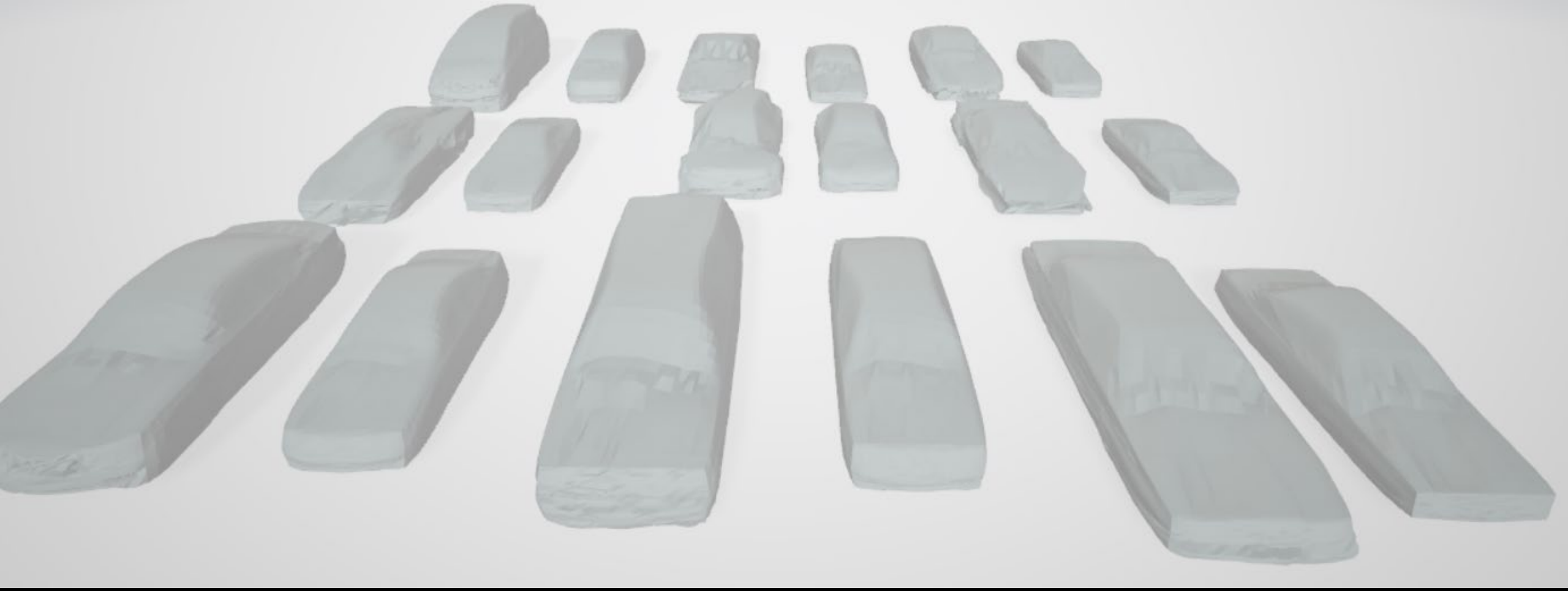


# Exploring Generative 3D Shapes Using Autoencoder Networks

Yanwen Xu

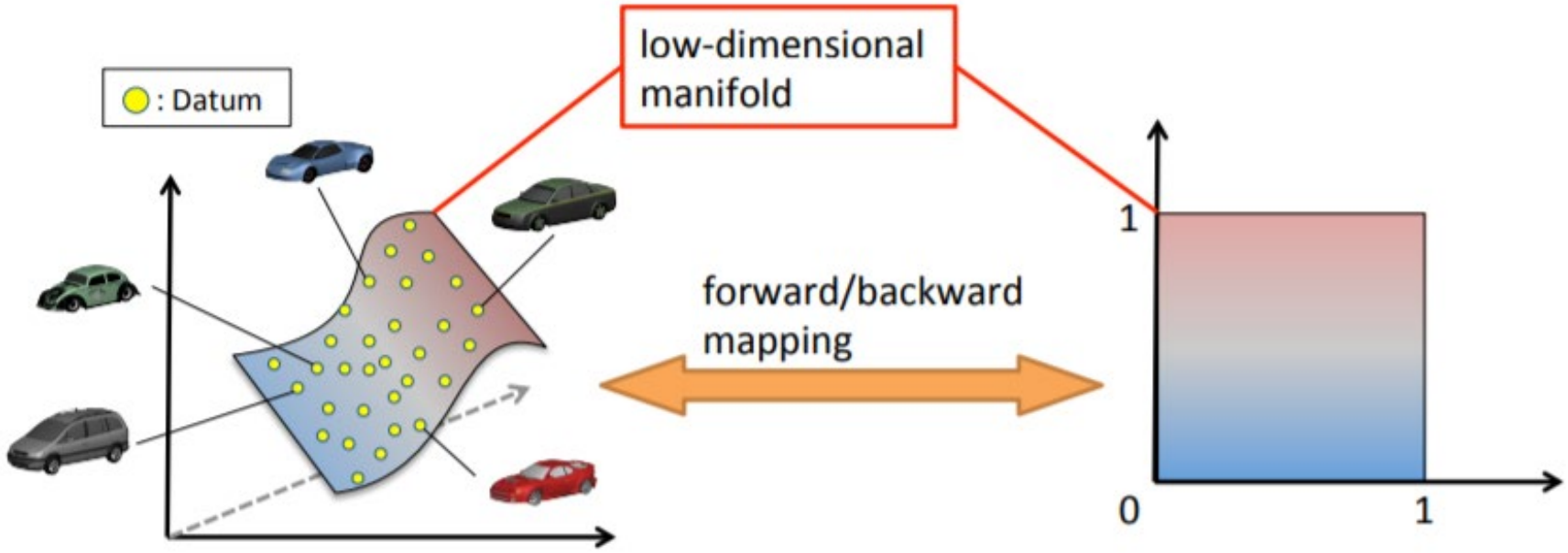
# Motivation

- We wanted to see if we could apply Machine Learning to some form of 3D procedural content generation

