# Lecture 4: embeddings, recurrent neural networks
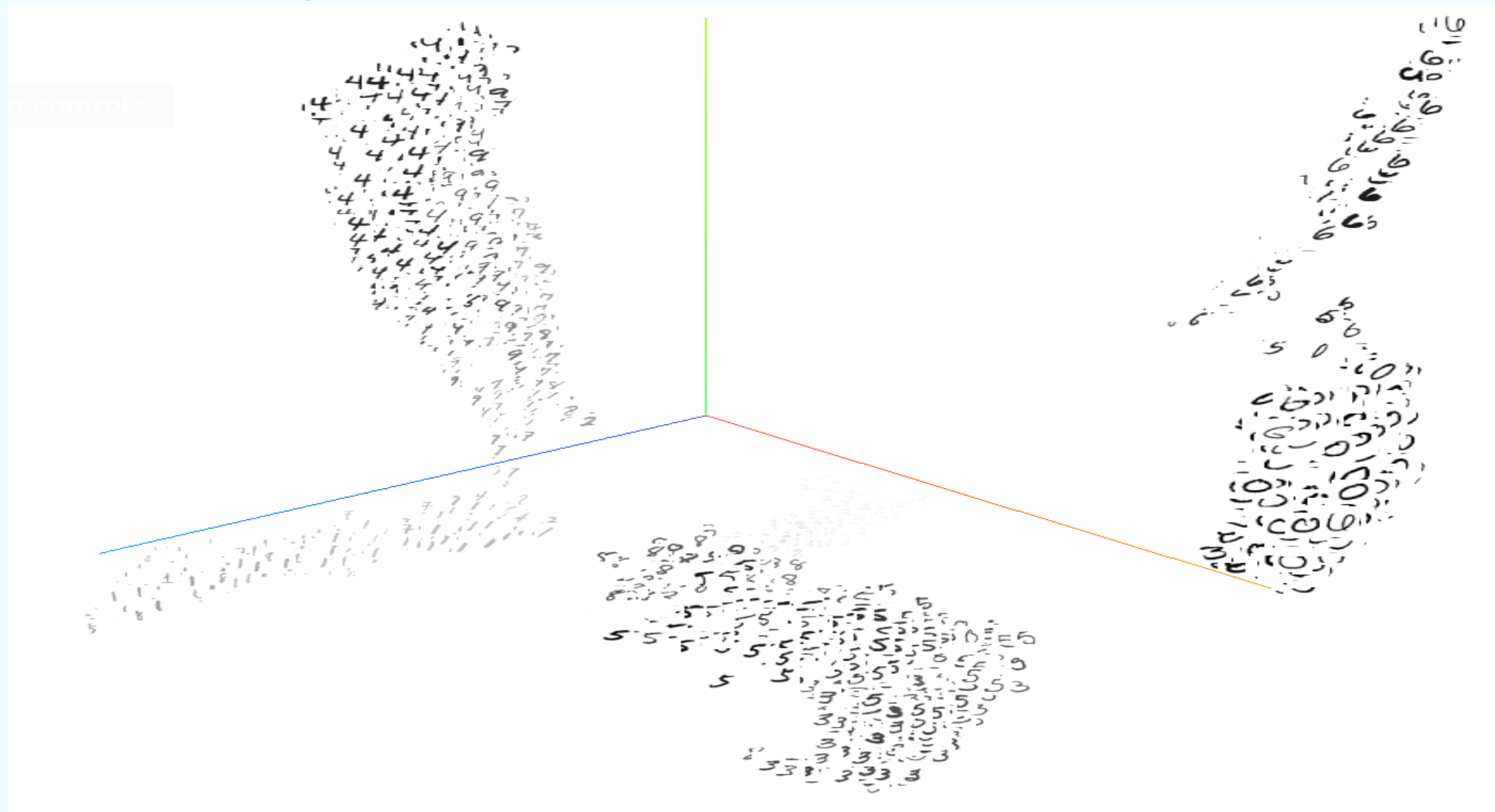
Machine Learning - 2

Data Science and Business Analytics Program
