COMPUTER VISION

Siamese Network

AGENDA

- Challenges in real world
- Object classification vs One shot learning
- One shot learning
- Siamese Network
- Different Loss functions
- Applications
- Pros and Cons
- Hands-On - Python notebook

Challenges in Real World

- Typical deep learning architecture relies on substantial data for sufficient outcomes
- ImageNet, for example, would need to train on hundreds of images before accurately assessing new images
- There are many use cases for machine learning where data is scarce
- This is where N shot learning technology comes into picture
- Learn to classify an unseen image using no more than 5 images
- N shot learning is sub classified into :
  - Zero shot learning
  - One shot learning
  - Few shots learning

← Focus of this discussion

Object Classification vs One Shot Learning

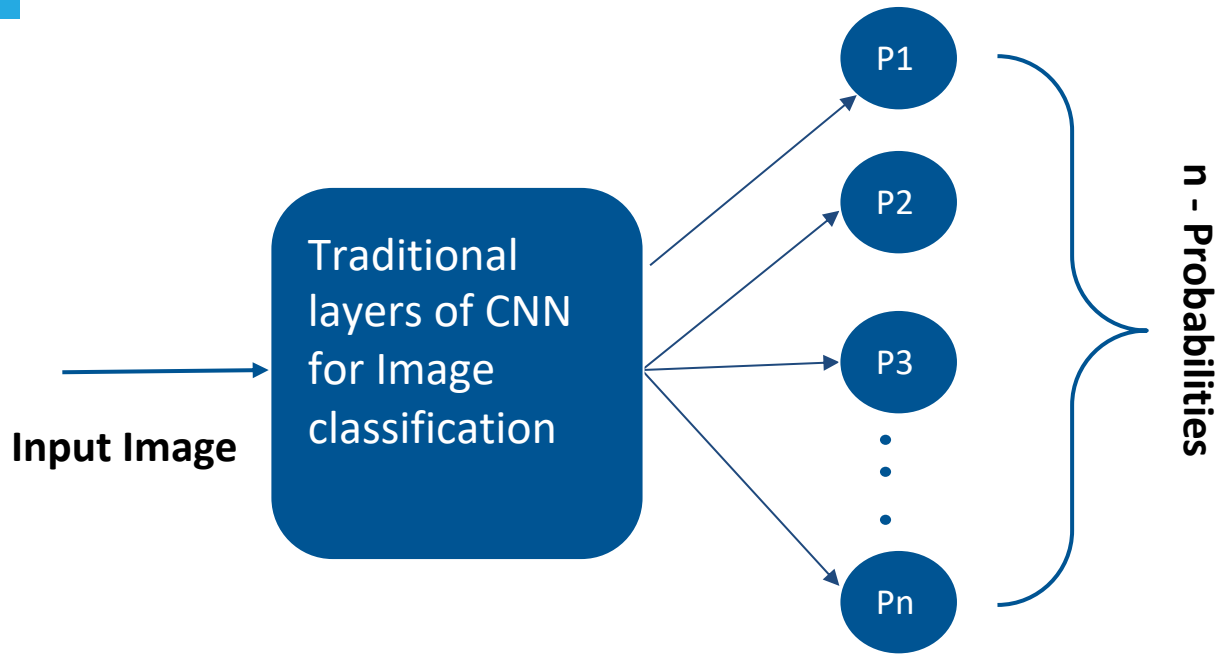


Figure 1: Traditional classification using CNN

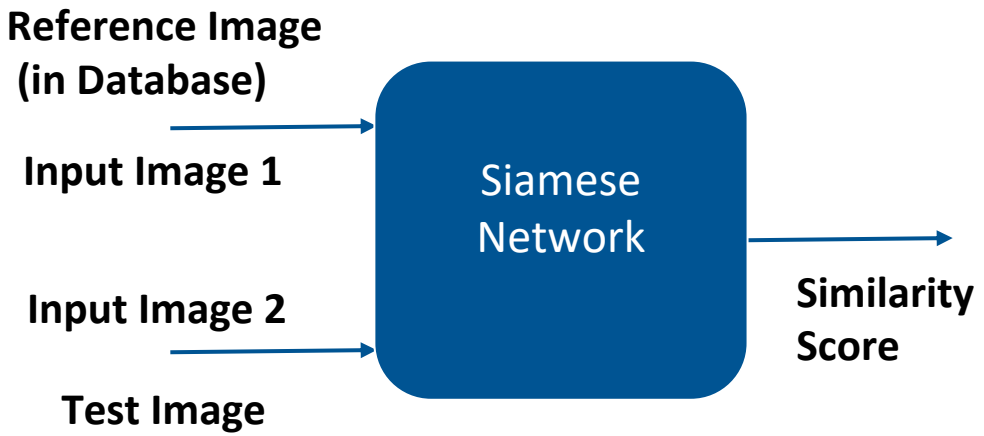


Figure 2: One shot Learning

Object Classification vs One Shot Learning

- Classification -
  - Input image is fed to a series of layers
  - At the output it generates a probability for all classes
  - Disadvantage : Cost of data collection and re-training is too high
- One shot learning -
  - ONLY one training example for each class - **“One Shot”**
  - Does not learn to classify input image directly to any one class
  - Rather learns **“similarity function”**
    - Takes two input images and find its similarity score
  - Advantage over classification :
    - Does not require too many instances of a class
    - Network predicts the score for new (test) image in one shot

One Shot Learning

- Learning information about object categories from a single training example
- In one-shot learning, we only have a single example of each class
- Siamese network is one such architecture developed to achieve this goal

