

# FEDPA: GENERATOR-BASED FEDERATED PROTOTYPE ADVERSARIAL LEARNING

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## Abstract

Federated Learning (FL) has emerged as a transformative paradigm enabling distributed model training without centralized data collection, thereby preserving user privacy. However, practical deployments of FL suffer from statistical heterogeneity (non-IID data), system heterogeneity, and class imbalance across clients, which significantly degrade global model convergence and generalization. Traditional federated averaging methods struggle when client data distributions vary widely, leading to representation drift and poor performance on underrepresented classes. This project proposes FedPA (Generator-Based Heterogeneous Federated Prototype Adversarial Learning), a novel federated learning framework designed to address heterogeneity using **class** prototypes and adversarial generative modeling. Instead of exchanging raw gradients or parameters alone, clients compute class-wise embedding prototypes, which are aggregated at the server to form global semantic anchors. A conditional generator synthesizes class-conditional embeddings, while a discriminator enforces adversarial alignment between generated and real aggregated prototypes. This adversarial mechanism enhances feature diversity and robustness, mitigating the impact of missing or rare classes on individual clients.