Geometric Computer Vision: Final Project

This notebook contains a revisited implementation of the paper: **Shape Non-rigid Kinematics (SNK): A Zero-Shot Method for Non-Rigid Shape Matching via Unsupervised Functional Map Regularized Reconstruction** by Attaiki and Ovsjanikov (2024).

Imports

```
from pyFM.functional import FunctionalMapping
from model_SURFMNet import SURFMNet
import numpy as np
import trimesh
from pyFM.mesh import TriMesh
import torch
from torch_geometric.data import Batch
from diffusion_net import DiffusionData, DiffusionOperatorsTransform,
DiffusionNet
from prism_decoder import PrismDecoder
import torch.optim as optim
from tqdm import tqdm
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d.art3d import Poly3DCollection
from matplotlib import cm
from loss import PrismRegularizationLoss
```

Load meshes

Let's first load the meshes of two dogs modified (non-rigid deformation using Blender):

```
# load some meshes
obj1 = r"./Samples/dog_small.obj"
obj2 = r"./Samples/dog_small_3.obj"
mesh1, mesh2 = TriMesh(obj1), TriMesh(obj2)
```

Compute correspondance from mesh2 to mesh1 using functional maps

I chose the pyFM package investigated in HW3 to compute a first correspondance map between

```
process_params = {
    'n_ev': (70, 70),  # Number of eigenvalues on source and Target
    'subsample_step': 20,  # In order not to use too many descriptors
    'descr_type': 'WKS',  # WKS or HKS
}
model = FunctionalMapping(mesh1, mesh2)
```

```
model.preprocess(**process_params, verbose=False)
fit_params = {
    'w_descr': 1e0,
    'w_lap': 1e-2,
    'w_dcomm': 1e-1,
    'w_orient': 0
}
model.fit(**fit_params, verbose=False)
p2p_21 = model.get_p2p(n_jobs=1)

import meshplot as mp

def double_plot_mp(myMesh1,myMesh2,cmap1=None,cmap2=None):
    p = mp.plot(myMesh1.vertlist, myMesh1.facelist, c=cmap1)
    v2_translated = myMesh2.vertlist.copy()
    f2_translated = myMesh2.facelist.copy()
    myMesh2_translated = TriMesh(v2_translated, f2_translated)
    myMesh2_translated.vertlist[:,0] =
myMesh2_translated.vertlist[:,0] + 30
    p.add_mesh(myMesh2_translated.vertlist,
myMesh2_translated.facelist, c=cmap2)

def visu(vertices):
    min_coord,max_coord =
np.min(vertices,axis=0,keepdims=True),np.max(vertices,axis=0,keepdims=
True)
    cmap = (vertices-min_coord)/(max_coord-min_coord)
    return cmap

cmap1 = visu(mesh1.vertlist); cmap2 = cmap1[p2p_21]
double_plot_mp(mesh1,mesh2,cmap1,cmap2)
```

{"model_id":"3c3b4574ea8945cc9537fb2e0f010ae3","version_major":2,"vers
ion_minor":0}

Compute latent vector

Following section 4.2 in the paper, we compute a latent vector (of length d1) per feature using DiffusionNet++ module, then apply max pooling to get a vector l of length d1. Then we aim to reconstruct the first shape by concatenating l to each feature of the second mesh and passing those to the decoder.

```
def compute_l(my_batch, diffusion_net):
    my_batch.x = my_batch.pos.clone()[0]
    output = diffusion_net(my_batch)
    l = output.x.max(dim=0).values
    return l

def reconstruct_s2(my_batch2, v2_t, l, decoder):
```

```
    l_expanded = l.unsqueeze(0).repeat(v2_t.shape[0],1)
    my_batch2.x = torch.cat((v2_t,l_expanded),dim=1) #.unsqueeze(0)
    s3 = decoder(my_batch2)
    return s3
```

Encode the first mesh using a DiffusionNet++ model

```
mesh1_diff = trimesh.load(obj1)
v1, f1 = np.array(mesh1.vertices), np.array(mesh1.faces)
v1_t = torch.from_numpy(v1)
f1_t = torch.from_numpy(f1)
data1 = DiffusionData(pos=v1_t, face=f1_t.T)
diffusion_transform = DiffusionOperatorsTransform(n_eig=50)  #97
compute the diffusion net operators with 97 eigenvalues
data1 = diffusion_transform(data1)
my_batch = Batch.from_data_list([data1])
my_batch.pos = my_batch.pos.unsqueeze(0)

mesh2_diff = trimesh.load(obj2)
v2, f2 = np.array(mesh2.vertices), np.array(mesh2.faces)
data2 = DiffusionData(pos=torch.from_numpy(v2),
face=torch.from_numpy(f2).T)
diffusion_transform = DiffusionOperatorsTransform(n_eig=50)  #97
compute the diffusion net operators with 97 eigenvalues
data2 = diffusion_transform(data2)
my_batch2 = Batch.from_data_list([data2])
my_batch2.pos = my_batch2.pos.unsqueeze(0)
#######
v2_t = torch.Tensor(v2)

my_batch.pos.requires_grad = True
v2_t.requires_grad = True
my_batch2.pos.requires_grad = True

print(my_batch)
print(my_batch2)
```

```
DiffusionDataBatch(pos=[1, 541, 3], face=[3, 1078], mass=[541, 541],
nnz=541], evals=[50], evecs=[541, 50], gradX=[541, 541, nnz=3775],
gradY=[541, 541, nnz=3775], L=[541, 541, nnz=3775], batch=[541],
ptr=[2])
DiffusionDataBatch(pos=[1, 487, 3], face=[3, 970], mass=[487, 487,
nnz=487], evals=[50], evecs=[487, 50], gradX=[487, 487, nnz=3397],
gradY=[487, 487, nnz=3397], L=[487, 487, nnz=3397], batch=[487],
ptr=[2])
```

```
from torch.sparse import mm
from model_SURFMNet import FunctionalMapNet
diffusion_net = DiffusionNet(3, 42)
my_batch.x = my_batch.pos.clone()[0]
```

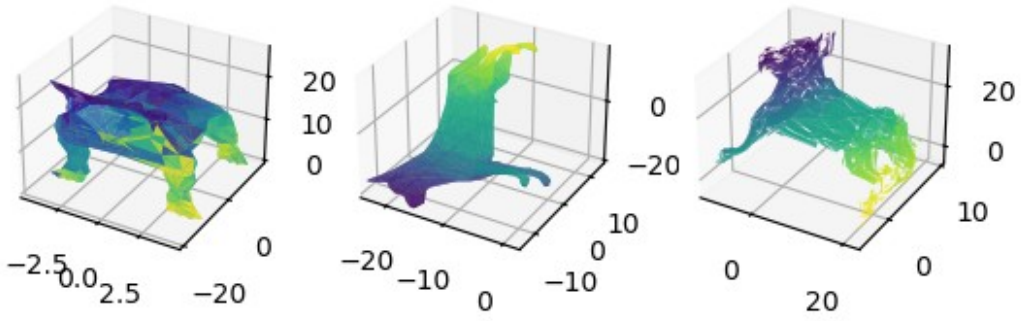
```
my_batch2.x = my_batch2.pos.clone()[0]
output1 = diffusion_net(my_batch)
output2 = diffusion_net(my_batch2)
evecs_T_1 = output1.evecs.t() @ output1.mass.to_dense()
evecs_T_2 = output2.evecs.t() @ output2.mass.to_dense()
fm_net = FunctionalMapNet() #SURFMNet
C1, C2 = fm_net(output1.x.unsqueeze(0), output2.x.unsqueeze(0),
evecs_T_1.unsqueeze(0), evecs_T_2.unsqueeze(0))
emb1 = output1.evecs #evects1[:, :k1] @ FM_12.T
emb2 = output2.evecs @ C1.squeeze() #evects1[:, :k1] @ FM_12.T
dist = torch.cdist(emb1, emb2)#, dim=1, p=None)
knn = dist.topk(1, largest=False, dim=0)

def double_plot(myMesh1, myMesh2, cmap1=None, cmap2=None,
title1='Mesh1',title2='Mesh2'):
    fig = plt.figure(figsize=plt.figaspect(0.5))
    ax1 = fig.add_subplot(1, 2, 1, projection='3d')
    ax1.plot_trisurf(myMesh1.vertlist[:, 0], myMesh1.vertlist[:, 1],
myMesh1.vertlist[:, 2],
                     triangles=myMesh1.facelist, cmap='viridis',
facecolors=cmap1)
    ax1.set_title(title1)
    ax2 = fig.add_subplot(1, 2, 2, projection='3d')
    ax2.plot_trisurf(myMesh2.vertlist[:, 0], myMesh2.vertlist[:, 1],
myMesh2.vertlist[:, 2],
                     triangles=myMesh2.facelist, cmap='viridis',
facecolors=cmap2)
    ax2.set_title(title2)
# cmap1 = visu(v1_remapped)
# cmap2 = visu(s3.features.detach().squeeze(0).numpy())
# double_plot(mesh1, mesh2, cmap1, cmap2, '', '')

def visu_face_colors(s1_faces_raw, s1_faces, s2_faces, s3_faces):

    cmap = cm.get_cmap('viridis', s3_faces.shape[0])  # Use a colormap
with 500 distinct colors
    face_colors = cmap(np.linspace(0, 1, s3_faces.shape[0]))

    average_z = np.mean(s2_faces[:, :, 2], axis=1)
    sorted_indices = np.argsort(average_z)

    sorted_s3_faces = s3_faces[sorted_indices]
    sorted_s2_faces = s2_faces[sorted_indices]
    sorted_s1_faces = s1_faces[sorted_indices]
    fig = plt.figure()
    ax1 = fig.add_subplot(131, projection='3d')
    ax2 = fig.add_subplot(132, projection='3d')
    ax3 = fig.add_subplot(133, projection='3d')
    for i, face in enumerate(s3_faces):
        # poly3d = [[vertices[vert_idx] for vert_idx in face]]
```

```
        poly3d_1 = [sorted_s1_faces[i]]
        poly3d_2 = [sorted_s2_faces[i]]
        poly3d_1_raw = [s1_faces_raw[i]]
        poly3d_3 = [sorted_s3_faces[i]]
        ax1.add_collection3d(Poly3DCollection(poly3d_1,
facecolors=face_colors[i], linewidths=1, edgecolors=None, alpha=.8))
        ax1.add_collection3d(Poly3DCollection(poly3d_1_raw,
facecolors='b', linewidths=1, edgecolors=None, alpha=.1))
        ax2.add_collection3d(Poly3DCollection(poly3d_2,
facecolors=face_colors[i], linewidths=1, edgecolors=None, alpha=.8))
        ax3.add_collection3d(Poly3DCollection(poly3d_3,
facecolors=face_colors[i], linewidths=1, edgecolors=None, alpha=.8))
    ax1.set_xlim([s1_faces[:,:,0].min(), s1_faces[:,:,0].max()])
    ax1.set_ylim([s1_faces[:,:,1].min(), s1_faces[:,:,1].max()])
    ax1.set_zlim([s1_faces[:,:,2].min(), s1_faces[:,:,2].max()])
    ax2.set_xlim([s2_faces[:,:,0].min(), s2_faces[:,:,0].max()])
    ax2.set_ylim([s2_faces[:,:,1].min(), s2_faces[:,:,1].max()])
    ax2.set_zlim([s2_faces[:,:,2].min(), s2_faces[:,:,2].max()])
    ax3.set_xlim([s3_faces[:,:,0].min(), s3_faces[:,:,0].max()])
    ax3.set_ylim([s3_faces[:,:,1].min(), s3_faces[:,:,1].max()])
    ax3.set_zlim([s3_faces[:,:,2].min(), s3_faces[:,:,2].max()])
    plt.show()

def compute_centroid(face):
    return np.mean(face, axis=0)

def find_closest_faces(lf1, lf2):
    centroids_lf1 = np.array([compute_centroid(face) for face in lf1])
    centroids_lf2 = np.array([compute_centroid(face) for face in lf2])

    closest_faces = []
    closest_faces_idx = []

    for centroid in centroids_lf2:
        distances = np.linalg.norm(centroids_lf1 - centroid, axis=1)
        closest_face_idx = np.argmin(distances)
        while closest_face_idx in closest_faces_idx:
            distances[closest_face_idx] = max(distances) + 1
            closest_face_idx = np.argmin(distances)
        closest_faces.append(lf1[closest_face_idx])
        closest_faces_idx.append(closest_face_idx)
    return closest_faces_idx

v1s = my_batch.pos.reshape(-1, 3)
f1s = my_batch.face.t()
s1_faces_tmp = v1s[f1s].detach().numpy()

def compute_fmaps(my_batch, my_batch2, diff_net_fts):
    my_batch.x = my_batch.pos.clone()[0]
    my_batch2.x = my_batch2.pos.clone()[0]
```

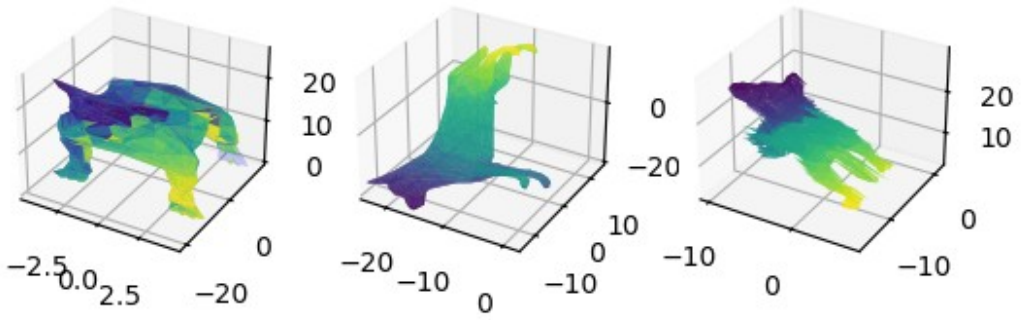
```
    output1 = diff_net_fts(my_batch)
    output2 = diff_net_fts(my_batch2)
    evecs_T_1 = output1.evecs.t() @ output1.mass.to_dense()
    evecs_T_2 = output2.evecs.t() @ output2.mass.to_dense()
    fm_net = FunctionalMapNet() #SURFMNet
    C1, C2 = fm_net(output1.x.unsqueeze(0), output2.x.unsqueeze(0),
evecs_T_1.unsqueeze(0), evecs_T_2.unsqueeze(0))
    emb1 = output1.evecs #evects1[:, :k1] @ FM_12.T
    emb2 = output2.evecs @ C1.squeeze() #evects1[:, :k1] @ FM_12.T
    dist = torch.cdist(emb1, emb2)#, dim=1, p=None)
    knn = dist.topk(1, largest=False, dim=0)
    p2p_21 = knn.indices.squeeze(0)
    return C1, C2, p2p_21

L_SPACE_SIZE = 42
diff_net_fts  = DiffusionNet(3, 42)
diffusion_net = DiffusionNet(3, L_SPACE_SIZE)
decoder = PrismDecoder(v1.shape[1]+L_SPACE_SIZE, v1.shape[0])
get_energy_loss = PrismRegularizationLoss(100)

diffusion_net.first_lin.weight.grad

# %debug
# l = compute_l(my_batch)
# s3 = reconstruct_s2(my_batch2, v2_t, l)
optimizer_diffnet = optim.AdamW(diffusion_net.parameters() ,lr=0.001,
weight_decay=0.001)
optimizer_diffnet_fts =
optim.AdamW(diff_net_fts.parameters() ,lr=0.001, weight_decay=0.001)
optimizer_decoder = optim.AdamW(decoder.parameters() ,lr=0.001,
weight_decay=0.001)
for epoch in (pbar:=tqdm(range(10000))):
    l = compute_l(my_batch, diffusion_net)
    l.retain_grad()
    s3 = reconstruct_s2(my_batch2, v2_t, l, decoder)
    s3.features.retain_grad()
    ###################################
    C1, C2, p2p_21 = compute_fmaps(my_batch, my_batch2, diff_net_fts)
    C1.retain_grad()
    C2.retain_grad()
    # p2p_21.retain_grad()
    ###################################
    v1_remapped = v1[p2p_21]
    loss_MSE =
torch.nn.functional.mse_loss(torch.Tensor(v1_remapped),s3.features)
    loss_FMAPS_1 = torch.nn.functional.mse_loss(C1@C2, torch.eye(50))
+ torch.nn.functional.mse_loss(C1.transpose(1,2)@C1, torch.eye(50))
    loss_FMAPS_2 = torch.nn.functional.mse_loss(C2@C1, torch.eye(50))
+ torch.nn.functional.mse_loss(C2.transpose(1,2)@C1, torch.eye(50))
    loss_E = get_energy_loss(s3.transformed_prism, s3.rotations,
```

```
s3.pos.reshape(-1, 3), s3.face)
    total_loss = 1e-10*loss_FMAPS_1 + 1e-10*loss_FMAPS_2 + loss_MSE +
loss_E*10
    pbar.set_description(f"{total_loss.detach():3f}")
    loss_MSE.retain_grad()
    loss_FMAPS_1.retain_grad()
    loss_FMAPS_2.retain_grad()
    loss_E.retain_grad()
    total_loss.backward()
    # import ipdb; ipdb.set_trace()
    # my_batch2.pos = my_batch2.pos.squeeze(0)
    optimizer_diffnet.step()
    optimizer_diffnet.zero_grad()
    optimizer_decoder.step()
    optimizer_decoder.zero_grad()
    optimizer_diffnet_fts.step()
    optimizer_diffnet_fts.zero_grad()
    if epoch%100 == 0:
        print(f'Epoch {epoch}: MSE loss = {loss_MSE}')
        print(f'Epoch {epoch}: Energy loss = {10*loss_E}')
        print(f'Epoch {epoch}: f1 loss = {1e-10*loss_FMAPS_1}')
        print(f'Epoch {epoch}: f2 loss = {1e-10*loss_FMAPS_2}')
        verts = my_batch2.pos.reshape(-1, 3)
        faces = my_batch2.face.t()
        s2_faces = verts[faces].detach().numpy()
        s3_faces = s3.transformed_prism.detach().squeeze(0).numpy()
        # closest_faces_idx = find_closest_faces(s3_faces,
s1_faces_tmp)
        closest_faces_idx =
find_closest_faces(s1_faces_tmp,s3_faces)#, s1_faces_tmp)
        s1_faces = s1_faces_tmp[closest_faces_idx]
        visu_face_colors(s1_faces_tmp, s1_faces, s2_faces, s3_faces)
        plt.show()

  0%|
| 0/10000 [00:00<?, ?it/s]C:\Users\Hadassa-Port\AppData\Local\Temp\
ipykernel_21200\2945219647.py:19: UserWarning: Using a target size
(torch.Size([1, 487, 3])) that is different to the input size
(torch.Size([487, 3])). This will likely lead to incorrect results due
to broadcasting. Please ensure they have the same size.
  loss_MSE =
torch.nn.functional.mse_loss(torch.Tensor(v1_remapped),s3.features)
C:\Users\Hadassa-Port\AppData\Local\Temp\
ipykernel_21200\2945219647.py:20: UserWarning: Using a target size
(torch.Size([50, 50])) that is different to the input size
(torch.Size([1, 50, 50])). This will likely lead to incorrect results
due to broadcasting. Please ensure they have the same size.
  loss_FMAPS_1 = torch.nn.functional.mse_loss(C1@C2, torch.eye(50)) +
torch.nn.functional.mse_loss(C1.transpose(1,2)@C1, torch.eye(50))
C:\Users\Hadassa-Port\AppData\Local\Temp\
```

