Linear Autoencoder ICP

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ECE 5258

Pattern Recognition

Fall 2021

Purpose

- Create a linear autoencoder
- Sample Covariance Matrix PCA
- Denoiseing

Theory

- Encoder
  - Sample Covariance Matrix PCA
  - Maps D to H dimensions
- Decoder
  - Maps H to D dimensions

Encoder

- Sample Mean
- Center Samples
- Sample Covariance Matrix
- EVD
- H Principal Components based on Total Variance Explained (p)

Encoding

- Center test samples
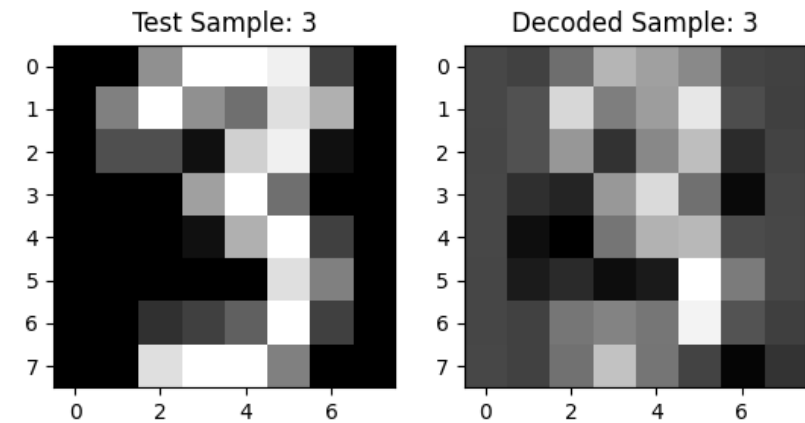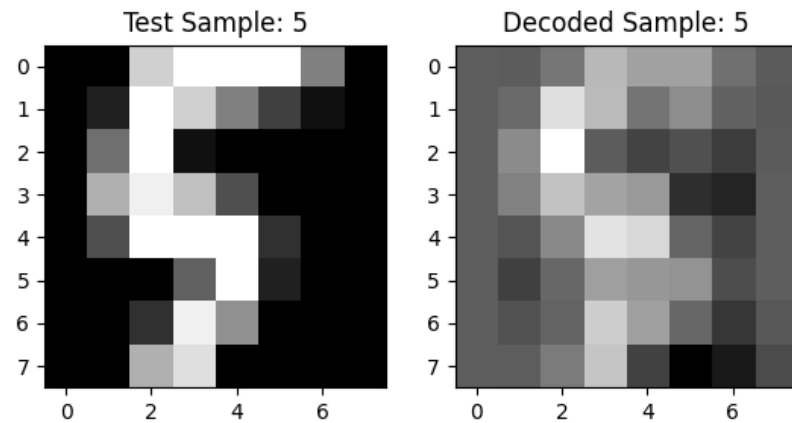- Transform with H Principal Components

Decoding

- Transform back with H Principal Components
- Decenter samples

Data

- Three Data Sets
  - MNIST 8x8 Digits
  - MNIST 28x28 Digits
  - Yale Faces
- Sample
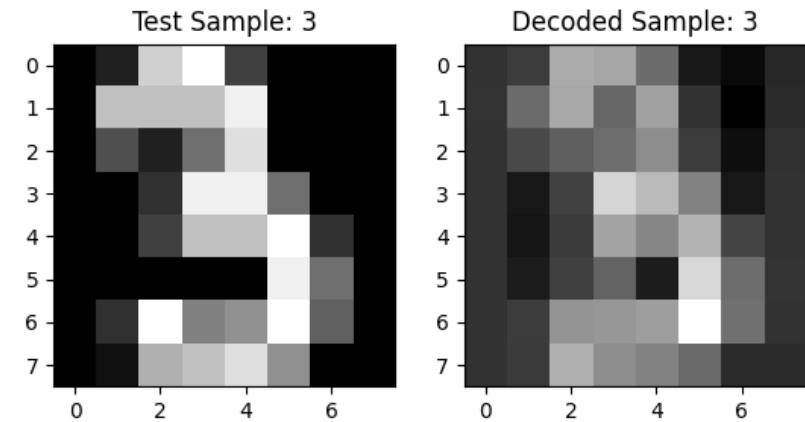 - D-length vector
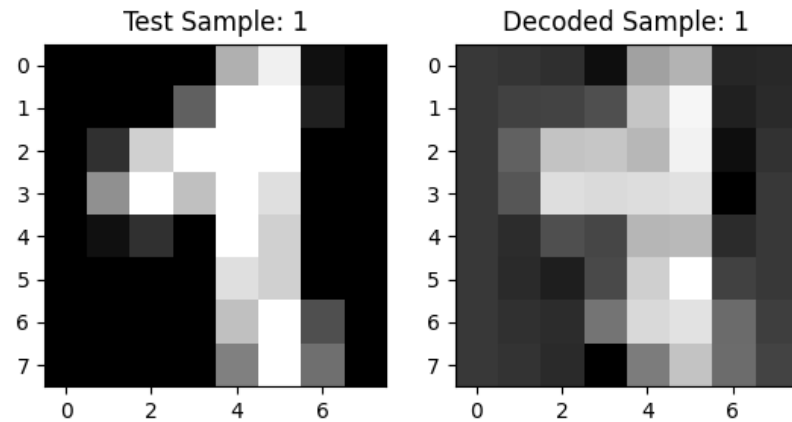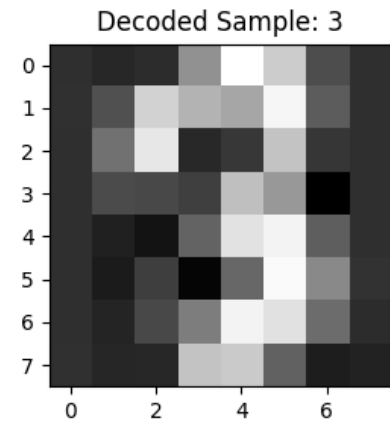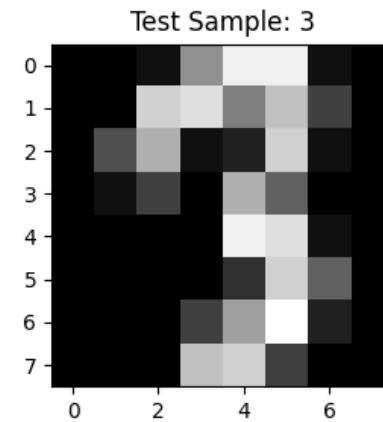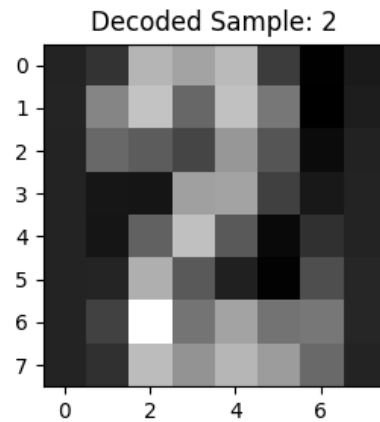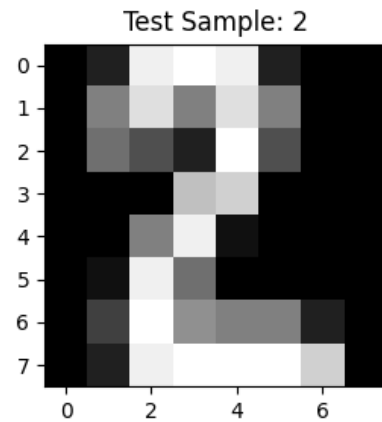 - Dimensions value = Pixel strength

