UNSUPERVISED AND SELF-SUPERVISED LEARNING

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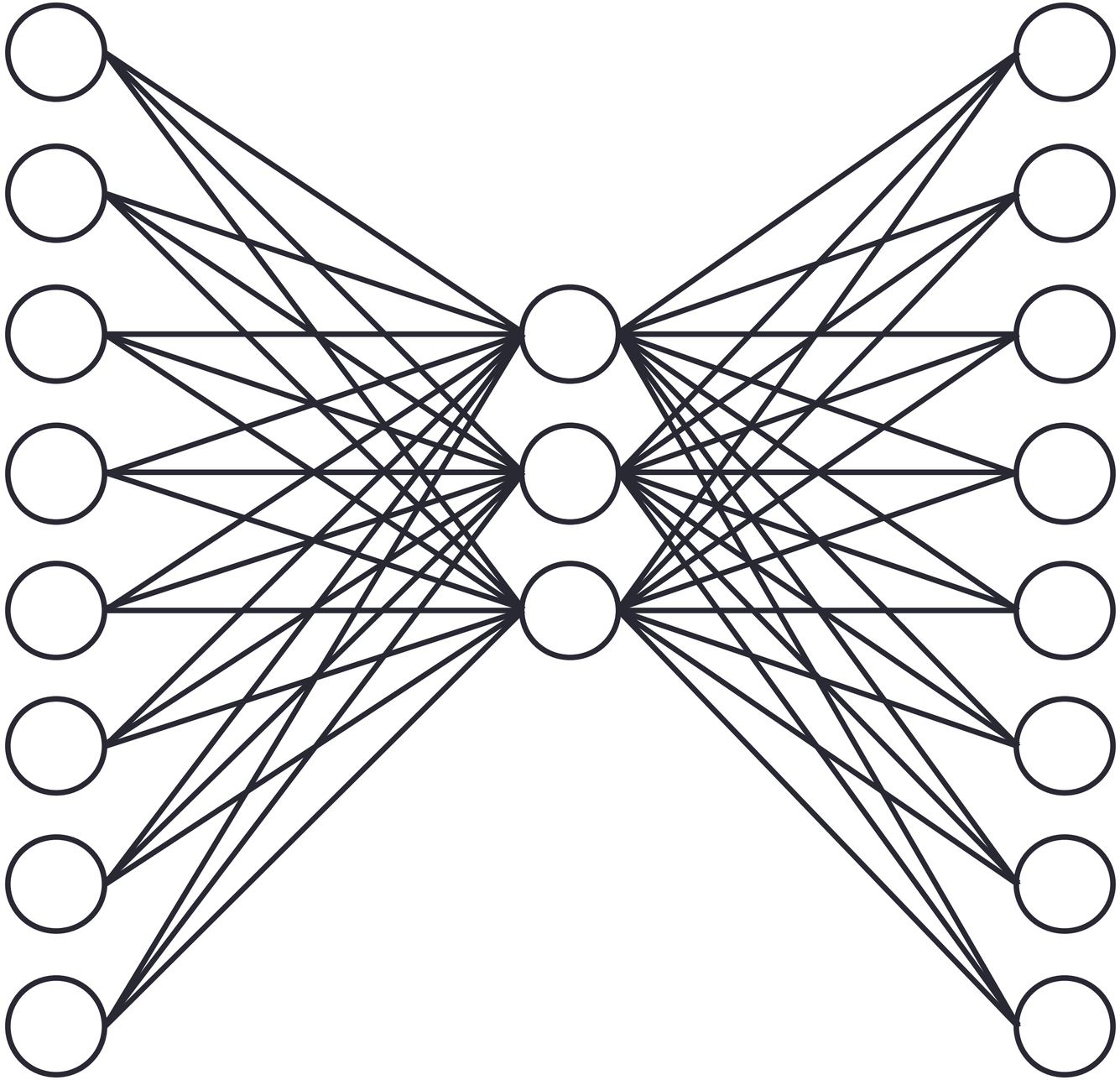
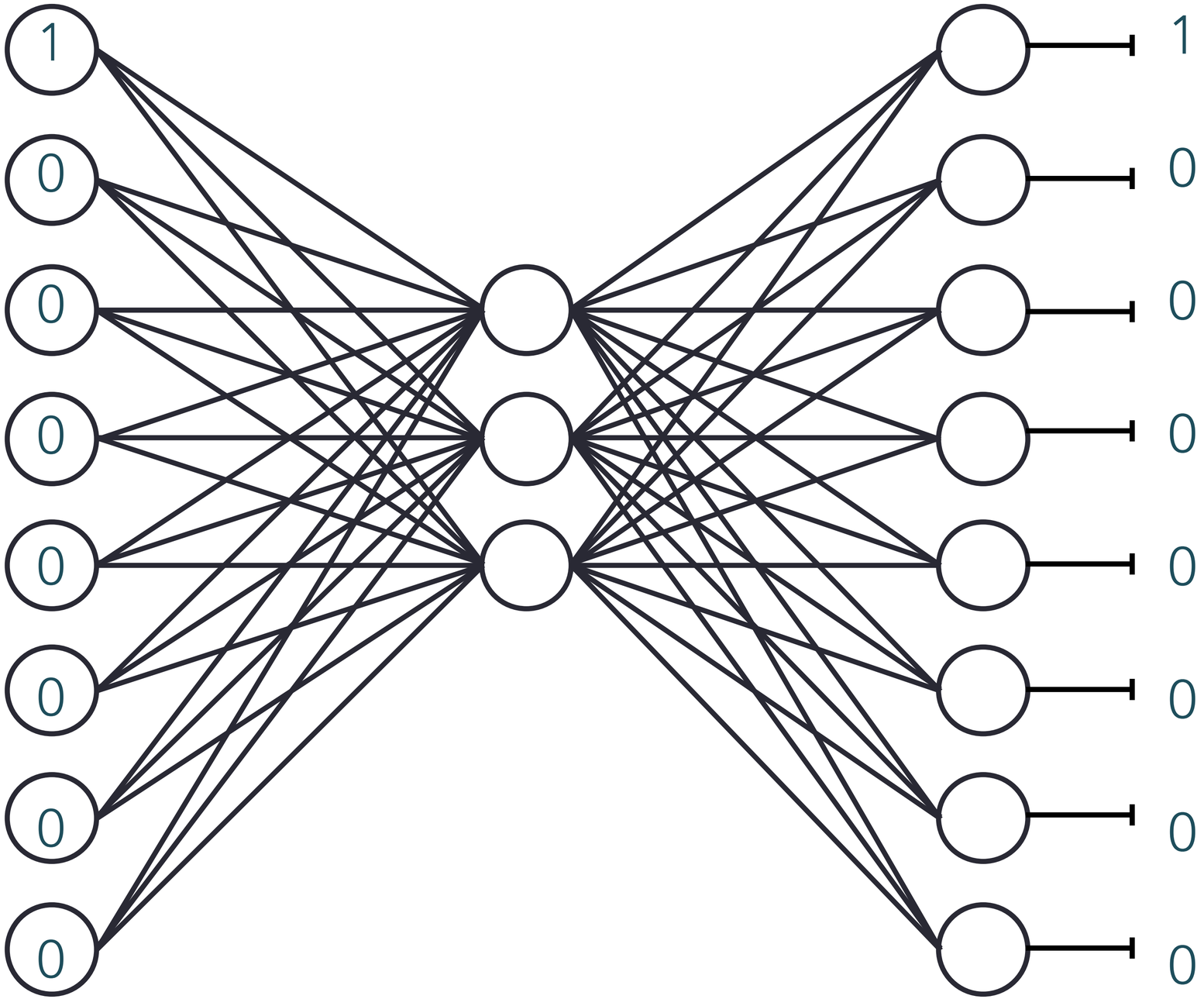
DAVIDSON COLLEGE