Umetani, 2017

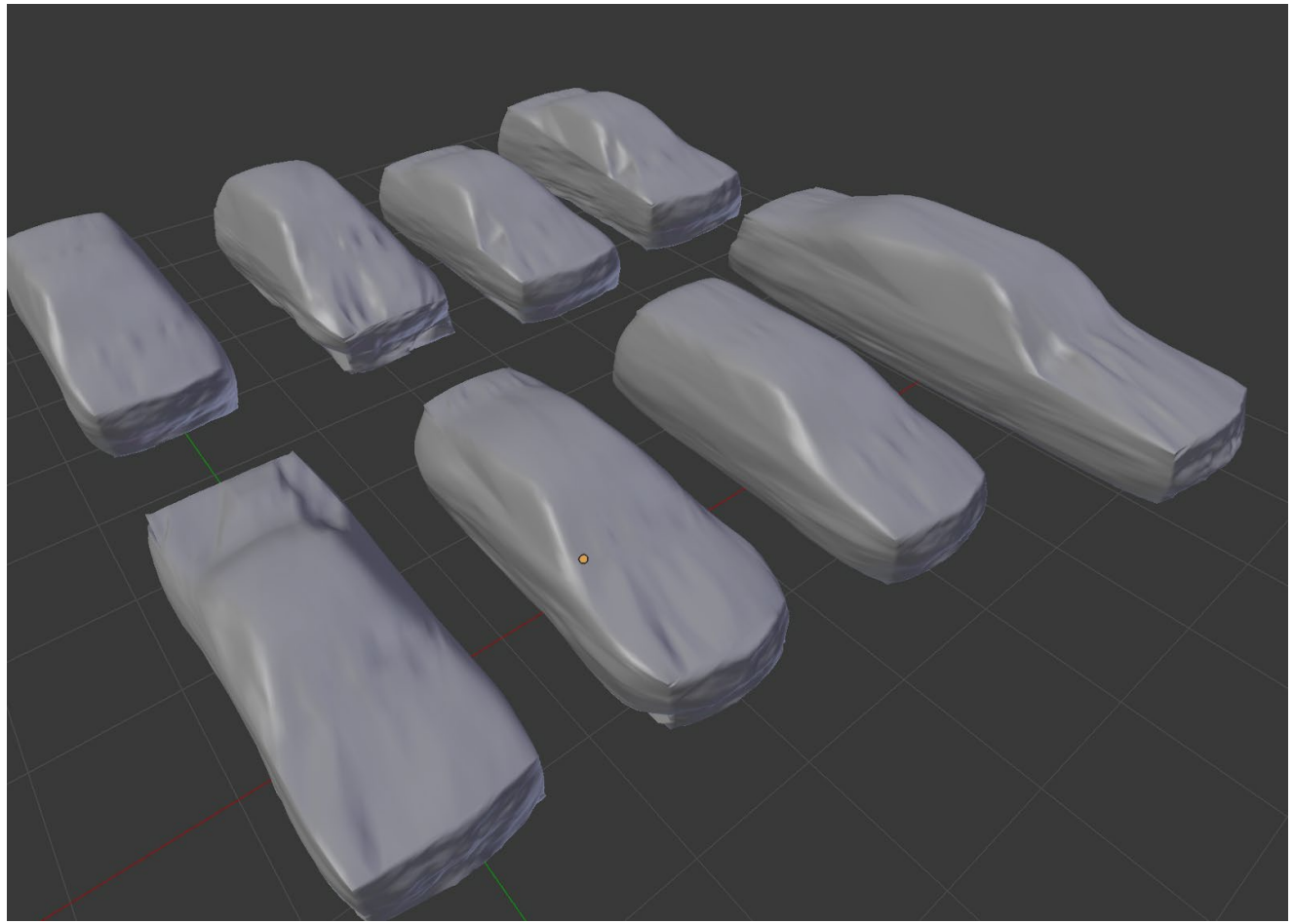
# Motivation

- Learning the 3D shape
  - Finding low dimensional manifold in space



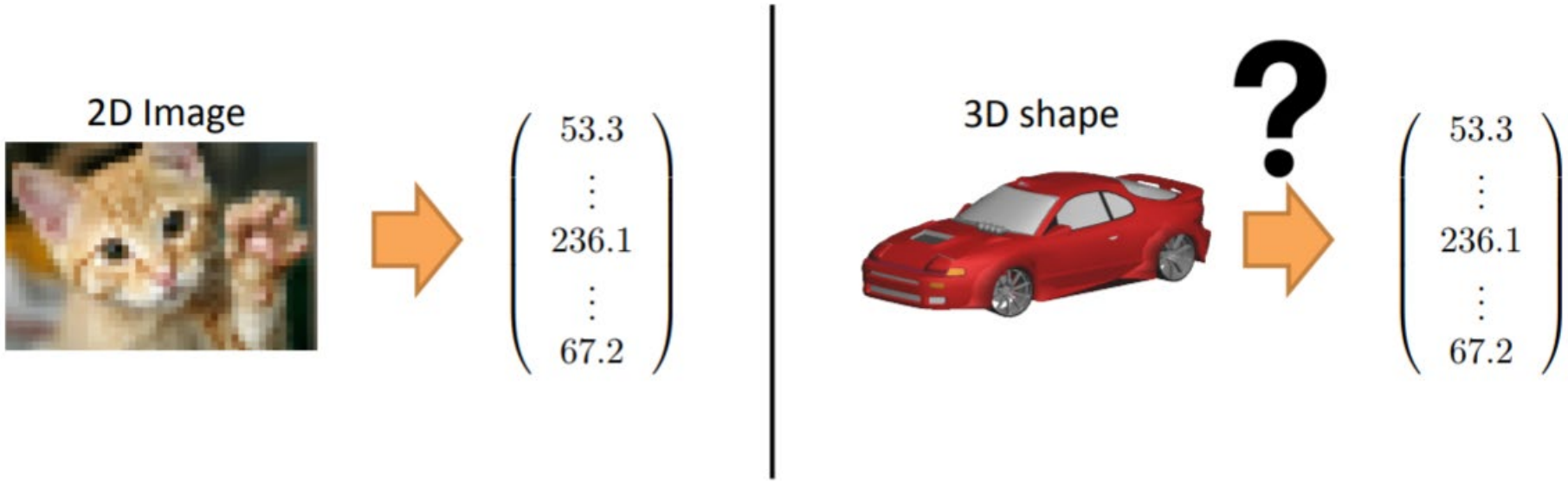

Umetani, 2017

# Preview of the Result: Our Latent Space



# Parameterization problem

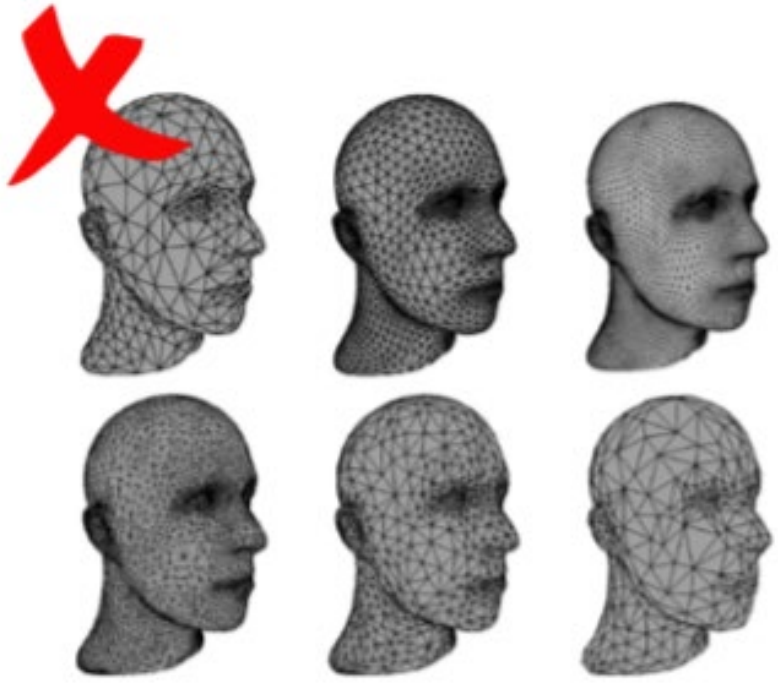