(DSBA) at HSE & LSE, 22/23
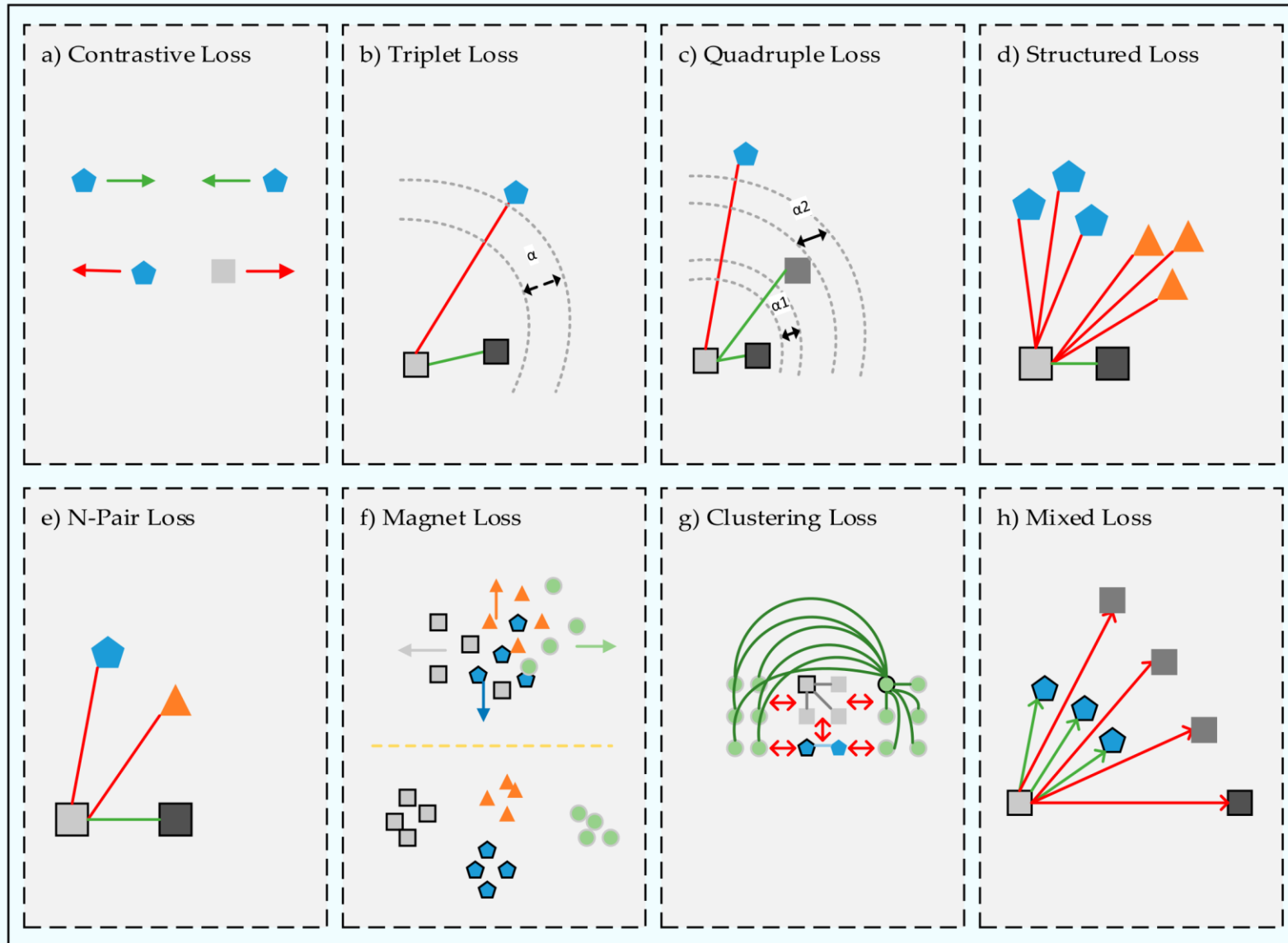
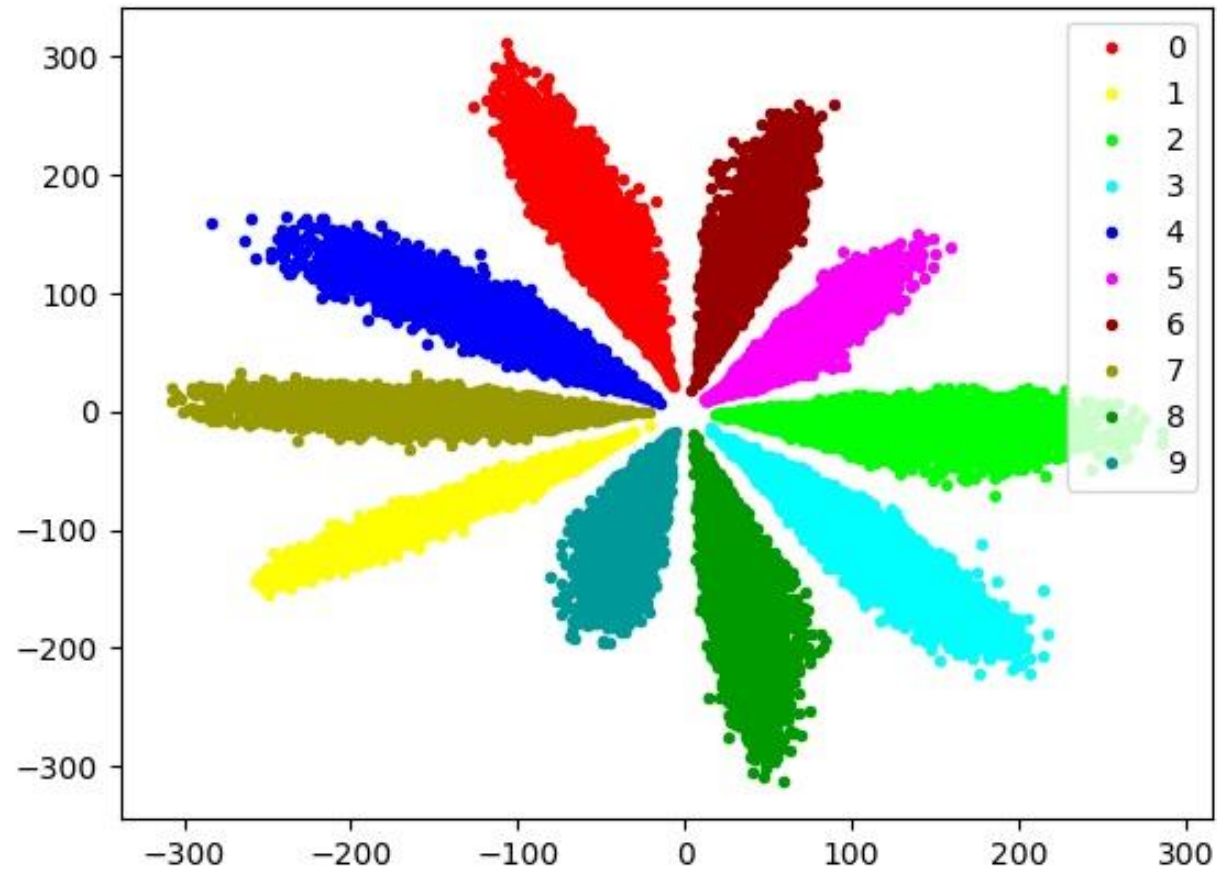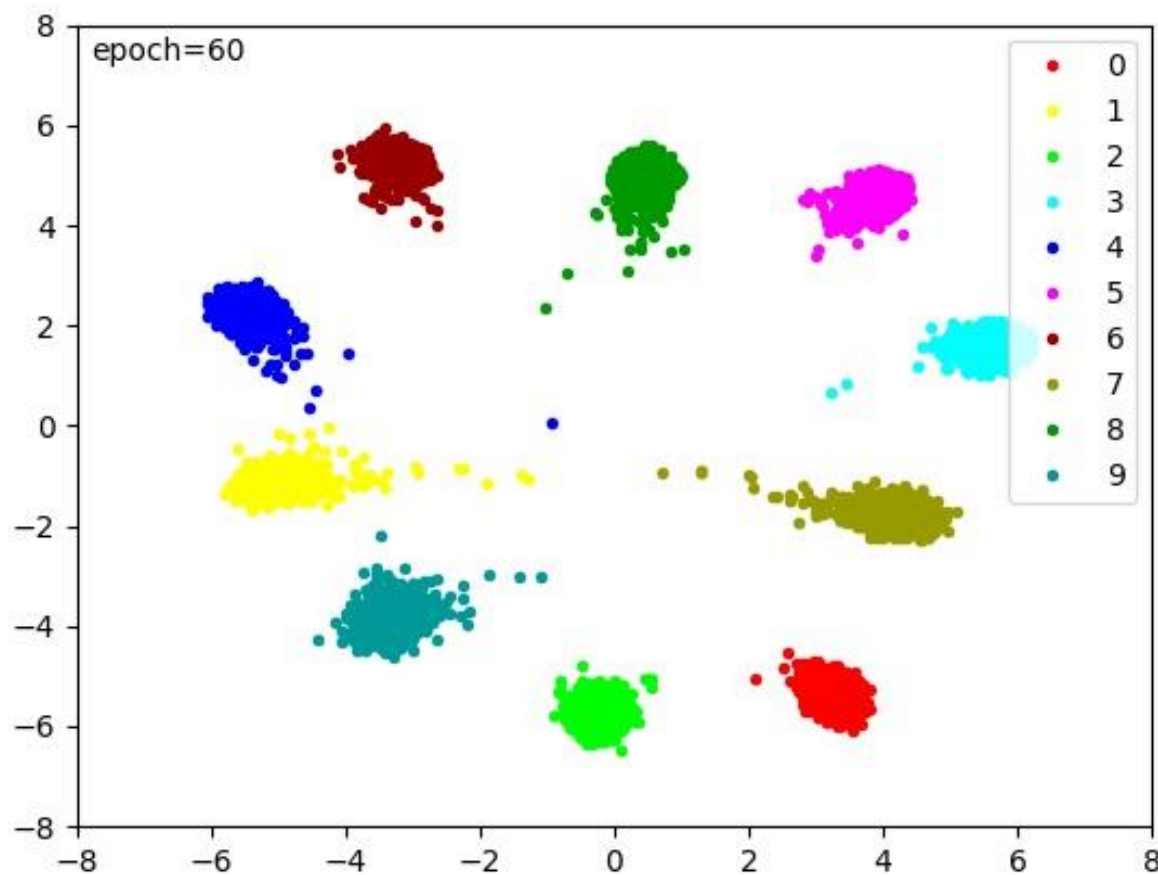Leonid Sanochkin

