The primary objective of this task is to compress meshes by representing them as Signed Distance Functions (SDFs) using different approaches. For instance, SIREN, NG-LOD and Instant-NGP. The modified Instant-NGP implementation is utilized to achieve a compact network size, enabling the compression of various 3D objects into lightweight SDF neural networks.

Signed Distance Function (SDF):

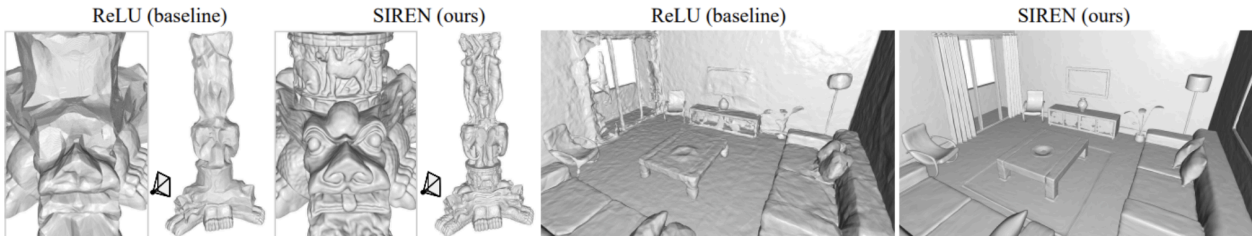
An SDF is a function that takes a point in 3D space as input and returns the distance from that point to the surface of the object. It is positive inside the object, zero on the boundary, and negative outside the object. SDF allows describing objects with minimal memory consumption and infinite resolution.

Neural Network Usage:

When an object is not represented as an SDF, there is a need to construct it. Storing SDF values for grid points and later interpolating between them is a naive approach with drawbacks. Advanced approaches involve constructing a neural network trained on sample points.

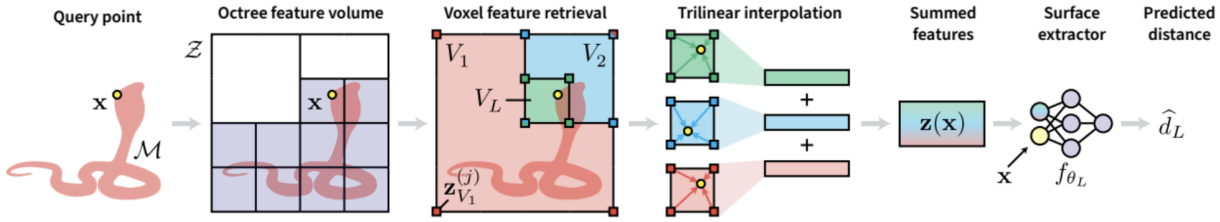
SIREN:

SIREN (SInusoidal REpresentation Networks) uses periodic activation functions (sinusoidal) instead of ReLU to represent fine details in signals. It is trained only on oriented point clouds, significantly increasing object details. The training loss involves points sampled on and off the mesh.



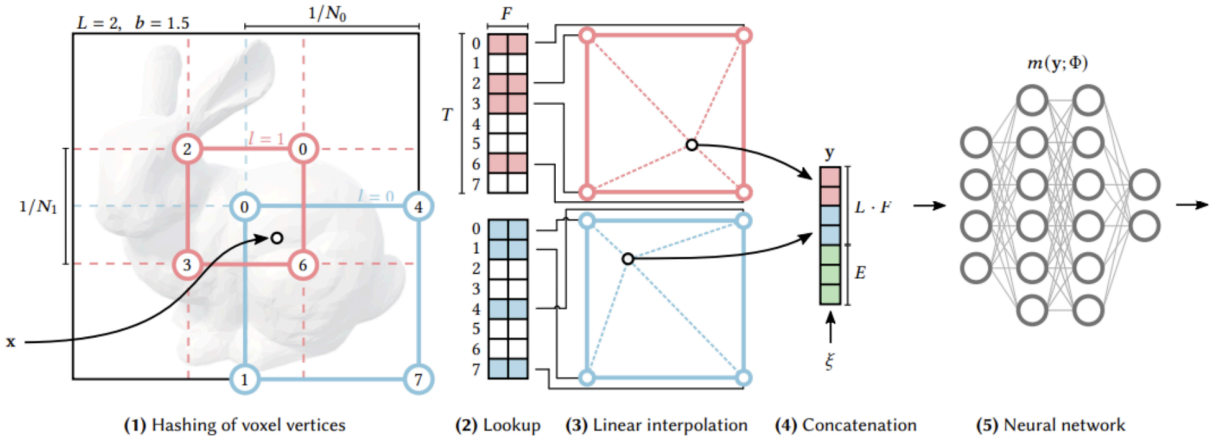
NG-LOD:

Neural Geometric Level Of Detail (NG-LOD) represents implicit surfaces using an octree-based feature volume, providing adaptive shapes with multiple LODs. It enables continuous LOD with SDF interpolation, capturing high-frequency details accurately.



Instant-NGP:

Instant-NGP reduces the training and evaluation cost by introducing a multiresolution hash encoding. It employs a smaller neural network augmented by a multiresolution hash table of trainable feature vectors. This method achieves a similar fidelity to NG-LOD with reduced computational cost.



Quality Measurement:

Quality is measured using the F1 score between the true SDF sign and predicted SDF sign of sampled points. Surface points with Gaussian noise and bounding volume

points are used for measurements. Instant-NGP is chosen for its balance between visual reconstruction quality, performance, and memory cost.

Conclusion:

The best approach would be Instant ngp. However, due to technical issues with setup using ready solutions on github the chosen approach was Siren. The mean f1 score for inside and outside were app. 0.41 and 0.46 while . Here is the tradeoff between choosing model size and accuracy. If we increase the amount of hidden layers the quality improves but the size of models gets bigger.

```
print(np.mean(surf_f1_lst))
print(np.mean(in_f1_lst))
print(np.mean(batch_ret))
```

```
0.4076579586533953
0.4625561133672501
0.004657868681282833
```