- Shape need to be represented by fixed dimensional vector/tensor




Umetani, 2017

# Parameterization problem

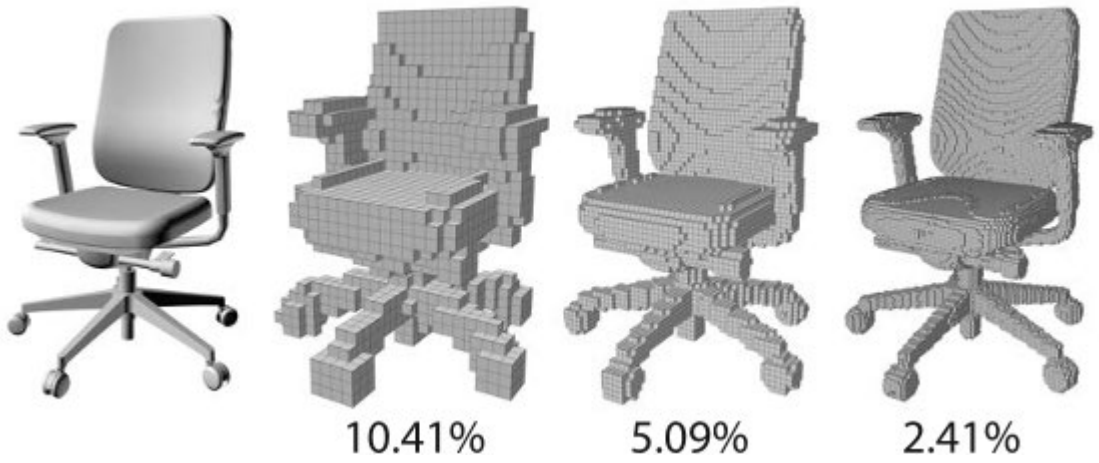
- Triangle mesh are not suitable for Machine Learning
  - Topology and Number of points are inconsistent



