Few-Shot Learning Based on Metric Learning Using Class Augmentation

Susumu Matsumi and Keiichi Yamada
Meijo University
Introduction

• Few-shot learning is a machine learning problem in which new classes are learned from only a few samples.

• We propose a few-shot learning approach based on metric learning in which the number of classes in the training data for performing metric learning is increased.
Problem Definition

- N-way K-shot learning: the few-shot learning from N classes data with K labeled samples in each class
- Three datasets are used for learning and testing.
  - Training set: dataset for learning prior knowledge
  - Support set: samples for learning N classes
  - Testing set: dataset for testing the few-shot learning results
Proposed Method

- New samples in an imaginary class generated by combining samples in two original training set classes.

![Diagram of the proposed method]

- **Original training set**
  - Class 1
  - Class 2
  - Class Ctrainset

- **Class augmentation**

- **Support set**
  - Metric learning
  - Embedding function (CNN)
  - Classifier

- **Testing samples**
Embedding Function

• A CNN is used as an embedding function for few-shot learning.

Embedding function (CNN)

Support set

Testing sample

Sample $x$ in class $c$

Conv1
Conv2
Conv3
Conv4
Fc1
Fc2
Fc3

Class $c$

Classifier

Embedding vector
Synthesis Method

One-stream

Sample $x$ in class $c$

Conv layers

Fc layers

Class $c$

Embedding vector

Two-stream during metric learning

Sample $x_a$ in class $c_1$

Conv layers

Sample $x_b$ in class $c_2$

Conv layers

Share parameters

average (element-wise)

Fc layers

Imaginary class $l(c_1, c_2)$

Embedding vector

Sample $x_a$ in class $c_1$

Conv layers

Share parameters

average (element-wise)

Fc layers

Imaginary class $l(c_1, c_2)$

Embedding vector
Results of Preliminary Experiments

- The number of classes has a greater impact on the accuracy of few-shot learning than the number of samples per class in training set.
Results of Main Experiments

- The accuracy of few-shot learning increases as the number of classes used in metric learning increases until $m = 16$. 

![Graph showing the increase in accuracy with the number of classes and samples per class for 5-way 1-shot and 10-way 1-shot.](image)

- **5-way 1-shot**: 
  - Baseline: 0.505
  - 3.1% pt up: 0.535

- **10-way 1-shot**: 
  - Baseline: 0.355
  - 2.6% pt up: 0.385

Number of classes

Number of samples per class
Conclusion

• We proposed a few-shot learning approach that increases the number of classes for the training data to perform metric learning.

• Although the proposed method is relatively simple, the method demonstrated good performance.

• Future works will involve investigating whether the combination of the proposed method with other approaches.
Thank you for listening.