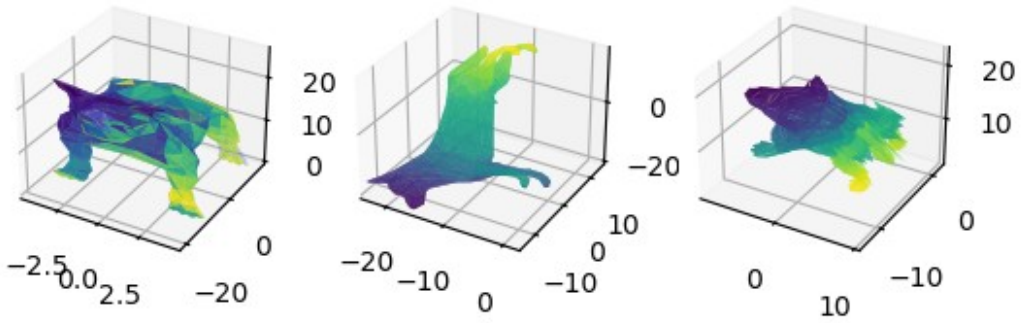
```
ipykernel_21200\2945219647.py:21: UserWarning: Using a target size
(torch.Size([50, 50])) that is different to the input size
(torch.Size([1, 50, 50])). This will likely lead to incorrect results
due to broadcasting. Please ensure they have the same size.
  loss_FMAPS_2 = torch.nn.functional.mse_loss(C2@C1, torch.eye(50)) +
torch.nn.functional.mse_loss(C2.transpose(1,2)@C1, torch.eye(50))
C:\Users\Hadassa-Port\Desktop\hadassa\Toar 2\Semester 1\Geometric
Computer Vision\SNK\loss.py:28: UserWarning: Using torch.cross without
specifying the dim arg is deprecated.
Please either pass the dim explicitly or simply use
torch.linalg.cross.
The default value of dim will change to agree with that of
linalg.cross in a future release. (Triggered internally at ..\aten\
src\ATen\native\Cross.cpp:66.)
  normal = torch.cross(edge1, edge2)
441.944489:   0%|
| 0/10000 [00:00<?, ?it/s]

Epoch 0: MSE loss = 138.4190216064453
Epoch 0: Energy loss = 303.43438720703125
Epoch 0: f1 loss = 0.014822783879935741
Epoch 0: f2 loss = 0.07625257223844528

C:\Users\Hadassa-Port\AppData\Local\Temp\
ipykernel_21200\2975563605.py:3: MatplotlibDeprecationWarning: The
get_cmap function was deprecated in Matplotlib 3.7 and will be removed
two minor releases later. Use ``matplotlib.colormaps[name]`` or
``matplotlib.colormaps.get_cmap(obj)`` instead.
  cmap = cm.get_cmap('viridis', s3_faces.shape[0])  # Use a colormap
with 500 distinct colors
```



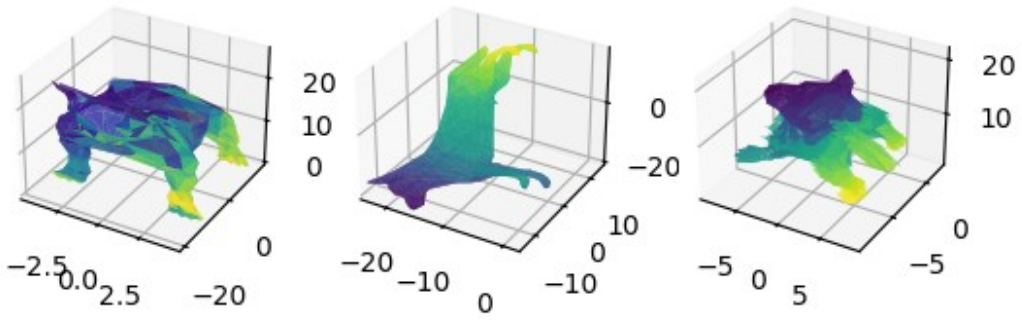

```
101.306755:   1%|
| 100/10000 [02:40<3:41:11,  1.34s/it]

Epoch 100: MSE loss = 84.59368896484375
Epoch 100: Energy loss = 15.418474197387695
Epoch 100: f1 loss = 0.5673588514328003
Epoch 100: f2 loss = 0.7272352576255798
```



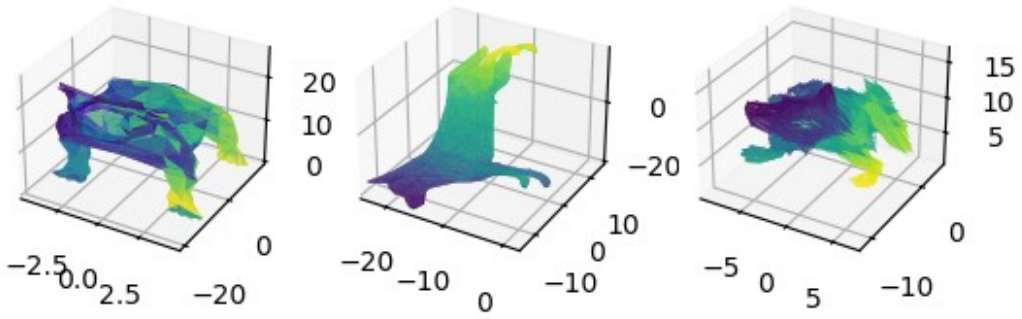

```
389.330383:   2%|
| 200/10000 [05:17<3:25:09,  1.26s/it]

Epoch 200: MSE loss = 62.243560791015625
Epoch 200: Energy loss = 14.786492347717285
Epoch 200: f1 loss = 116.22406005859375
Epoch 200: f2 loss = 196.07626342773438
```



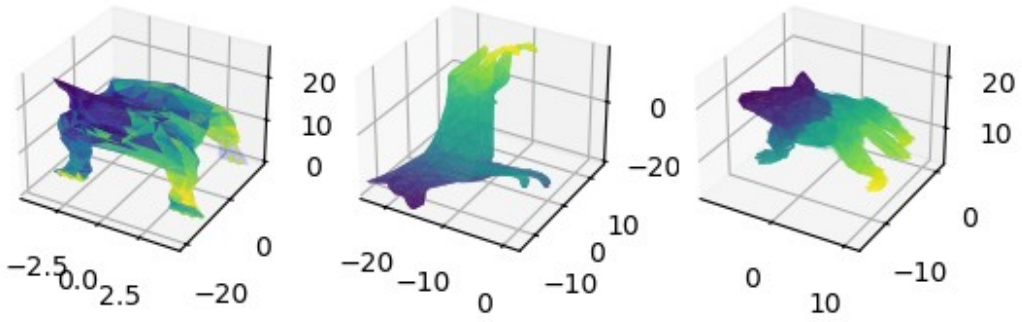

```
78.396454:   3%|
| 300/10000 [07:53<3:23:45,  1.26s/it]

Epoch 300: MSE loss = 62.15915298461914
Epoch 300: Energy loss = 16.153026580810547
Epoch 300: f1 loss = 0.01310831680893898
Epoch 300: f2 loss = 0.07116103917360306
```



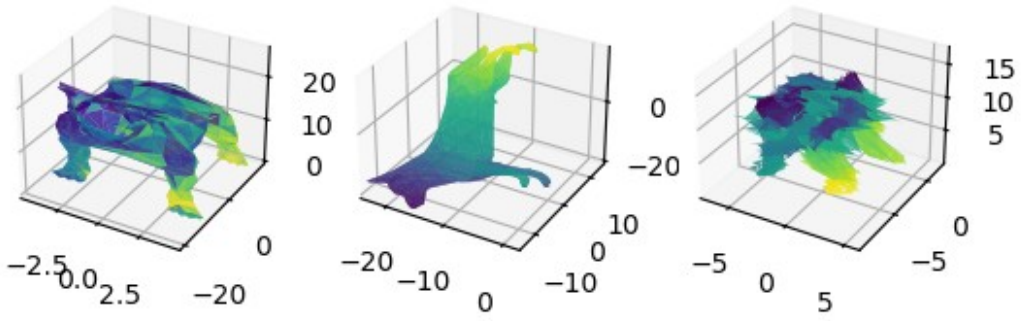

```
110.424339:   4%|▊
| 400/10000 [10:30<3:19:16,  1.25s/it]

Epoch 400: MSE loss = 85.4991683959961
Epoch 400: Energy loss = 17.634859085083008
Epoch 400: f1 loss = 0.0022359283175319433
Epoch 400: f2 loss = 7.288074493408203
```



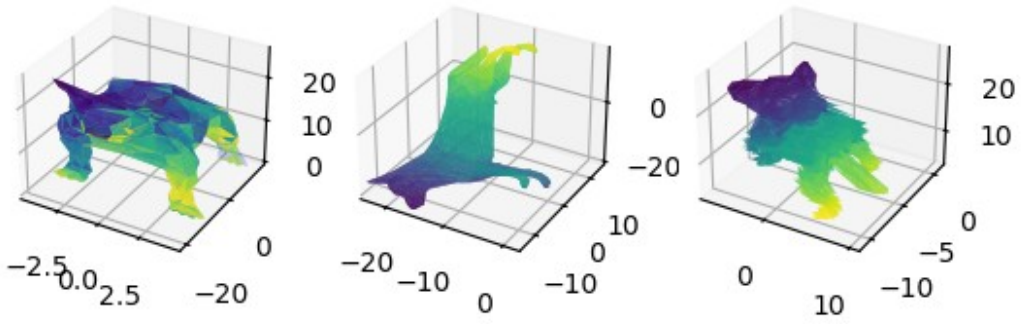

```
64.594574:   5%|▉
| 500/10000 [13:03<3:17:11,  1.25s/it]

Epoch 500: MSE loss = 54.403465270996094
Epoch 500: Energy loss = 9.752196311950684
Epoch 500: f1 loss = 0.37450987100601196
Epoch 500: f2 loss = 0.06440340727567673
```



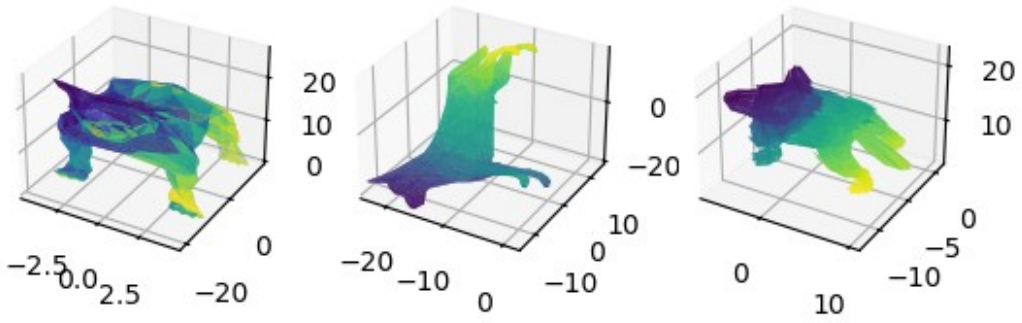

```
191.702759:   6%|▉         
| 600/10000 [15:42<3:19:24,  1.27s/it]

Epoch 600: MSE loss = 158.76788330078125
Epoch 600: Energy loss = 21.617042541503906
Epoch 600: f1 loss = 8.677755355834961
Epoch 600: f2 loss = 2.6400654315948486
```



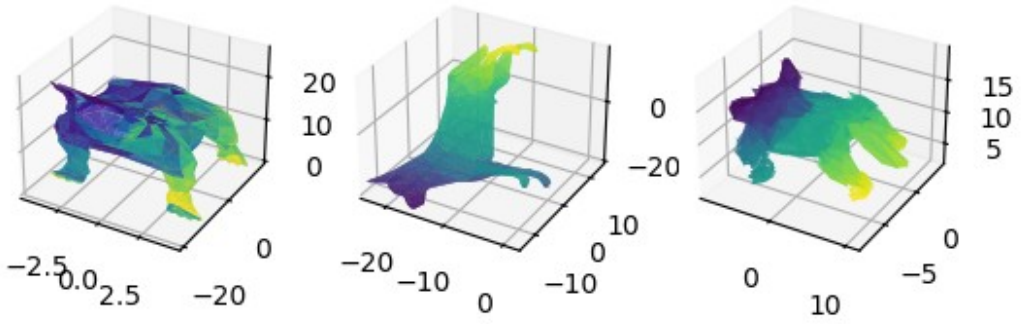

```
205.595535:   7%|▉         
| 700/10000 [18:30<3:09:08,  1.22s/it]

Epoch 700: MSE loss = 192.72781372070312
Epoch 700: Energy loss = 11.030577659606934
Epoch 700: f1 loss = 0.14665056765079498
Epoch 700: f2 loss = 1.6904958486557007
```



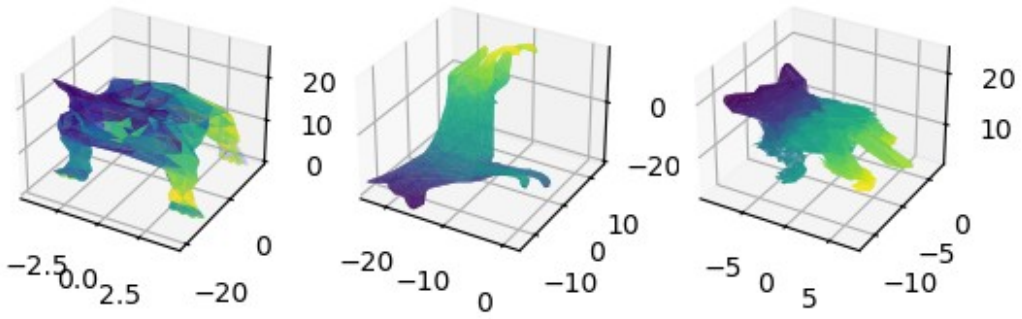

```
142.739319:   8%|
| 800/10000 [21:05<3:09:25,  1.24s/it]

Epoch 800: MSE loss = 131.19796752929688
Epoch 800: Energy loss = 11.491016387939453
Epoch 800: f1 loss = 0.03889824077486992
Epoch 800: f2 loss = 0.011435823515057564
```



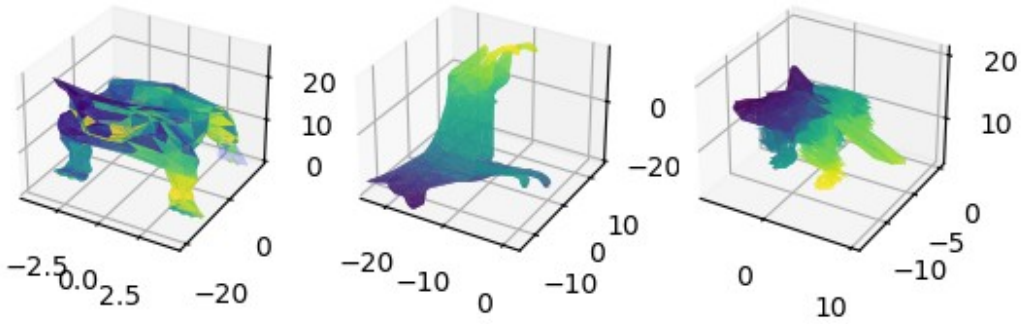

```
76.922302:   9%|
| 900/10000 [23:49<3:42:16,  1.47s/it]

Epoch 900: MSE loss = 64.81265258789062
Epoch 900: Energy loss = 11.948801040649414
Epoch 900: f1 loss = 0.005377727095037699
Epoch 900: f2 loss = 0.1554747372865677
```



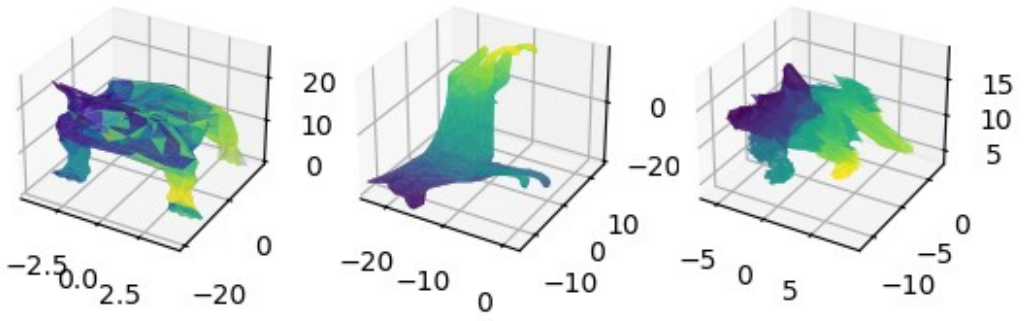

```
199.078140:  10%|
| 1000/10000 [26:58<3:32:11,  1.41s/it]

Epoch 1000: MSE loss = 74.0458755493164
Epoch 1000: Energy loss = 11.746149063110352
Epoch 1000: f1 loss = 112.19220733642578
Epoch 1000: f2 loss = 1.0939030647277832
```



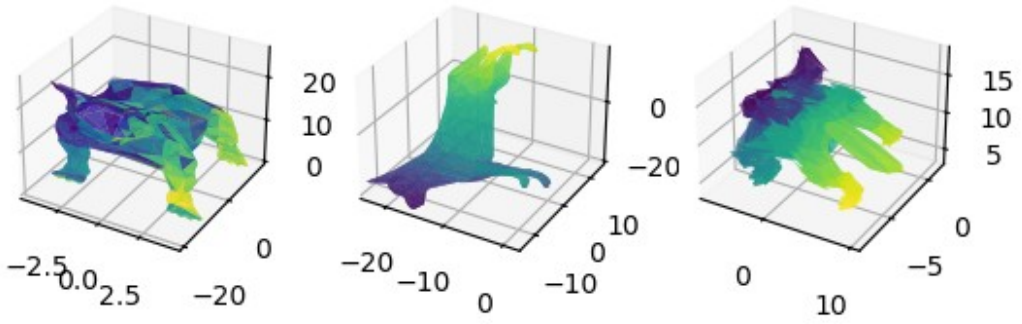

```
51.597801:  11%|
| 1100/10000 [30:21<4:00:55,  1.62s/it]

Epoch 1100: MSE loss = 35.986412048339844
Epoch 1100: Energy loss = 15.169523239135742
Epoch 1100: f1 loss = 0.029017485678195953
Epoch 1100: f2 loss = 0.4128505289554596
```



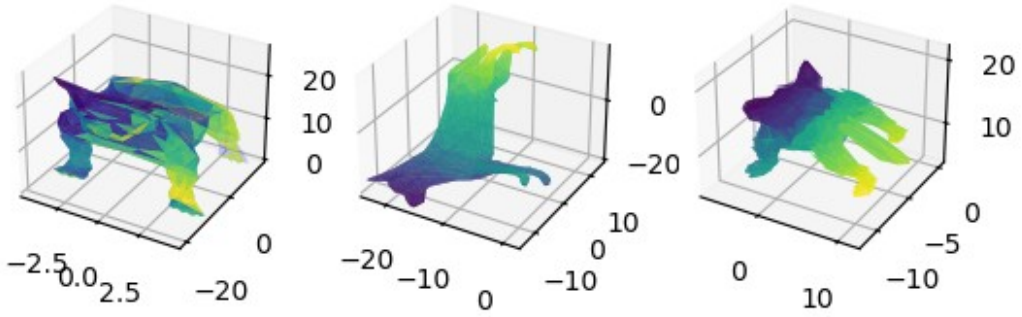

```
73.428291:  12%|
| 1200/10000 [33:41<3:11:45,  1.31s/it]

Epoch 1200: MSE loss = 57.123775482177734
Epoch 1200: Energy loss = 16.2049503326416
Epoch 1200: f1 loss = 0.08186553418636322
Epoch 1200: f2 loss = 0.017696553841233253
```



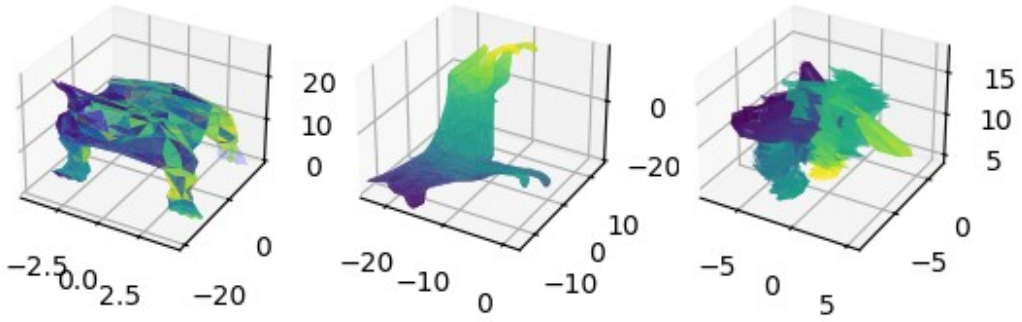

```
46.046829:  13%|
| 1300/10000 [37:10<3:11:11,  1.32s/it]

Epoch 1300: MSE loss = 31.36875343322754
Epoch 1300: Energy loss = 14.604534149169922
Epoch 1300: f1 loss = 0.001092314487323165
Epoch 1300: f2 loss = 0.07245117425918579
```