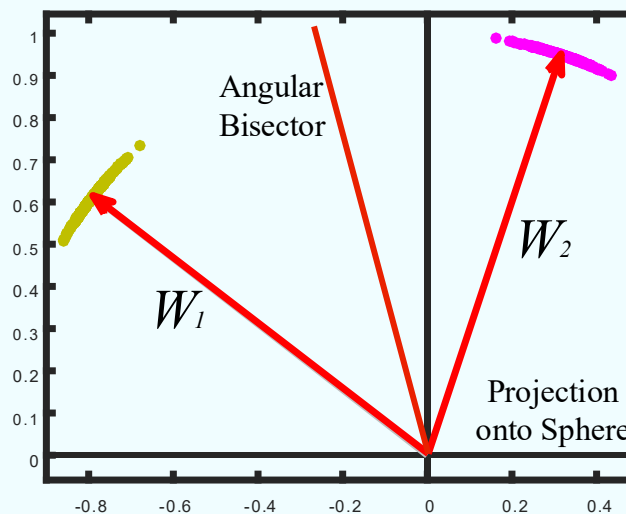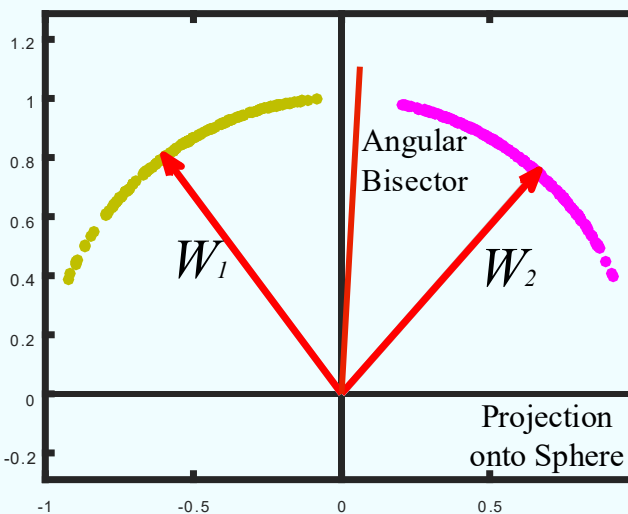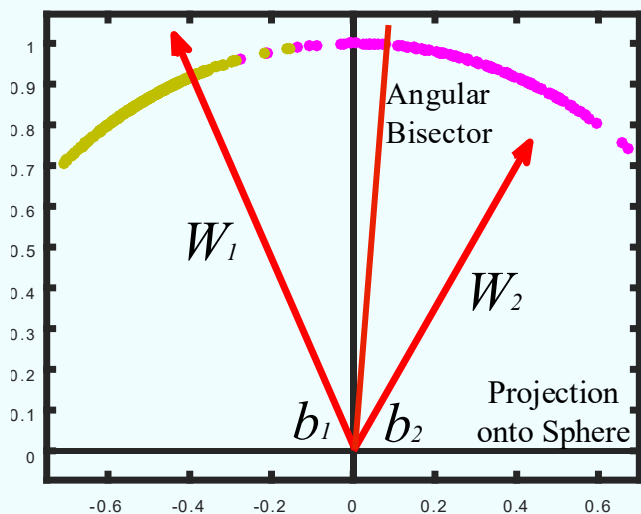# Embeddings

