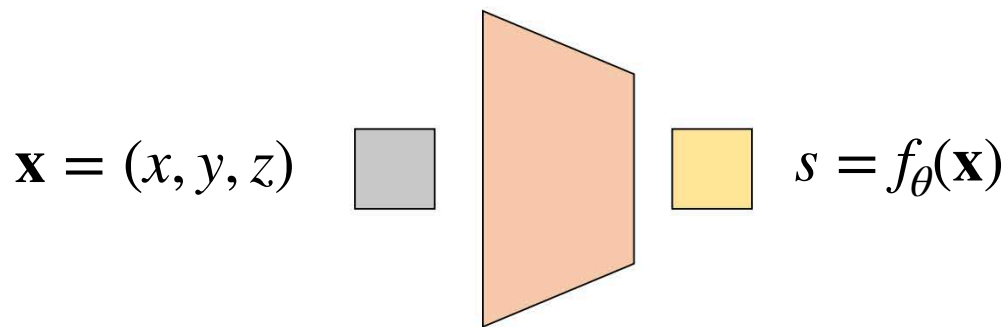
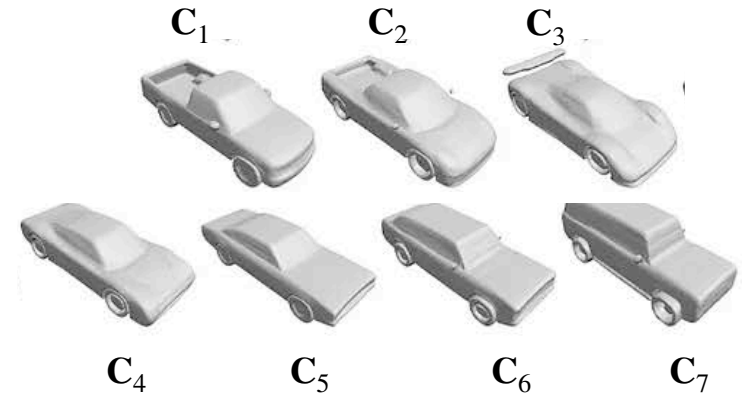
- Represent a 3D surface S by the zero crossings of a **signed distance function**

$$f: \mathbb{R}^3 \rightarrow \mathbb{R}$$

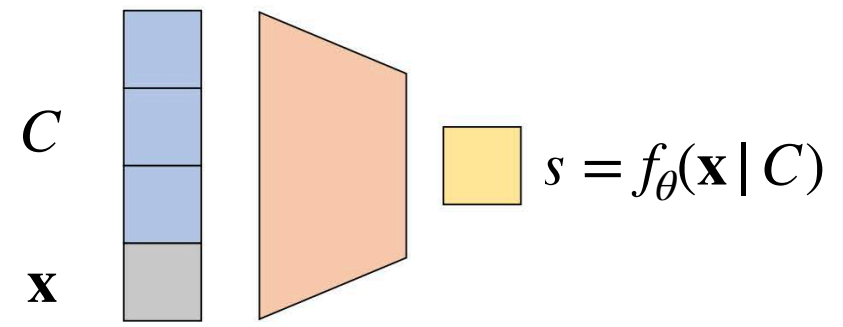
$\forall \mathbf{x} \in \mathbb{R}^3$, $f(\mathbf{x})$ is the signed distance to the surface.

- Such surfaces can easily change topology, which is harder to do with explicit surface representations.
- SDFs have long been appealing in theory but hard to use in practice because it was necessary to store the 3D values of f in a cube like structure until