8x8 Digits

- P = 0.8
- H = 13

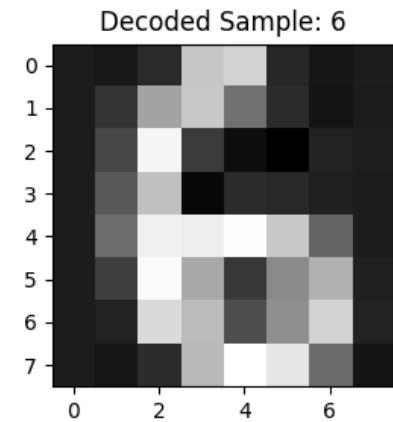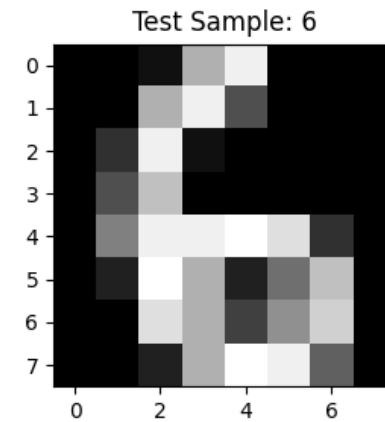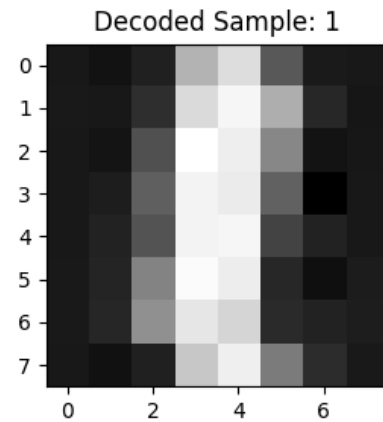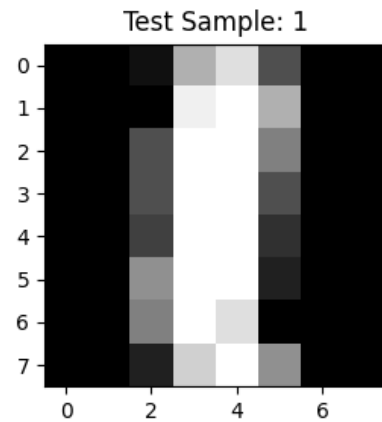Test Sample: 5 | Decoded Sample: 5 | Test Sample: 3 | Decoded Sample: 3
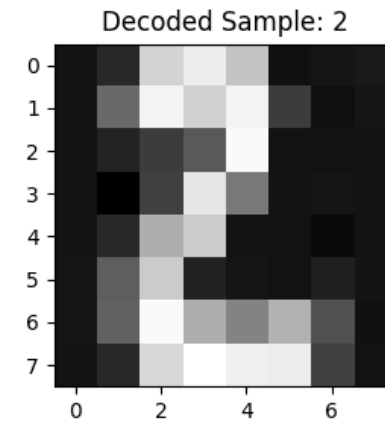
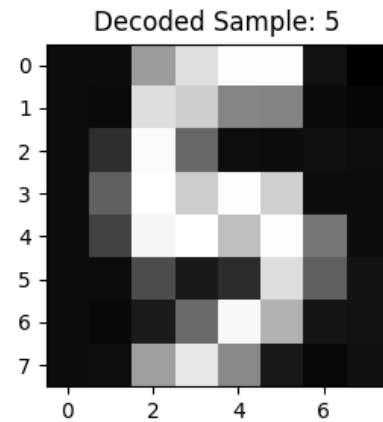# 8x8 Digits