# Deep metric learning. Contrastive approaches



a) Contrastive Loss
b) Triplet Loss
c) Quadruple Loss
d) Structured Loss
e) N-Pair Loss
f) Magnet Loss
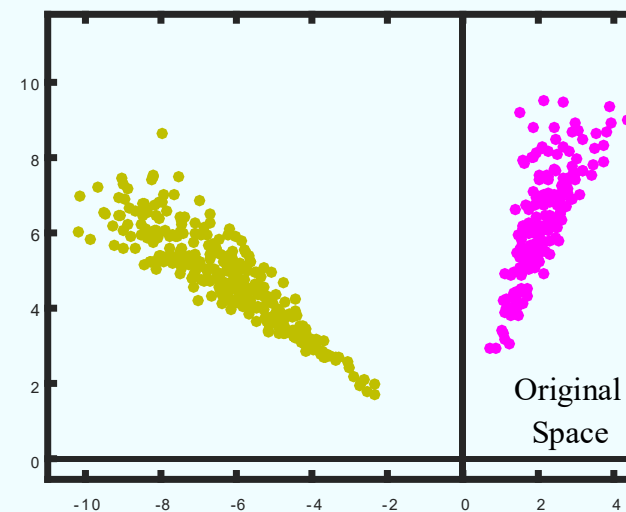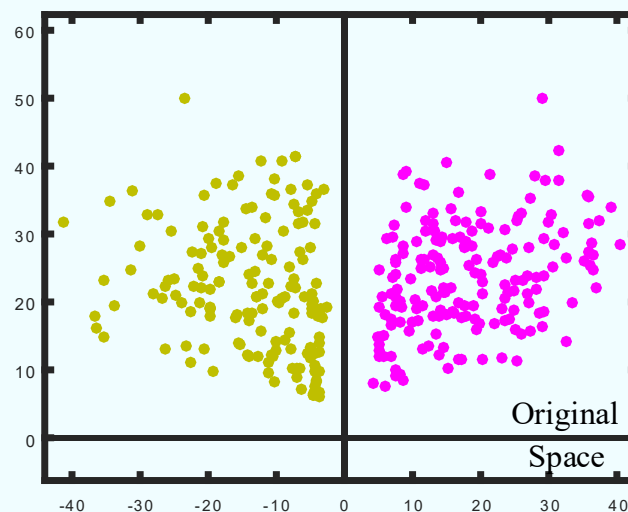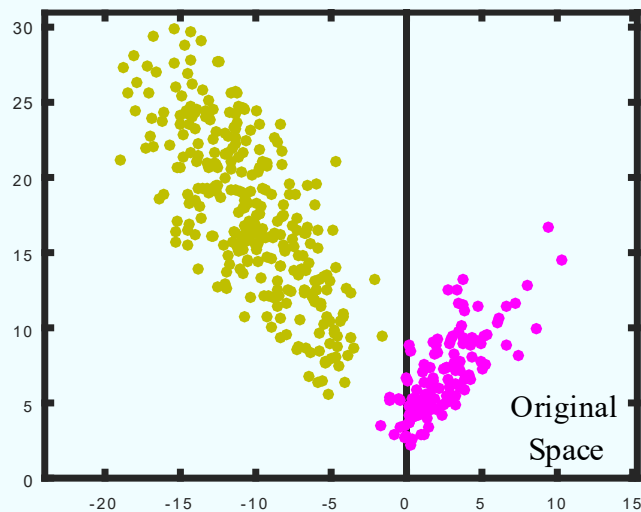g) Clustering Loss
h) Mixed Loss