JOINT ICTP-IAEA SCHOOL ON AI FOR NUCLEAR, PLASMA, AND FUSION SCIENCE

ICTP
23 MAY 2023

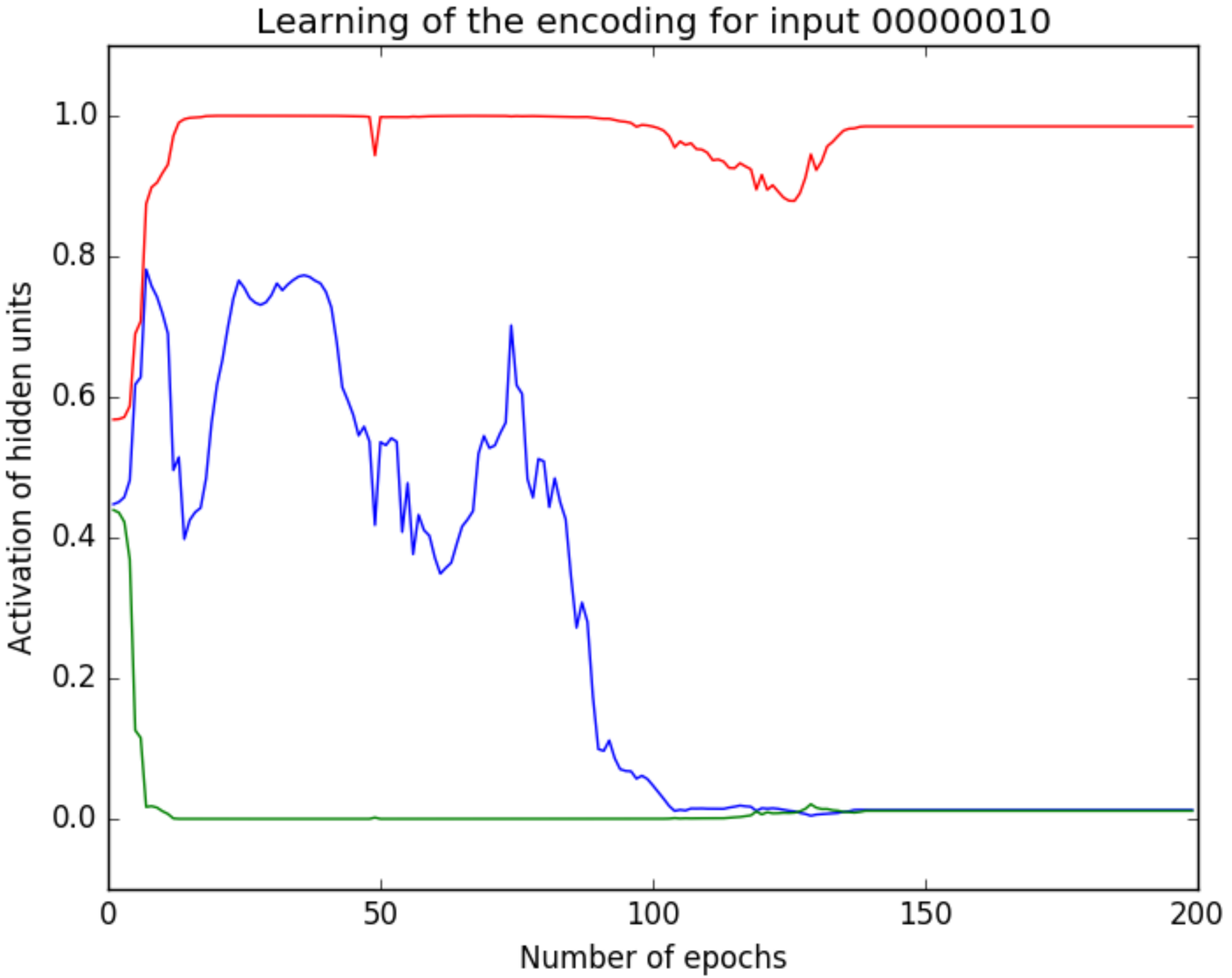


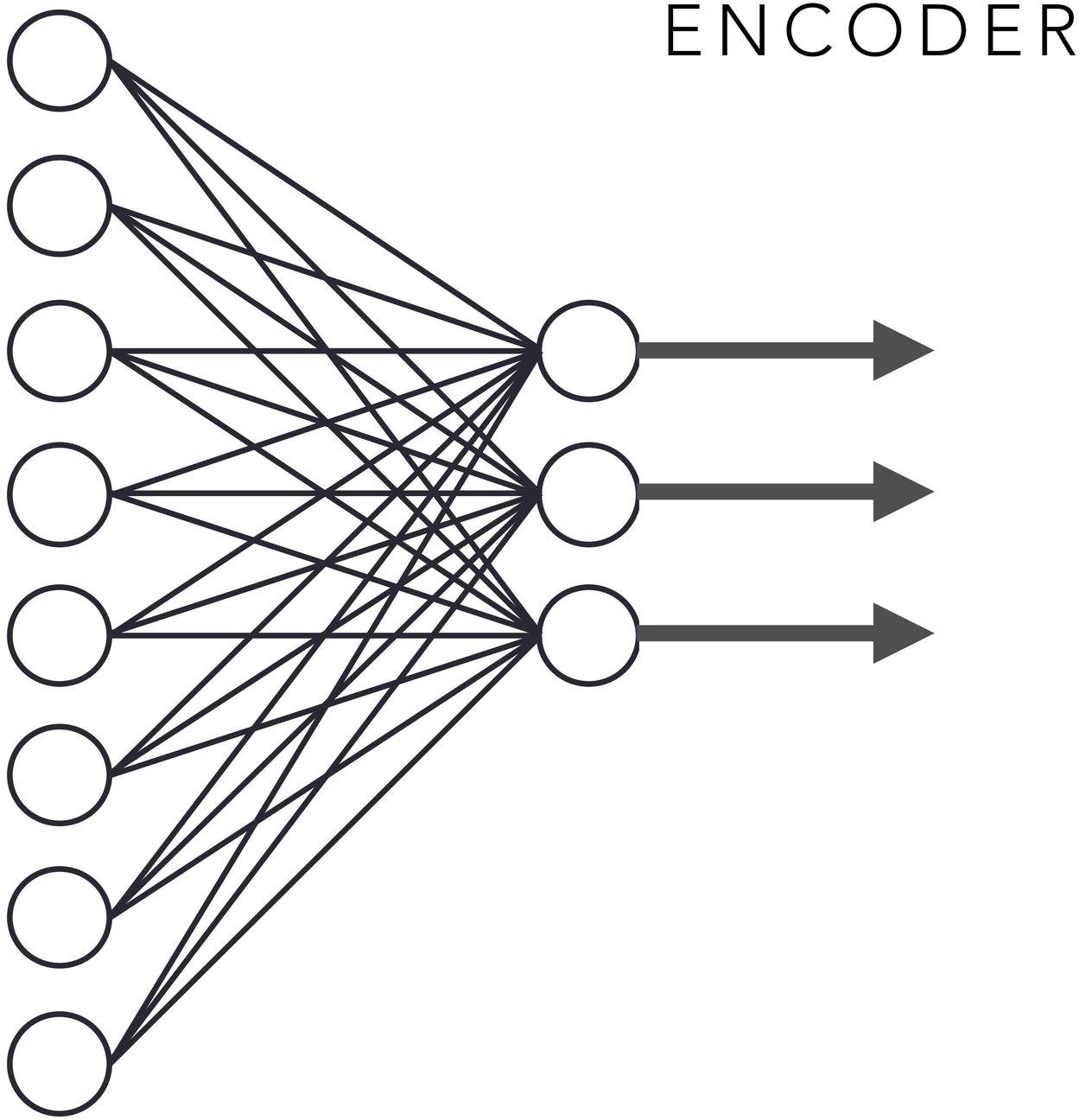
Input	Output
10000000	10000000
01000000	01000000
00100000	00100000
00010000	00010000
00001000	00001000
00000100	00000100


1
0
0
0
0
0
0
0
1
0
0
0
0
0
0
0

Input	Output
10000000	10000000
01000000	01000000
00100000	00100000
00010000	00010000
00001000	00001000
00000100	00000100