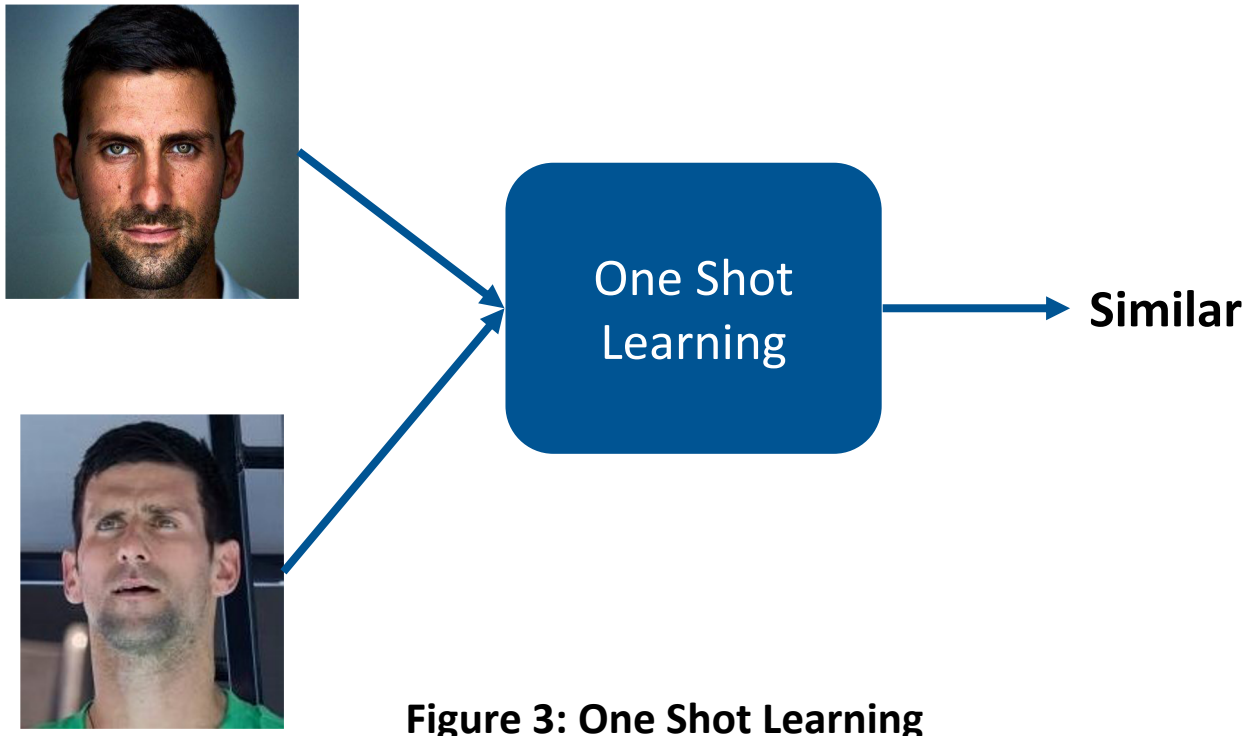


Figure 3: One Shot Learning

Siamese Network

- It is a class of neural network – One or more identical networks
- Sometimes called as twin neural network
- It is a one shot classification model
- It uses same weights on 2 different input vectors for computing comparable output vectors while working in tandem (architecture, weights and parameters are same).
- Identifies similarities of inputs – comparing feature vectors
- Objective is:
  - Similarity score comparison for given two inputs.
- The Similarity score can be calculated using:
  - Binary cross-entropy, Contrastive function, or Triplet loss