- P = 0.85
- H = 17

8x8 Digits

- P = 0.9
- H = 21

8x8 Digits

- P = 0.95
- H = 29

Test Sample: 1   Decoded Sample: 1

Test Sample: 6   Decoded Sample: 6

8x8 Digits

- P = 0.99
- H = 41

Test Sample: 5   Decoded Sample: 5   Test Sample: 2   Decoded Sample: 2
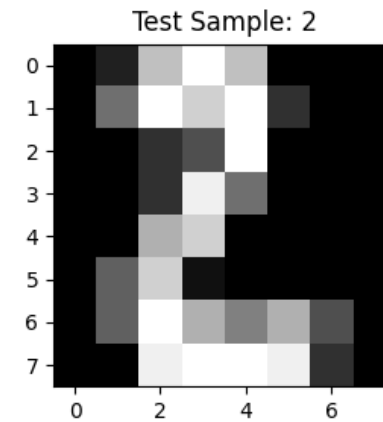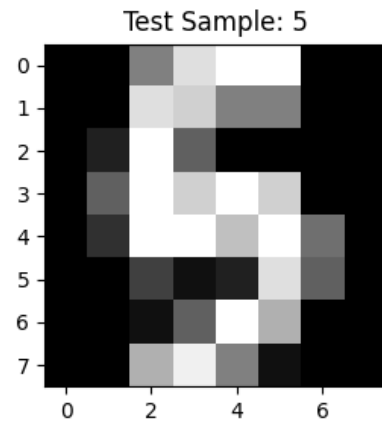
8x8 Digits with Noise