Input	A1	A2	A3	Output
10000000	0.9911	0.9869	0.0093	10000000
01000000	0.9892	0.0095	0.0124	01000000
00100000	0.0094	0.0283	0.0122	00100000
00010000	0.9840	0.9836	0.9900	00010000
00001000	0.0139	0.9904	0.0186	00001000
00000100	0.0128	0.9805	0.9868	00000100

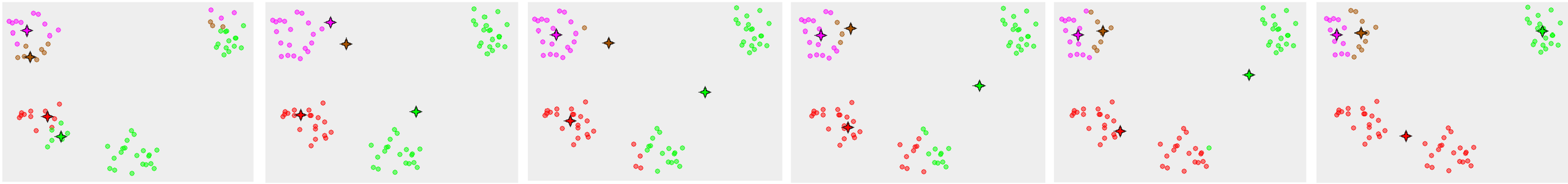

Learning of the encoding for input 00000010
Activation of hidden units
Number of epochs
1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
200