Siamese Network

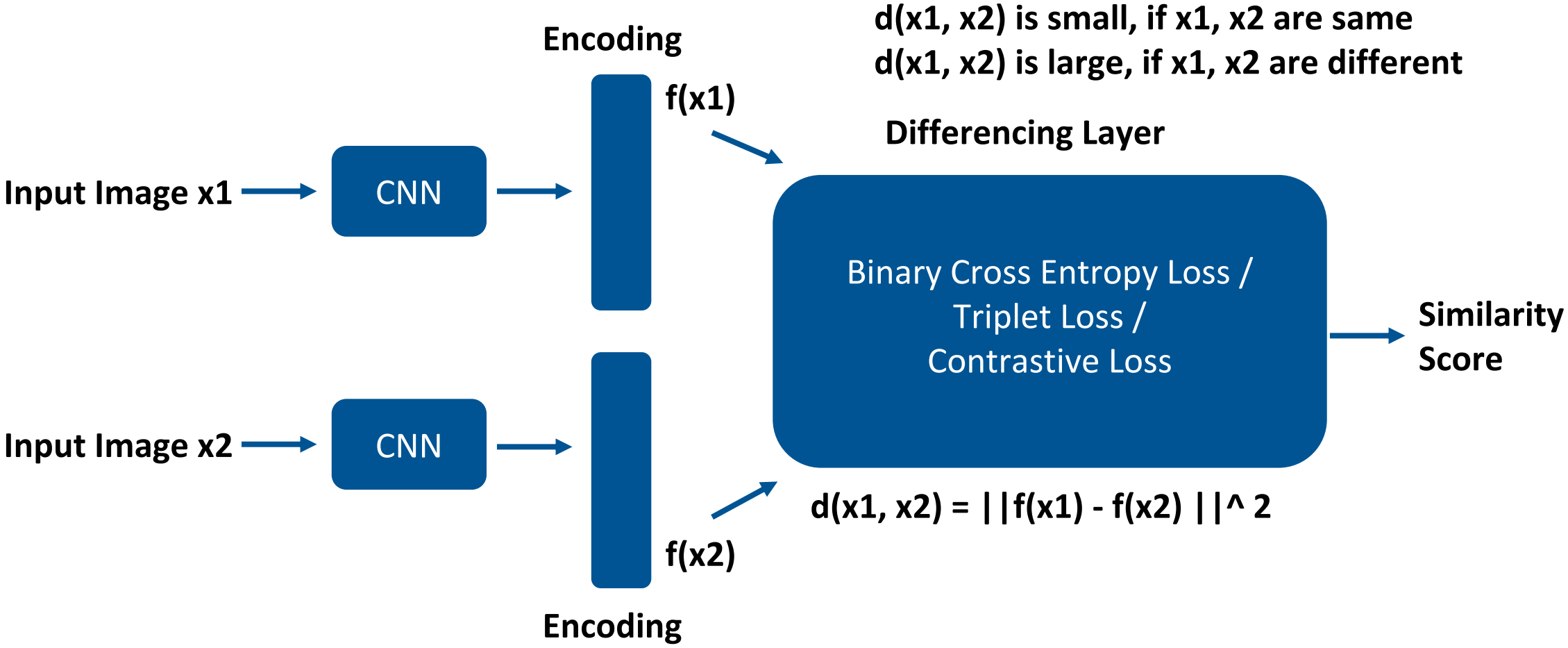


Figure 4: Siamese Network Architecture

Loss Functions in Siamese Network

- Uses metrics learning approach, which finds the relative distance between its inputs
- Similarity score can be calculated using:
  - Triplet loss function
  - Contrastive function
  - Binary cross entropy

Triplet Loss

- Uses triplet of data instead of pairs
- The triplet is formed by an anchor (a), a positive sample (p) and a negative sample (n)
- Most widely applied for facial recognition