Deep SDF

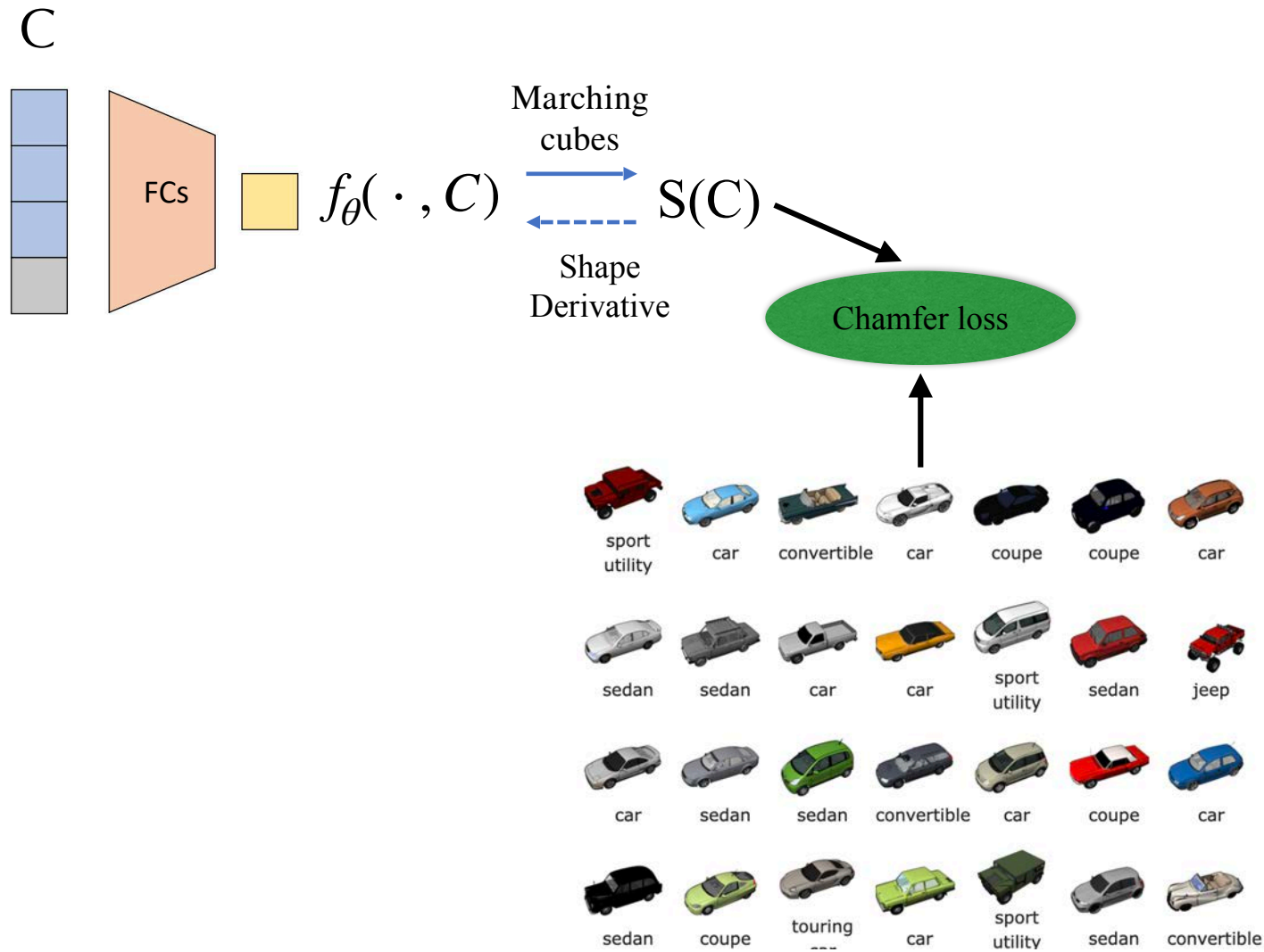


Single Shape DeepSDF



Coded Shape DeepSDF

Learning a Latent Representation



Train an auto-decoder using ShapeNet cars.