ENCODER

CLUSTERING — KMEANS

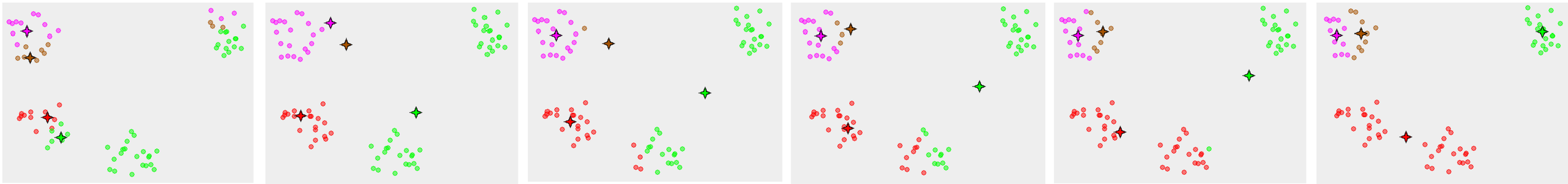
Goal: minimize pairwise distances between points in *same* cluster

$$\min \sum_{i=1}^{k} \frac{1}{2N} \sum_{x,y,x \neq y}^{N} (\vec{x} - \vec{y})^2$$



Goal: maximize pairwise distances between points in *different* clusters

CLUSTERING — KMEANS



GENERATIVE MODELS

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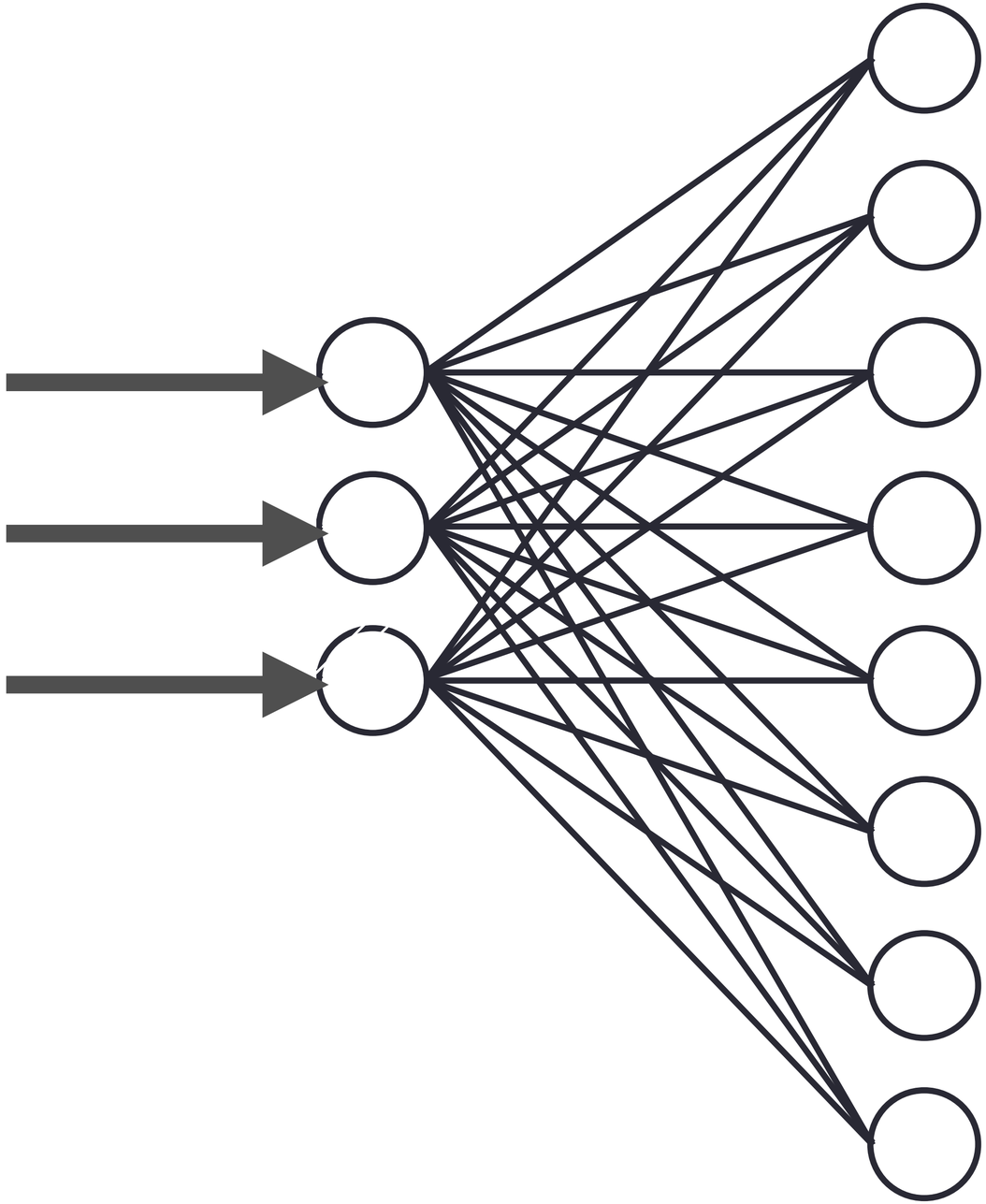
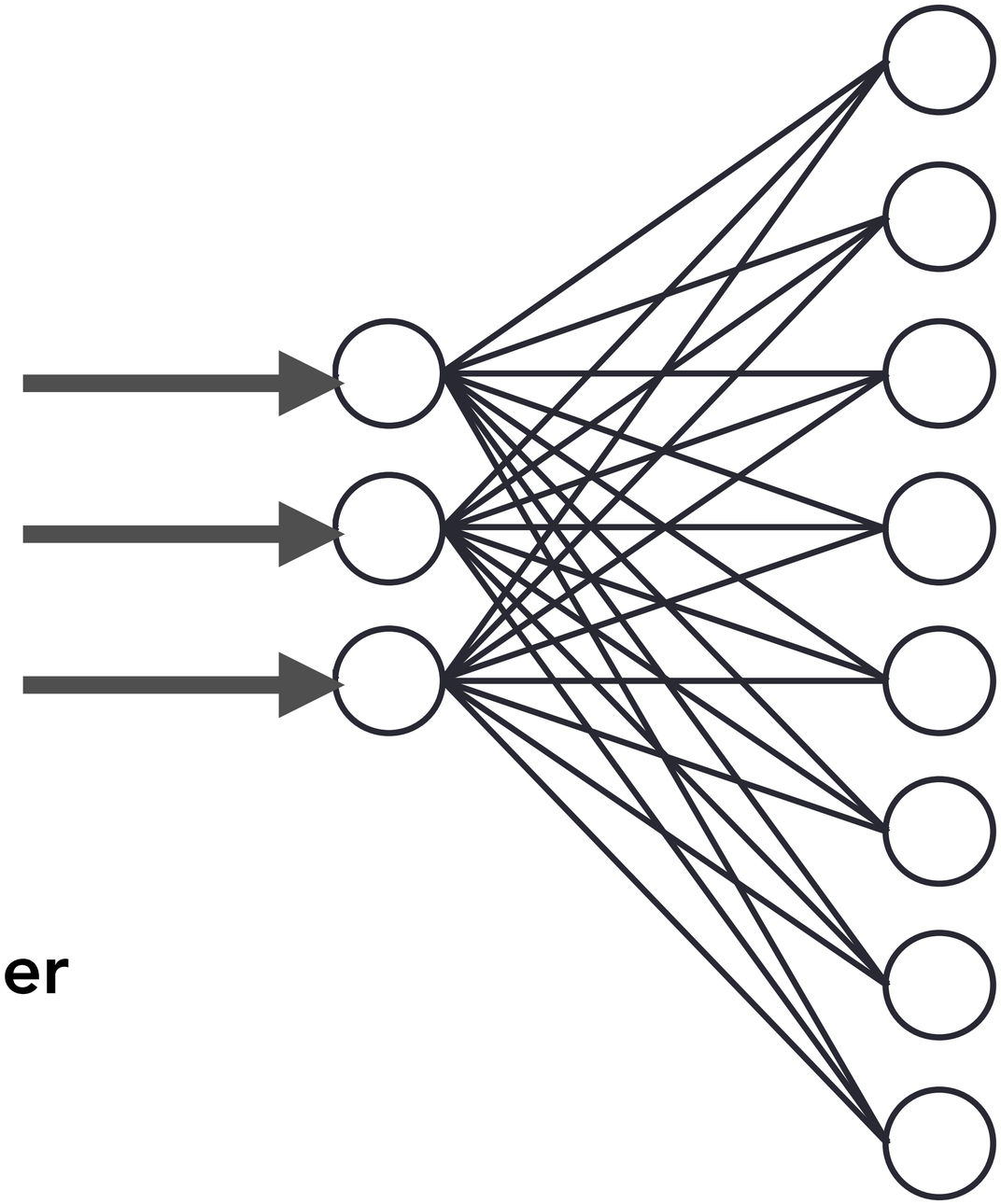
DECODER