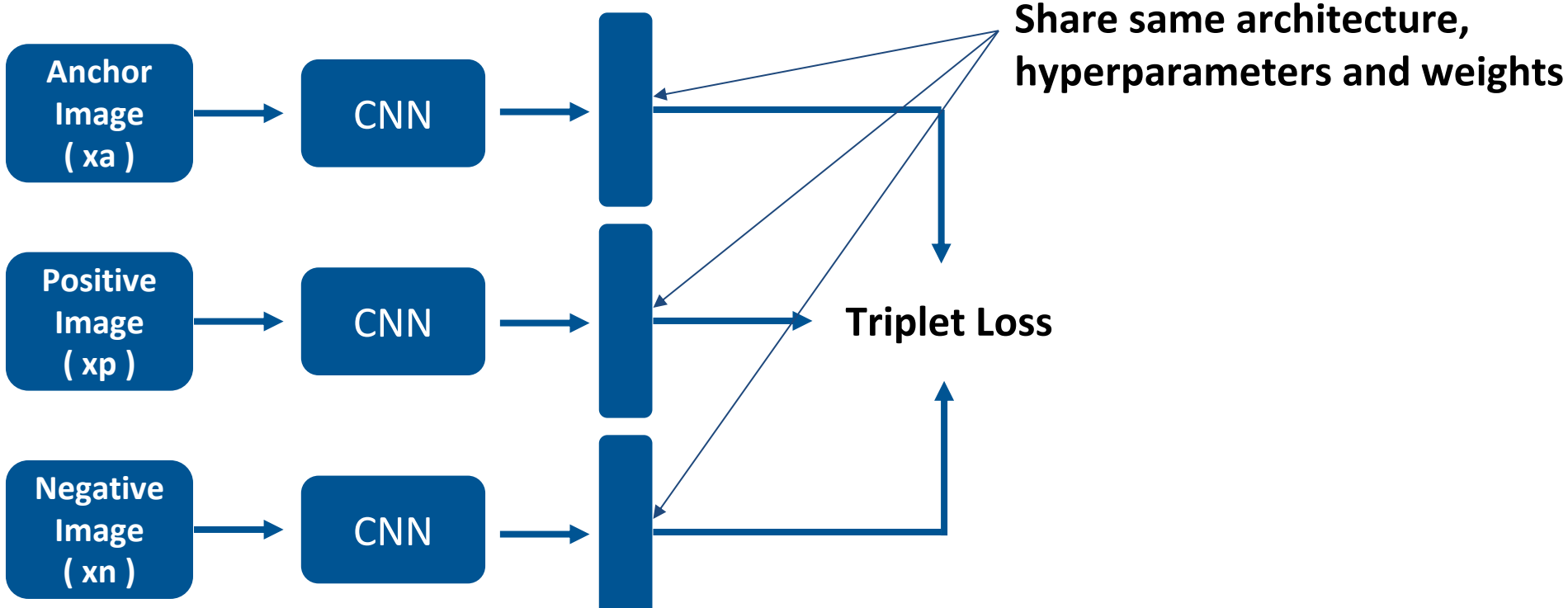
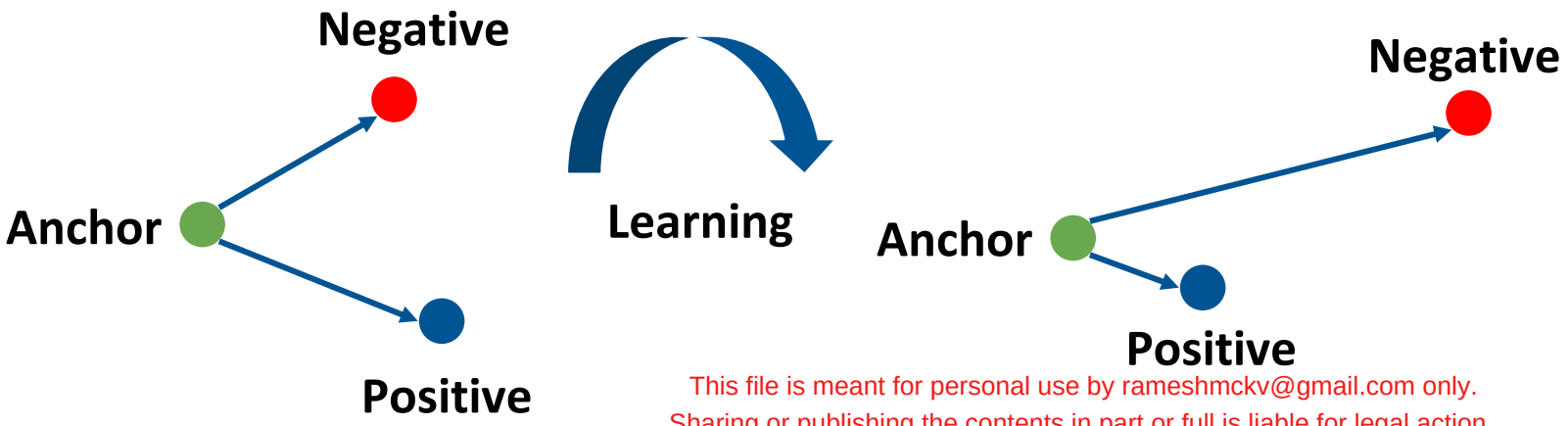


Figure 5: Triplet Loss

Triplet Loss

- Triplet loss :
  - Anchor and Positive : Minimum distance
  - Anchor and Negative: Maximum distance
- Loss **L = max(d(a, p) - d(a, n) + margin, 0)** -> This keeps the Loss in negative
- So alternatively **L = max(d(a, n) - d(a, p) + margin, 0) ->** To make it positive

Where, d – distance metric, d(a,p) – distance between anchor and positive, d(a,n) – distance between anchor and negative