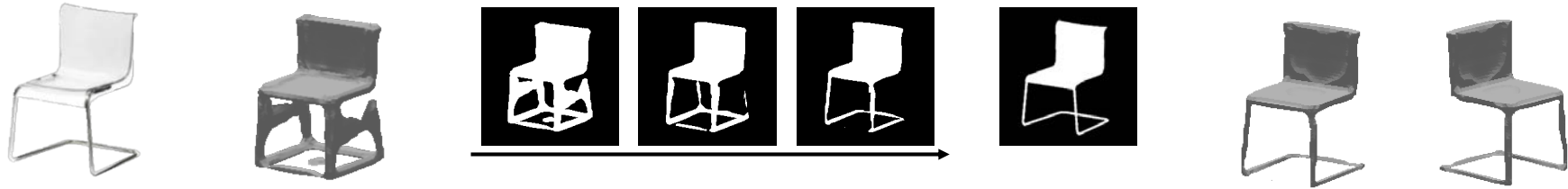
End-to-End Differentiable Pipeline



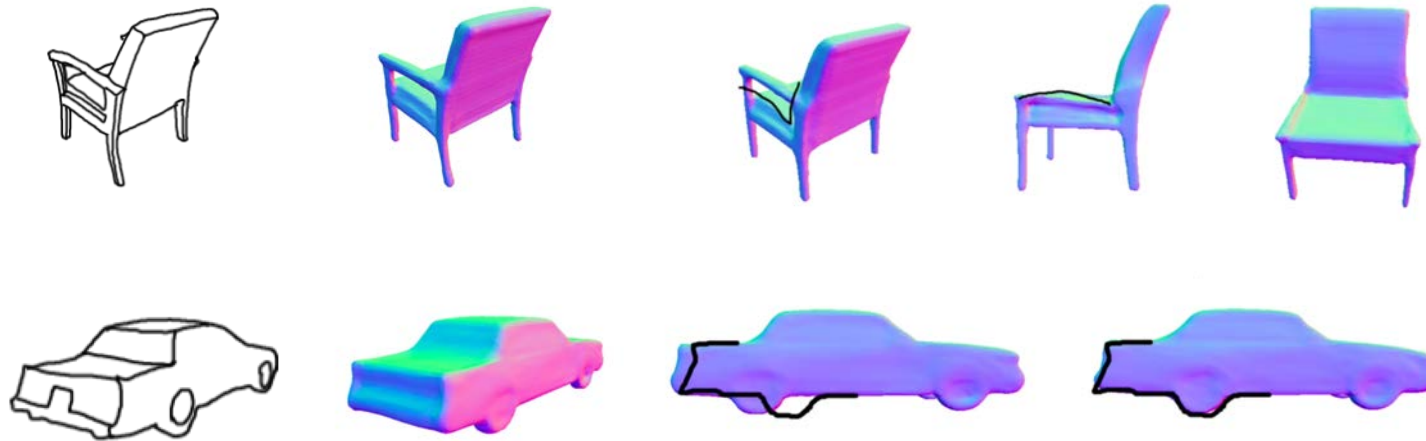
1. Start with a Deep SDF code.
2. Use marching cube to compute vertices and facets.
3. Use them for the forward pass and **for backpropagation**.
4. Update the SDF code and iterate.

—> We can turn a genus 0 cow into a genus 1 duck by minimizing a differentiable objection function.