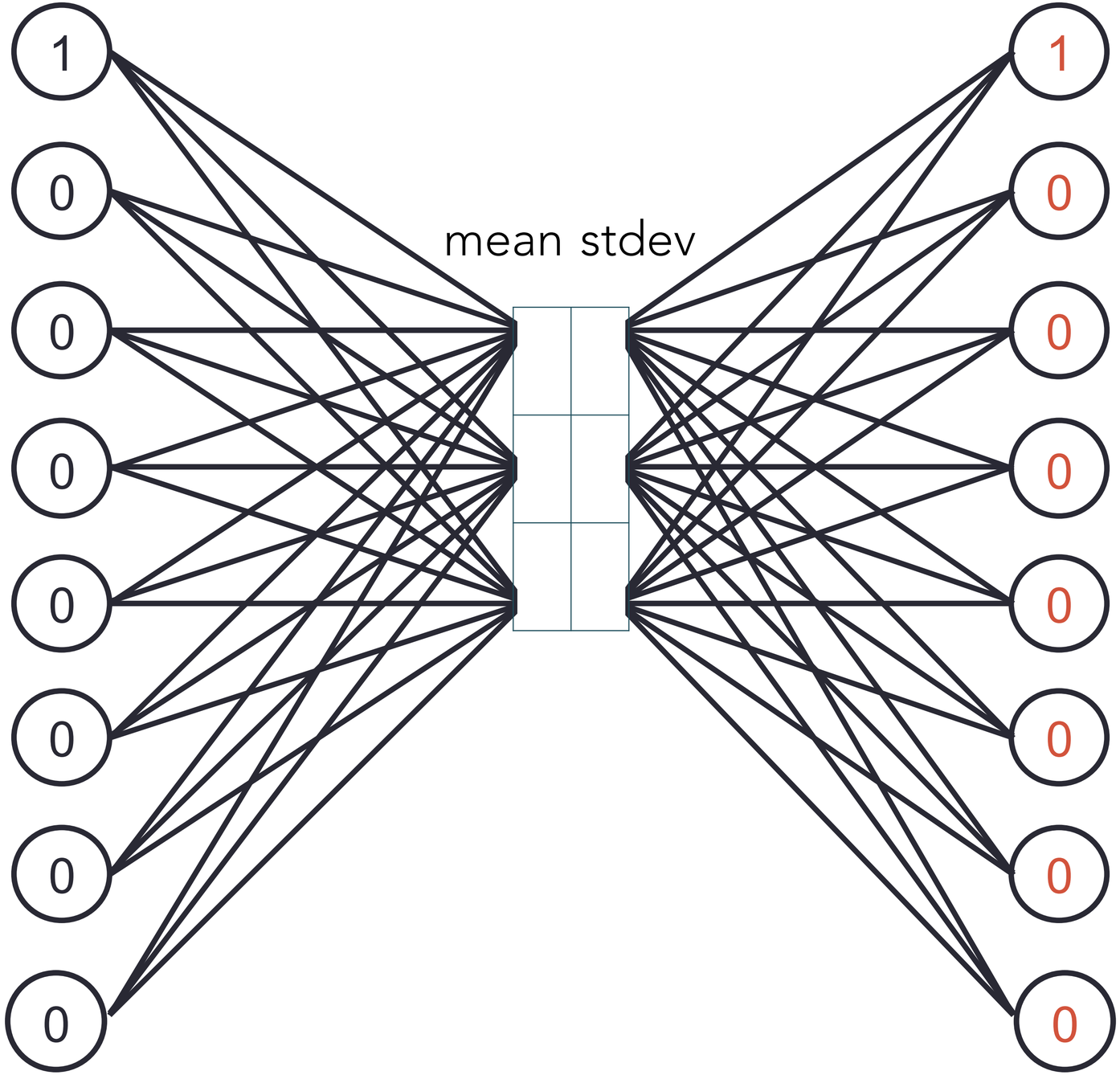
DECODER

How do we know that we are providing a latent vector that represents those seen in training?