P = 0.9

P = 0.95

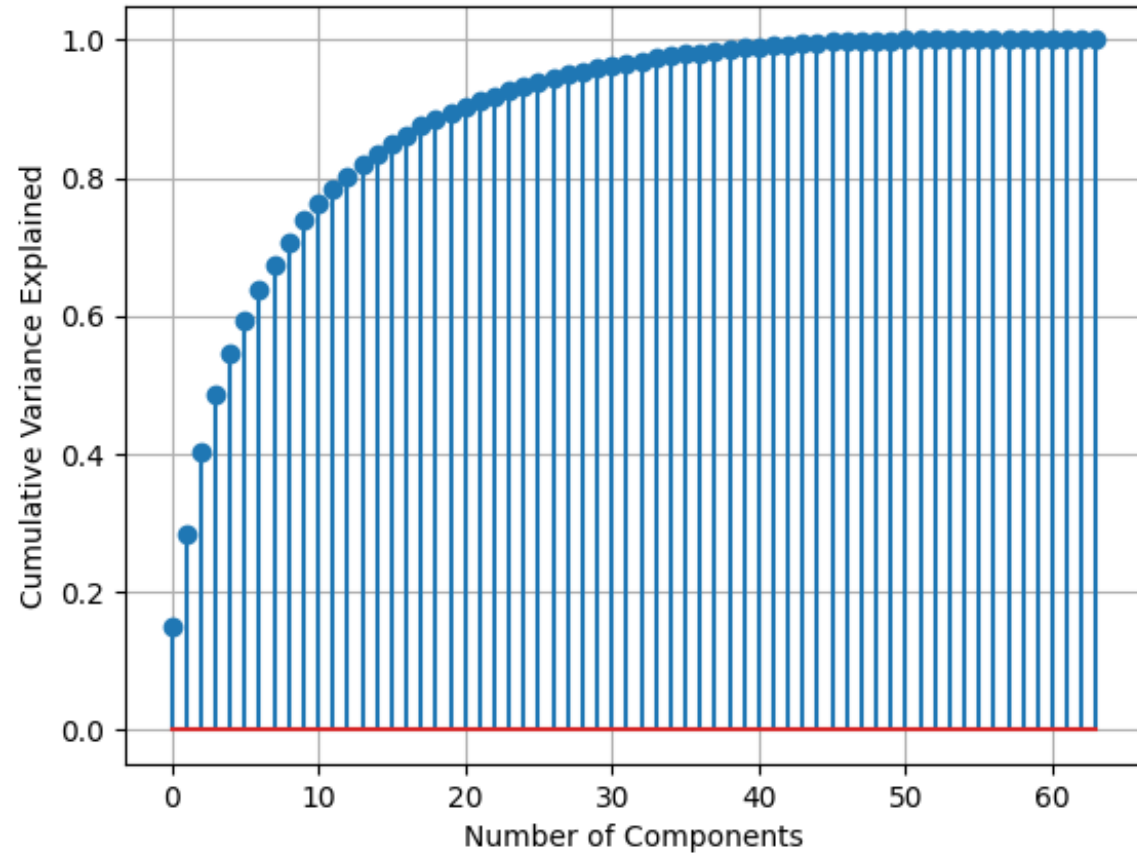Test Sample: 0

Decoded Sample: 0

Test Sample: 1

Decoded Sample: 1
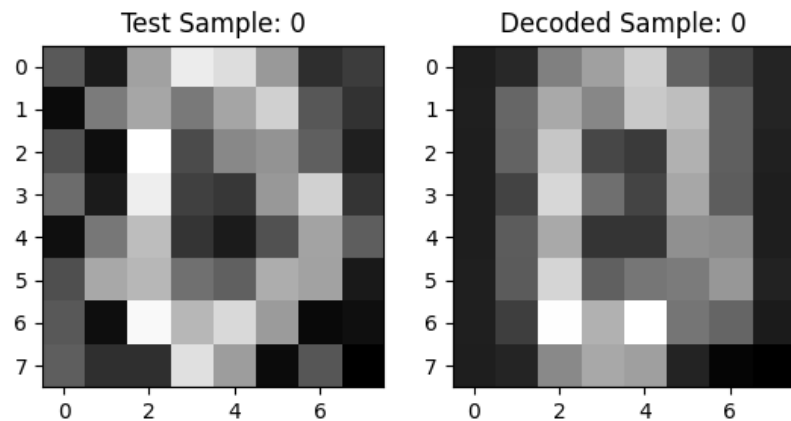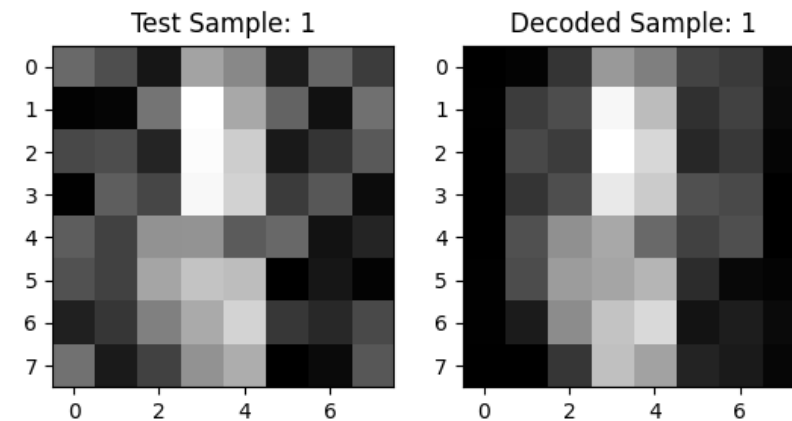
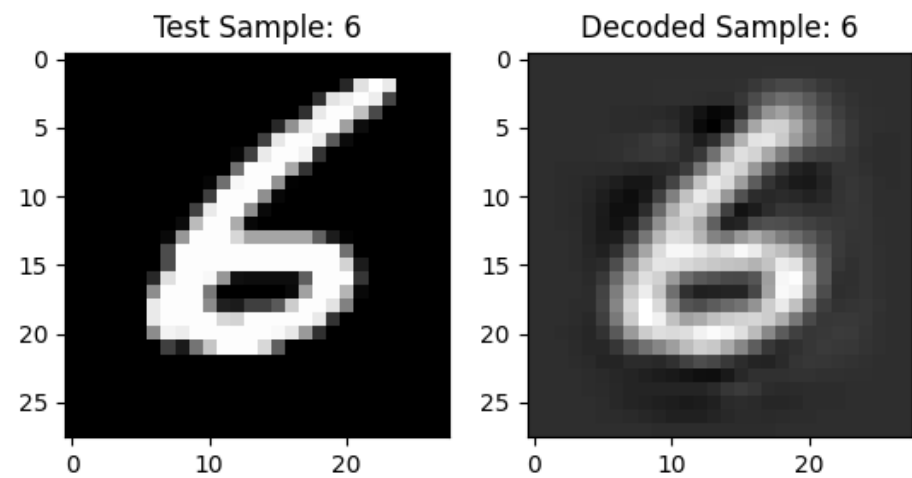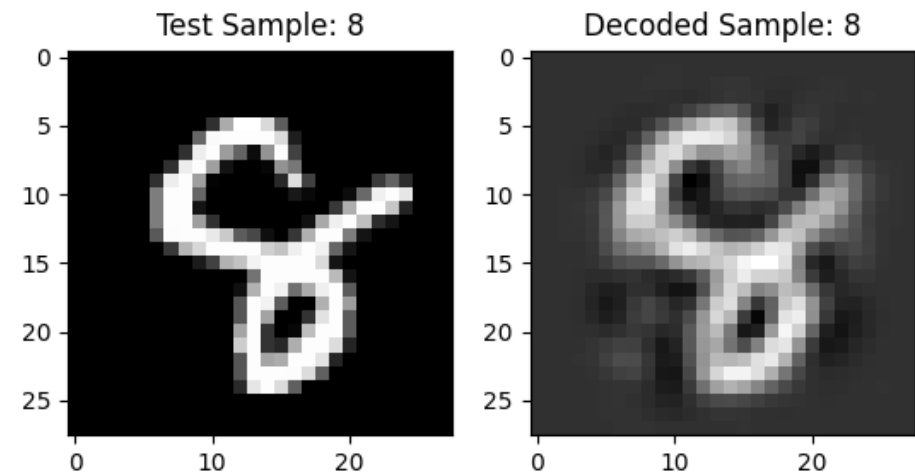# Cumulative Total Variance Explained