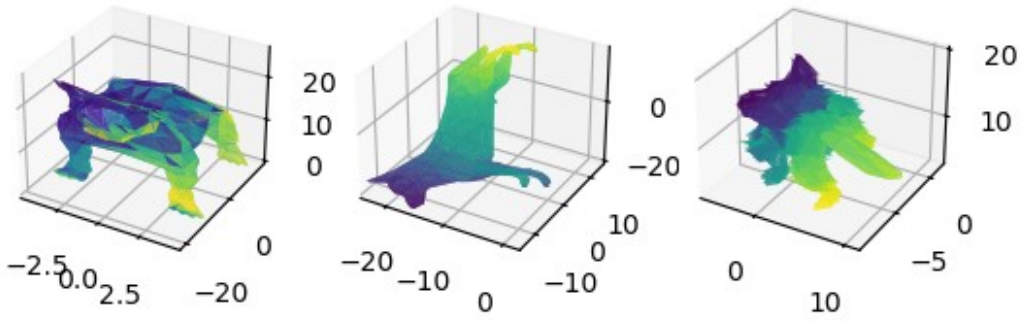

```
118.135956:  14%|
| 1400/10000 [41:14<3:11:47,  1.34s/it]

Epoch 1400: MSE loss = 106.15186309814453
Epoch 1400: Energy loss = 11.93130111694336
Epoch 1400: f1 loss = 0.04649919271469116
Epoch 1400: f2 loss = 0.006287424359470606
```



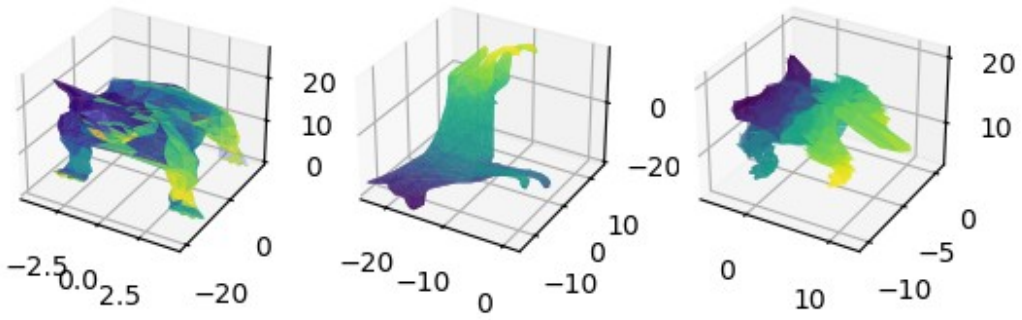

```
71.062225:  15%|
| 1500/10000 [44:36<4:06:58,  1.74s/it]

Epoch 1500: MSE loss = 50.54459762573242
Epoch 1500: Energy loss = 20.486000061035156
Epoch 1500: f1 loss = 0.03056538663804531
Epoch 1500: f2 loss = 0.0010624895803630352
```



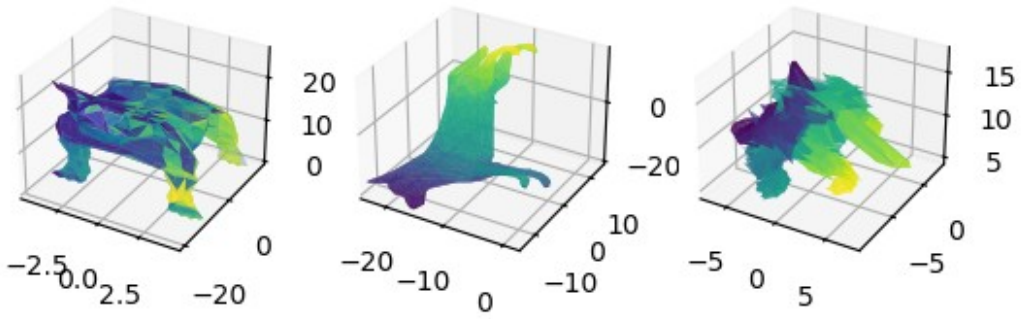

```
103.634705:  16%|
| 1600/10000 [48:37<4:20:22,  1.86s/it]

Epoch 1600: MSE loss = 88.33651733398438
Epoch 1600: Energy loss = 15.207642555236816
Epoch 1600: f1 loss = 0.0004653192590922117
Epoch 1600: f2 loss = 0.09008392691612244
```



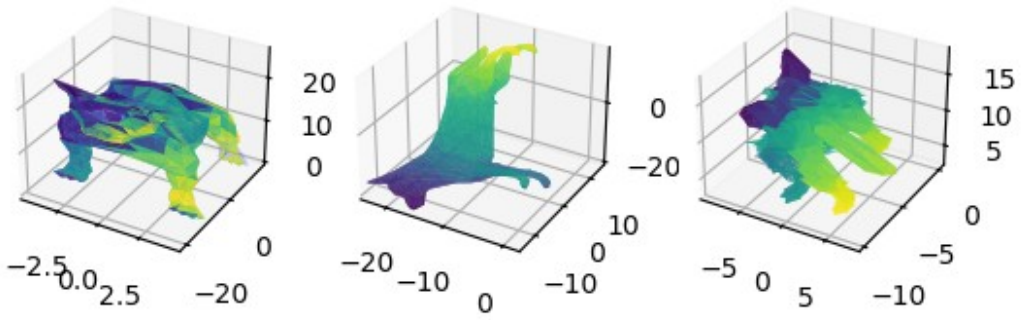

```
61.896221:  17%|
| 1700/10000 [52:01<3:33:07,  1.54s/it]

Epoch 1700: MSE loss = 48.62522506713867
Epoch 1700: Energy loss = 13.07433032989502
Epoch 1700: f1 loss = 0.006607468705624342
Epoch 1700: f2 loss = 0.19005973637104034
```



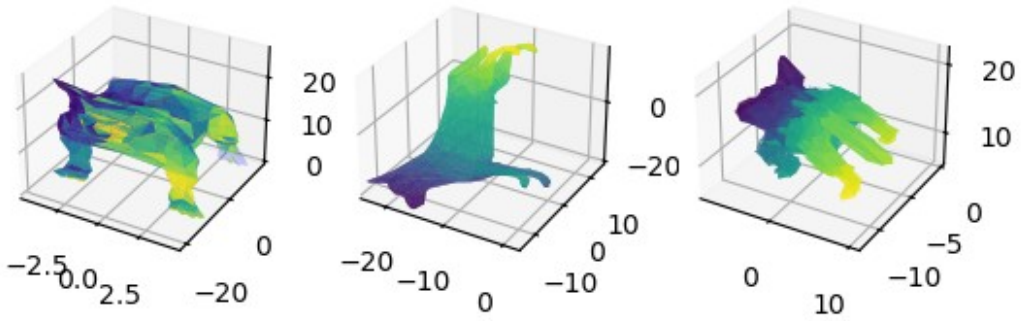

```
58135.273438:  18%|
| 1800/10000 [55:19<3:29:30,  1.53s/it]

Epoch 1800: MSE loss = 27.78762435913086
Epoch 1800: Energy loss = 17.796245574951172
Epoch 1800: f1 loss = 58011.9375
Epoch 1800: f2 loss = 77.75072479248047
```



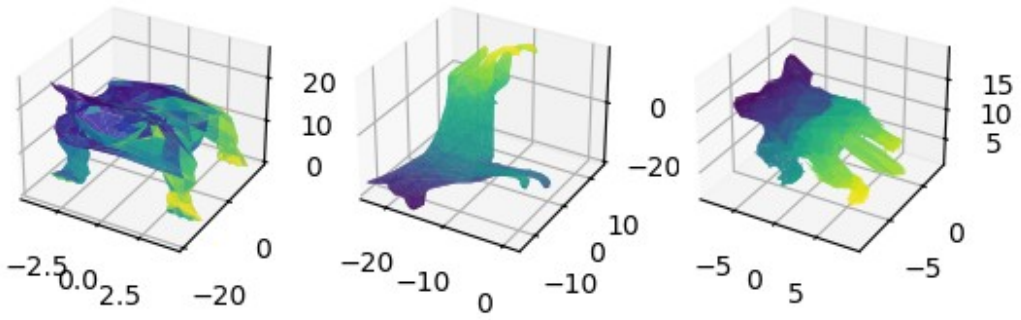

```
134.287643:  19%|
| 1900/10000 [58:45<3:36:09,  1.60s/it]

Epoch 1900: MSE loss = 118.1742172241211
Epoch 1900: Energy loss = 15.890031814575195
Epoch 1900: f1 loss = 0.19845710694789886
Epoch 1900: f2 loss = 0.02494070865213871
```



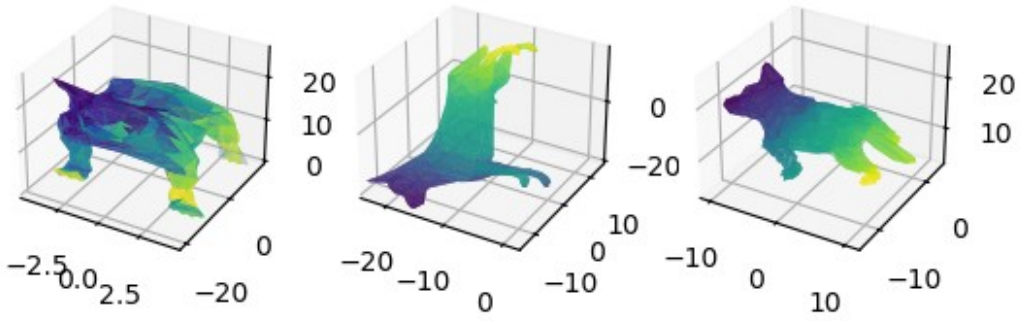

```
91.834633:  20%|
| 2000/10000 [1:02:09<3:05:55,  1.39s/it]

Epoch 2000: MSE loss = 66.97698974609375
Epoch 2000: Energy loss = 13.020589828491211
Epoch 2000: f1 loss = 11.77174186706543
Epoch 2000: f2 loss = 0.06530854105949402
```



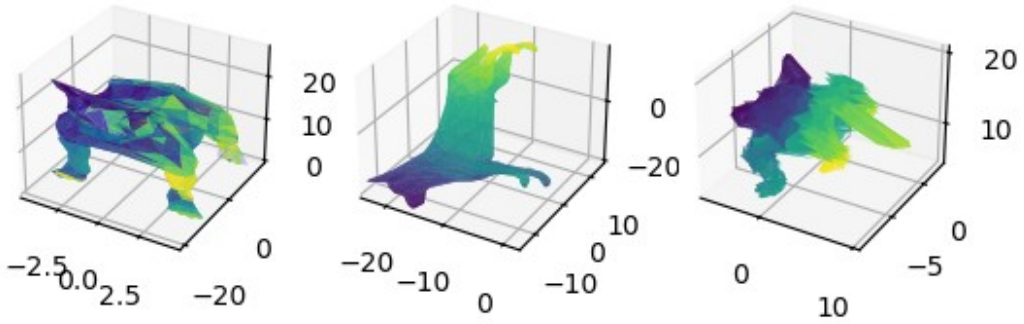

```
194.612015:  21%|
| 2100/10000 [1:05:34<2:55:52,  1.34s/it]

Epoch 2100: MSE loss = 44.03076934814453
Epoch 2100: Energy loss = 13.104503631591797
Epoch 2100: f1 loss = 107.11314392089844
Epoch 2100: f2 loss = 30.36359977722168
```



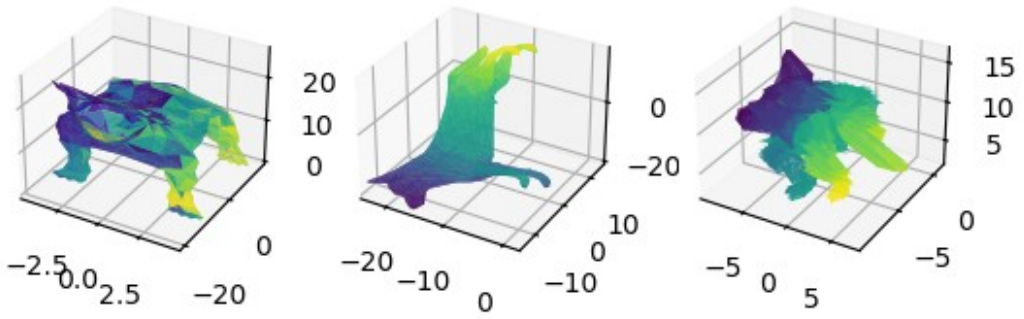

```
135.633987:  22%|
| 2200/10000 [1:08:56<2:54:38,  1.34s/it]

Epoch 2200: MSE loss = 125.95999908447266
Epoch 2200: Energy loss = 8.396061897277832
Epoch 2200: f1 loss = 0.5419024229049683
Epoch 2200: f2 loss = 0.7360300421714783
```



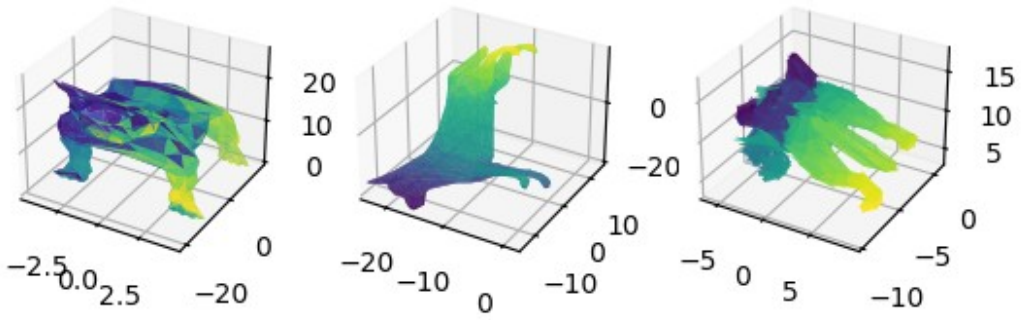

```
135.777557:  23%|
| 2300/10000 [1:12:09<3:20:24,  1.56s/it]

Epoch 2300: MSE loss = 120.1104736328125
Epoch 2300: Energy loss = 15.652190208435059
Epoch 2300: f1 loss = 0.0036718028131872416
Epoch 2300: f2 loss = 0.011231154203414917
```



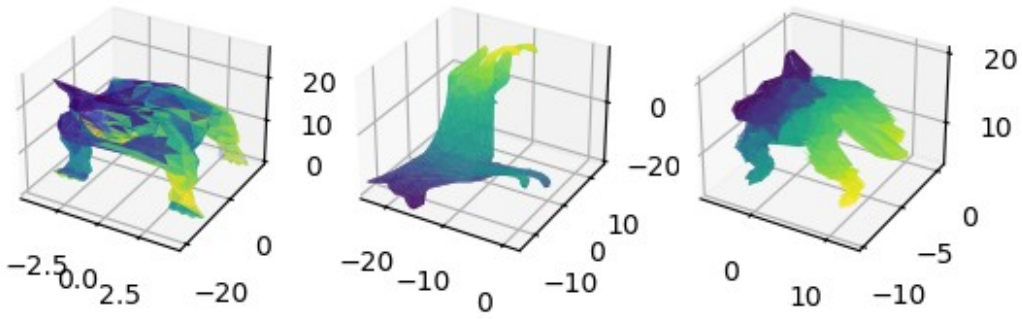

```
92.570679:  24%|████████████████████████████████
| 2400/10000 [1:15:31<2:49:36,  1.34s/it]

Epoch 2400: MSE loss = 76.92635345458984
Epoch 2400: Energy loss = 15.631635665893555
Epoch 2400: f1 loss = 0.0034903977066278458
Epoch 2400: f2 loss = 0.009200639091432095
```



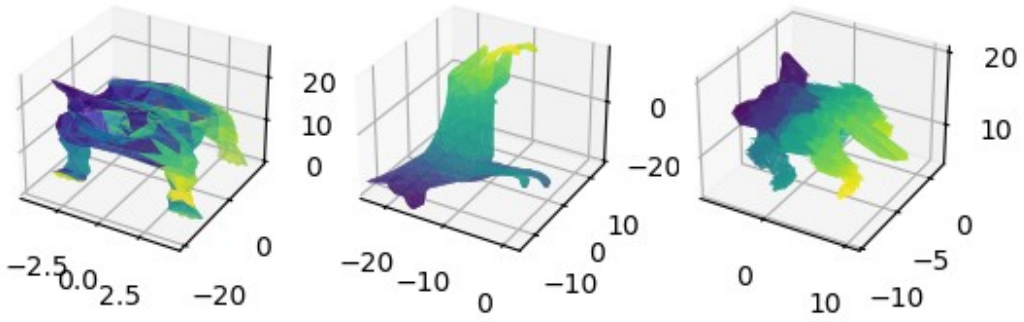

```
71.552452:  25%|████████████████████████████████
| 2500/10000 [1:18:57<2:57:07,  1.42s/it]

Epoch 2500: MSE loss = 47.19223403930664
Epoch 2500: Energy loss = 14.415288925170898
Epoch 2500: f1 loss = 9.758109092712402
Epoch 2500: f2 loss = 0.1868216097354889
```



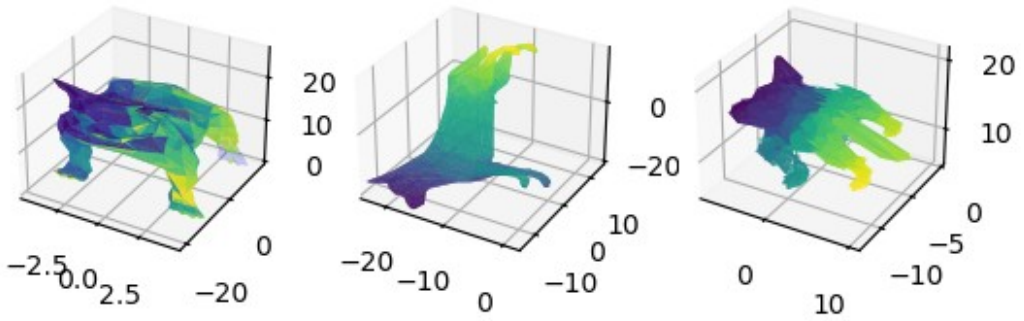

```
81.699722:  26%|
| 2600/10000 [1:22:24<3:18:14,  1.61s/it]

Epoch 2600: MSE loss = 70.85128021240234
Epoch 2600: Energy loss = 10.847509384155273
Epoch 2600: f1 loss = 0.0001780273742042482
Epoch 2600: f2 loss = 0.0007531830342486501
```



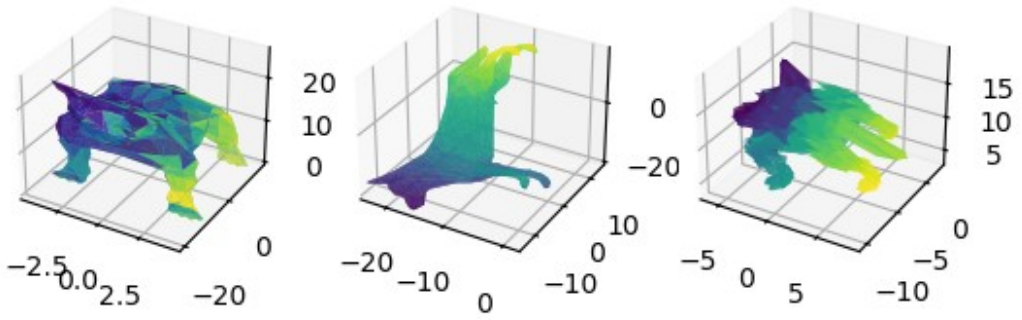

```
145.625000:  27%|
| 2700/10000 [1:25:45<3:09:30,  1.56s/it]

Epoch 2700: MSE loss = 130.90032958984375
Epoch 2700: Energy loss = 12.551244735717773
Epoch 2700: f1 loss = 1.1347119808197021
Epoch 2700: f2 loss = 1.0387150049209595
```



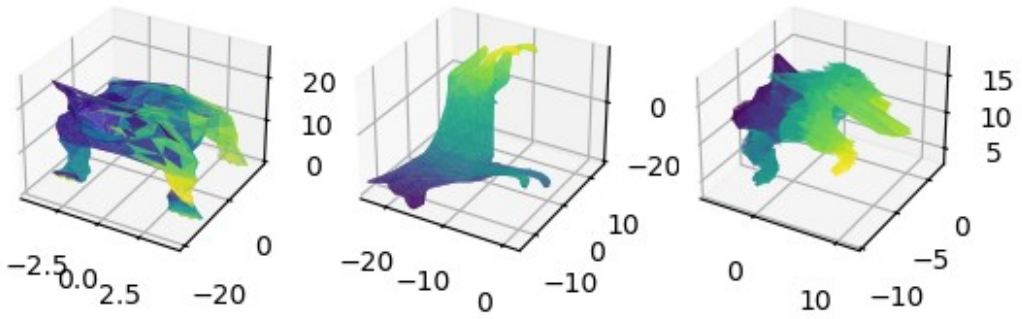

```
116.853851:  28%|
| 2800/10000 [1:29:07<2:50:08,  1.42s/it]

Epoch 2800: MSE loss = 104.1912612915039
Epoch 2800: Energy loss = 12.661748886108398
Epoch 2800: f1 loss = 8.419603545917198e-05
Epoch 2800: f2 loss = 0.0007531362934969366
```



