COMPUTER VISION

Project Mid-Evaluation
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Problem Statement:

Establish the use of implicit fields for learning generative models of shapes and introduce an implicit field decoder for shape generation, aimed at improving the final visual quality of these generated shapes.

Steps in Implementation:

1. Understanding the Paper
2. Data Gathering and Preparation
3. Implementation of Auto-encoder
4. Implementation if IM-NET Decoder
5. Implementation of GAN
6. Results

Problem

- Typical state-of-the-art architectures for 3D generative shape modelling using standard CNNs and GANs are poor in terms of visual quality .
- They exhibit discontinuous and overly smoothed surfaces, provide low resolution outputs and are susceptible to irregularities in training data.
- CNNs learn voxel distributions over a volume, rather than the shape boundary itself

Solution

- Implicit Fields used in Decoder feeds the point coordinates along with shape feature vector to determine whether a certain point lies on the inside or the outside, relative to the shape .
- The method allows to learn shape boundaries and output at multiple resolutions, irrespective of the resolution of the training data.
- This shape aware network produces shapes of higher visual quality on interpolation through latent GANs

Definitions

- **VOXEL**
  A pixel is a 2-dimensional Raster graphic, therefore having the values of width and length, with colour placed inside the coordinate. A voxel is a raster graphic on a 3-dimensional grid, with the values of length, width and depth. It also contains multiple scalar values such as opacity, color and density.
- **IMPLICIT SURFACE**
  Implicit surfaces are actually explicit volumes they explicitly define what is the inside and outside of the object. Consider the function which takes a 3D point (x,y,z) as input and returns a single value. This value tells us explicitly if we are outside or inside the volume

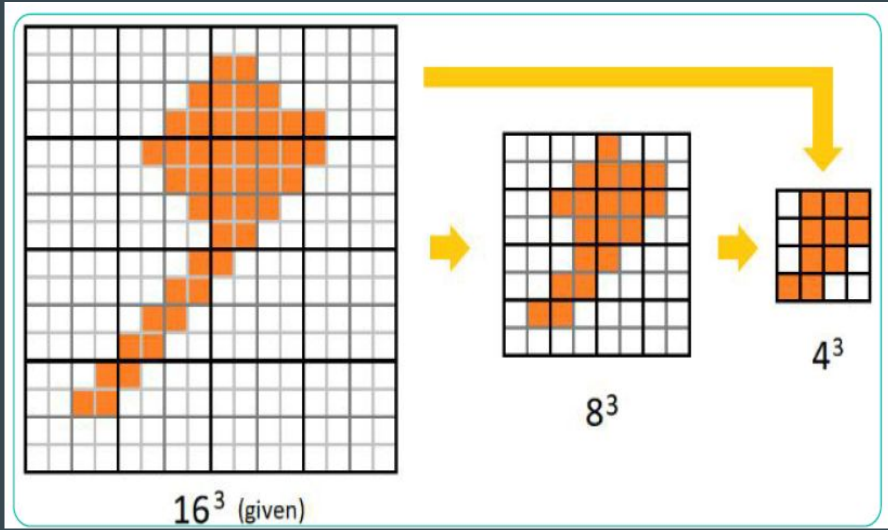
Definitions

- **ISO-SURFACE**
  An isosurface is a three-dimensional surface that represents points of a constant value within a volume of space. Thus for our purpose, the object we need to construct has a zero ISOsurface. A mesh surface can be reconstructed by finding the zero isosurface of the implicit field.

Data Preparation

We need a point value cloud for the training of our implicit decoder.

For 3D shapes, to get voxel models in different resolutions (16x16x16 to 128x128x128), we sample points on each resolution in order to train the model progressively.



Data Preparation

However, a naive sampling would imply taking the center of each voxel and thus produce ***n*** points in each dimension i.e., ***n x n x n*** points.

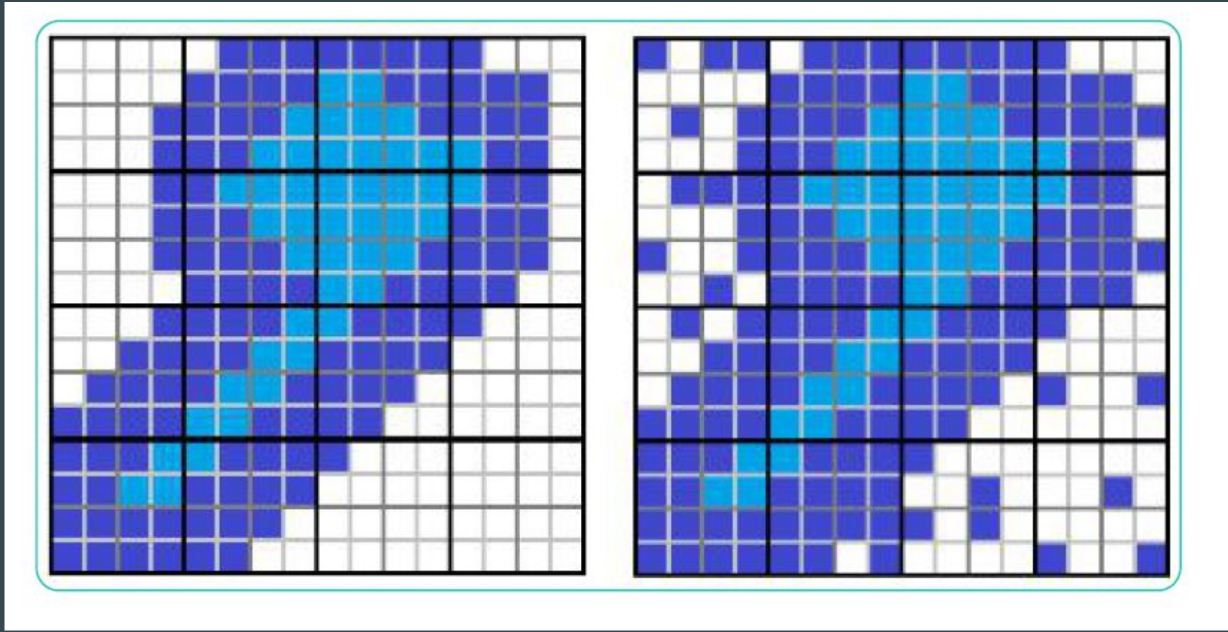
We aim to get n x n points and thus sample more points closer to the shape surfaces and neglect points far away.

To compensate for a density change, we assigned weights of all sampled points to 1, because we want the model to pay more attention to the surface and allow small errors in the void area.

Voxel grid resolution	16^3	32^3	64^3	128^3
Number of points	16^3	$16^3 \times 2$	32^3	$32^3 \times 4$

Data Preparation

Sample points which are within 3 voxel (in all x, y, z directions) from shape boundaries are taken. If the number of sampled points does not exceed the limit, randomly sample more points up to a limit.



Dataset Sample

Airplane dataset image sample at different resolutions and it is visualized at 3 axes:

RESOLUTION 16:

Dataset Sample

RESOLUTION 32:



Dataset Sample

RESOLUTION 64:

Next Steps in the Implementation

- Implementation of the CNN Auto-encoder
- IM-NET decoder unique to the paper is implemented.
- Implementation of GAN to demonstrate generation of models based on input models
- Results