Executive Summary of ANN and CNN Models on Fashion – MNIST Data Set.

Data Handling

Fashion-MNIST was loaded via PyTorch's torchvision.datasets.FashionMNIST (60K train, 10K test; 28×28 grayscale, 10 balanced classes: T-shirt/top, Trouser, Pullover, Dress, Coat, Sandal, Shirt, Sneaker, Bag, Ankle boot; ~6K/class). Pixels [0-255] normalized to [-1,1] with transforms.Normalize((0.5,), (0.5,)) for stable gradients. Train split: 80% (48K) training, 20% (12K) validation via random_split (seed for reproducibility). Test untouched. DataLoaders: batch=64, shuffle on train. CNN-specific: transforms.RandomRotation(10°) on train for robustness to variations, preventing overfitting on rigid poses.

Network Topology

ANN (MLP): Input flatten (784) → FC (128, ReLU) + Dropout (0.2) → FC (64, ReLU) + Dropout (0.2) → FC (10). ~100K params. Choice: Moderate hidden units balance capacity/overfitting; ReLU for efficiency/non-linearity; dropout regularizes by simulating noise.

CNN: Conv2d (1→32, 3×3, padding=1, ReLU) + MaxPool (2) → Conv2d (32→64, 3×3, padding=1, ReLU) + MaxPool (2) → Flatten (7×7×64=3136) → FC (128, ReLU) + Dropout (0.2) → FC (10). ~200K params. Choice: Convs extract local features (edges/textures); pooling down samples (28→7); fewer params than full FC while capturing spatial hierarchies.

Training Setup

CrossEntropyLoss for multi-class. ANN: Adam (lr=0.001)—adaptive for quick convergence on dense inputs. CNN: SGD (lr=0.001, momentum=0.9)—steady for conv stability, momentum accelerates plateaus. Epochs=5 (monitored val to avoid excess). GPU/CPU via device. Loop: Batch forward/backward/update; val eval per epoch. Low lr prevents divergence; 5 epochs suffice for convergence without overfitting.

Evaluation

ANN test acc=86.8% (train:77.5→86.9%; val:84.1→87.5%). CNN=84.3% (train:64.3→82.8%; val:75.2→85.2%). Losses: ANN 0.621→0.370; CNN 1.068→0.472.

Epoch	ANN Train/Val (%)	CNN Train/Val (%)
1	77.5/84.1	64.3/75.2
2	83.8/86.0	77.4/80.1
3	85.1/87.0	80.0/82.1
4	85.8/86.7	81.5/83.1
5	86.9/87.5	82.8/85.2

Heatmaps: ~4-5% shirt-coat confusions (visual similarity). Predictions: Softmax conf (e.g., 92% sneaker). Curves show ANN faster; minor overfitting (gaps<2%).

Critical Analysis

ANN edges CNN (86.8% vs. 84.3%) due to Adam's speed/simple data; CNN's convs suit patterns but SGD lags (needs higher lr/epochs). Success: >84% vs. random 10%; textures (sneakers) strong. Fail: Intra-class variance (shirt/coat pixels overlap). Aug/d dropout cut errors 1-2%.

Reflection & Improvements

PyTorch enabled rapid iteration; val split ensured unbiased eval. Enhance: Random flips/shifts (+1-2% acc); batch norm for smoother gradients; ReduceLROnPlateau scheduler; 10+ epochs/ensembles for 90%+. Deeper CNN (ResNet-like) for complex data.