From Silhouettes to 3D Shapes

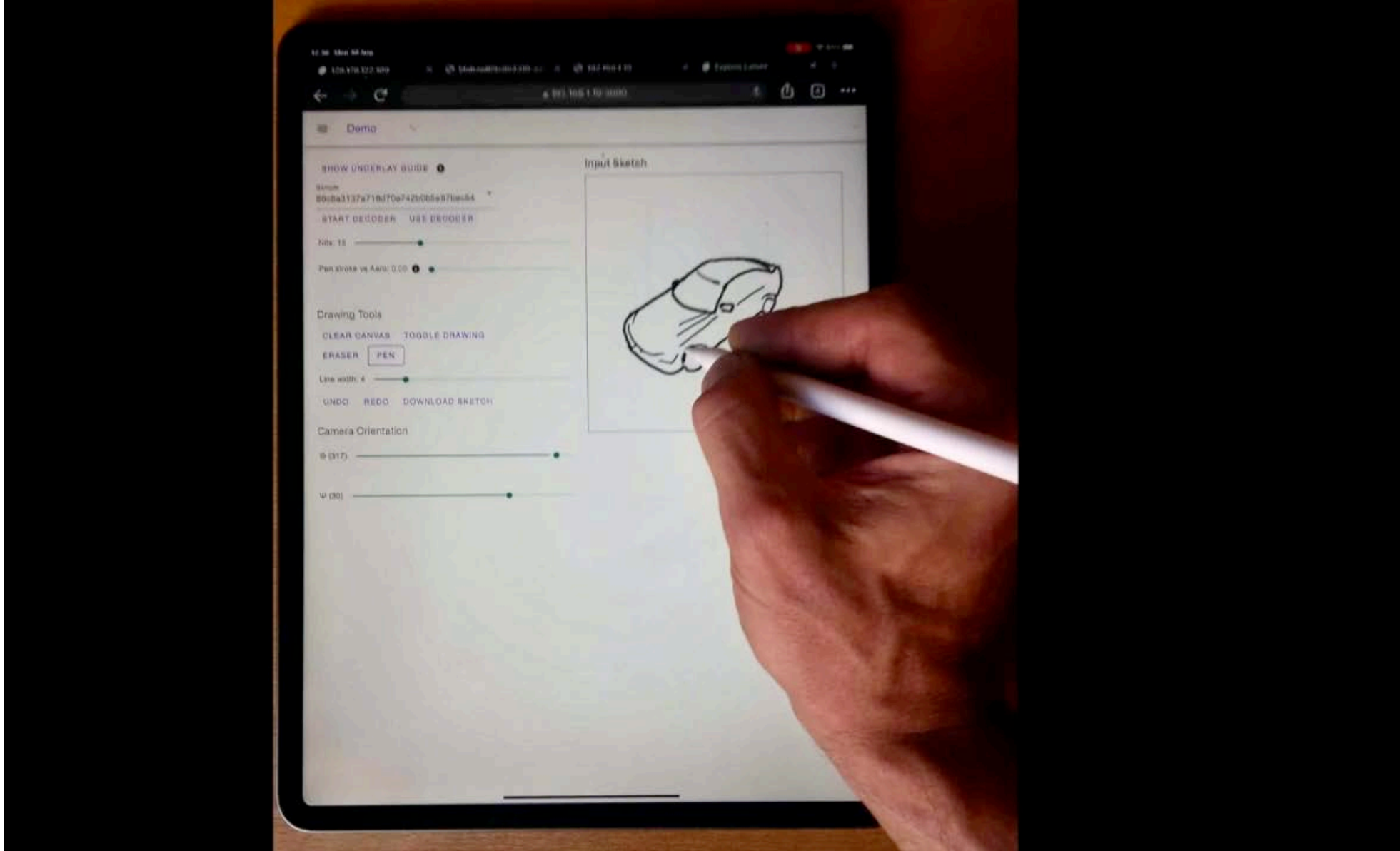


3D Model from Image

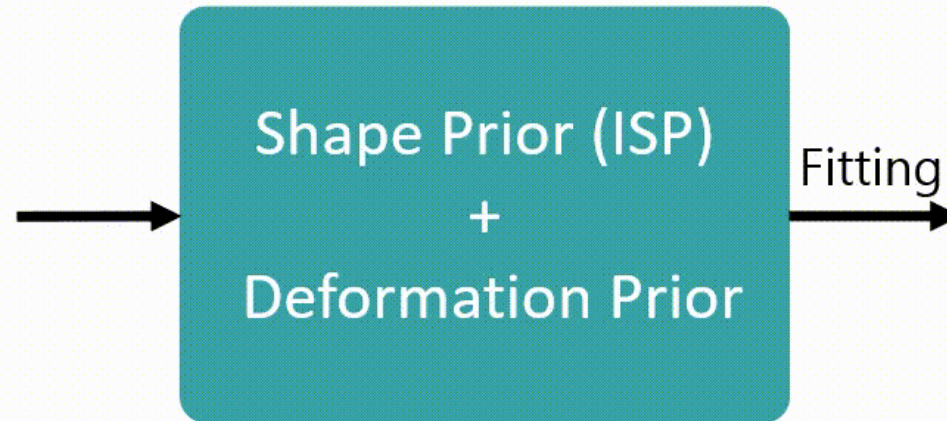


Editable 3D Model from Sketch

Interactive Design



Clothed People from Images



- Model the clothes in terms of a distance away from implicit sewing patterns.
- Add a deformation model to allow the garment to move away from the body.