Triangle mesh Umetani, 2017

# Related work: Voxel model

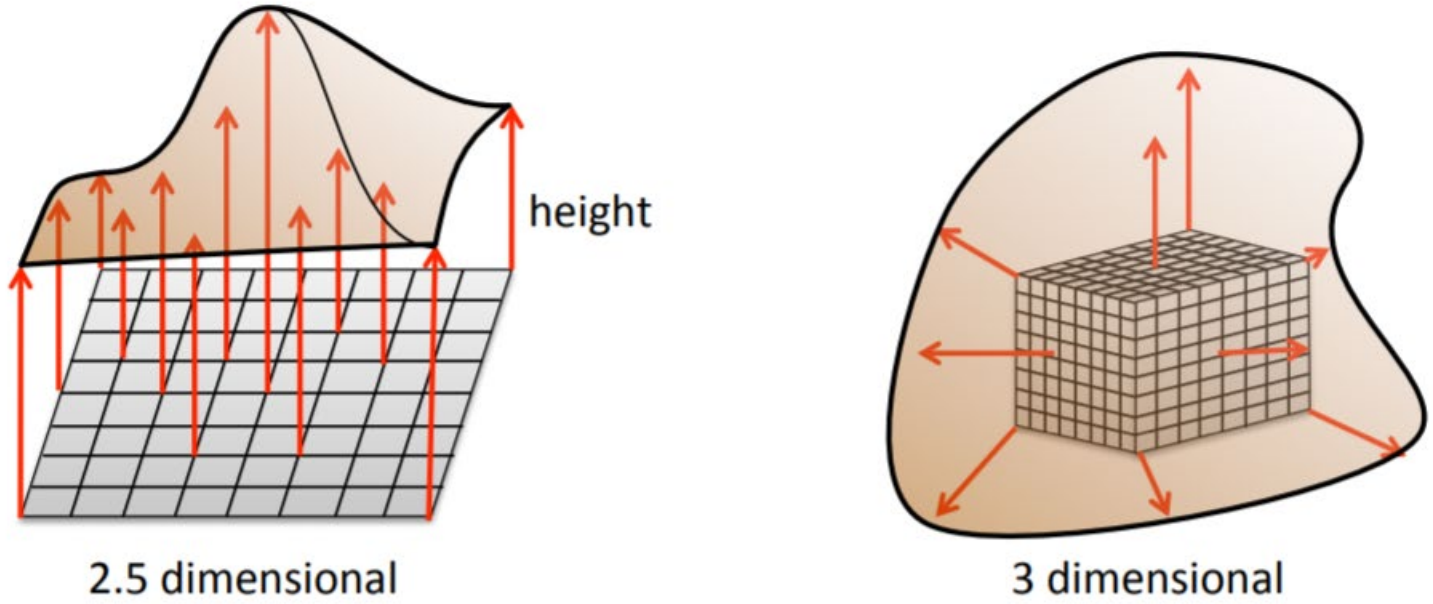
- limited resolution / expensive memory cost, noise…




FPNN, Li et al., 2017

# 3D Shape as Height Field

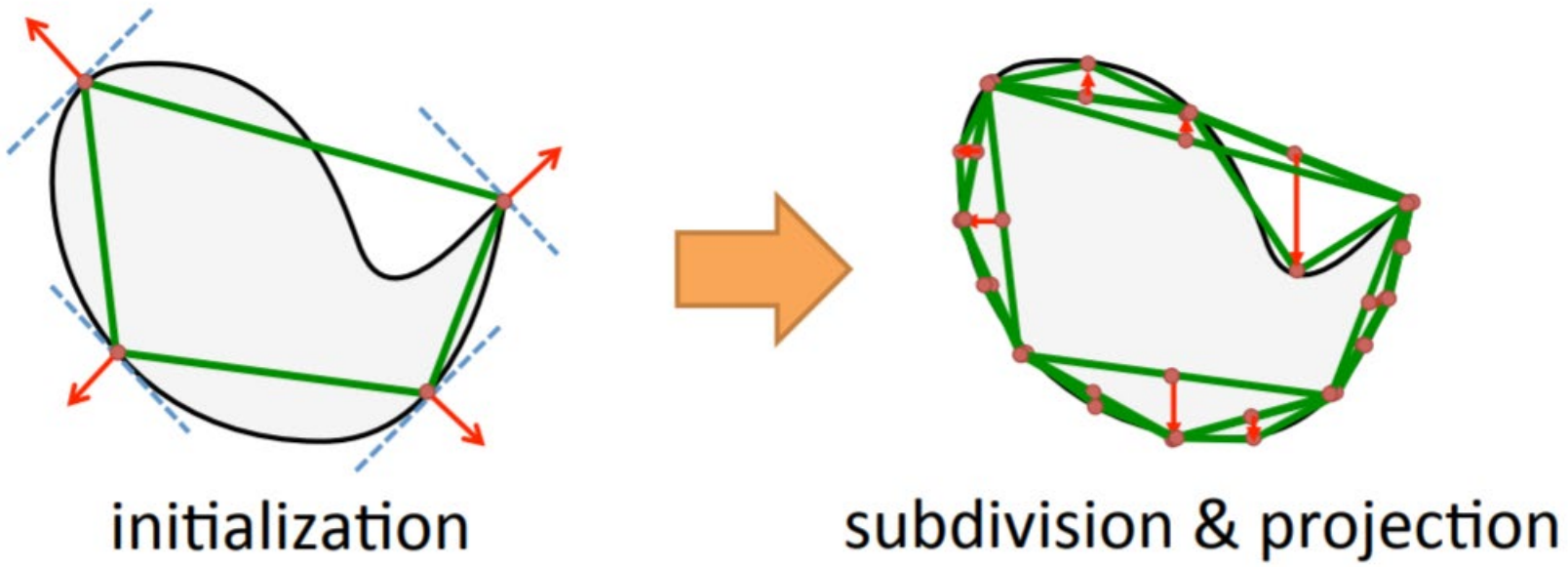
- Storing XYZ coordinates is redundant
- Height field from a cube in its normal