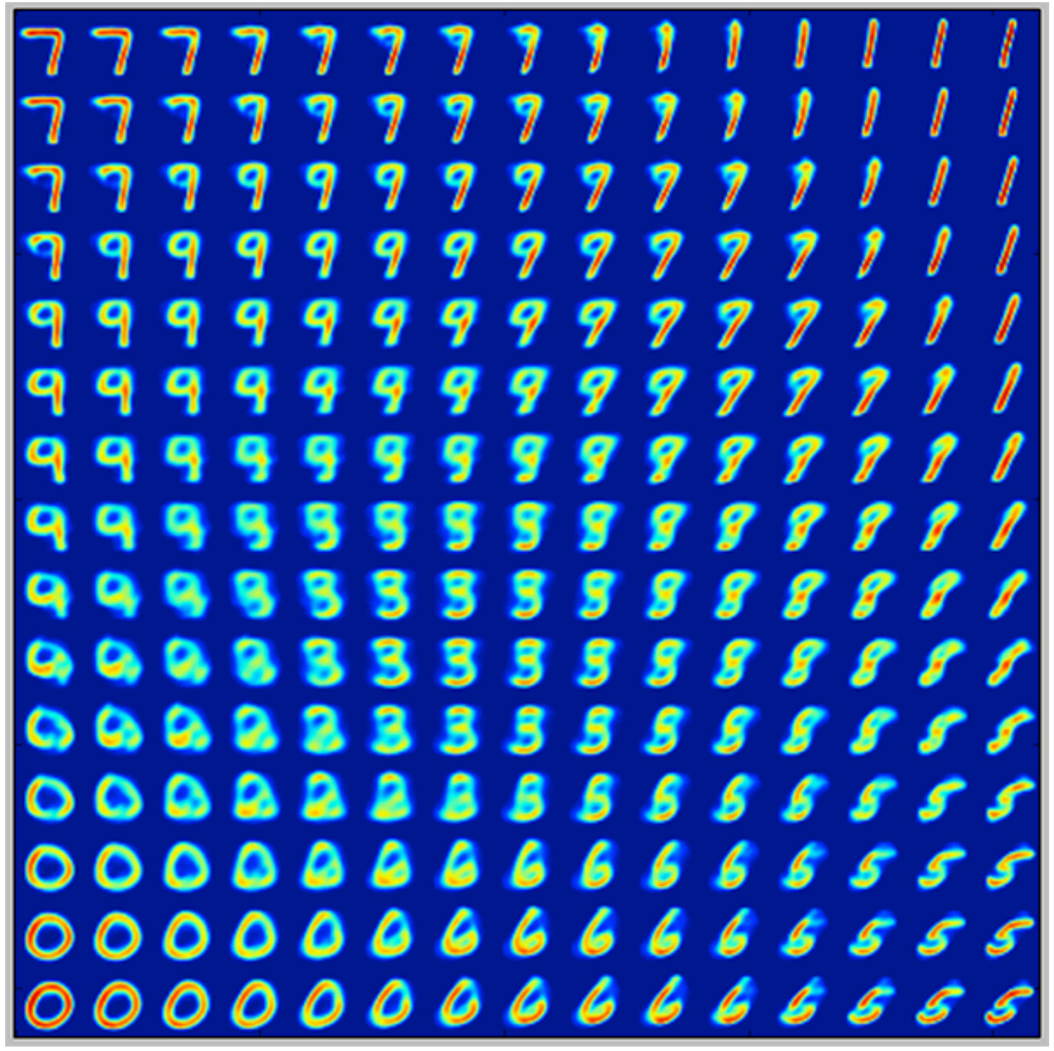
Variational Autoencoder

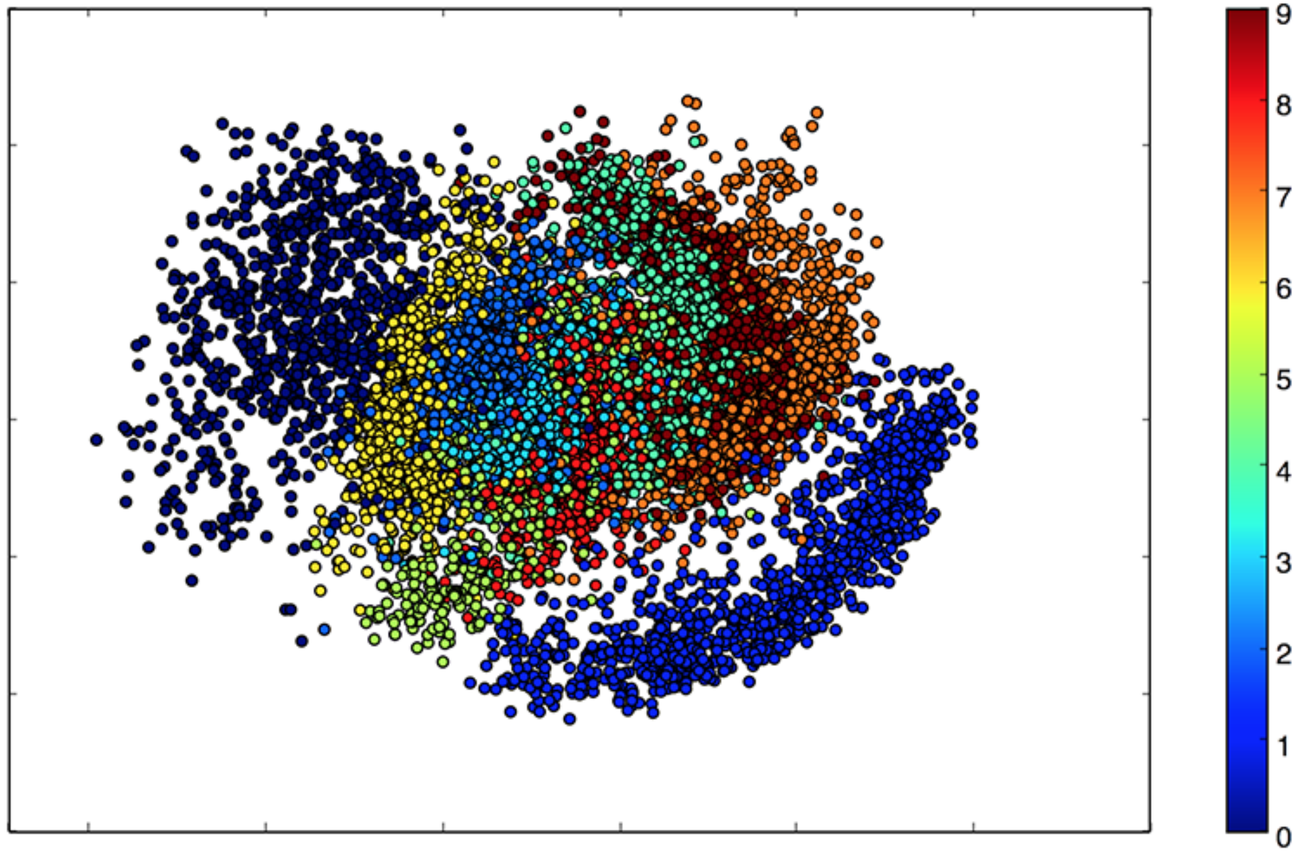


Encode to two outputs for each latent