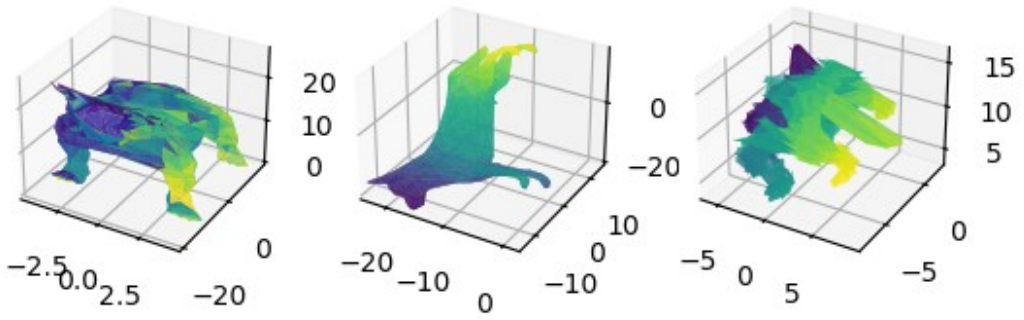

```
110.282585:  29%|
| 2900/10000 [1:32:30<2:46:57,  1.41s/it]

Epoch 2900: MSE loss = 96.53112030029297
Epoch 2900: Energy loss = 13.42004680633545
Epoch 2900: f1 loss = 0.2557222545146942
Epoch 2900: f2 loss = 0.07569536566734314
```



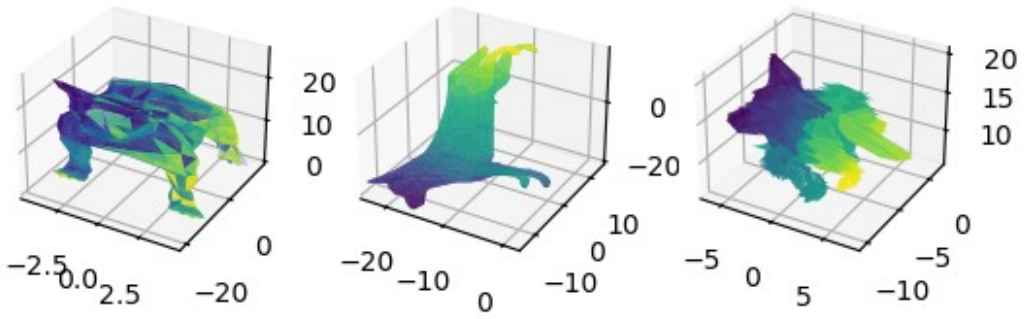

```
126.544975:  30%|
| 3000/10000 [1:35:55<2:59:16,  1.54s/it]

Epoch 3000: MSE loss = 113.17498779296875
Epoch 3000: Energy loss = 13.07945442199707
Epoch 3000: f1 loss = 0.0007745520561002195
Epoch 3000: f2 loss = 0.2897607386112213
```



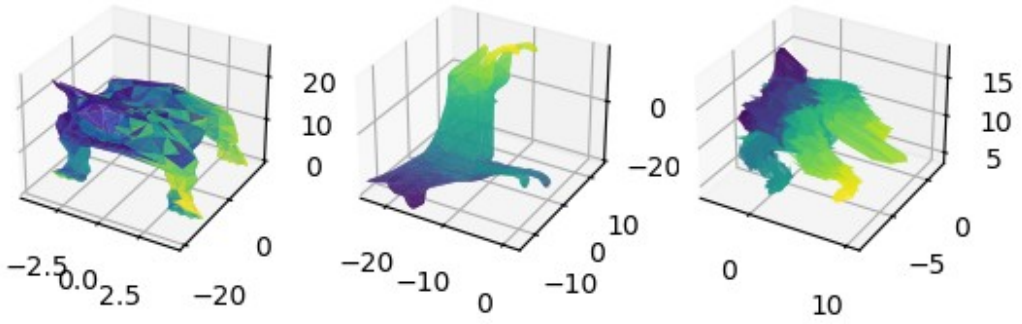

```
101.915543:  31%|
| 3100/10000 [1:39:20<3:05:09,  1.61s/it]

Epoch 3100: MSE loss = 85.51105499267578
Epoch 3100: Energy loss = 16.215091705322266
Epoch 3100: f1 loss = 0.1856037974357605
Epoch 3100: f2 loss = 0.0037972840946167707
```



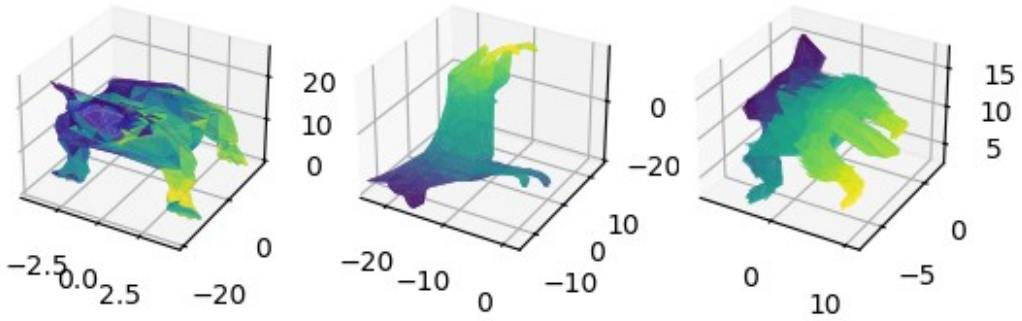

```
130.510254:  32%|████████████████████████████████████████████████
| 3200/10000 [1:42:48<2:30:15,  1.33s/it]

Epoch 3200: MSE loss = 113.7905044555664
Epoch 3200: Energy loss = 16.666759490966797
Epoch 3200: f1 loss = 0.04575716704130173
Epoch 3200: f2 loss = 0.007230190560221672
```



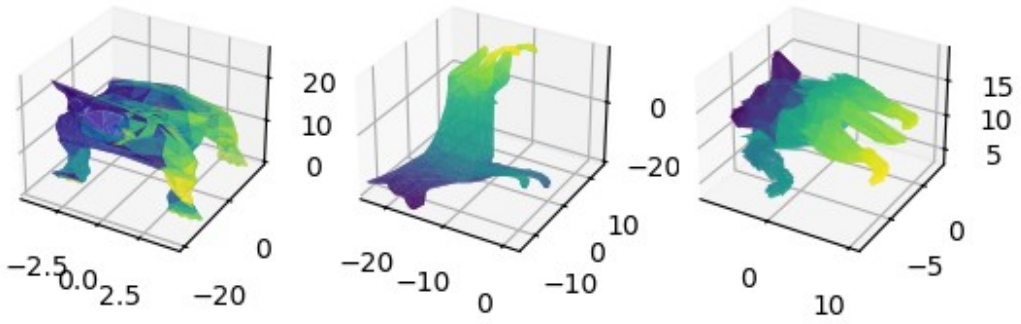

```
52.753689:  33%|████████████████████████████████████████████████
| 3300/10000 [1:46:15<3:00:43,  1.62s/it]

Epoch 3300: MSE loss = 34.67832565307617
Epoch 3300: Energy loss = 14.27651596069336
Epoch 3300: f1 loss = 3.779261589050293
Epoch 3300: f2 loss = 0.019586067646741867
```



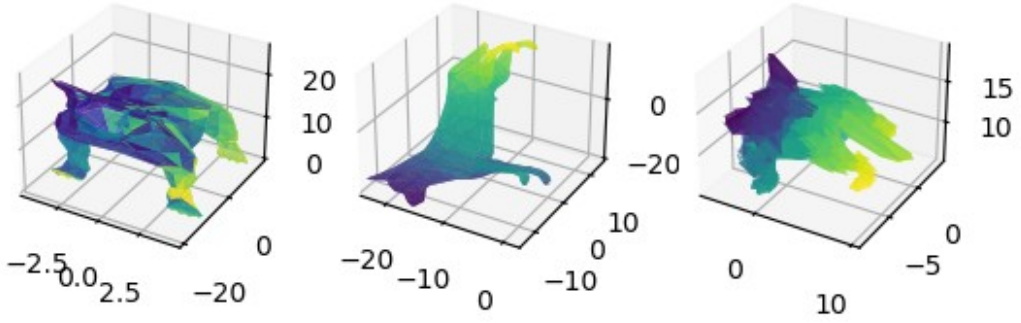

```
69.109978:  34%|
| 3400/10000 [1:49:43<2:49:32,  1.54s/it]

Epoch 3400: MSE loss = 57.740577697753906
Epoch 3400: Energy loss = 11.366235733032227
Epoch 3400: f1 loss = 0.002429555868729949
Epoch 3400: f2 loss = 0.0007368364022113383
```



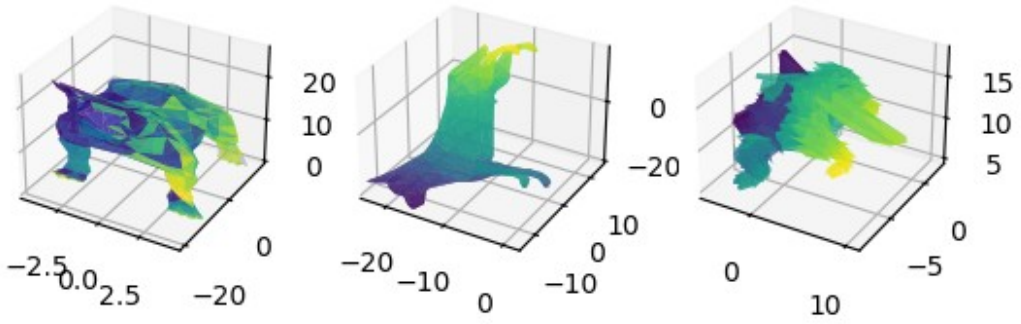

```
134.334839:  35%|
| 3500/10000 [1:53:06<2:26:15,  1.35s/it]

Epoch 3500: MSE loss = 123.61683654785156
Epoch 3500: Energy loss = 10.593358993530273
Epoch 3500: f1 loss = 0.01946951448917389
Epoch 3500: f2 loss = 0.10517560690641403
```



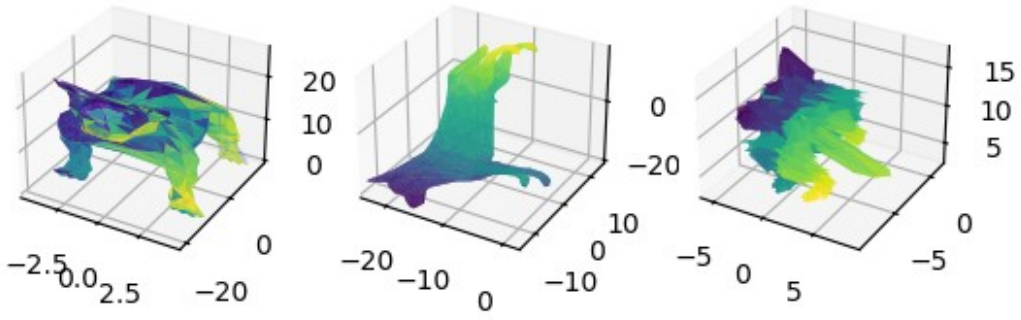

```
159.782883:  36%|
| 3600/10000 [1:56:29<2:34:28,  1.45s/it]

Epoch 3600: MSE loss = 120.44023895263672
Epoch 3600: Energy loss = 13.642826080322266
Epoch 3600: f1 loss = 11.408793449401855
Epoch 3600: f2 loss = 14.291030883789062
```



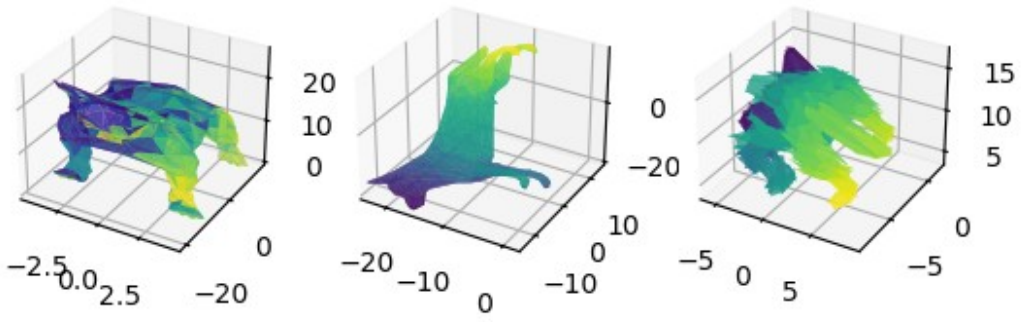

```
124.012421:  37%|
| 3700/10000 [1:59:53<2:40:21,  1.53s/it]

Epoch 3700: MSE loss = 108.57910919189453
Epoch 3700: Energy loss = 15.23764705657959
Epoch 3700: f1 loss = 0.1879320740699768
Epoch 3700: f2 loss = 0.007730198558419943
```



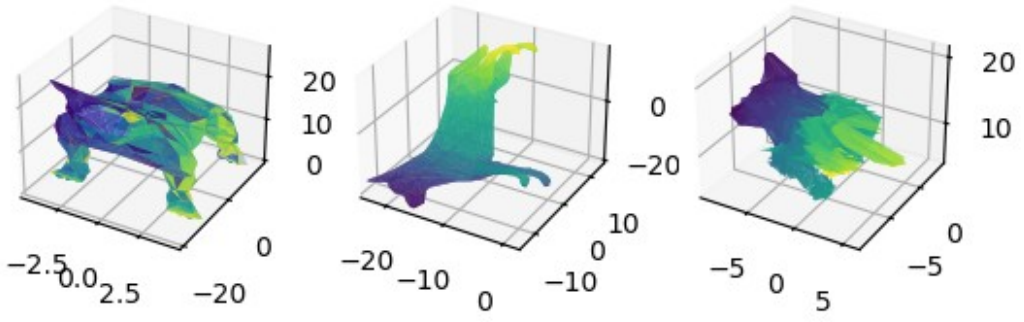

```
124.911423:  38%|
| 3800/10000 [2:03:21<2:22:06,  1.38s/it]

Epoch 3800: MSE loss = 108.26319885253906
Epoch 3800: Energy loss = 16.00284194946289
Epoch 3800: f1 loss = 0.10270579159259796
Epoch 3800: f2 loss = 0.542682409286499
```



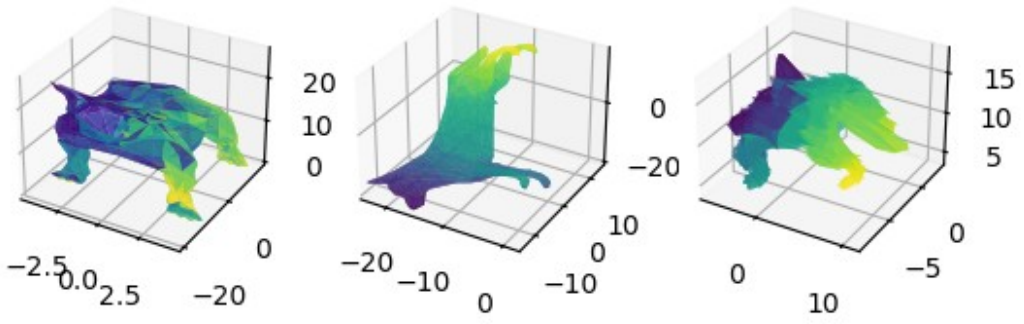

```
123.245995:  39%|
| 3900/10000 [2:06:49<2:33:45,  1.51s/it]

Epoch 3900: MSE loss = 108.59770965576172
Epoch 3900: Energy loss = 14.602813720703125
Epoch 3900: f1 loss = 0.0022757297847419977
Epoch 3900: f2 loss = 0.04319242760539055
```



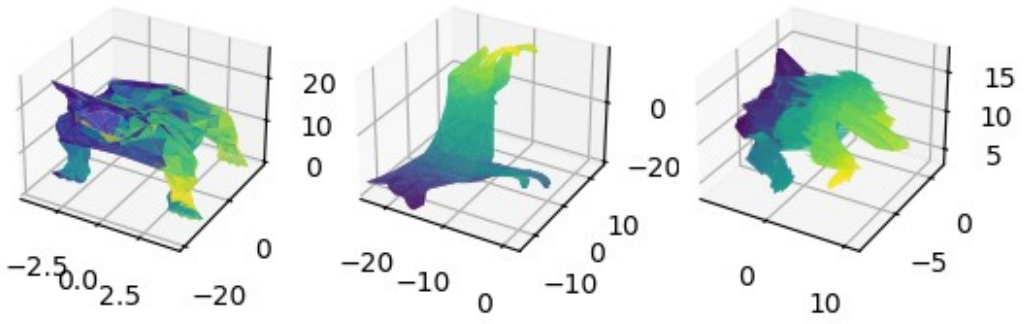

```
119.962463:  40%|
| 4000/10000 [2:10:18<2:35:05,  1.55s/it]

Epoch 4000: MSE loss = 104.53607177734375
Epoch 4000: Energy loss = 15.408740997314453
Epoch 4000: f1 loss = 0.012941724620759487
Epoch 4000: f2 loss = 0.004710355773568153
```



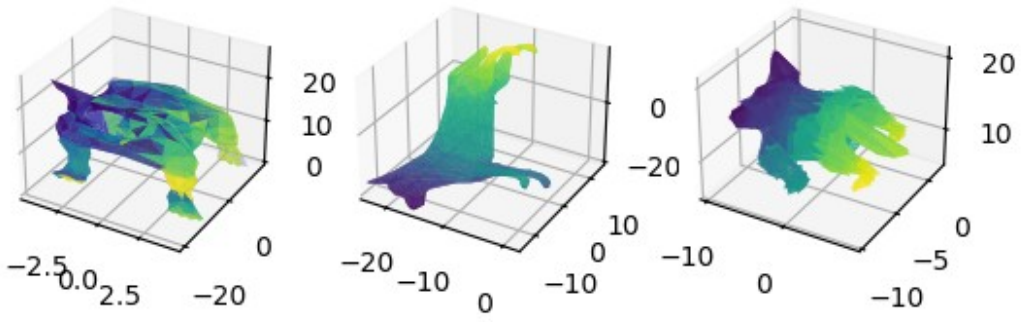

```
56.942379:  41%|
| 4100/10000 [2:13:46<2:14:24,  1.37s/it]

Epoch 4100: MSE loss = 44.5427360534668
Epoch 4100: Energy loss = 12.300982475280762
Epoch 4100: f1 loss = 0.0912981852889061
Epoch 4100: f2 loss = 0.007359548006206751
```



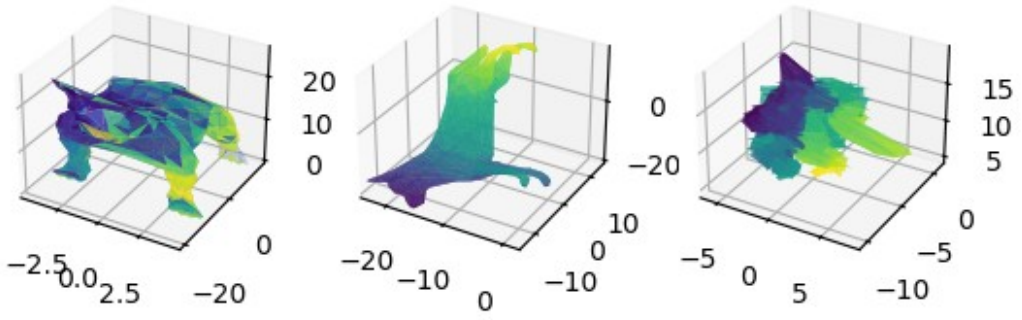

```
181.086777:  42%|
| 4200/10000 [2:17:11<2:28:31,  1.54s/it]

Epoch 4200: MSE loss = 39.45859146118164
Epoch 4200: Energy loss = 12.357421875
Epoch 4200: f1 loss = 128.32054138183594
Epoch 4200: f2 loss = 0.9502289891242981
```