Umetani, 2017

# Hierarchical Projection

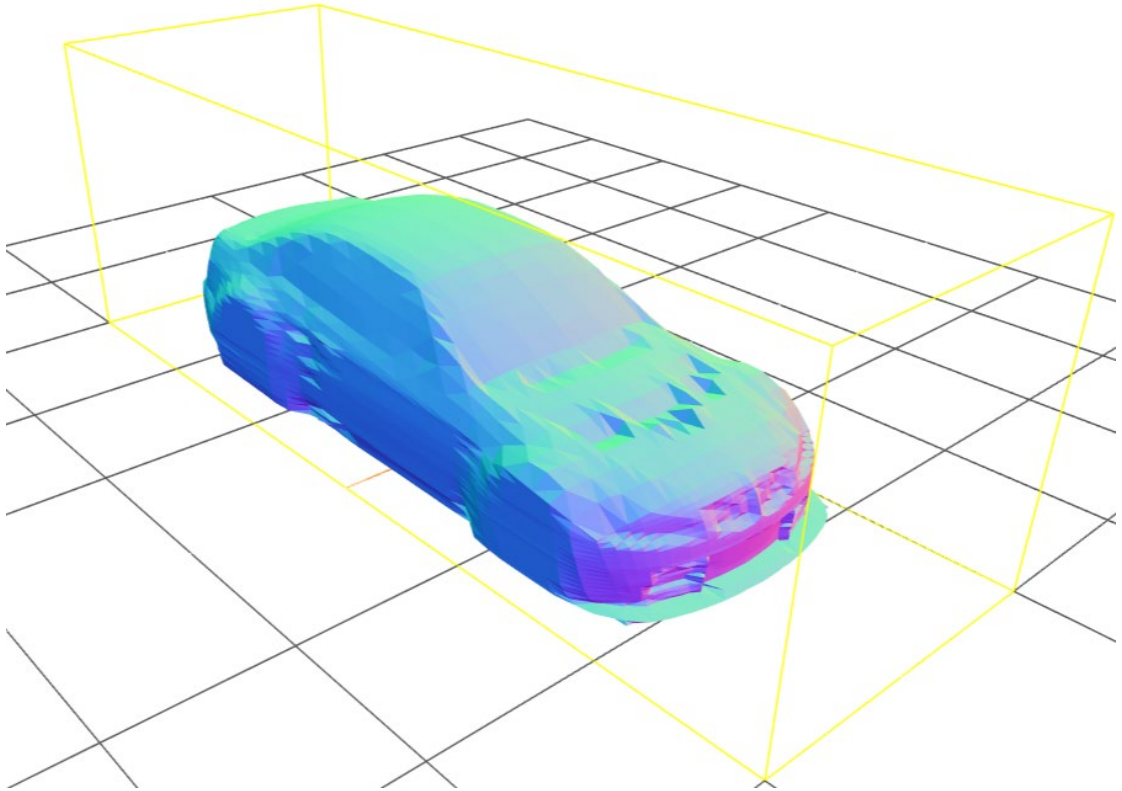
- Repeat subdivision and projection to avoid distortion




Umetani, 2017

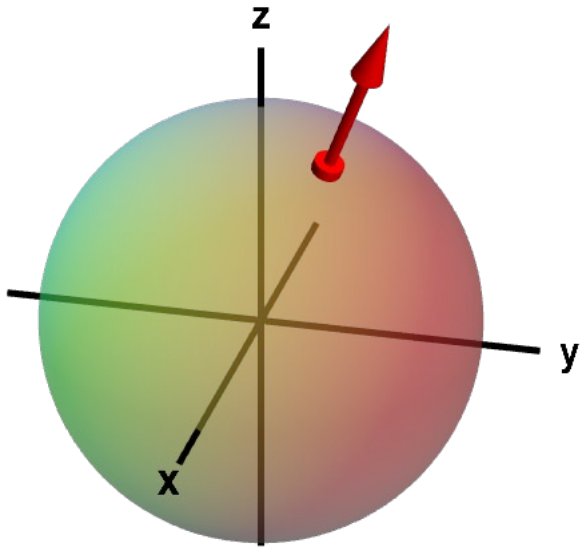
# Our Approach:

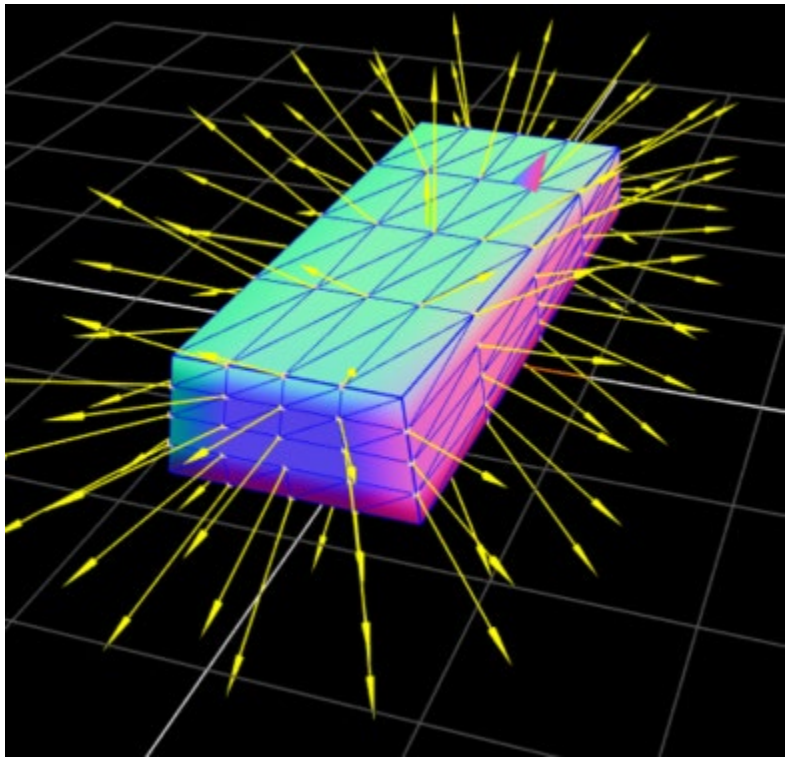
- Triangle mesh with constant topology
- Deforming a template mesh into input shape