Contrastive Loss

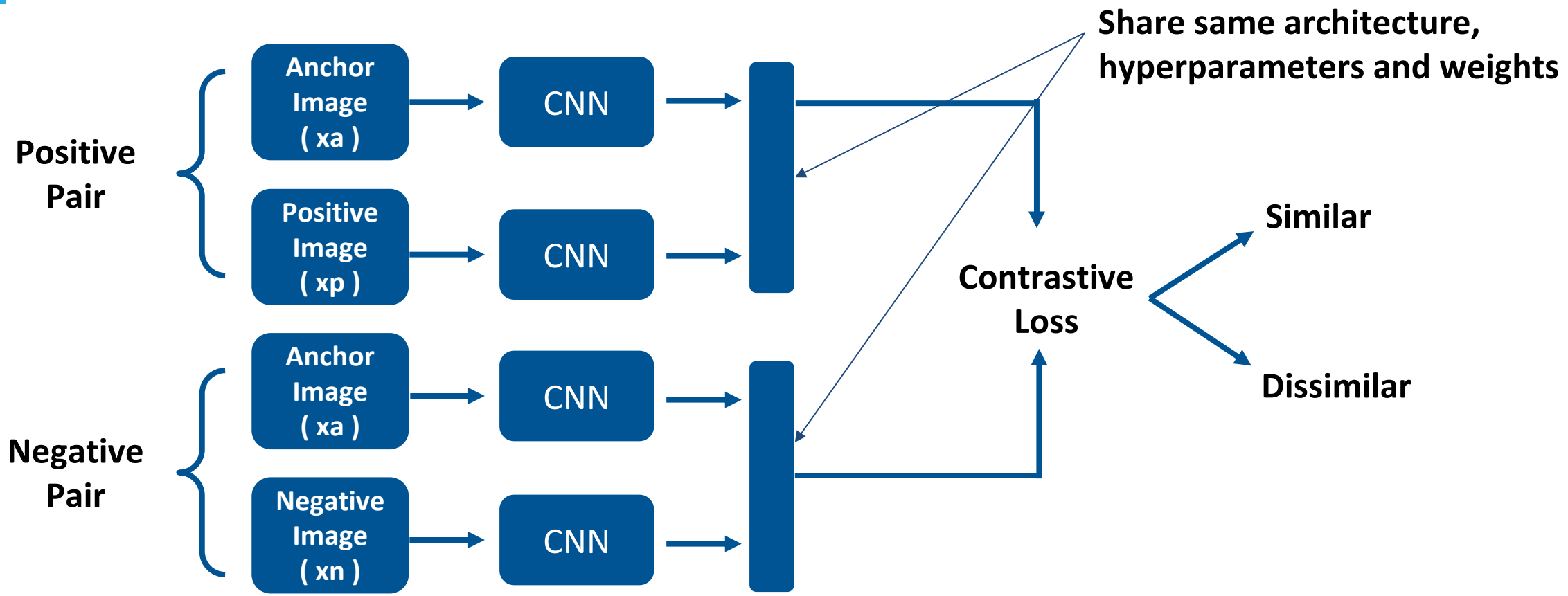


Figure 6: Contrastive Loss

Contrastive Loss Function

- It calculates the distance between two pairs of images
- Distance small – same class, Distance large – different class
- **Contrastive Loss = Y * Dw^2 + (1-Y) * {max (0, margin - Dw^2)}**
  - Y = 0 when the inputs are from the same class;
  - Y = 1 when the inputs are from different class
  - margin : It defines the radius to indicate that dissimilar pairs.

    Beyond this margin it will not contribute to the loss and it value will be >0.
  - Dw – Euclidean distance between two networks

Applications of Siamese Network

- Face recognition
- Signature verification
- Evaluate disease severity based on clinical grading
- Text similarity in resume matching
- Text similarity for pairing similar questions

Pros and Cons of Siamese Networks

- **Pros :**
  - It requires less information as it is more robust to class imbalance.
  - It learns from semantic similarity.
  - Simple averaging of Siamese network with a classifier performs better than ensemble classifiers.
  - One shot learning – Training can be done with one example.
  - It can work with highly imbalanced data.
- **Cons :**
  - Output results are similarity scores and not probabilities.
  - As the learning is based on quadratic pairs, takes more time for training.
  - It cannot be generalized.

SUMMARY

- Difference between traditional classification and one shot learning
- Siamese Neural Network
- Different loss functions in Siamese Network
- Applications
- Pros and Cons

Hands - On Case Study

Thank You

Happy Learning :)