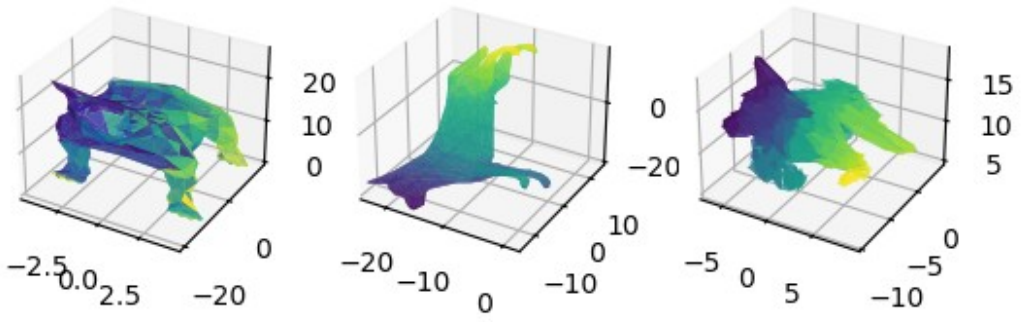

```
81.503967:  43%|
| 4300/10000 [2:20:39<2:30:09,  1.58s/it]

Epoch 4300: MSE loss = 70.4593276977539
Epoch 4300: Energy loss = 11.044417381286621
Epoch 4300: f1 loss = 0.00013098414638079703
Epoch 4300: f2 loss = 8.919739775592461e-05
```



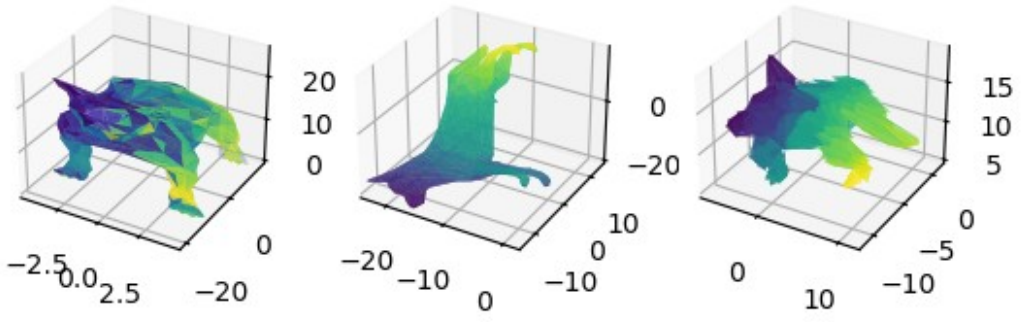

```
49.869175:  44%|
| 4400/10000 [2:24:01<2:07:05,  1.36s/it]

Epoch 4400: MSE loss = 33.705116271972656
Epoch 4400: Energy loss = 15.837178230285645
Epoch 4400: f1 loss = 0.3191782832145691
Epoch 4400: f2 loss = 0.007703568786382675
```



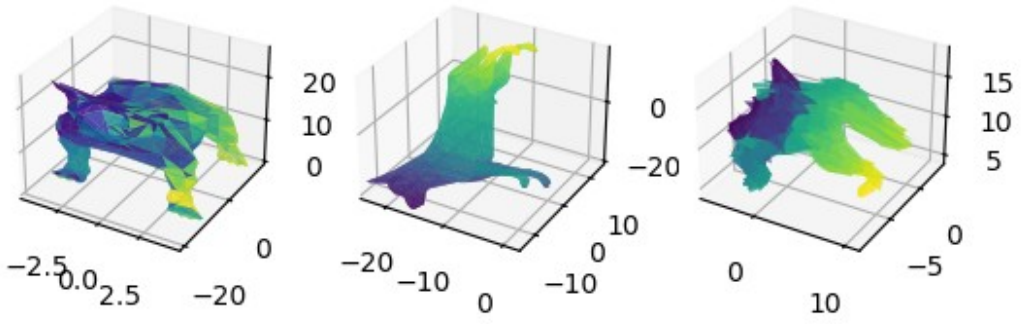

```
59.592987:  45%|
| 4500/10000 [2:27:28<2:29:18,  1.63s/it]

Epoch 4500: MSE loss = 45.57386779785156
Epoch 4500: Energy loss = 13.584615707397461
Epoch 4500: f1 loss = 0.0007912294240668416
Epoch 4500: f2 loss = 0.4337102472782135
```




```
144.371002:  46%|
| 4600/10000 [2:30:53<2:23:04,  1.59s/it]

Epoch 4600: MSE loss = 91.05794525146484
Epoch 4600: Energy loss = 12.067108154296875
Epoch 4600: f1 loss = 0.07221687585115433
Epoch 4600: f2 loss = 41.17372512817383
```

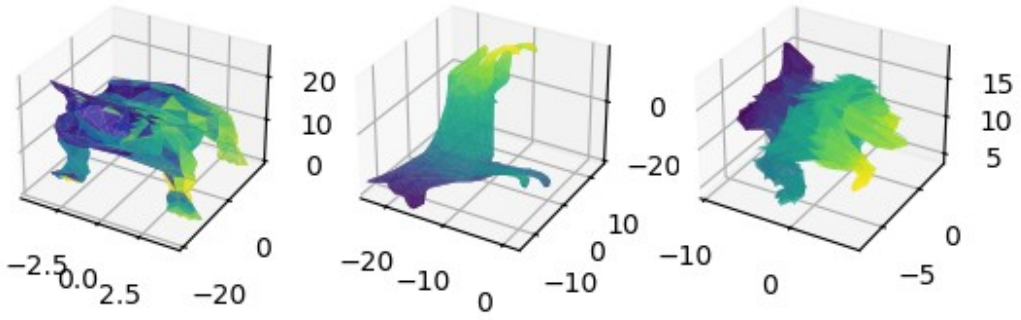



```
133.939484:  47%|
| 4700/10000 [2:34:17<1:59:26,  1.35s/it]

Epoch 4700: MSE loss = 120.99455261230469
Epoch 4700: Energy loss = 12.811744689941406
Epoch 4700: f1 loss = 0.04469681158661842
Epoch 4700: f2 loss = 0.08848919719457626
```



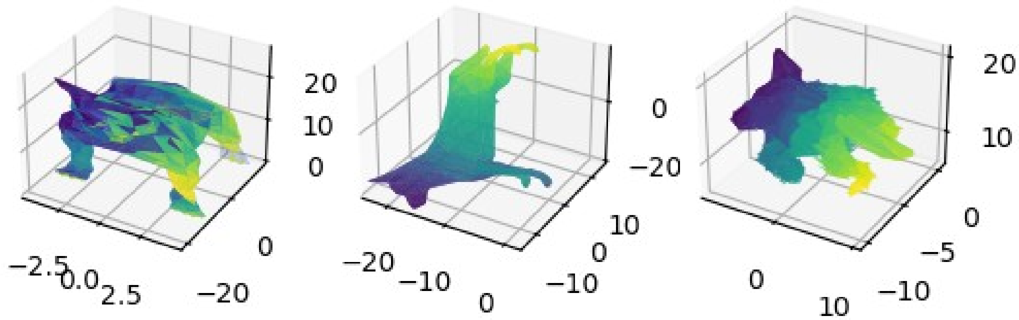

```
102.258751:  48%|
```

```
| 4800/10000 [2:37:43<2:15:22,  1.56s/it]

Epoch 4800: MSE loss = 85.24440002441406
Epoch 4800: Energy loss = 13.454198837280273
Epoch 4800: f1 loss = 3.0868983268737793
Epoch 4800: f2 loss = 0.47325554490089417
```

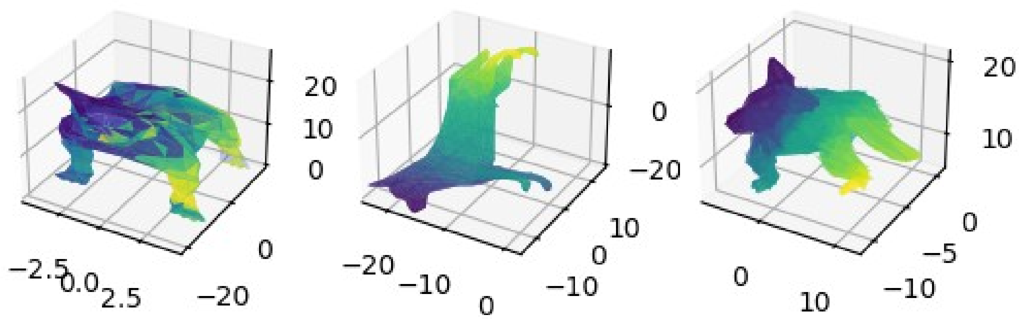



```
113.419037:  49%|
```

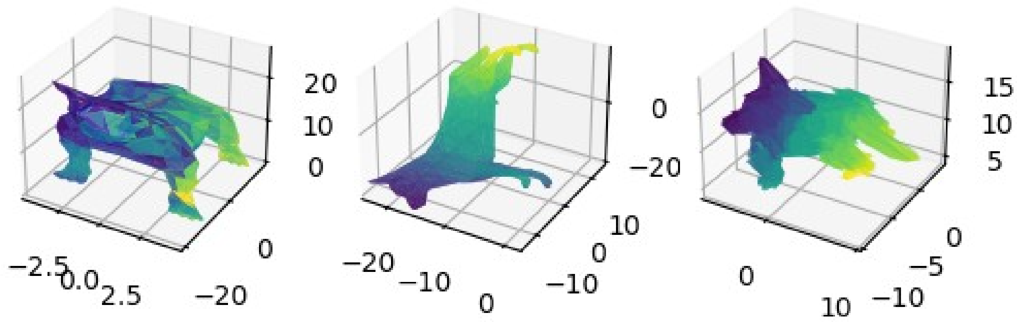
```
| 4900/10000 [2:41:10<2:10:04,  1.53s/it]

Epoch 4900: MSE loss = 101.9107666015625
Epoch 4900: Energy loss = 11.457845687866211
Epoch 4900: f1 loss = 0.008396034128963947
Epoch 4900: f2 loss = 0.04202989861369133
```



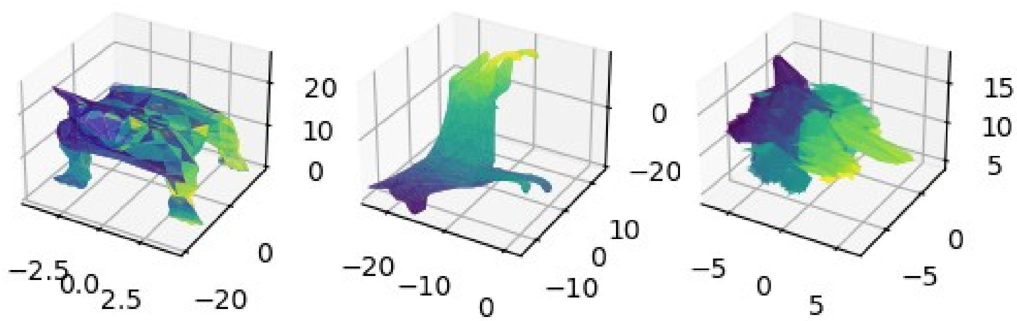
```
105.511551:  50%|
[redacted]
| 5000/10000 [2:44:35<1:48:17,  1.30s/it]

Epoch 5000: MSE loss = 95.16519165039062
Epoch 5000: Energy loss = 10.162062644958496
Epoch 5000: f1 loss = 0.17048360407352448
Epoch 5000: f2 loss = 0.013813060708343983
```



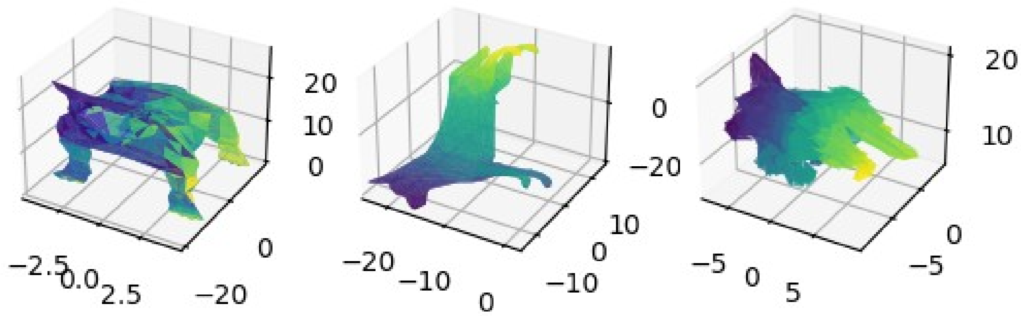
```
84.429184:  51%|
[redacted]
| 5100/10000 [2:47:59<2:02:04,  1.49s/it]

Epoch 5100: MSE loss = 72.90951538085938
Epoch 5100: Energy loss = 11.423993110656738
Epoch 5100: f1 loss = 0.005810747388750315
Epoch 5100: f2 loss = 0.08986225724220276
```



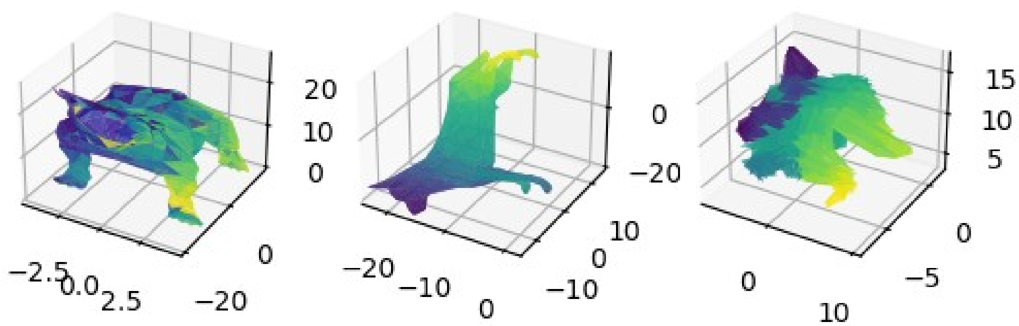

```
450.419678:  52%|
| 5200/10000 [2:51:21<2:03:37,  1.55s/it]

Epoch 5200: MSE loss = 83.13867950439453
Epoch 5200: Energy loss = 15.673971176147461
Epoch 5200: f1 loss = 346.8845520019531
Epoch 5200: f2 loss = 4.722484588623047
```



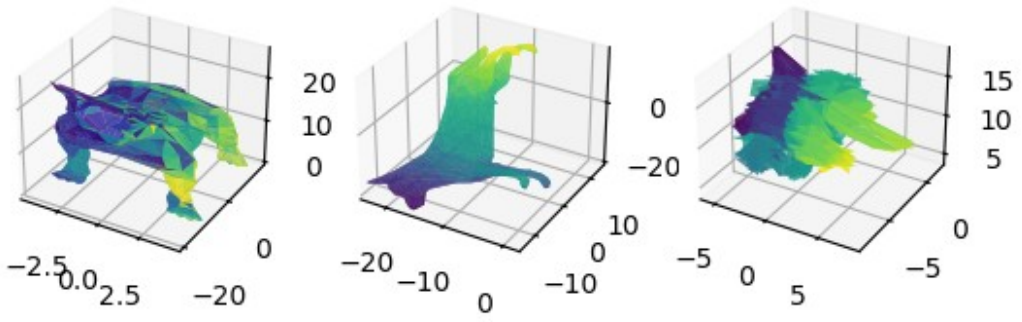

```
73.158928:  53%|
| 5300/10000 [2:54:50<1:42:45,  1.31s/it]

Epoch 5300: MSE loss = 49.130828857421875
Epoch 5300: Energy loss = 12.511900901794434
Epoch 5300: f1 loss = 11.332438468933105
Epoch 5300: f2 loss = 0.18375878036022186
```



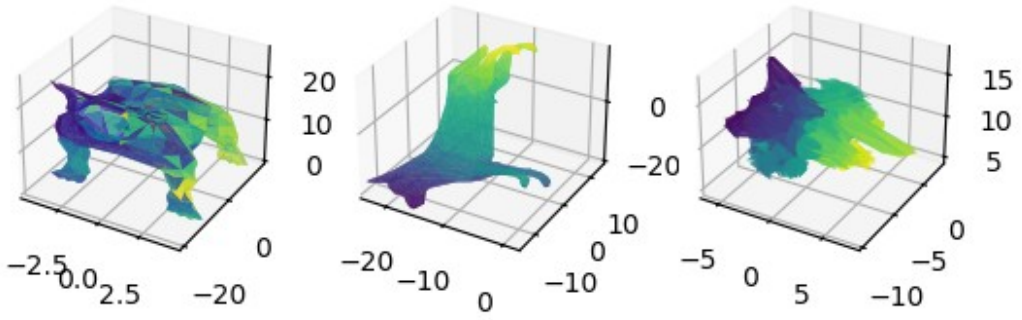

```
74.434235:  54%|
[redacted]
| 5400/10000 [2:58:15<1:57:11,  1.53s/it]

Epoch 5400: MSE loss = 61.00910186767578
Epoch 5400: Energy loss = 13.421124458312988
Epoch 5400: f1 loss = 0.0034101279452443123
Epoch 5400: f2 loss = 0.0005997715052217245
```



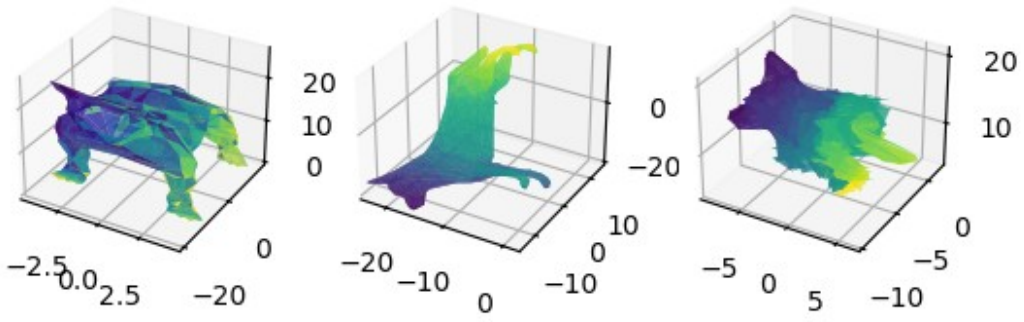

```
74.866058:  55%|
[redacted]
| 5500/10000 [3:01:44<1:42:53,  1.37s/it]

Epoch 5500: MSE loss = 59.64122009277344
Epoch 5500: Energy loss = 15.090228080749512
Epoch 5500: f1 loss = 0.018885118886828423
Epoch 5500: f2 loss = 0.11572907865047455
```



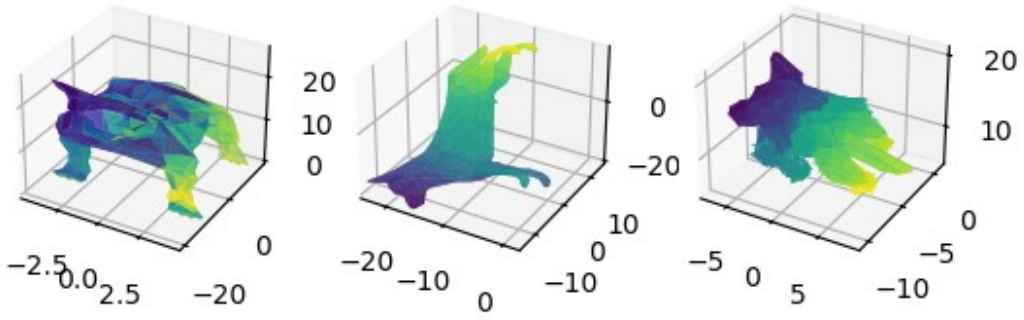

```
61.153816:  56%|
| 5600/10000 [3:05:14<1:53:24,  1.55s/it]

Epoch 5600: MSE loss = 46.63825988769531
Epoch 5600: Energy loss = 14.51231575012207
Epoch 5600: f1 loss = 0.0013059302000328898
Epoch 5600: f2 loss = 0.0019316618563607335
```



