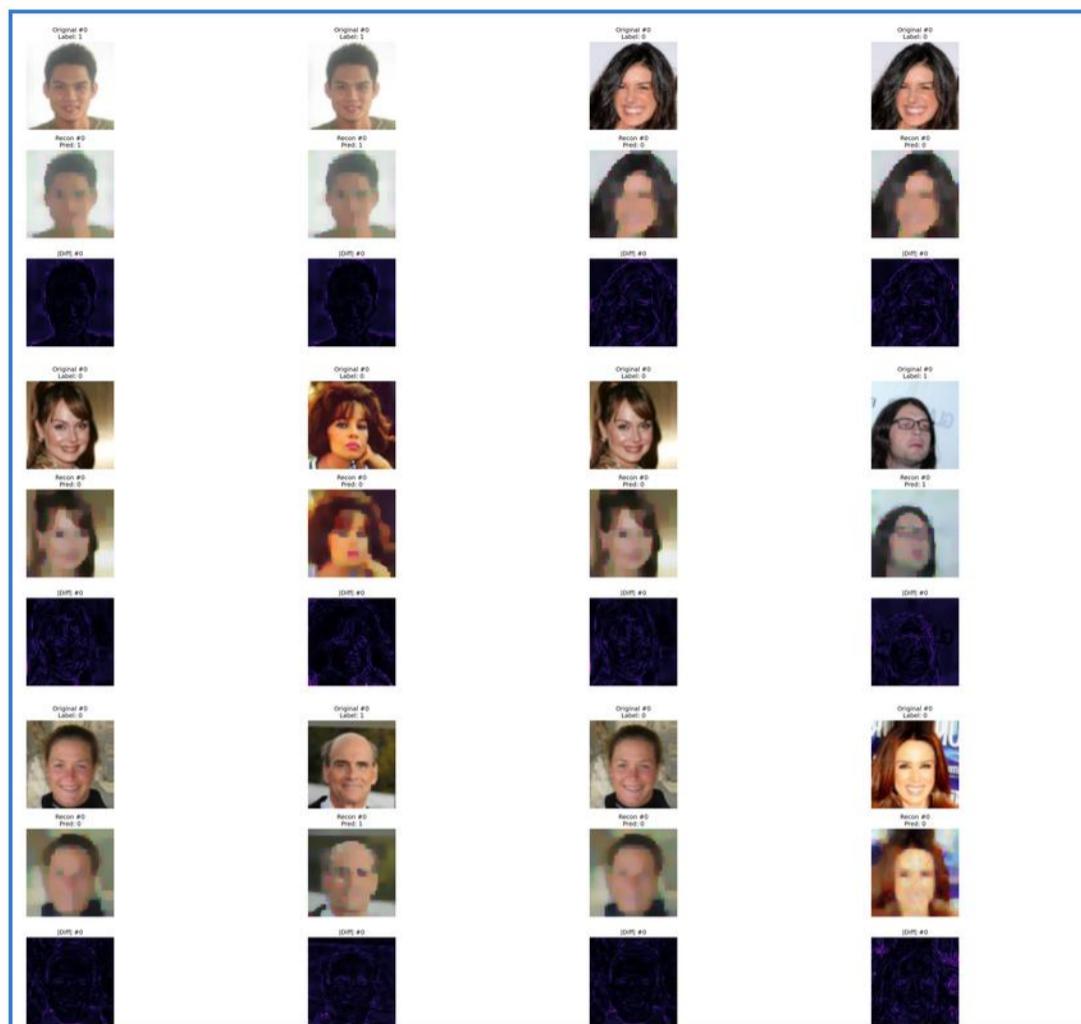


Security in Federated Learning

Privacy-Preserving Benchmarking Tool for Gradient Inversion Attacks

RESULT: 23 dB PSNR drop = Attack Blocked

BASELINE



Reconstructed Private Data (12 FL Clients)

