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Self-Supervised Learning in Computer Vision: A Comprehensive Review

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Abstract: Self-supervised learning (SSL) has revolutionized computer vision by enabling models to learn meaningful visual representations without requiring large-scale labeled datasets. By designing pretext tasks that generate supervisory signals from the data itself, SSL bridges the gap between unsupervised and supervised learning. This paper offers a comprehensive review of prominent SSL frameworks in computer vision, such as contrastive learning (SimCLR, MoCo), clustering-based methods (SwAV), and predictive approaches (BYOL, MAE). We analyze their theoretical foundations, practical applications, and impact on downstream tasks like image classification, object detection, and segmentation. We also explore the limitations, ethical implications, and emerging trends in this domain. The review concludes that SSL is a promising direction for scalable, data-efficient, and generalizable visual learning.

Keywords: Self-Supervised Learning, Computer Vision, Contrastive Learning, SimCLR, BYOL, MoCo, Visual Representation Learning, Unlabeled Data, Deep Learning, Transfer Learning