# Our Approach:

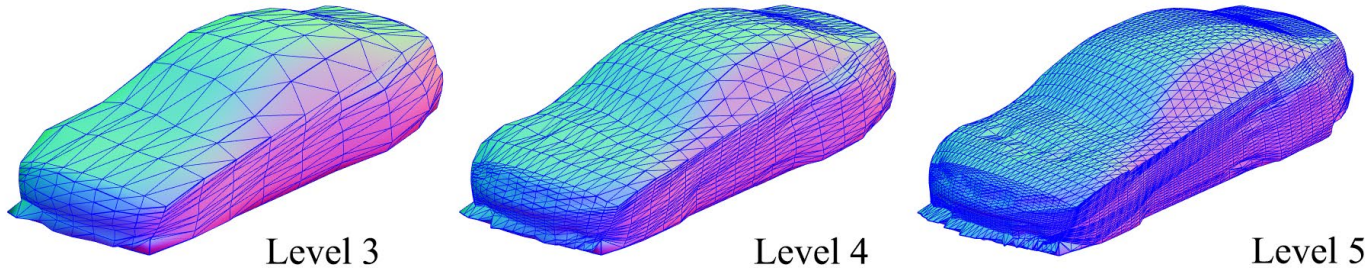
- Sphere Normal

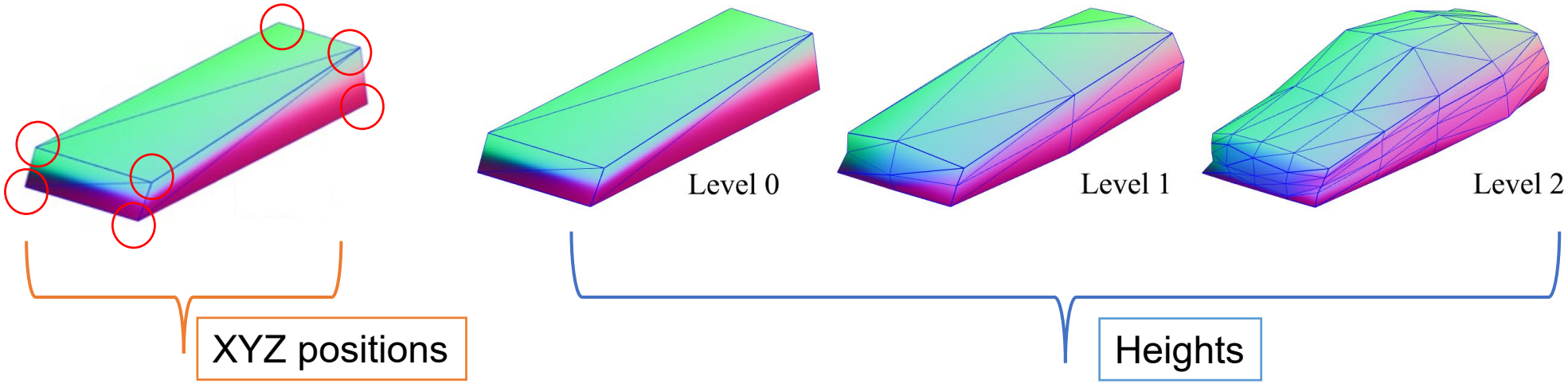


Spherical normal $\vec{d}$ are predefined for each vertex.