# Center loss

# Center loss

# SphereFace



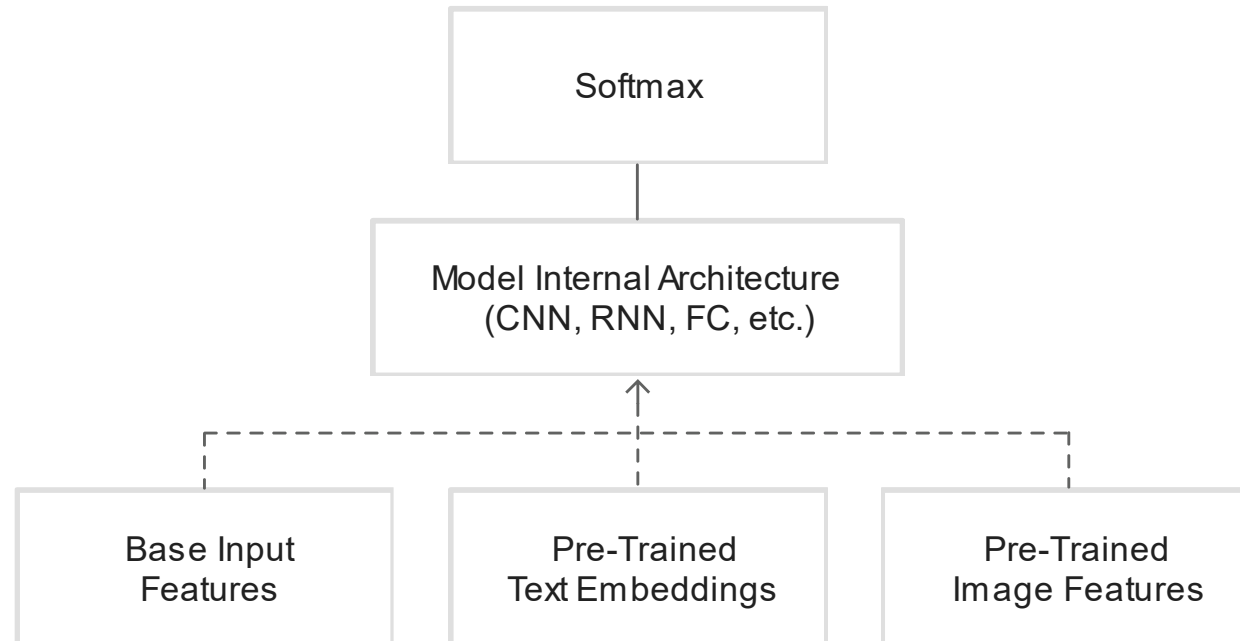Softmax

Modified Softmax

SphereFace

# SphereFace



Softmax     SphereFace     CosFace     ArcFace

# Deep metric learning

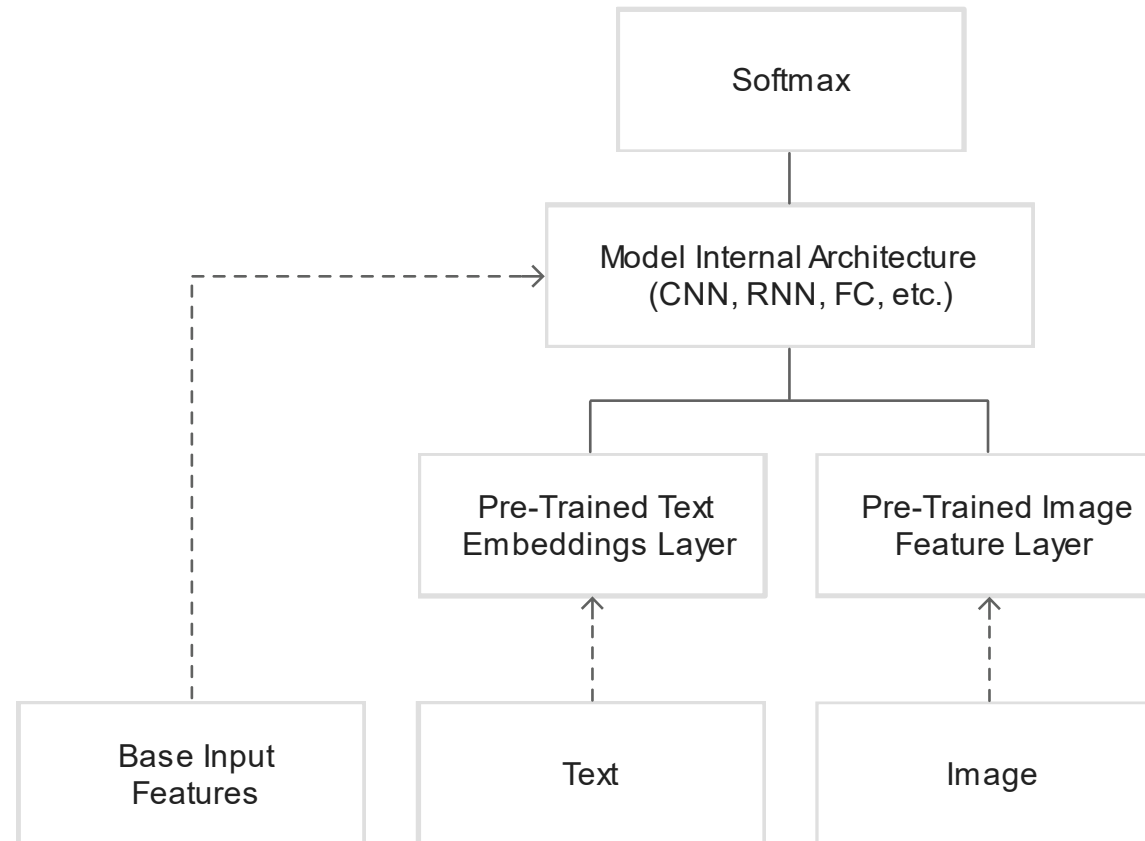**Source:**

- https://hav4ik.github.io/articles/deep-metric-learning-survey
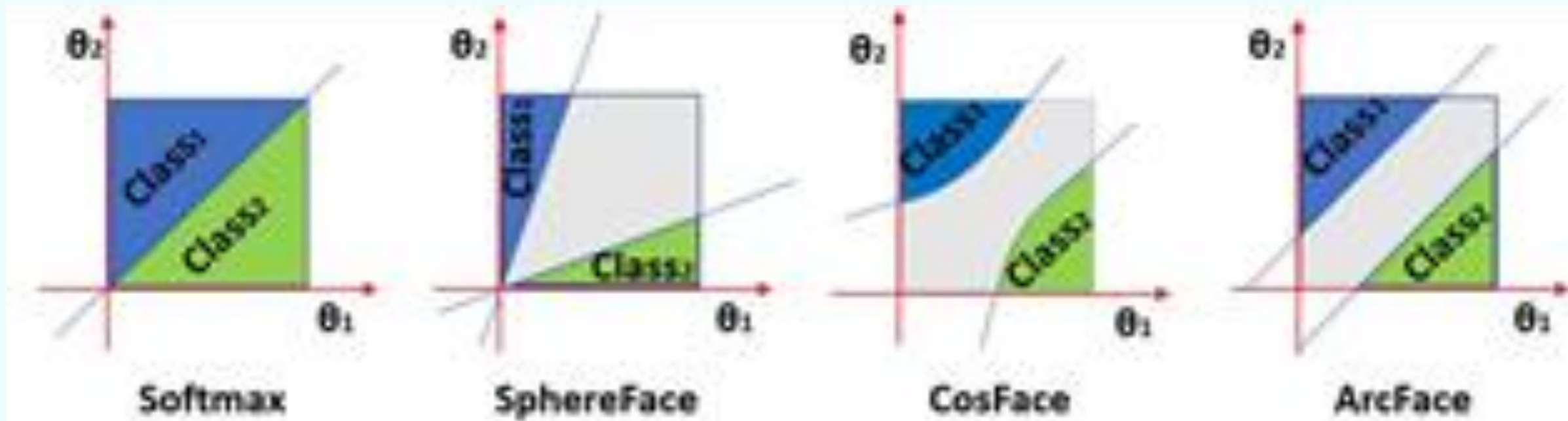
# Embedding usage

