Unsupervised Embedding Learning via Invariant and Spreading Instance Feature

Mang Ye 1, Xu Zhang 2, Pong C. Yuen 1, Shih-Fu Chang 2 1 Hong Kong Baptist University 2 Columbia University

Introduction

Unsupervised Embedding Learning:
1. Learn a similarity-preserving embedding on a set of unlabeled images,
2. Similarity between learned features is consistent with the visual similarity
3. Output Feature f

Main Idea

Instance-wise Feature Learning
1. Invariance Augmentation:
   - Use random data augmentation to generate the positive sample for each image instance
2. Instance Spread-out:
   - Separate each instance from all the other sampled instances

Highlights

Data augmentation invariant and instance spread-out feature:
1. Optimize the embedding directly on the real-time instance features with softmax function
2. Achieve much faster learning speed and better accuracy than existing methods
3. Perform well on both seen and unseen testing categories

Proposed Method

Softmax Embedding on ‘Real’ Instance Feature
1. We consider a small random sampled batch \( \{x_1, ..., x_n\} \) rather than all instances
2. The augmented sample \( x_i \) should be classified into instance \( i \)
   \[
P(i|x_i) = \frac{\exp(f(x_i))}{\sum_{j \neq i} \exp(f(x_j))}
   \]
   Maximize
3. The negative sample \( x_j \) should not be classified into instance \( i \)
   \[
P(i|x_j) = \frac{1}{\sum_{j \neq i} \exp(f(x_j))}
   \]
   Minimize

Siamese Network Training
1. Branch 1: randomly selected anchor instances
2. Branch 2: Random data augmentation of the \( n \) anchor instances

Experimental Results

Unseen Testing Category
1. Training and testing set do not have the same categories

Acknowledgement:
This work is partially supported by Research Grants Council (RGC/MBU1220051B), Hong Kong. This work is partially supported by the United States Air Force Research Laboratory (AFRL) and the Defense Advanced Research Projects Agency (DARPA) under Contract No. FA8750-16-C-0166. Any opinions, findings and conclusions or recommendations expressed in this material are solely the responsibility of the authors and do not necessarily represent the official views of AFRL, DARPA, or the U.S. Government.

Code: https://github.com/mangye16/Unsupervised_Embedding_Learning