- Majority in first few components

28x28 Digits

- P = 0.8
- H = 44

28x28 Digits
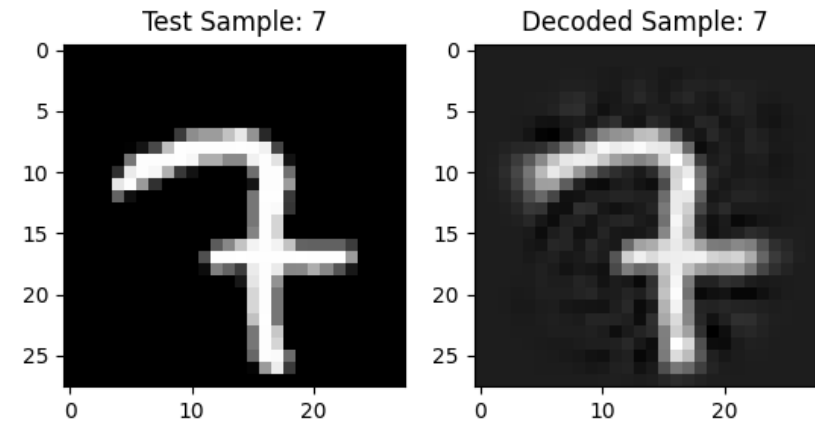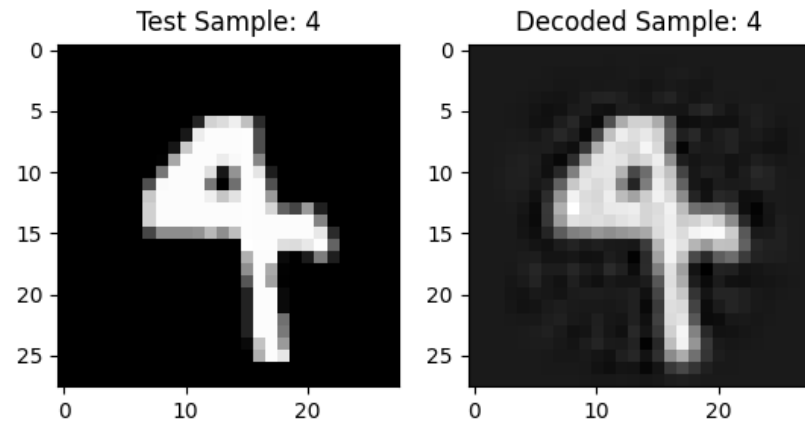
- P = 0.85
- H = 59

Test Sample: 8 Decoded Sample: 8

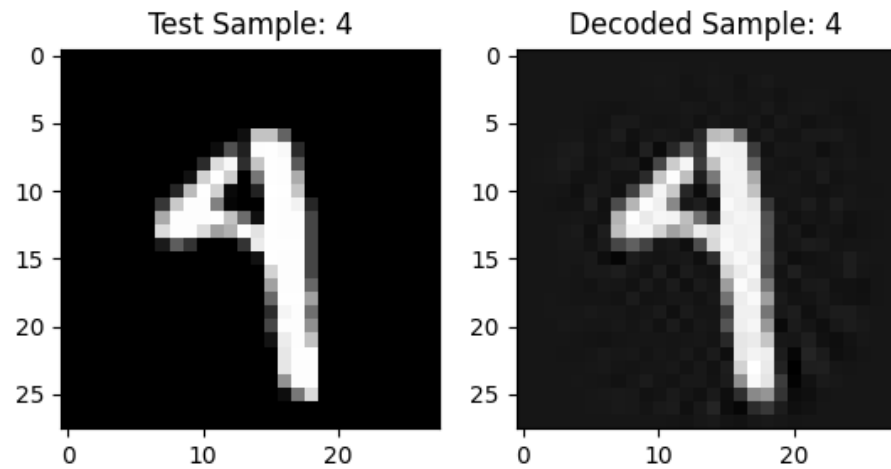# 28x28 Digits
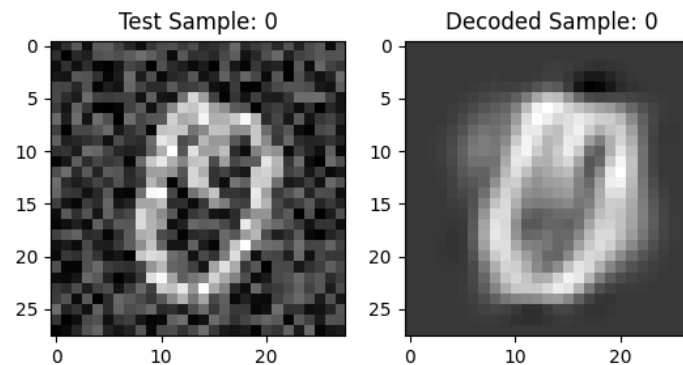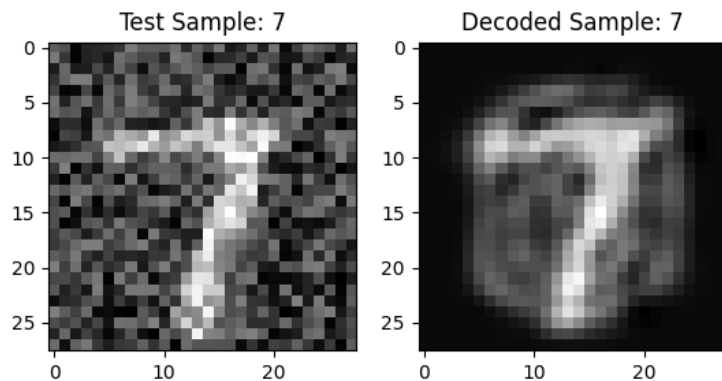
- P = 0.9
- H = 87