dimension: mean and stdev



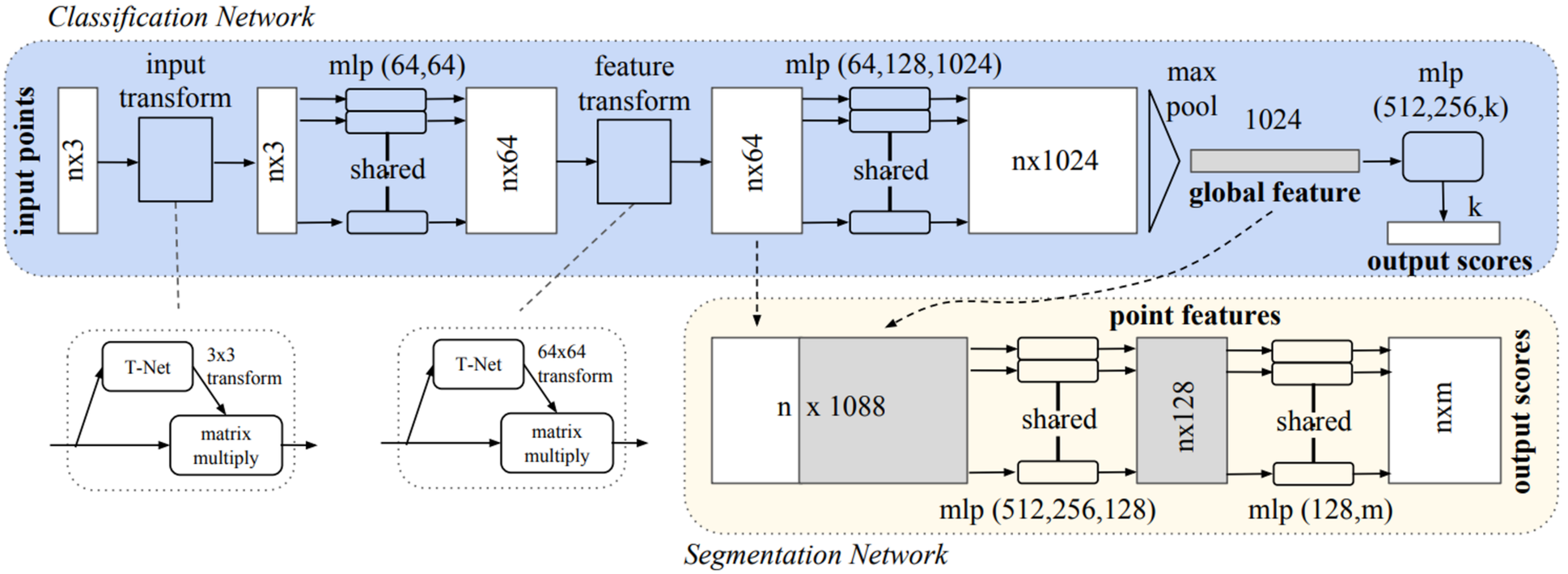
Sample similar points in latent space, decode, and compare with regularization