# Embedding usage

# Recurrent neural networks

Output layer

Hidden state

Input



$\mathbf{H}_{t-1}$  $\mathbf{H}_{t}$  $\mathbf{H}_{t+1}$

$\phi$  $\phi$  $\phi$

$\mathbf{X}_{t-1}$  $\mathbf{X}_{t}$  $\mathbf{X}_{t+1}$

$\phi$  FC layer with activation function
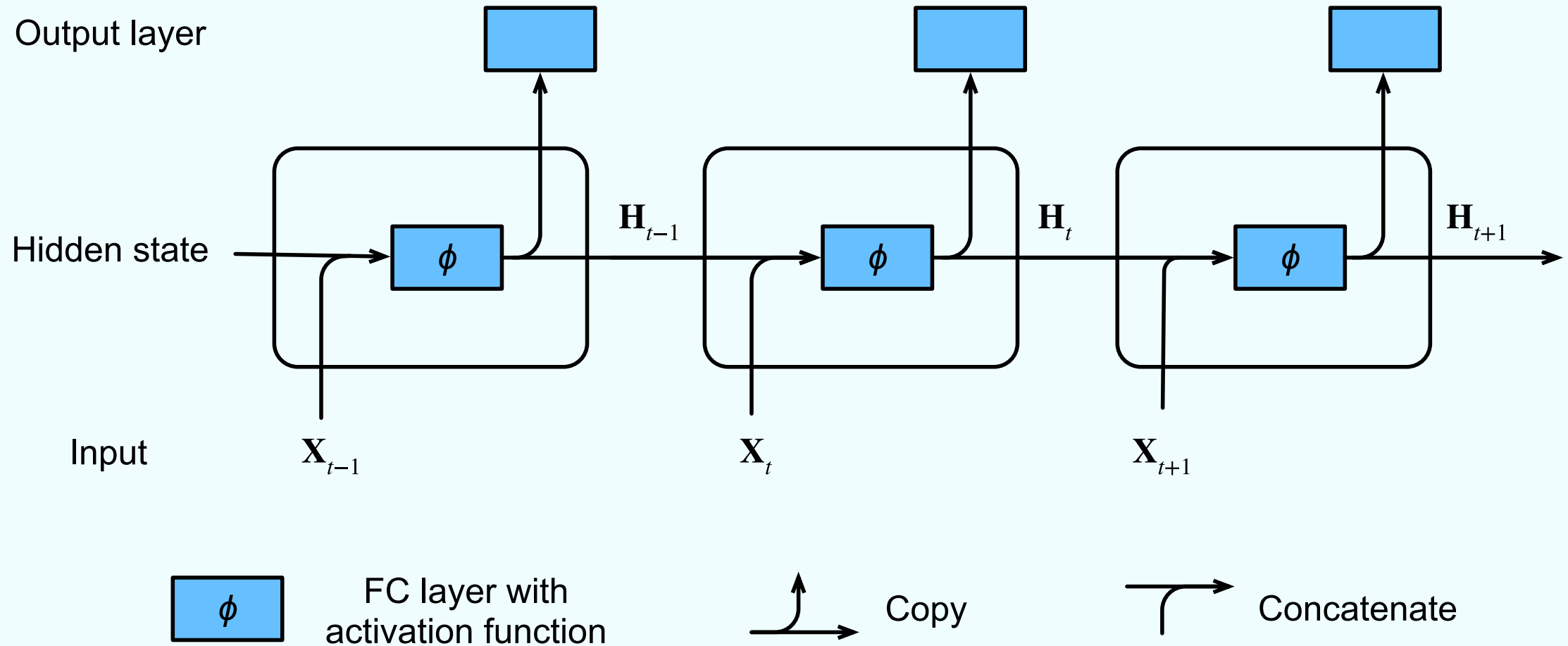
Copy