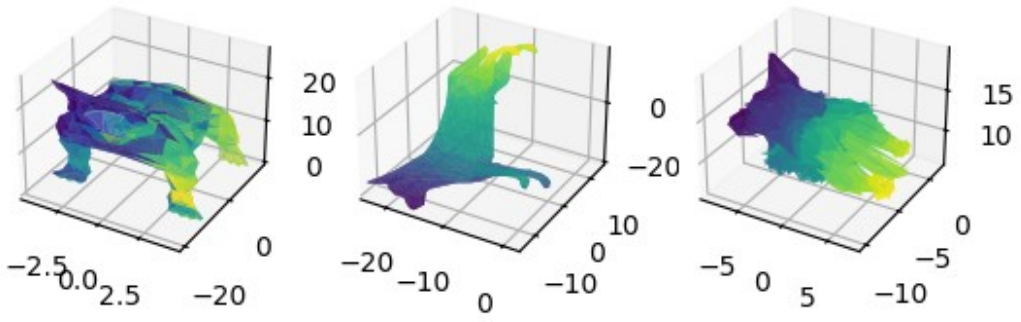

```
96.455498:  57%|
| 5700/10000 [3:09:03<2:02:19,  1.71s/it]

Epoch 5700: MSE loss = 80.50399017333984
Epoch 5700: Energy loss = 14.689935684204102
Epoch 5700: f1 loss = 1.241753339767456
Epoch 5700: f2 loss = 0.019820403307676315
```



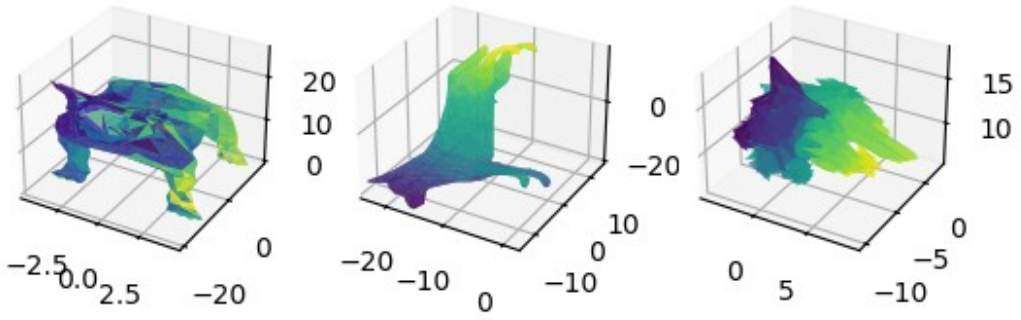

```
74.350777:  58%|
| 5800/10000 [3:12:52<1:49:28,  1.56s/it]

Epoch 5800: MSE loss = 62.22893142700195
Epoch 5800: Energy loss = 12.084227561950684
Epoch 5800: f1 loss = 0.002362170722335577
Epoch 5800: f2 loss = 0.0352545902132988
```



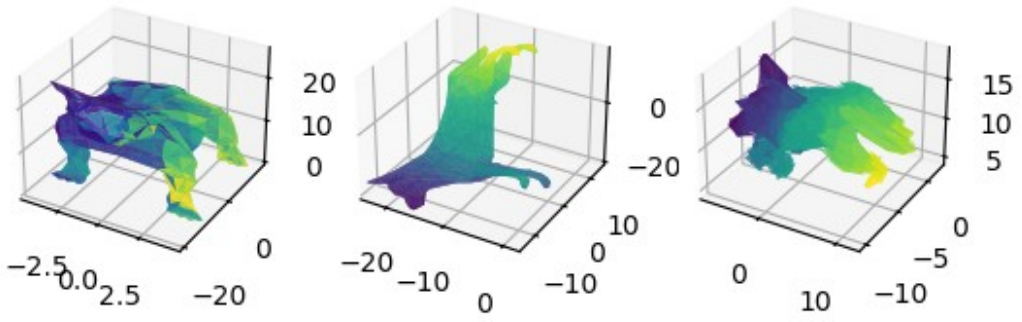

```
170.655182:  59%|
| 5900/10000 [3:16:28<1:51:50,  1.64s/it]

Epoch 5900: MSE loss = 158.05934143066406
Epoch 5900: Energy loss = 12.592269897460938
Epoch 5900: f1 loss = 0.00320369191467762
Epoch 5900: f2 loss = 0.00037174910539761186
```




```
128.249451:  60%|
| 6000/10000 [3:20:04<1:39:52,  1.50s/it]

Epoch 6000: MSE loss = 90.55164337158203
Epoch 6000: Energy loss = 14.795979499816895
Epoch 6000: f1 loss = 0.005473766475915909
Epoch 6000: f2 loss = 22.8963623046875
```

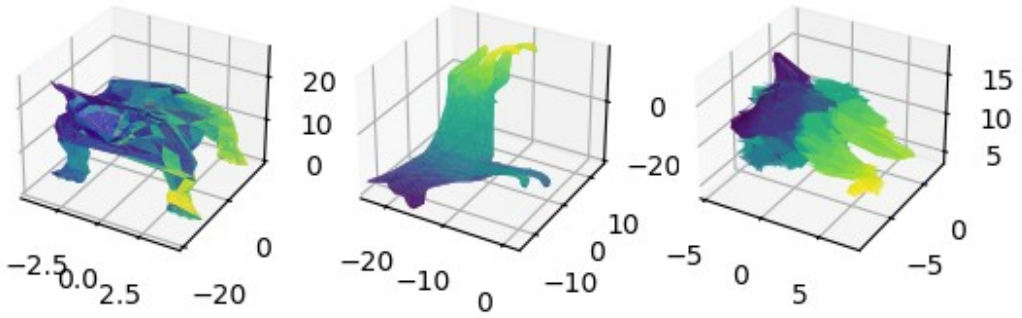



```
79.735710:  61%|
| 6100/10000 [3:24:19<1:37:32,  1.50s/it]

Epoch 6100: MSE loss = 69.58786010742188
Epoch 6100: Energy loss = 9.80348014831543
Epoch 6100: f1 loss = 0.26468169689178467
Epoch 6100: f2 loss = 0.07968537509441376
```



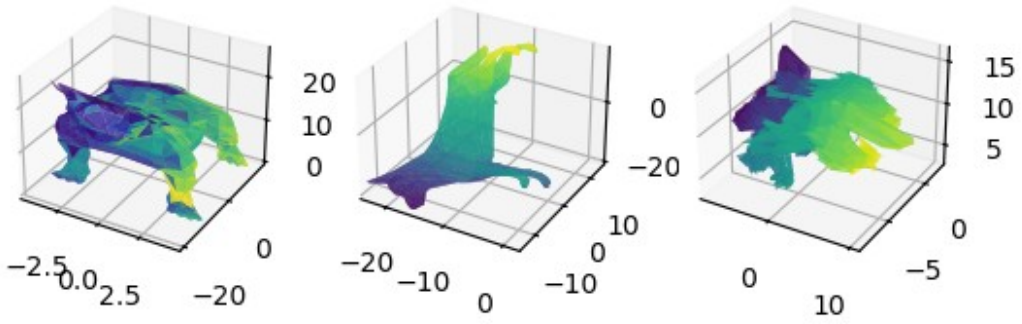

```
62.122410:  62%|
```

```
| 6200/10000 [3:27:48<1:23:25,  1.32s/it]

Epoch 6200: MSE loss = 46.6884880065918
Epoch 6200: Energy loss = 15.059398651123047
Epoch 6200: f1 loss = 0.00489977328106761
Epoch 6200: f2 loss = 0.3696241080760956
```

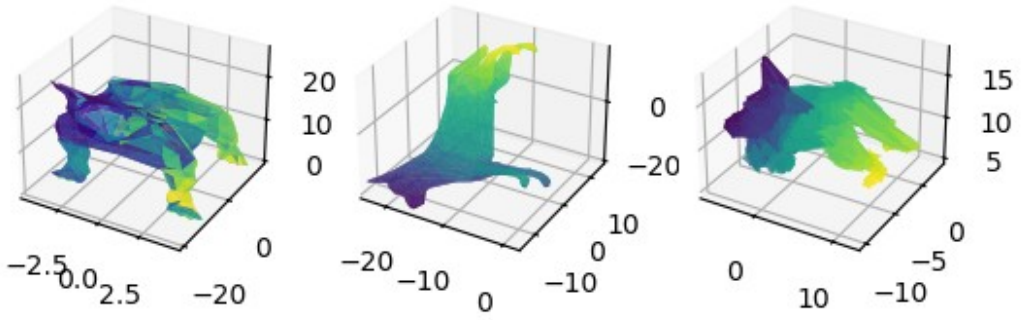



```
104.171524:  63%|
```

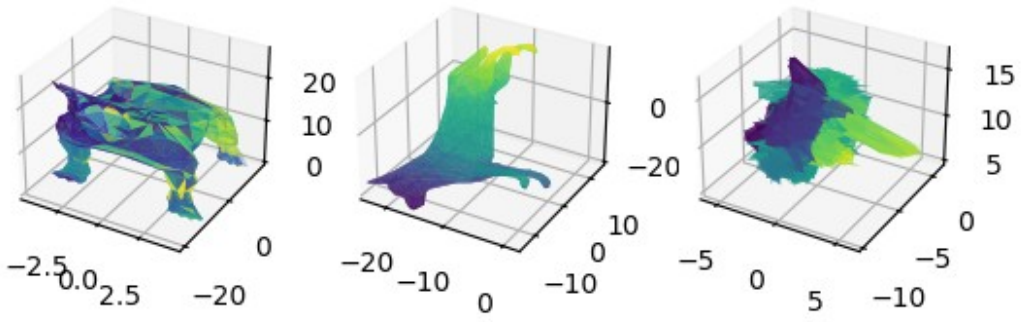
```
| 6300/10000 [3:31:22<1:37:51,  1.59s/it]

Epoch 6300: MSE loss = 91.8114013671875
Epoch 6300: Energy loss = 12.31852912902832
Epoch 6300: f1 loss = 0.014882151037454605
Epoch 6300: f2 loss = 0.02671211212873459
```



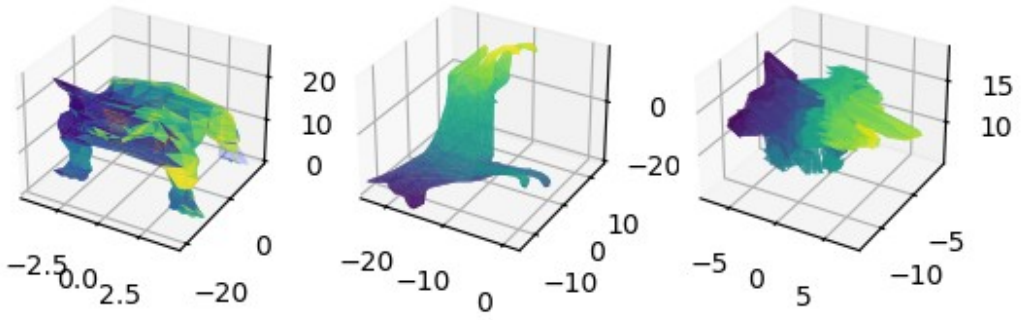

```
85.573715:  64%|
| 6400/10000 [3:34:49<1:19:10,  1.32s/it]

Epoch 6400: MSE loss = 74.81857299804688
Epoch 6400: Energy loss = 10.572466850280762
Epoch 6400: f1 loss = 0.1481216847896576
Epoch 6400: f2 loss = 0.03455916419625282
```



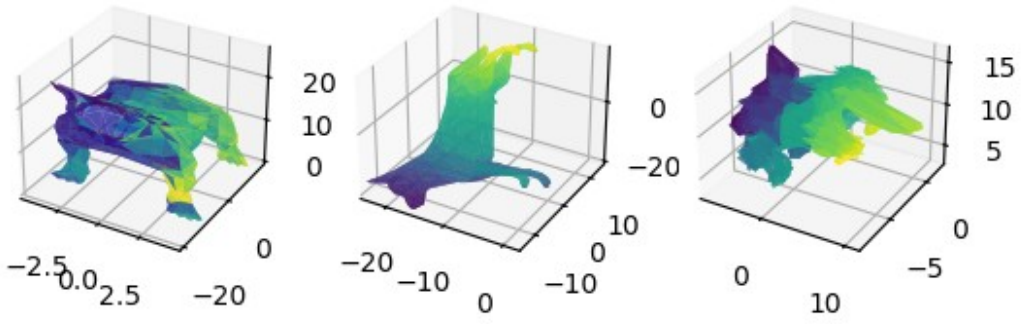

```
94.458603:  65%|
| 6500/10000 [3:38:17<1:28:41,  1.52s/it]

Epoch 6500: MSE loss = 76.0320053100586
Epoch 6500: Energy loss = 18.423580169677734
Epoch 6500: f1 loss = 0.0023540270049124956
Epoch 6500: f2 loss = 0.0006665781838819385
```



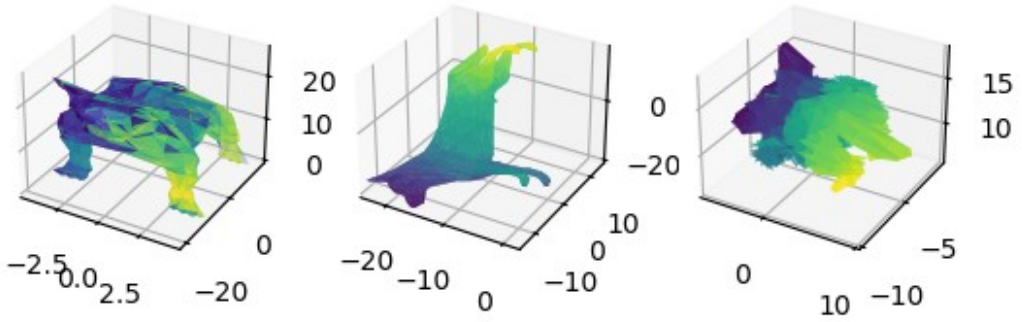

```
98.334946:  66%|
| 6600/10000 [3:41:51<1:17:36,  1.37s/it]

Epoch 6600: MSE loss = 83.62423706054688
Epoch 6600: Energy loss = 14.708995819091797
Epoch 6600: f1 loss = 0.00014611922961194068
Epoch 6600: f2 loss = 0.0015667061088606715
```



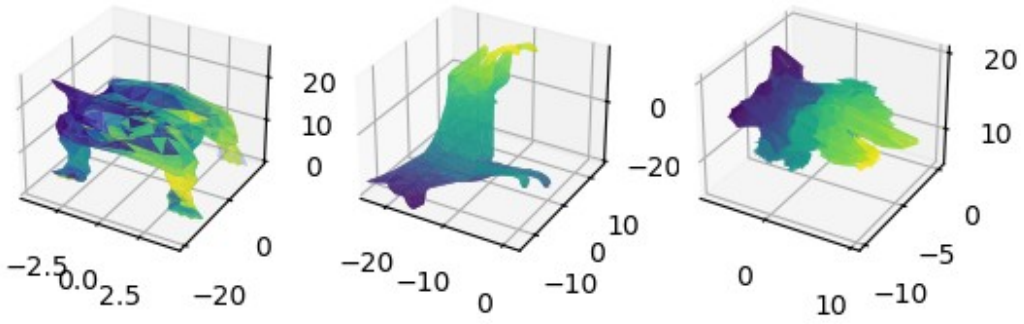

```
111.897476:  67%|
| 6700/10000 [3:45:24<1:26:50,  1.58s/it]

Epoch 6700: MSE loss = 99.60868835449219
Epoch 6700: Energy loss = 12.274126052856445
Epoch 6700: f1 loss = 0.012867055833339691
Epoch 6700: f2 loss = 0.0017963218269869685
```



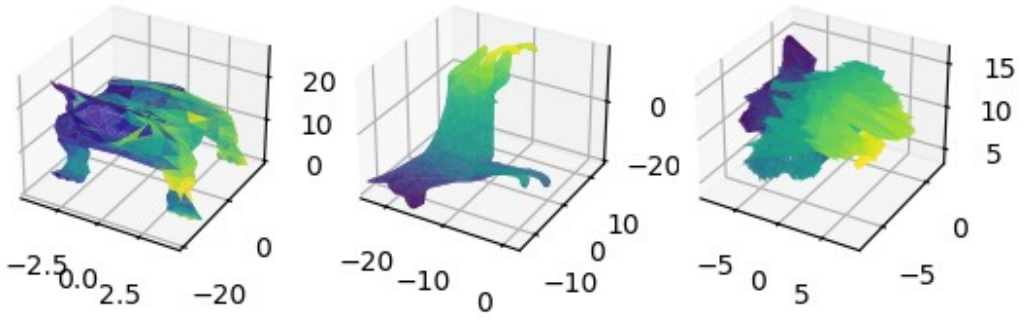

```
112.661697:  68%|
| 6800/10000 [3:48:52<1:21:45,  1.53s/it]

Epoch 6800: MSE loss = 98.41017150878906
Epoch 6800: Energy loss = 14.093432426452637
Epoch 6800: f1 loss = 0.15528617799282074
Epoch 6800: f2 loss = 0.002811260288581252
```



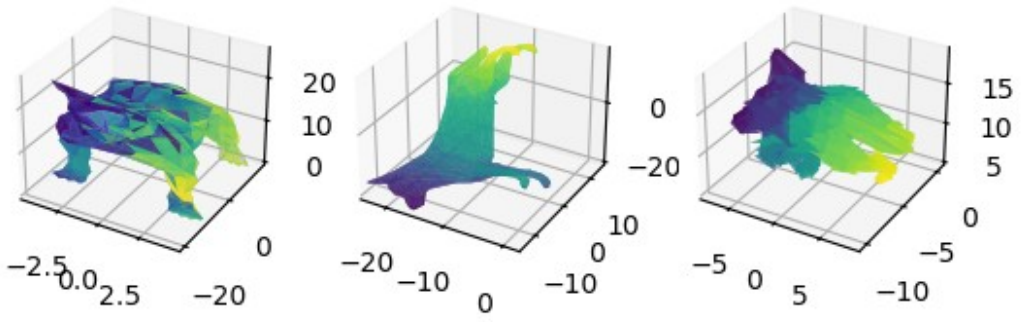

```
137.543533:  69%|
| 6900/10000 [3:52:26<1:18:06,  1.51s/it]

Epoch 6900: MSE loss = 125.50194549560547
Epoch 6900: Energy loss = 12.027569770812988
Epoch 6900: f1 loss = 0.002276299288496375
Epoch 6900: f2 loss = 0.01174819003790617
```




```
84.038971:  70%|
| 7000/10000 [3:55:53<1:14:34,  1.49s/it]

Epoch 7000: MSE loss = 71.02739715576172
Epoch 7000: Energy loss = 13.001675605773926
Epoch 7000: f1 loss = 0.004543713293969631
Epoch 7000: f2 loss = 0.005355107132345438
```

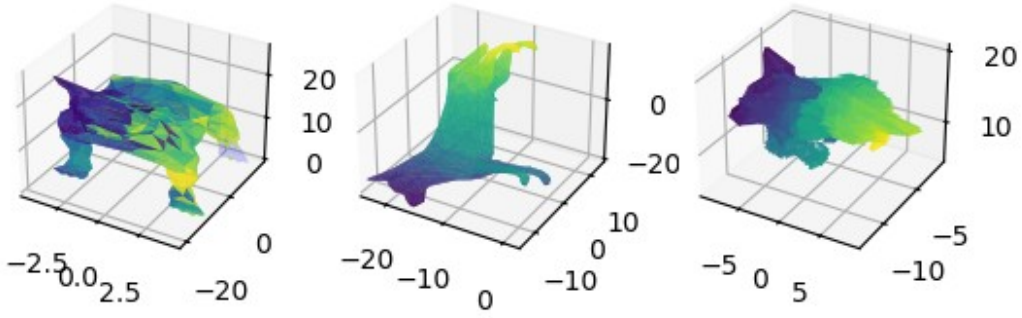



```
112.081505:  71%|
| 7100/10000 [3:59:27<1:08:14,  1.41s/it]

Epoch 7100: MSE loss = 99.32754516601562
Epoch 7100: Energy loss = 12.460679054260254
Epoch 7100: f1 loss = 0.06804623454809189
Epoch 7100: f2 loss = 0.22523410618305206
```