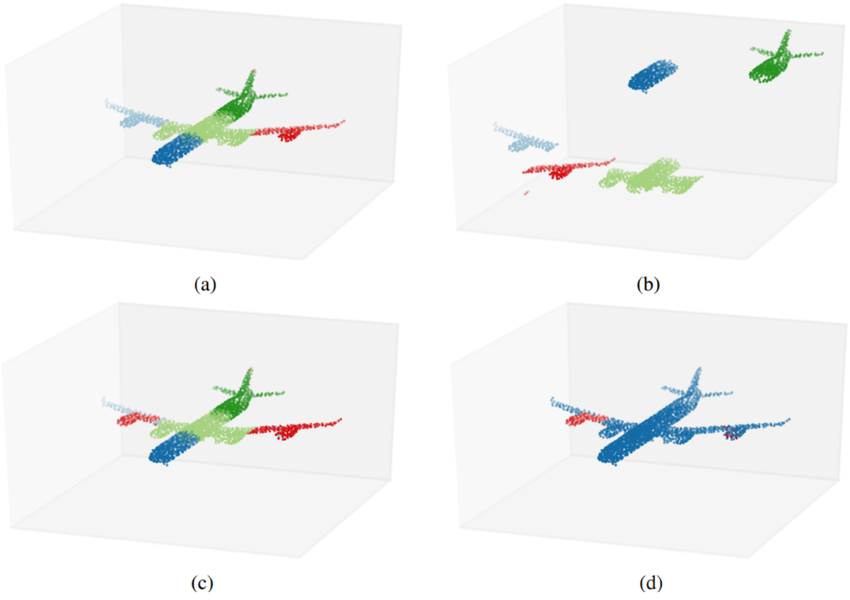


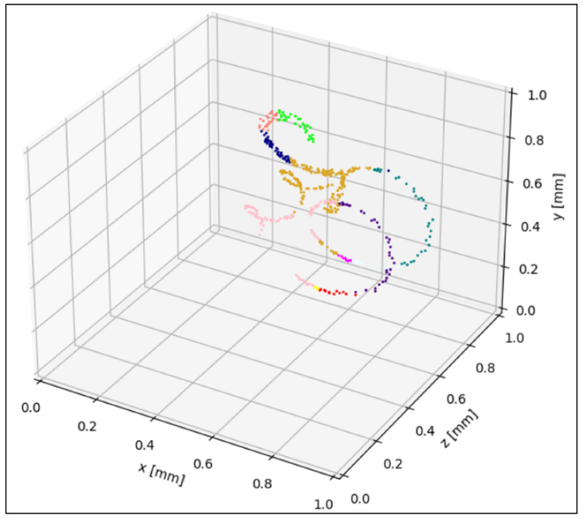


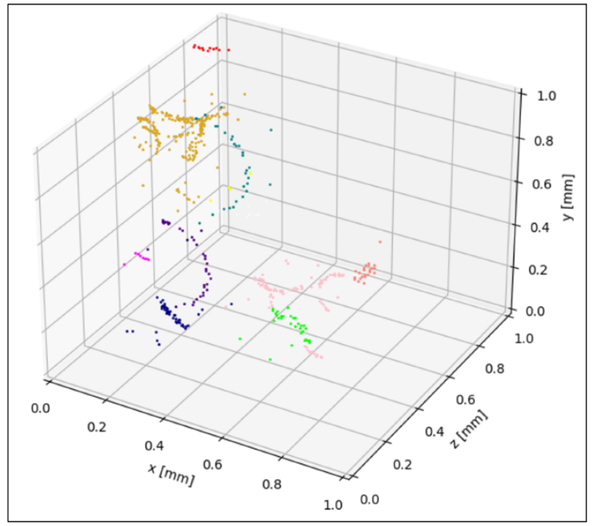
https://blog.keras.io/building-autoencoders-in-keras.html

POINT CLOUDS

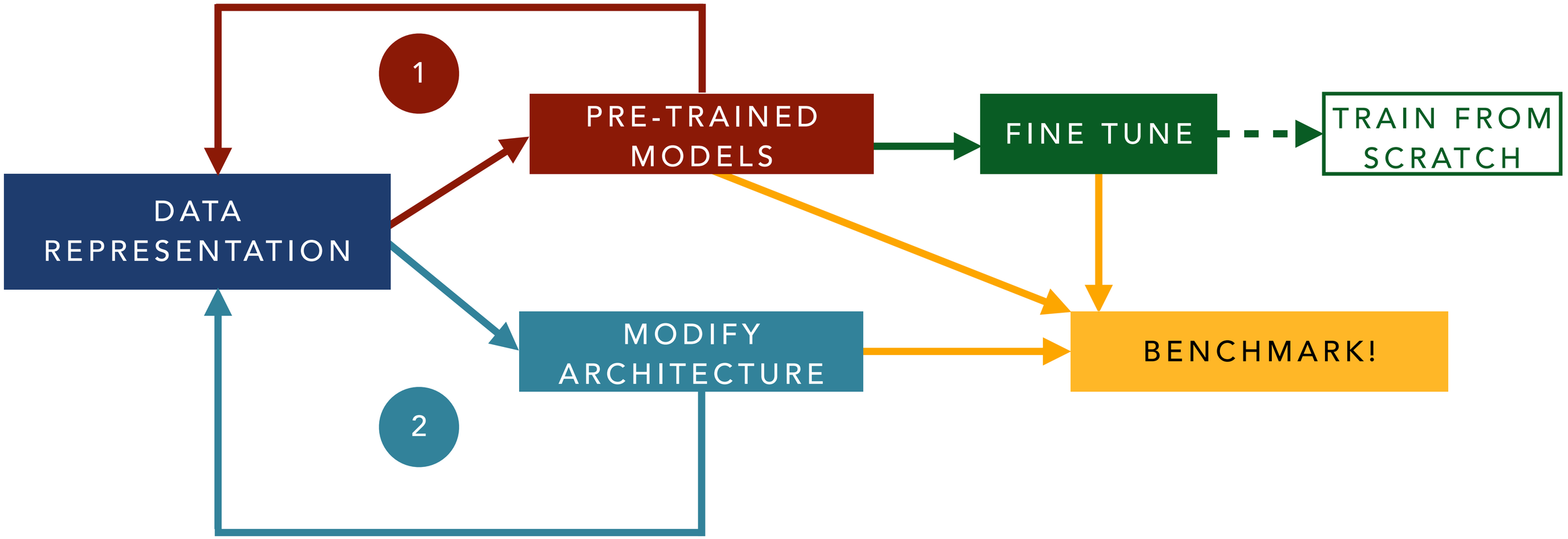

Classification Network
input points
nx3
input transform
nx3
mlp (64,64)
shared
nx64
feature transform
nx64
mlp (64,128,1024)
shared
nx1024
max pool
1024
global feature
mlp (512,256,k)
k
output scores
T-Net
3x3 transform
matrix multiply
T-Net
64x64 transform
matrix multiply
point features
n x 1088
shared
nx128
shared
nxm
output scores
mlp (512,256,128)
mlp (128,m)
Segmentation Network


(a)
(b)
(c)
(d)


x [mm]
z [mm]
y [mm]


x [mm]
z [mm]
y [mm]

EXAMPLE WORKFLOW



EXAMPLE WORKFLOW