Concatenate

# Recurrent neural networks
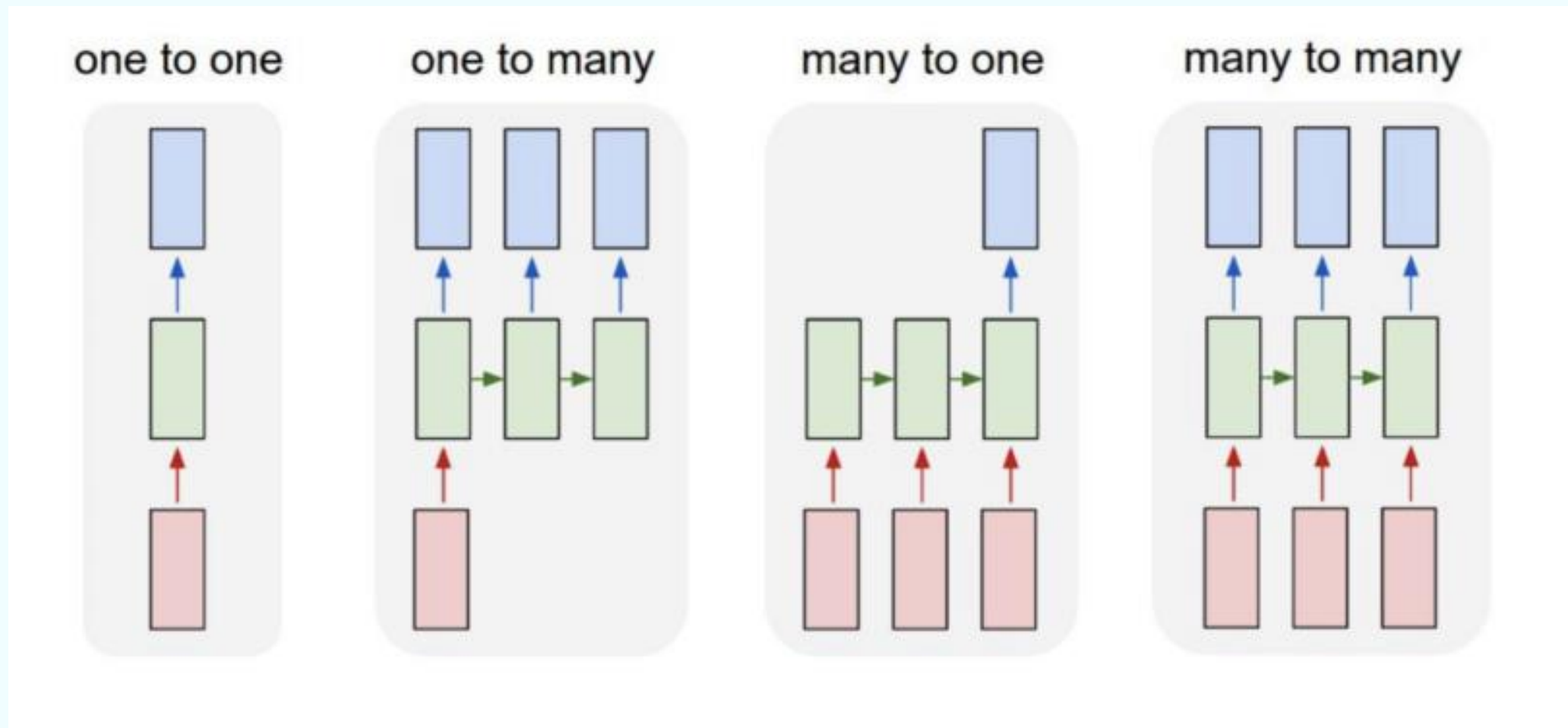
# Backpropagation Through Time

- Full computation
- Truncating Time Steps
- Randomized Truncation

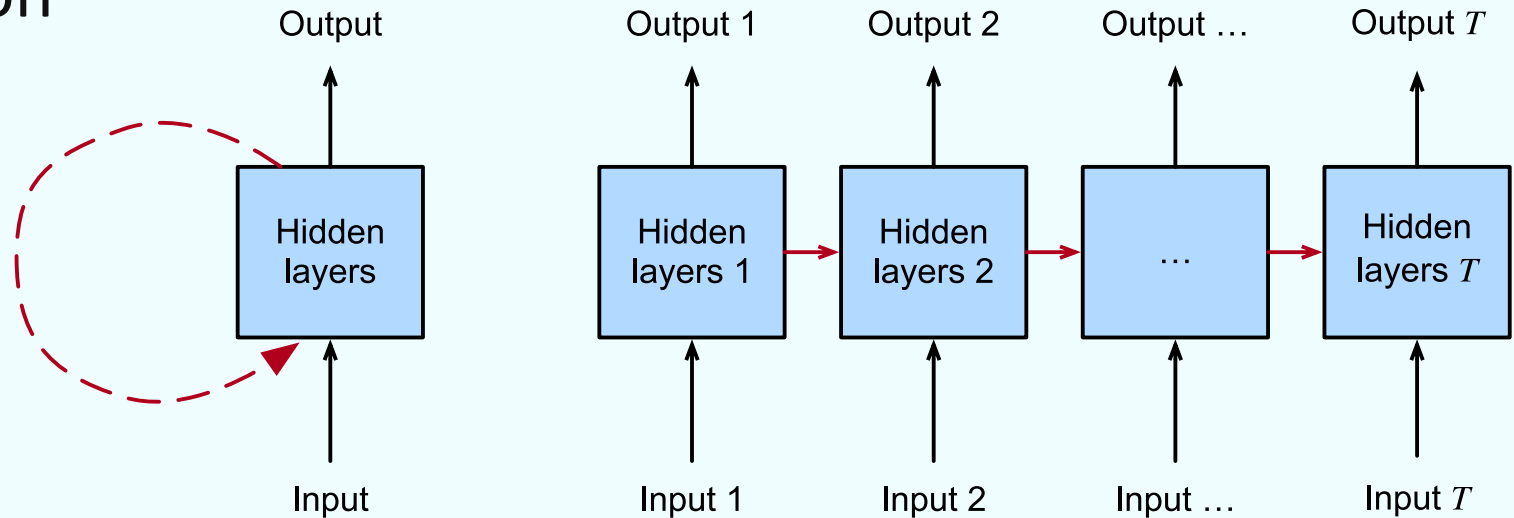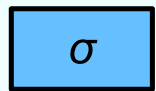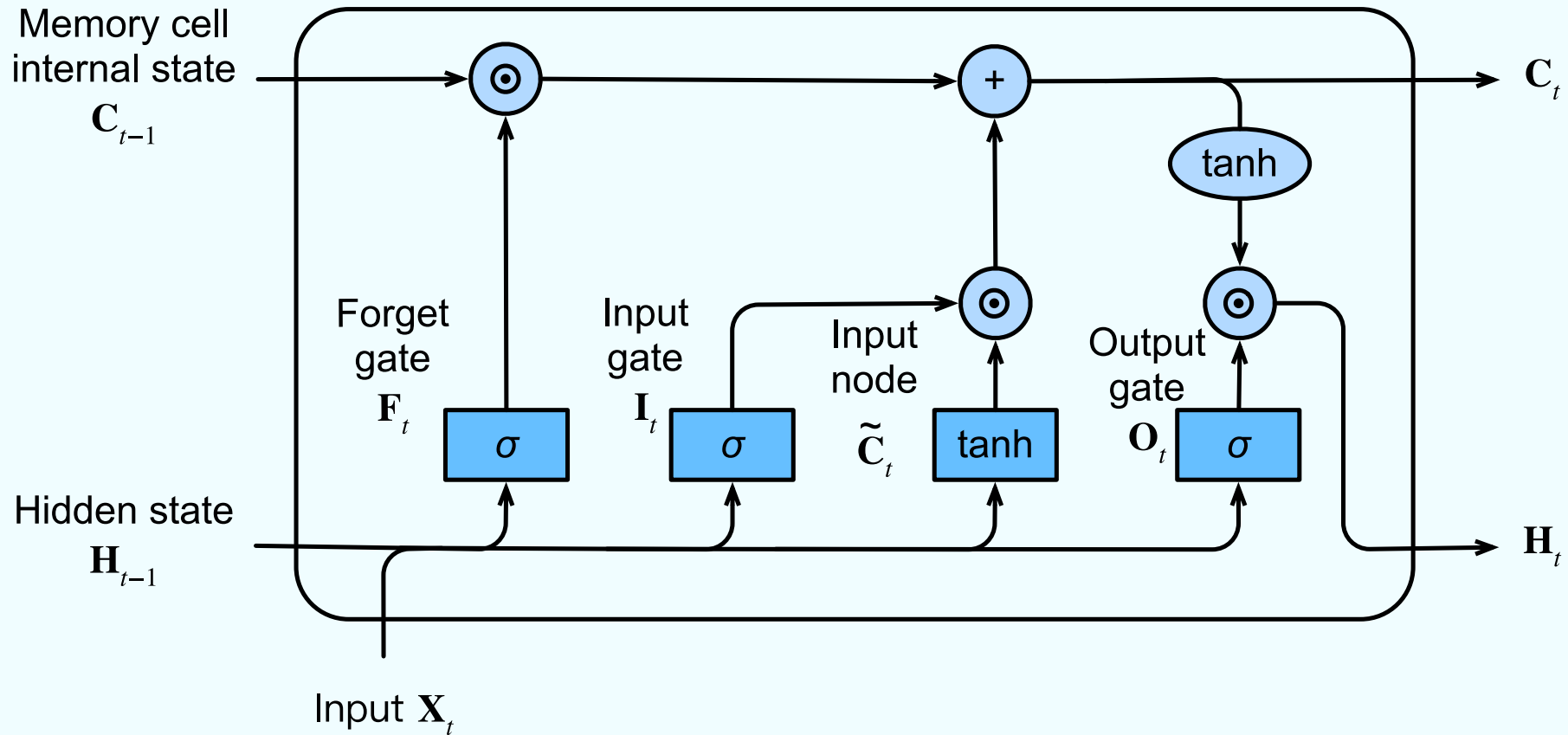# Long Short-Term Memory (LSTM)
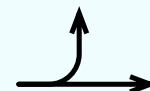
# Gated Recurrent Units (GRU)



