Negative Sampling for Triplet-Based Loss: Improving Representation in Self-Supervised Representation Learning

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Abstract. Significant strides have been made in artificial neural networks across various fields, necessitating extensive labeled data for effective training. However, the acquisition of such annotated data is both costly and labor-intensive. To address this challenge, Self-Supervised Representation Learning (SSRL) has emerged as a promising solution. One prominent SSRL method, Contrastive Self-Supervised Learning (CSL), enhances feature representations by discerning similarities and differences among samples in the feature space. Yet, accurately identifying dissimilar samples remains a persistent issue, limiting CSL's effectiveness. In response, an innovative enhancement to CSL is proposed in this paper. Explicit negative sampling strategies using a binary classification algorithm within the feature space are introduced to distinguish between similar and dissimilar features precisely. Additionally, Triplet Loss, originally designed for tasks such as person re-identification and face recognition, is incorporated to further refine feature learning. Experimental evaluations on the CIFAR-10 and SVHN datasets validate the proposed method's superiority in content-based image retrieval (CBIR) and classification tasks. Significant improvements are demonstrated in metrics such as mean average precision (MAP), accuracy, recall, precision, and F1-score compared to existing techniques. This framework contributes to the advancement of SSRL by enabling scalable neural network training on large datasets with minimal annotation, effectively bridging the gap between supervised and unsupervised learning paradigms.

Keywords: Self Representation Learning · Self Supervision · Triplet Loss · Negative Sampling · CBIR · Image Classification · Computer Vision.

1 Introduction

In recent years, significant advancements have been demonstrated by artificial neural networks across diverse fields such as economics [40], medicine [36], and industry [30]. Traditional approaches to training these networks have heavily relied