# Subdivision & Projection

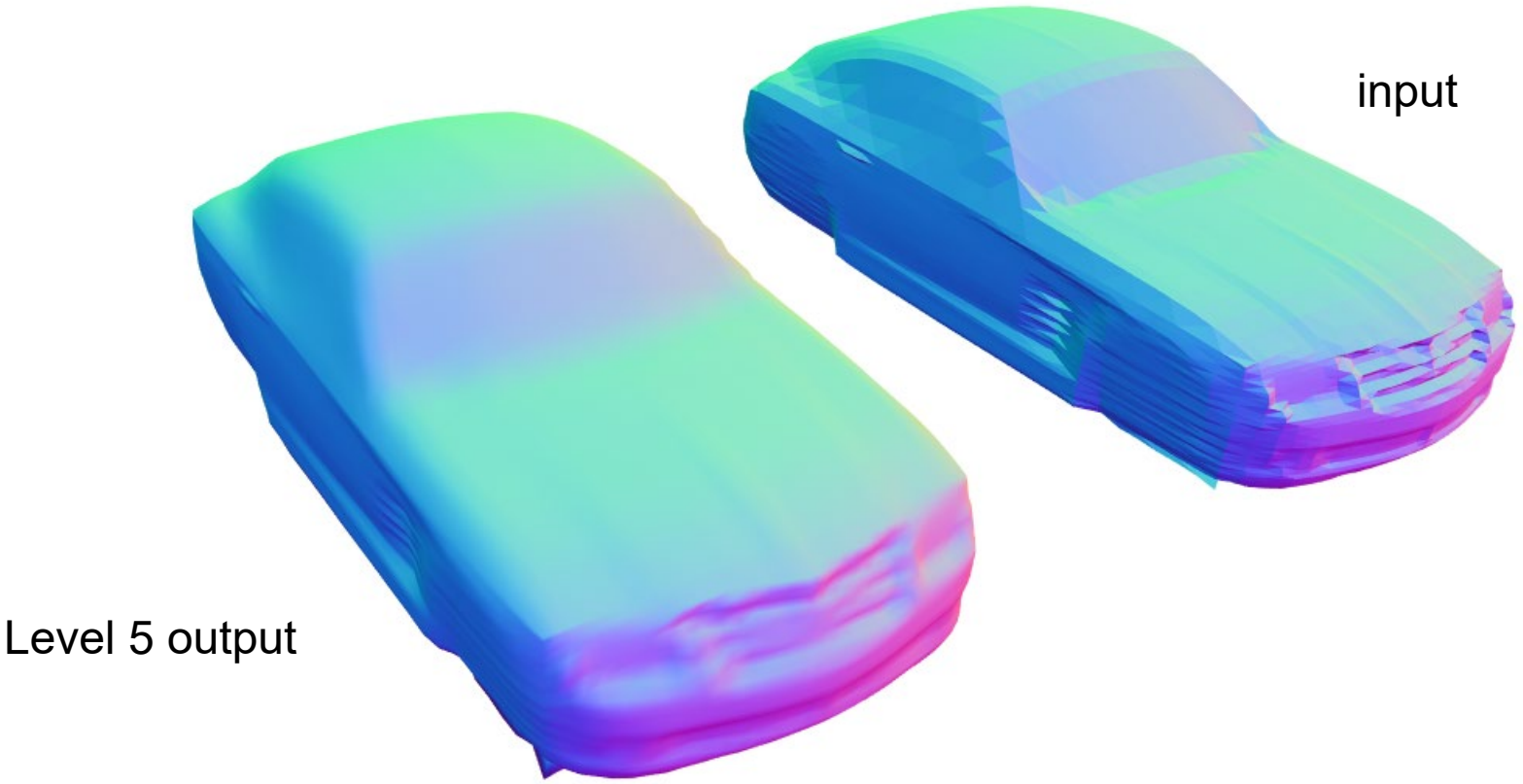



{ ..... | ..... }

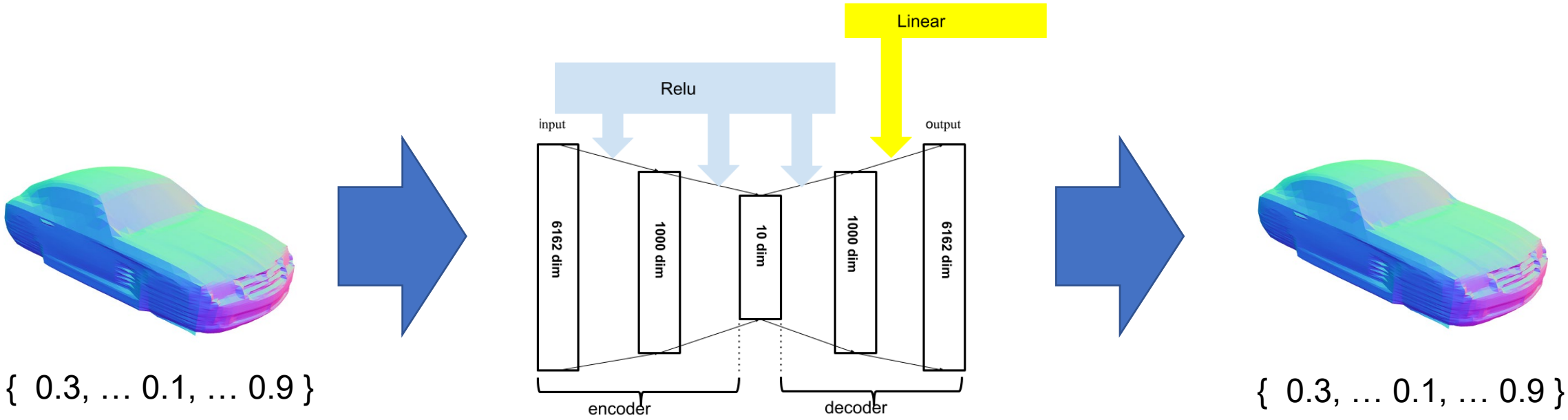
Parameter Vector

# Example of Our Result



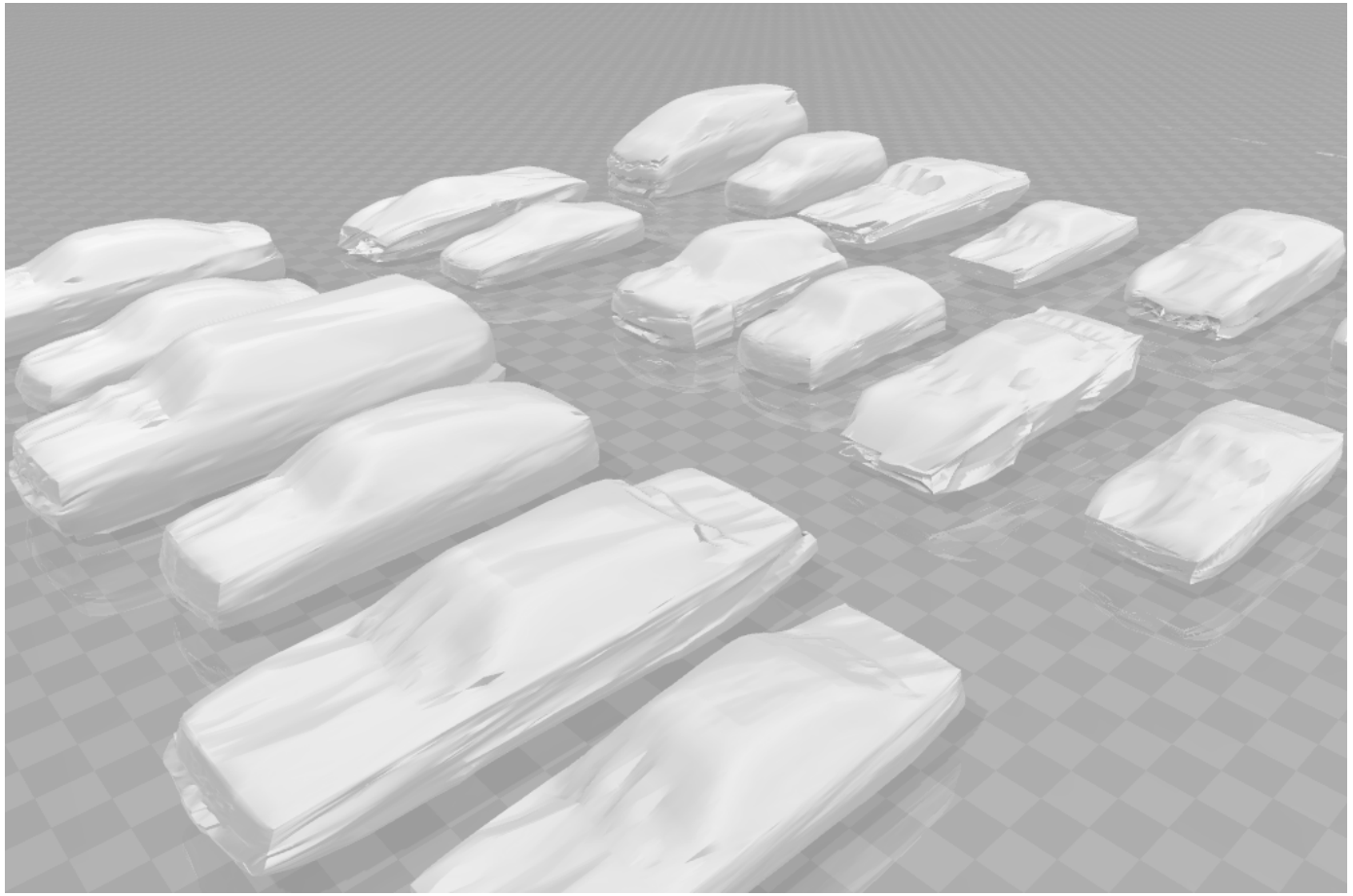
# Autoencoder

- Input and output of network is as same as possible




Configuration of our autoencoder network.

# Our Result

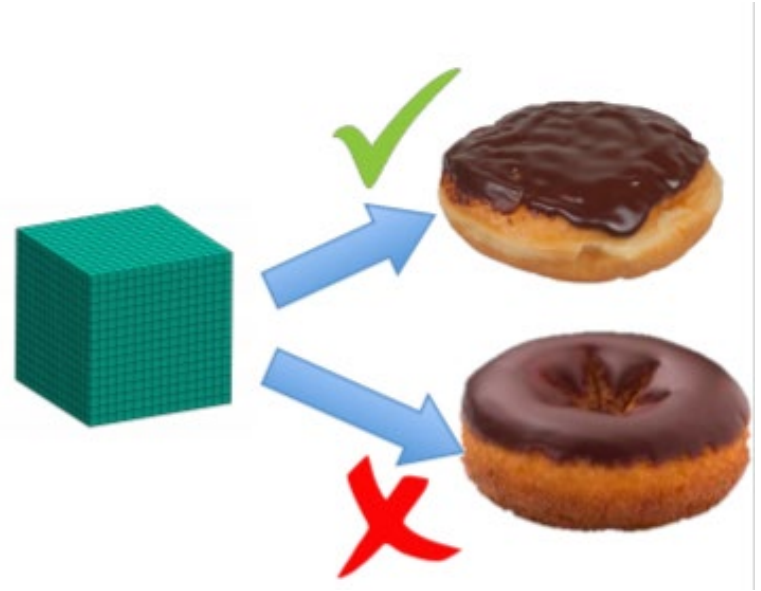


We obtained over 1,200 Car Shapes from ShapeNet [chang et al. 2015]

# Future work

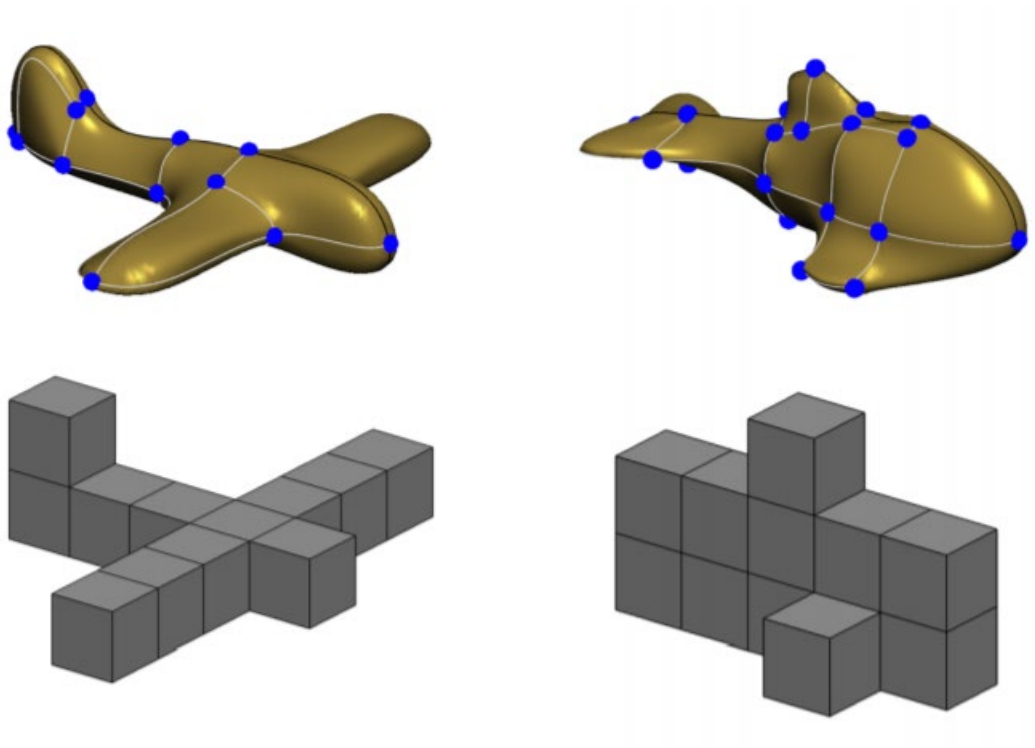
- Advanced generation framework
  - GAN / VAE


- Non-Convex Shapes



Umetani, 2017

# Poly Cube



Umetani, 2018

wikipedia.org/wiki/Polycube

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- Nobuyuki Umetani. Exploring generative 3d shapes using autoencoder networks. In *SIGGRAPH Asia 2017 Technical Briefs*, page 24. ACM, 2017
- Umetani, Nobuyuki, and Bernd Bickel. "Learning three-dimensional flow for interactive aerodynamic design." *ACM Transactions on Graphics (TOG)* 37.4 (2018): 89
- Angel X. Chang and (2015). ShapeNet: An Information-Rich 3D Model Repository. *CoRR, abs/1512.03012*