Hidden state $\mathbf{H}_{t-1}$

$\mathbf{H}_t$

Reset gate $\mathbf{R}_t$

Update gate $\mathbf{Z}_t$

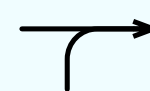Candidate hidden state $\widetilde{\mathbf{H}}_t$

Input $\mathbf{X}_t$
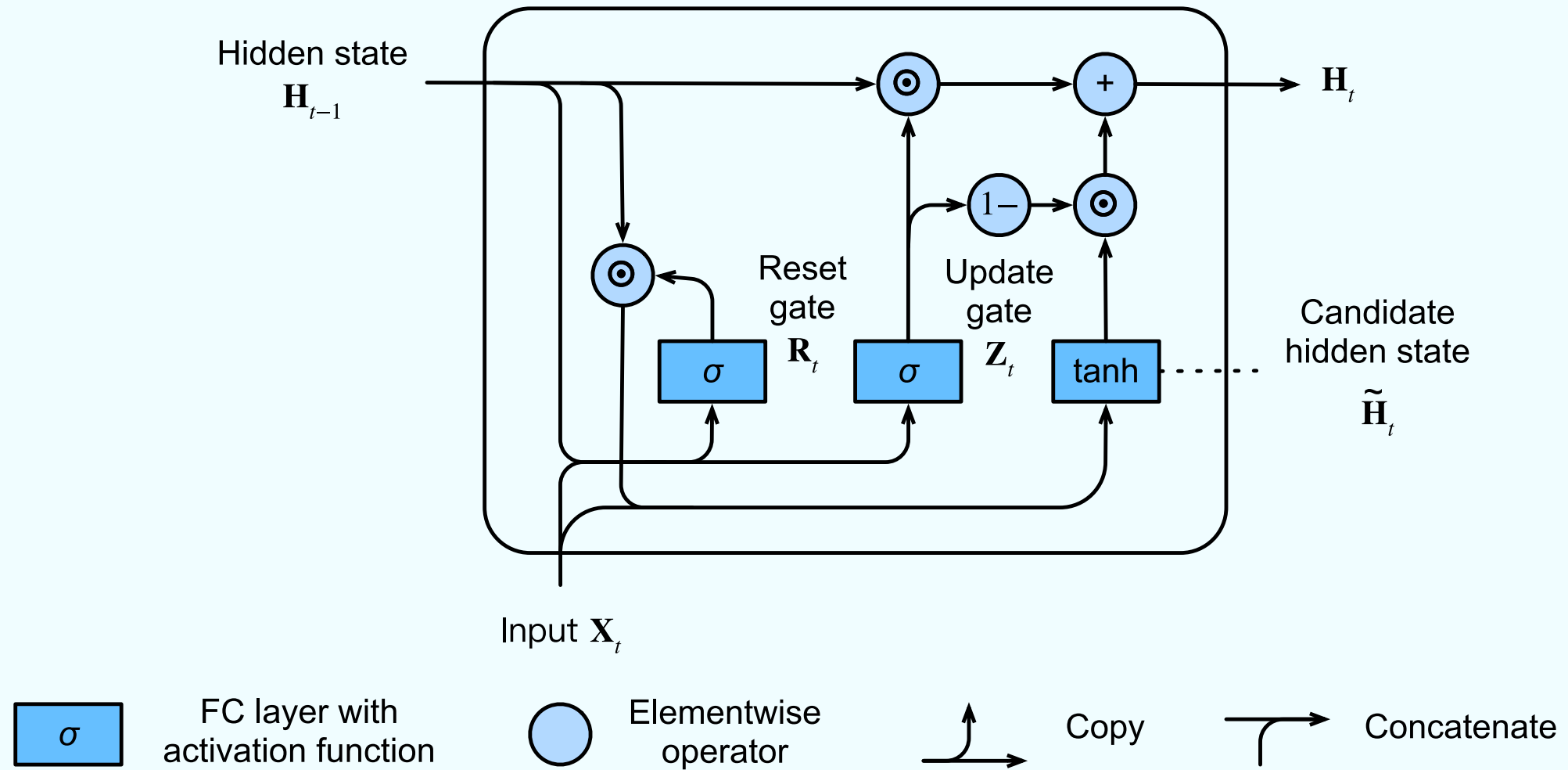
| $\sigma$ | FC layer with activation function | ⬤ Elementwise operator | Copy | Concatenate |

# Summary

- An embedding is a mapping of a discrete — categorical — variable to a vector of continuous numbers

- State of the art metric learning techniques can help construct "better" embeddings

- Recurrent neural networks are deep learning models that capture the dynamics of sequences via recurrent connections, which can be thought of as cycles in the network of nodes

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