28x28 Digits

- P = 0.95

- H = 154

Test Sample: 4 | Decoded Sample: 4 | Test Sample: 7 | Decoded Sample: 7

28x28 Digits

- P = 0.99
- H = 331

Test Sample: 1   Decoded Sample: 1

p = 0.9

Test Sample: 0   Decoded Sample: 0   Test Sample: 7   Decoded Sample: 7

p = 0.8   p = 0.95
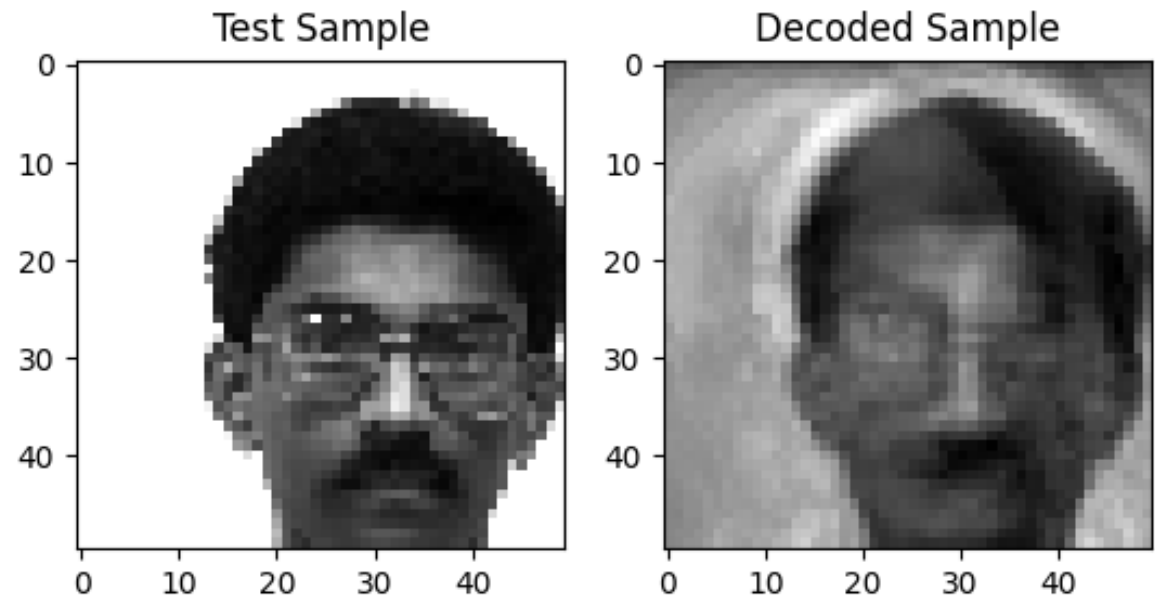