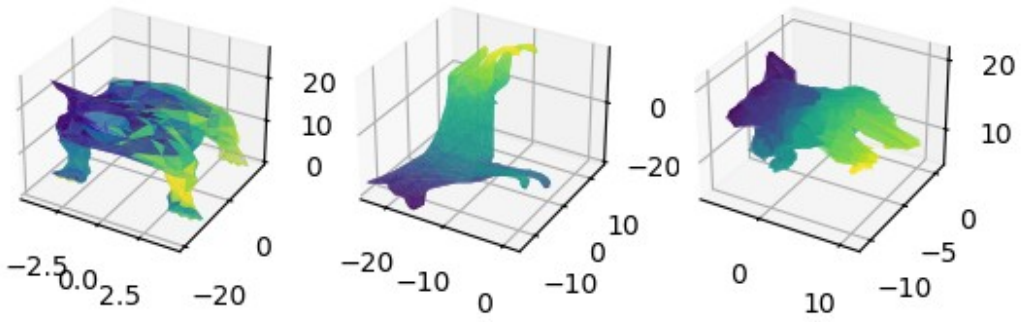

```
93.930611:  72%|
```

```
| 7200/10000 [4:02:54<1:11:09,  1.52s/it]

Epoch 7200: MSE loss = 82.81610107421875
Epoch 7200: Energy loss = 11.084904670715332
Epoch 7200: f1 loss = 0.004419948905706406
Epoch 7200: f2 loss = 0.025184322148561478
```

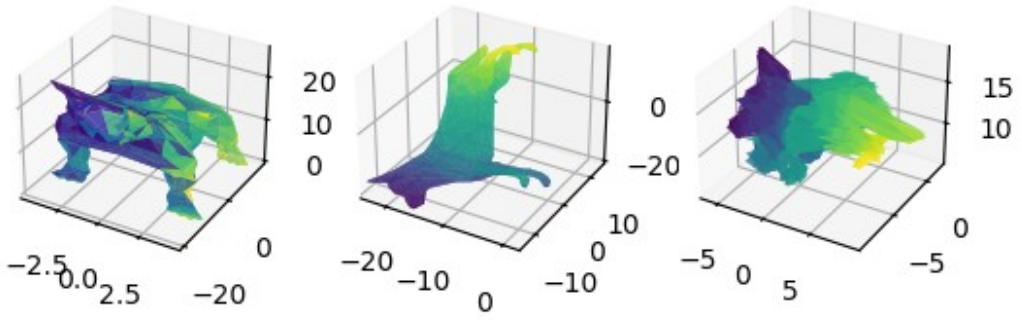



```
95.196014:  73%|
```

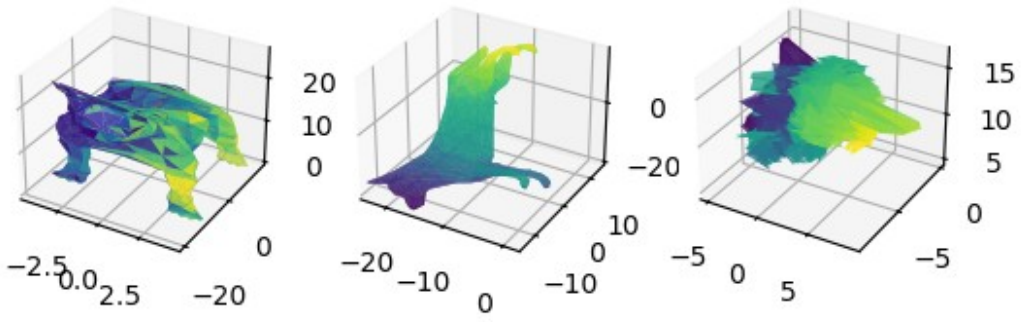
```
| 7300/10000 [4:06:22<1:13:55,  1.64s/it]

Epoch 7300: MSE loss = 85.10733795166016
Epoch 7300: Energy loss = 10.070757865905762
Epoch 7300: f1 loss = 0.015638114884495735
Epoch 7300: f2 loss = 0.0022822923492640257
```




```
66.426727:  74%|
| 7400/10000 [4:09:48<58:31,  1.35s/it]

Epoch 7400: MSE loss = 54.1306037902832
Epoch 7400: Energy loss = 12.259466171264648
Epoch 7400: f1 loss = 0.031549349427223206
Epoch 7400: f2 loss = 0.005110486410558224
```

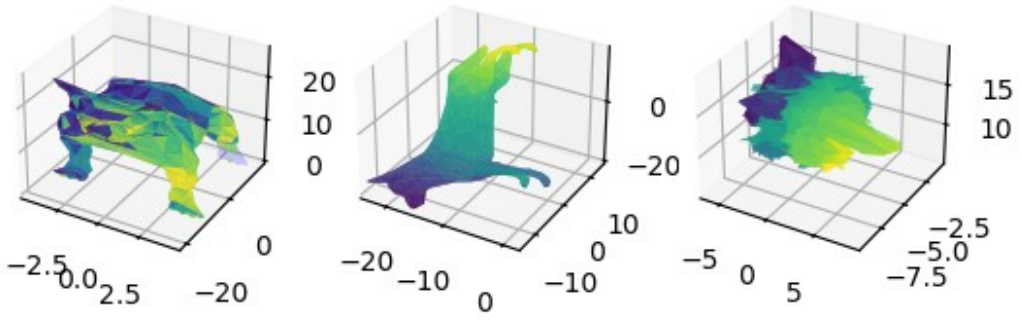



```
74.118683:  75%|
| 7500/10000 [4:13:19<1:06:28,  1.60s/it]

Epoch 7500: MSE loss = 58.947784423828125
Epoch 7500: Energy loss = 15.165406227111816
Epoch 7500: f1 loss = 0.00507731270045042
Epoch 7500: f2 loss = 0.0004151529283262789
```



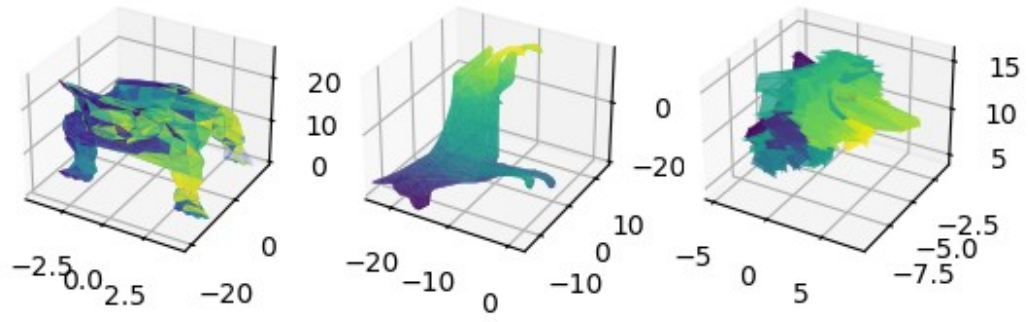

```
112.079765:  76%|
```

```
| 7600/10000 [4:16:51<59:31,  1.49s/it]

Epoch 7600: MSE loss = 95.60213470458984
Epoch 7600: Energy loss = 14.913339614868164
Epoch 7600: f1 loss = 0.007361915893852711
Epoch 7600: f2 loss = 1.5569281578063965
```



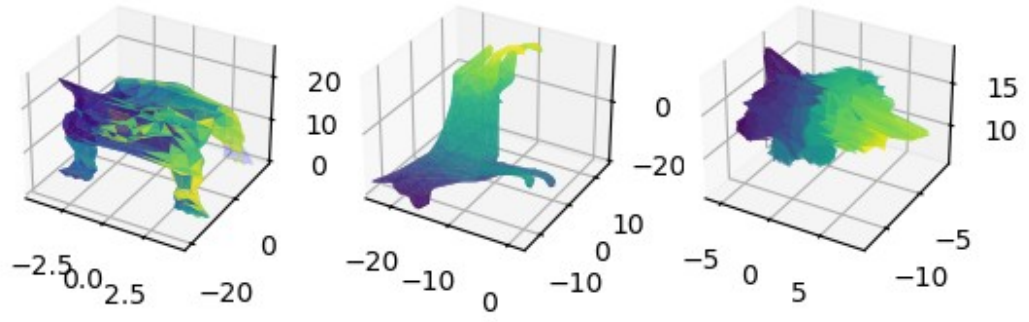

```
109.589630:  77%|
```

```
| 7700/10000 [4:20:25<53:59,  1.41s/it]

Epoch 7700: MSE loss = 91.1583023071289
Epoch 7700: Energy loss = 17.238521575927734
Epoch 7700: f1 loss = 0.9923180937767029
Epoch 7700: f2 loss = 0.2004840224981308
```



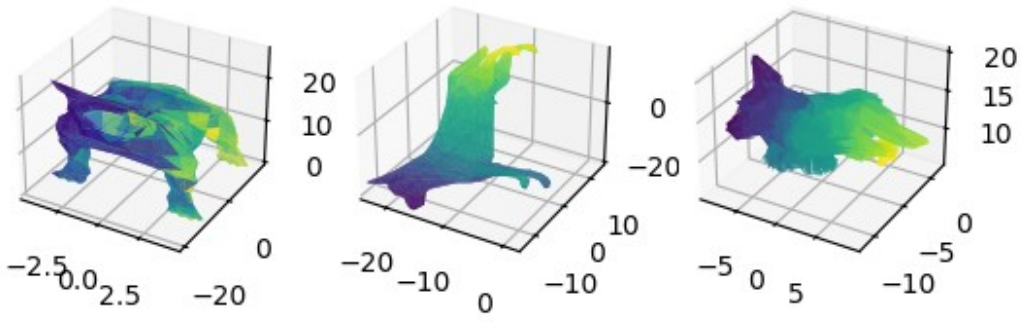

```
60.587887:  78%|
```

```
| 7800/10000 [4:24:00<58:03,  1.58s/it]

Epoch 7800: MSE loss = 46.44302749633789
Epoch 7800: Energy loss = 14.135884284973145
Epoch 7800: f1 loss = 0.005710158962756395
Epoch 7800: f2 loss = 0.0032651035580784082
```

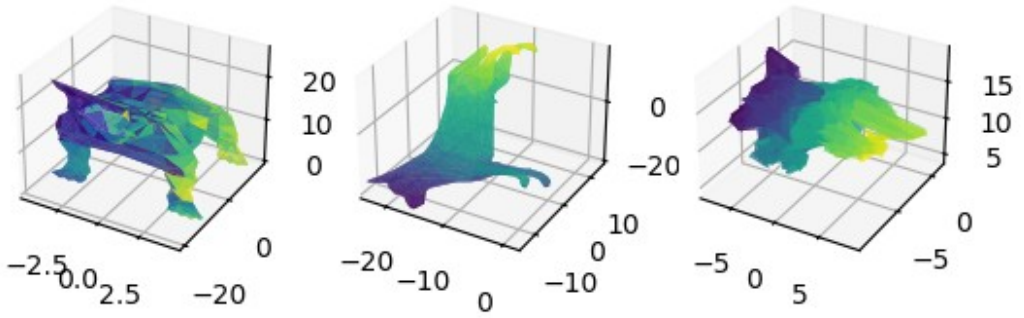



```
67.913170:  79%|
```

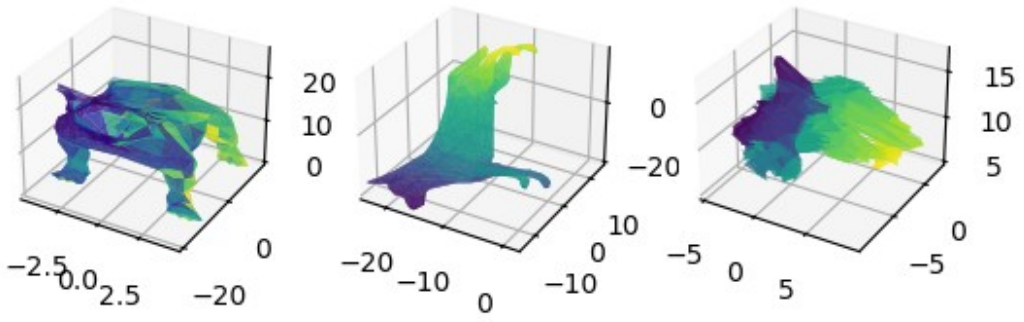
```
| 7900/10000 [4:27:30<46:37,  1.33s/it]

Epoch 7900: MSE loss = 57.100833892822266
Epoch 7900: Energy loss = 10.788277626037598
Epoch 7900: f1 loss = 0.014254715293645859
Epoch 7900: f2 loss = 0.009805936366319656
```




```
118.308685:  80%|
| 8000/10000 [4:30:57<53:11,  1.60s/it]

Epoch 8000: MSE loss = 105.23762512207031
Epoch 8000: Energy loss = 10.98361587524414
Epoch 8000: f1 loss = 0.36695030331611633
Epoch 8000: f2 loss = 1.7204970121383667
```

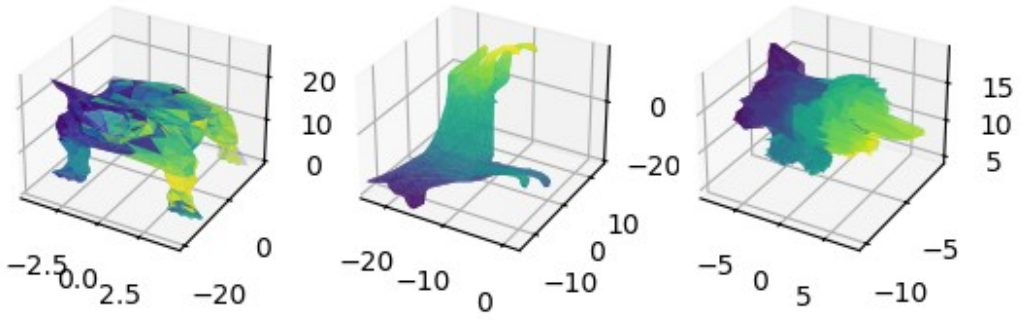



```
54.546375:  81%|
| 8100/10000 [4:34:25<42:51,  1.35s/it]

Epoch 8100: MSE loss = 39.528953552246094
Epoch 8100: Energy loss = 13.3958101272583
Epoch 8100: f1 loss = 0.1911027580499649
Epoch 8100: f2 loss = 1.4305086135864258
```



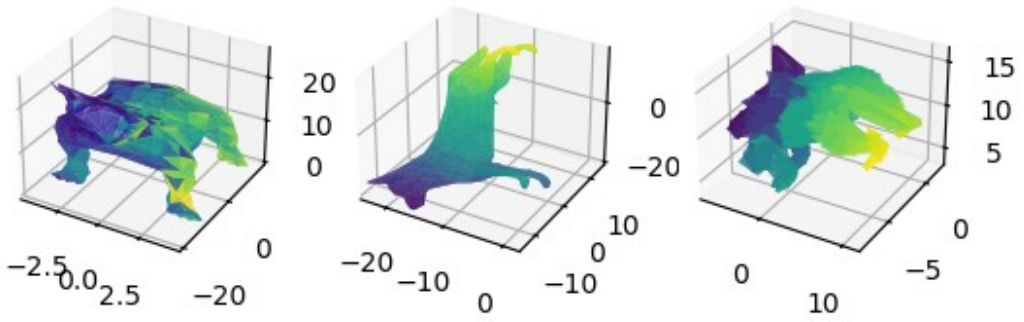

```
126.357414:  82%|
```

```
| 8200/10000 [4:37:56<47:55,  1.60s/it]

Epoch 8200: MSE loss = 75.69306945800781
Epoch 8200: Energy loss = 12.745185852050781
Epoch 8200: f1 loss = 37.862144470214844
Epoch 8200: f2 loss = 0.0570170059800148
```

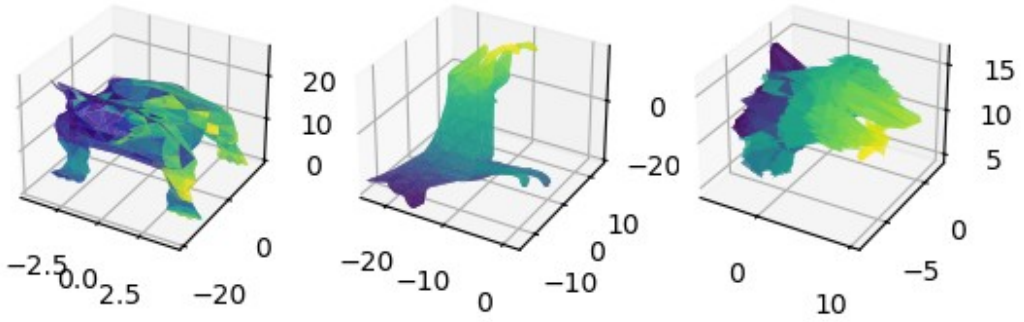



```
64.284576:  83%|
```

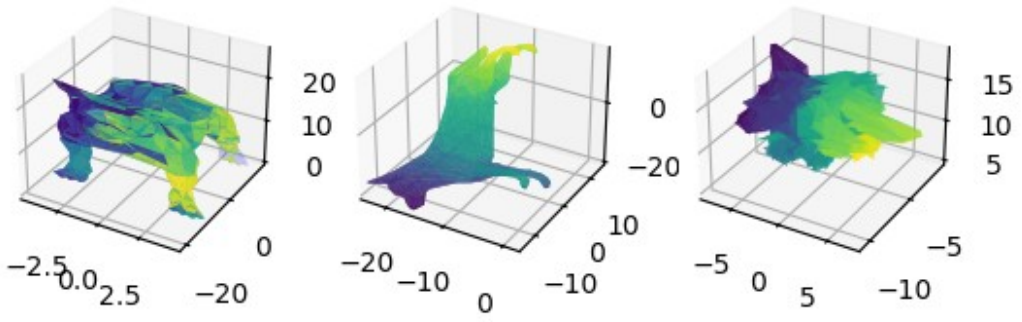
```
| 8300/10000 [4:41:29<38:21,  1.35s/it]

Epoch 8300: MSE loss = 52.57515335083008
Epoch 8300: Energy loss = 11.286636352539062
Epoch 8300: f1 loss = 0.3183002471923828
Epoch 8300: f2 loss = 0.10448973625898361
```




```
181.053802:  84%|
| 8400/10000 [4:44:59<41:46,  1.57s/it]

Epoch 8400: MSE loss = 131.85736083984375
Epoch 8400: Energy loss = 12.667200088500977
Epoch 8400: f1 loss = 36.328189849853516
Epoch 8400: f2 loss = 0.20104777812957764
```

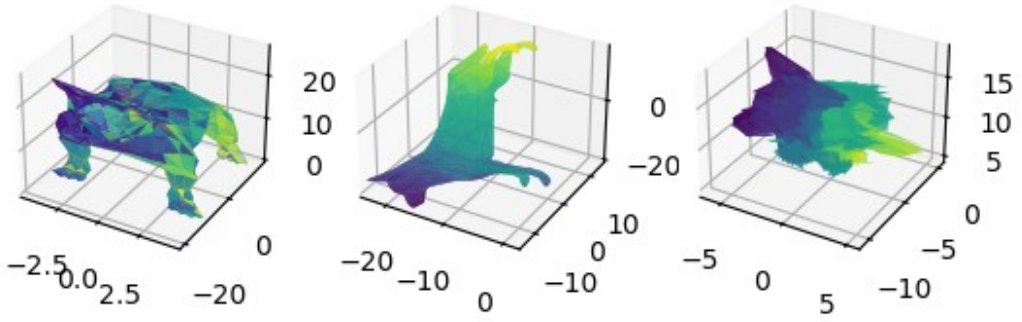



```
53.667122:  85%|
| 8500/10000 [4:48:29<33:42,  1.35s/it]

Epoch 8500: MSE loss = 39.792659759521484
Epoch 8500: Energy loss = 13.852118492126465
Epoch 8500: f1 loss = 0.0017169727943837643
Epoch 8500: f2 loss = 0.020625099539756775
```



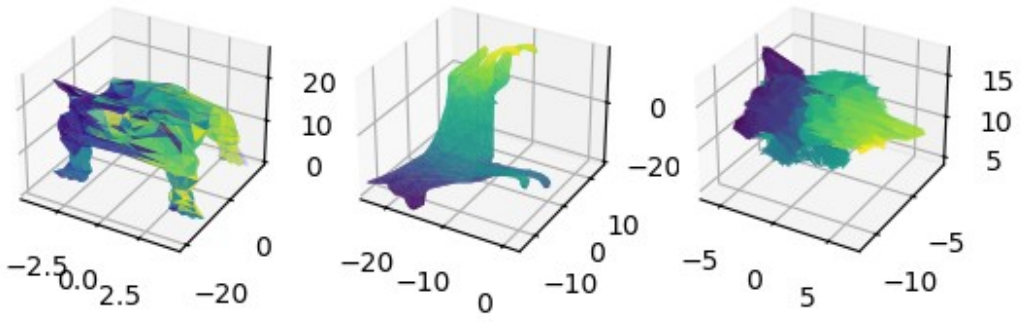

```
73.689117:  86%|
```

```
| 8600/10000 [4:52:00<35:48,  1.53s/it]

Epoch 8600: MSE loss = 56.43167495727539
Epoch 8600: Energy loss = 17.253765106201172
Epoch 8600: f1 loss = 0.003165320260450244
Epoch 8600: f2 loss = 0.000515670282766223
```