Test Sample: 7   Decoded Sample: 7
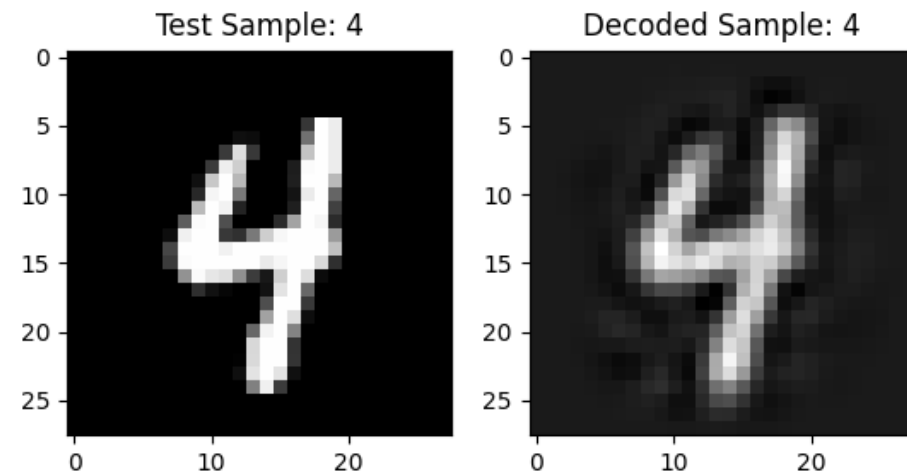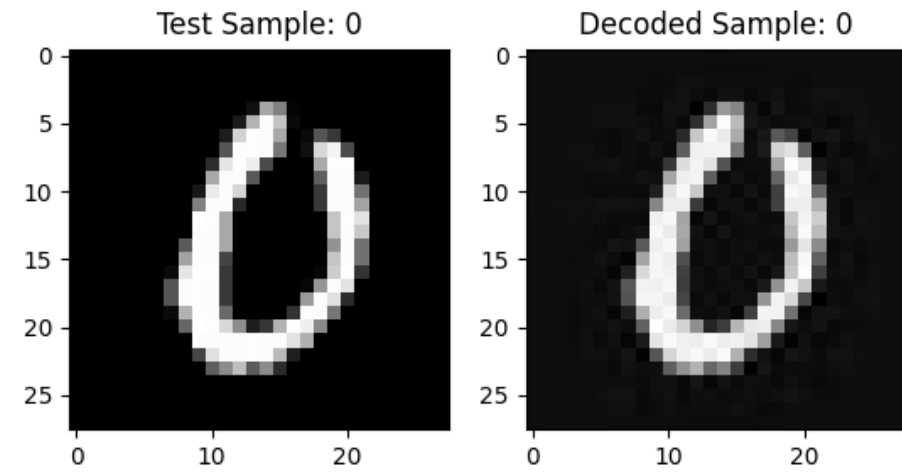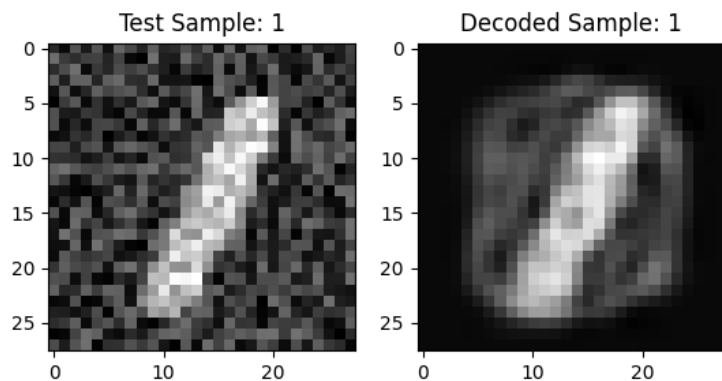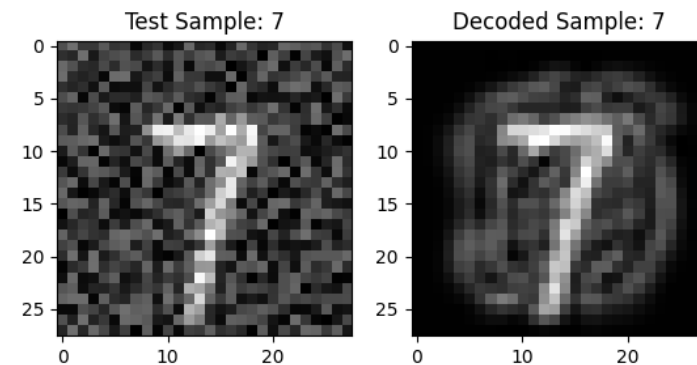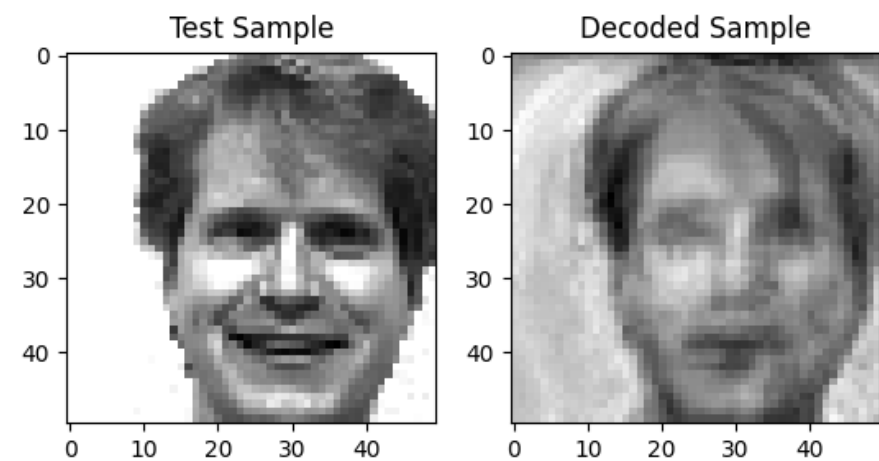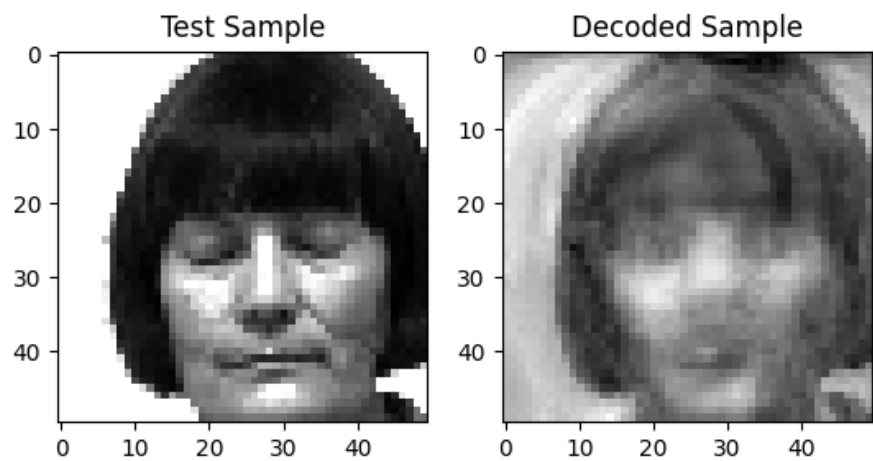
p = 0.9