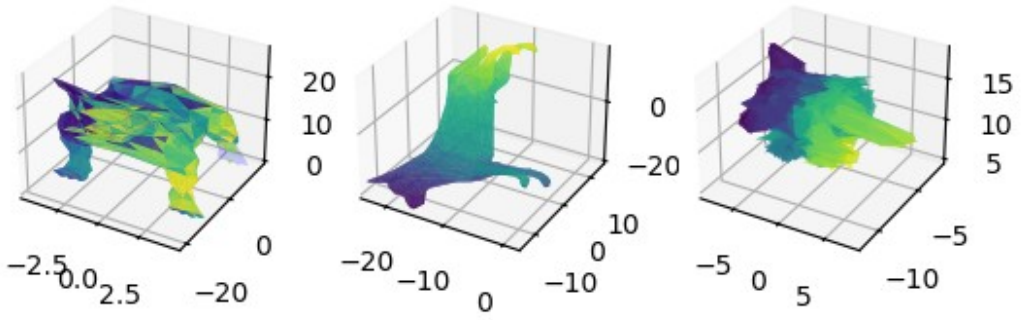



```
41.980648:  87%|
```

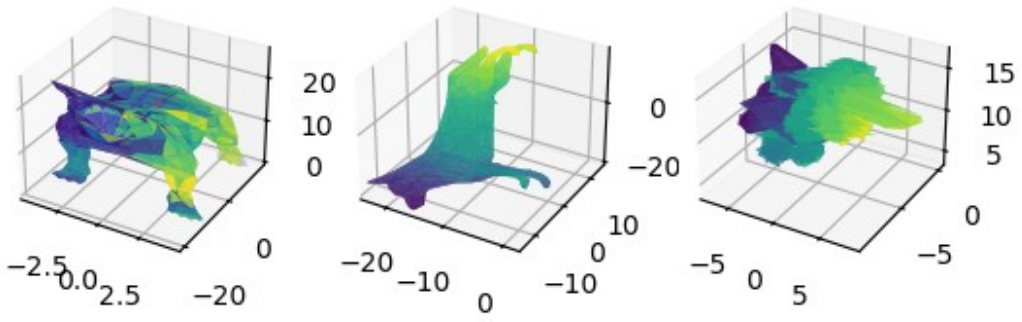
```
| 8700/10000 [4:55:33<29:27,  1.36s/it]

Epoch 8700: MSE loss = 27.354936599731445
Epoch 8700: Energy loss = 14.616411209106445
Epoch 8700: f1 loss = 0.0050104218535125256
Epoch 8700: f2 loss = 0.004290134180337191
```




```
525402.000000:  88%|
| 8800/10000 [4:59:08<30:24,  1.52s/it]

Epoch 8800: MSE loss = 71.76712799072266
Epoch 8800: Energy loss = 15.027170181274414
Epoch 8800: f1 loss = 525296.375
Epoch 8800: f2 loss = 18.85719108581543
```

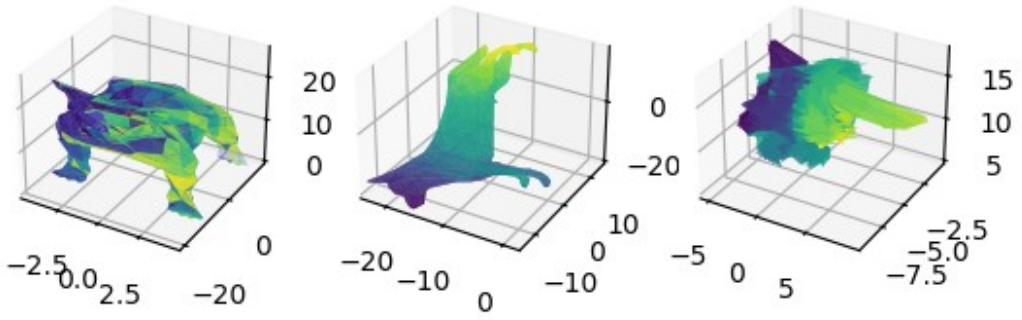



```
91.817207:  89%|
| 8900/10000 [5:02:41<29:17,  1.60s/it]

Epoch 8900: MSE loss = 77.6731948852539
Epoch 8900: Energy loss = 13.827415466308594
Epoch 8900: f1 loss = 0.2539275586605072
Epoch 8900: f2 loss = 0.06266950815916061
```



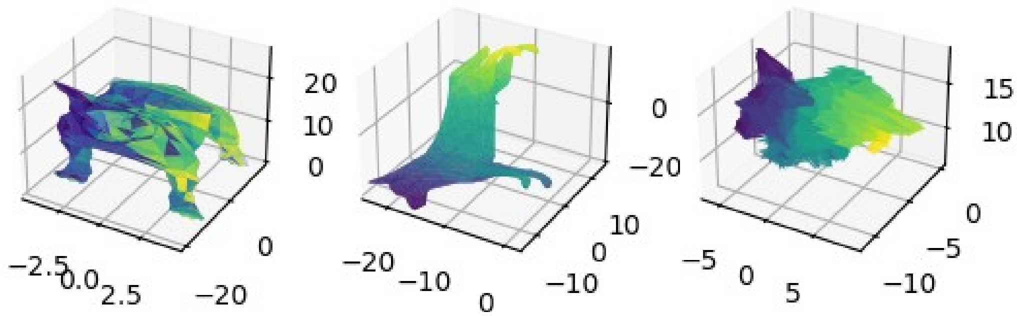
```
87.104935:  90%|
```

```
| 9000/10000 [5:06:15<22:44,  1.36s/it]

Epoch 9000: MSE loss = 71.15874481201172
Epoch 9000: Energy loss = 15.872835159301758
Epoch 9000: f1 loss = 0.05758344382047653
Epoch 9000: f2 loss = 0.01577364094555378
```

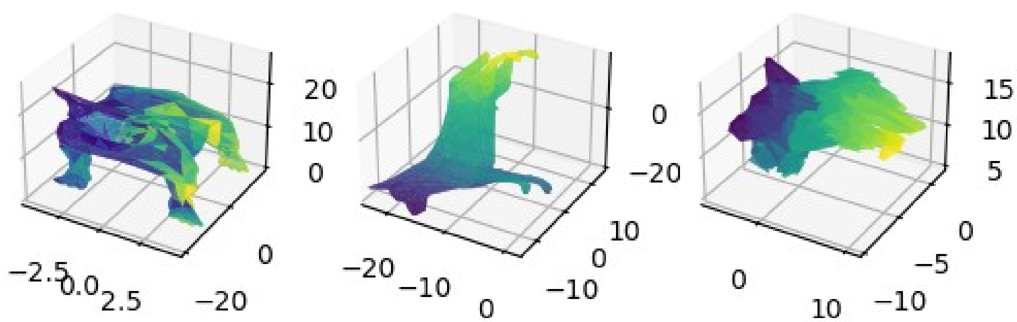


```
62.515560:  91%|
```

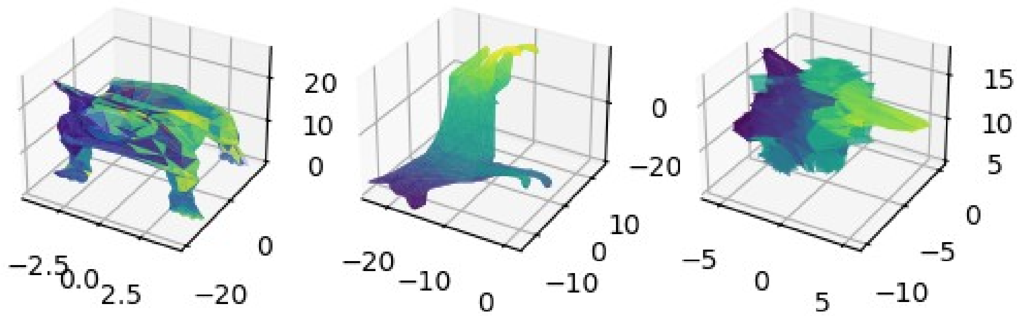
```
| 9100/10000 [5:09:52<23:21,  1.56s/it]

Epoch 9100: MSE loss = 47.712852478027344
Epoch 9100: Energy loss = 13.635639190673828
Epoch 9100: f1 loss = 0.0022993297316133976
Epoch 9100: f2 loss = 1.164768099784851
```



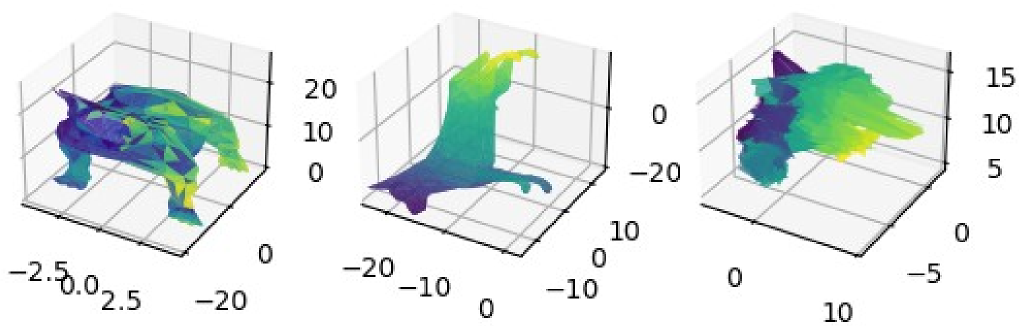

```
100.165710:  92%|
| 9200/10000 [5:13:20<19:44,  1.48s/it]

Epoch 9200: MSE loss = 88.60223388671875
Epoch 9200: Energy loss = 11.088390350341797
Epoch 9200: f1 loss = 0.46549370884895325
Epoch 9200: f2 loss = 0.009596948511898518
```



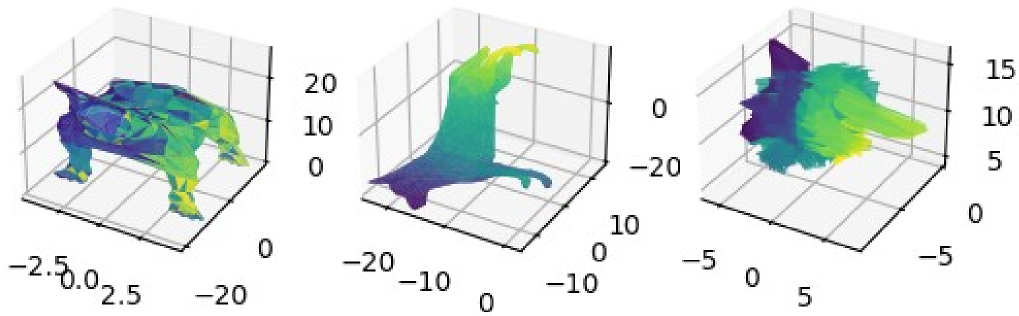

```
137.139374:  93%|
| 9300/10000 [5:16:49<18:14,  1.56s/it]

Epoch 9300: MSE loss = 118.29869079589844
Epoch 9300: Energy loss = 18.438114166259766
Epoch 9300: f1 loss = 0.05490834638476372
Epoch 9300: f2 loss = 0.34766116738319397
```



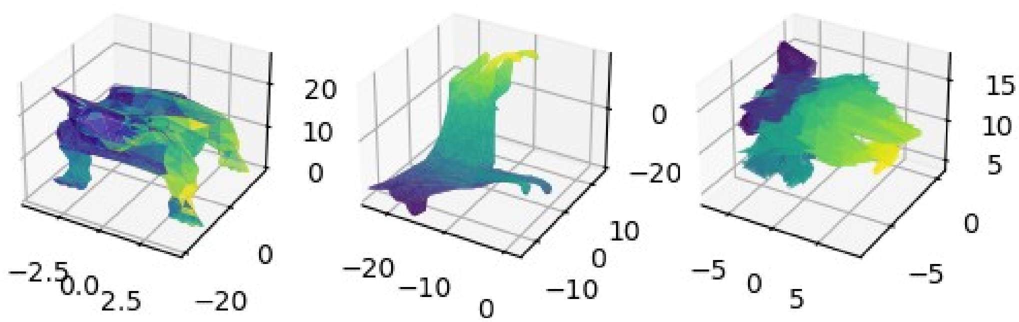

```
65.959839:  94%|                    | 9400/10000 [5:20:20<15:20,  1.53s/it]

Epoch 9400: MSE loss = 50.20254898071289
Epoch 9400: Energy loss = 14.71146011352539
Epoch 9400: f1 loss = 0.510416567325592
Epoch 9400: f2 loss = 0.5354181528091431
```



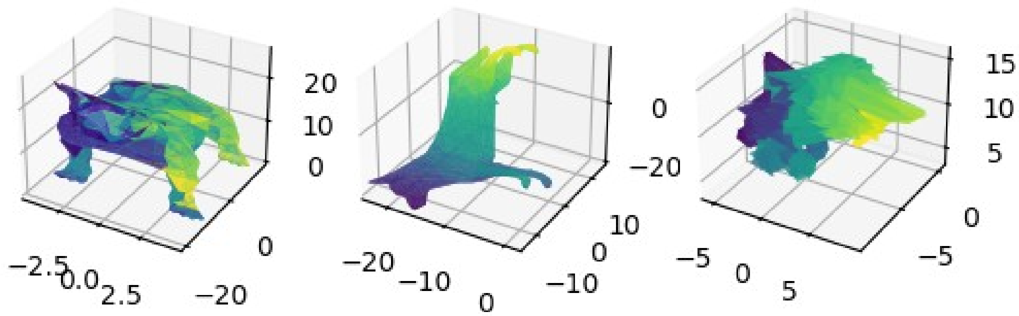

```
58.800320:  95%|                    | 9500/10000 [5:23:56<11:16,  1.35s/it]

Epoch 9500: MSE loss = 41.593177795410156
Epoch 9500: Energy loss = 16.789154052734375
Epoch 9500: f1 loss = 0.4135289788246155
Epoch 9500: f2 loss = 0.004458288662135601
```



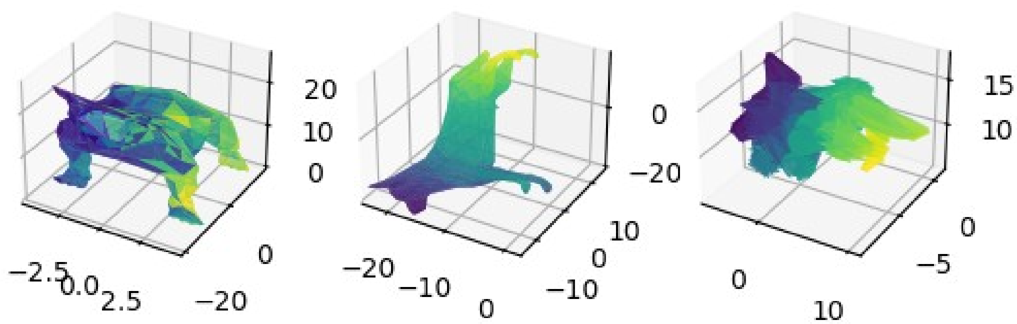

```
97.049278:  96%|
```
[redacted]
```
| 9600/10000 [5:27:37<09:41,  1.45s/it]

Epoch 9600: MSE loss = 84.96973419189453
Epoch 9600: Energy loss = 12.059536933898926
Epoch 9600: f1 loss = 0.006253623869270086
Epoch 9600: f2 loss = 0.013752649538218975
```



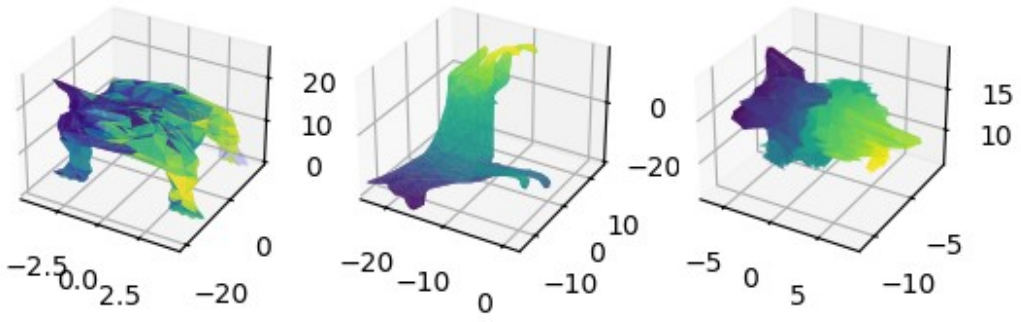

```
45.455379:  97%|
```
[redacted]
```
| 9700/10000 [5:31:05<07:40,  1.54s/it]

Epoch 9700: MSE loss = 29.070720672607422
Epoch 9700: Energy loss = 13.887406349182129
Epoch 9700: f1 loss = 2.4899983406066895
Epoch 9700: f2 loss = 0.007254406344145536
```




```
709.324646:  98%|[redacted]| 9800/10000 [5:34:41<04:29,  1.35s/it]

Epoch 9800: MSE loss = 123.96302032470703
Epoch 9800: Energy loss = 12.735799789428711
Epoch 9800: f1 loss = 534.519775390625
Epoch 9800: f2 loss = 38.10610580444336
```




```
113.975517:  99%|[redacted]| 9900/10000 [5:38:15<02:38,  1.59s/it]

Epoch 9900: MSE loss = 72.50479125976562
Epoch 9900: Energy loss = 13.458986282348633
Epoch 9900: f1 loss = 27.332685470581055
Epoch 9900: f2 loss = 0.6790546774864197
```




```
91.352242: 100%|
```

```
| 10000/10000 [5:41:46<00:00,  2.05s/it]
```

```
print(s3_faces.shape)
print(s1_faces_tmp.shape)
print(s1_faces.shape)
```

```
(970, 3, 3)
(1078, 3, 3)
(970, 3, 3)
```

```
lf1, lf2 = s1_faces_tmp, s3_faces

centroids_lf1 = np.array([compute_centroid(face) for face in lf1])
centroids_lf2 = np.array([compute_centroid(face) for face in lf2])

closest_faces = []
closest_faces_idx = []

for centroid in centroids_lf2:
    distances = np.linalg.norm(centroids_lf1 - centroid, axis=1)
    closest_face_idx = np.argmin(distances)
    while closest_face_idx in closest_faces_idx:
        distances[closest_face_idx] = max(distances) + 1
        # print(closest_face_idx, np.argmin(distances))
        closest_face_idx = np.argmin(distances)
    closest_faces.append(lf1[closest_face_idx])
    closest_faces_idx.append(closest_face_idx)
print(len(closest_faces_idx))
print(max(closest_faces_idx))

# for centroid in centroids_lf2:
#     distances = np.linalg.norm(centroids_lf1 - centroid, axis=1)
#     closest_face_idx = np.argmin(distances)
#     while closest_face_idx in closest_faces_idx:
#         distances[closest_face_idx] = max(distances) + 1
#         # print(closest_face_idx, np.argmin(distances))
```

```
#         closest_face_idx = np.argmin(distances)
#     closest_faces.append(lf1[closest_face_idx])
#     closest_faces_idx.append(closest_face_idx)
# print(len(closest_faces_idx))
# print(max(closest_faces_idx))
```

```
970
1077
```

```
v1s = my_batch.pos.detach().numpy()[0]
v3s = s3.features.detach().squeeze(0).numpy()[0]
print(v1s, v3s)
```

```
[[ 3.1602659e+00 -1.0895985e+01  1.0343000e-02]
 [ 3.7360101e+00 -1.1155475e+01  4.6799000e-02]
 [ 5.8451301e-01 -1.9746441e+01  2.1269619e+01]
 ...
 [-1.0321780e+00  1.3775474e+01  8.3145781e+00]
 [-7.1533501e-01  1.1227485e+01  1.3906136e+01]
 [-3.3355400e-01  1.4022309e+01  7.2379370e+00]] [-1.09389   -
3.4720056  7.0445876]
```

```
np.save('shape1_baseline.npy', v1_remapped)
np.save('shape2_reconstruction.npy',
s3.features.detach().squeeze(0).numpy())
```