28x28 Digits with Noise

Yale Faces

- 200 x 200
- Down sampled by 4
- D = 2500

Yale Faces

- P = 0.8
- H = 11

Test Sample

Decoded Sample
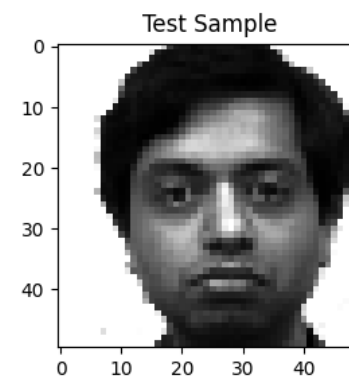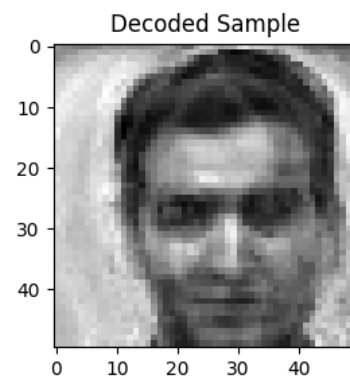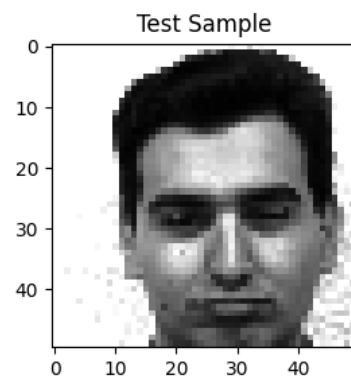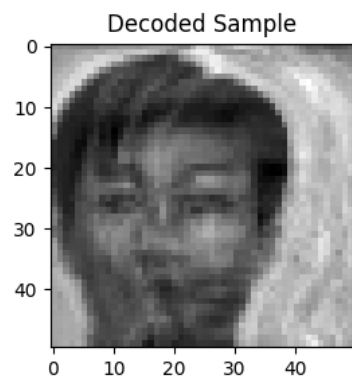
Yale Faces

- P = 0.85
- H = 17

Test Sample   Decoded Sample   Test Sample   Decoded Sample

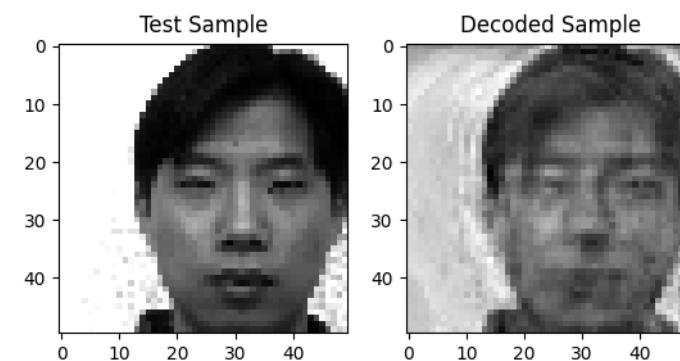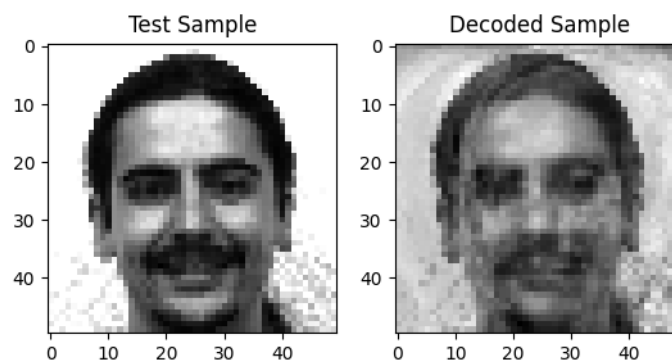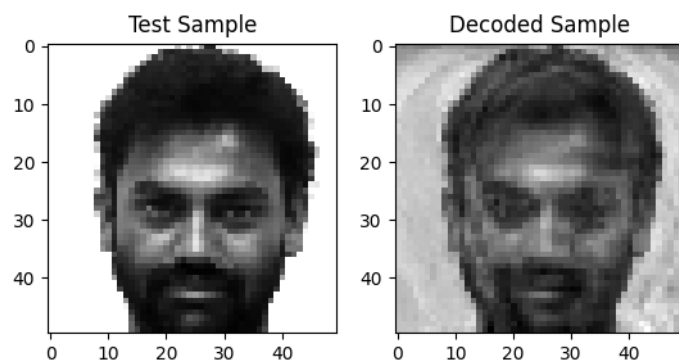# Yale Faces

- P = 0.9
- H = 26
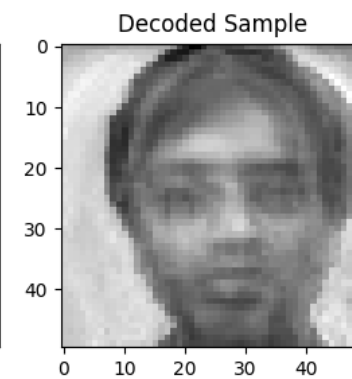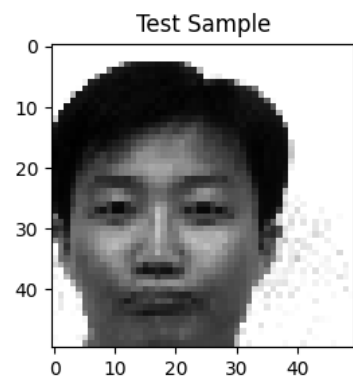
Yale Faces

- P = 0.95
- H = 50

Yale Faces

- P = 0.99
- H = 106