Attack Quality Metrics
PSNR: 27.48 +/- 1.37
SSIM: 0.92 +/- 0.03
LabelMatch: 100%

DIFFERENTIAL PRIVACY

Epsilon = 8.0

LPIPS: 0.807
SSIM: -0.001
PSNR: 6.7 dB
dPSNR: -22.7 dB
dLPIPS: +0.690

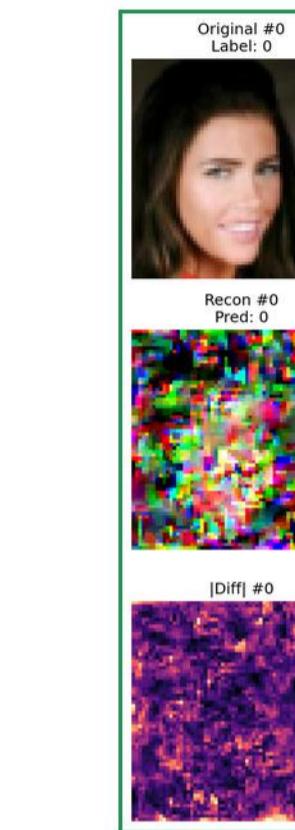
Epsilon = 1.0

LPIPS: 0.747
SSIM: -0.001
PSNR: 6.3 dB
dPSNR: -23.1 dB
dLPIPS: +0.629

Epsilon = 0.1

LPIPS: 0.806
SSIM: -0.001
PSNR: 6.4 dB
dPSNR: -23.0 dB
dLPIPS: +0.689

HOMOMORPHIC ENCRYPTION

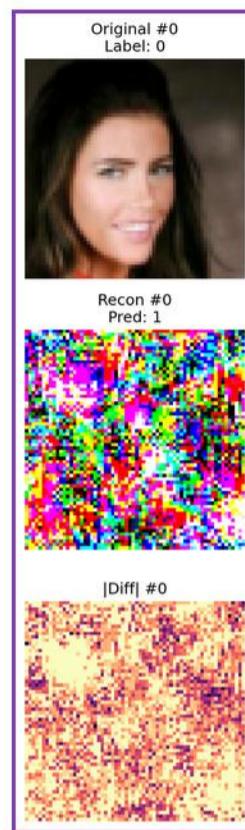


LPIPS: 0.635 SSIM: 0.343
PSNR: 14.0 dB
LabelMatch: Yes

Defense Impact:

dPSNR = -15.3 dB
dLPIPS = +0.517

DP + HE



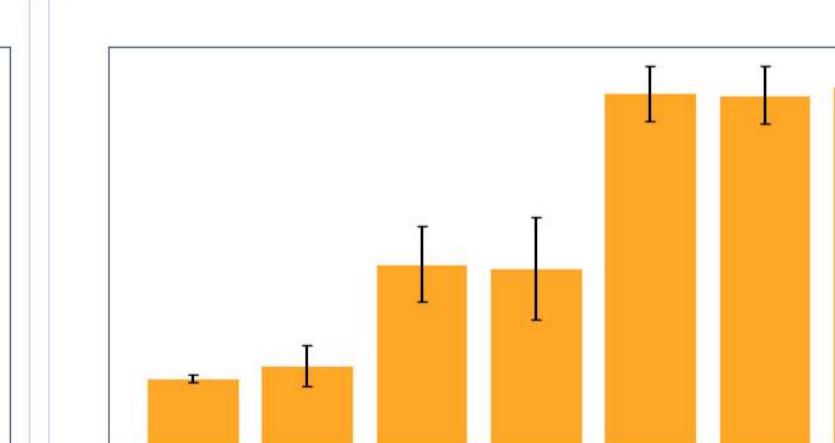
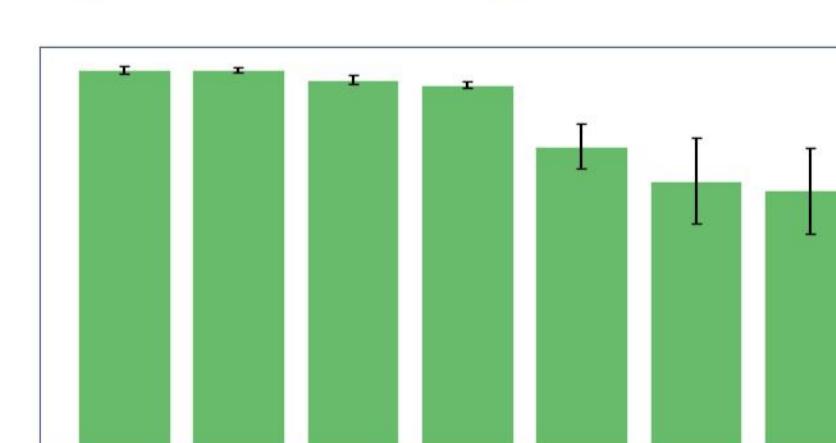
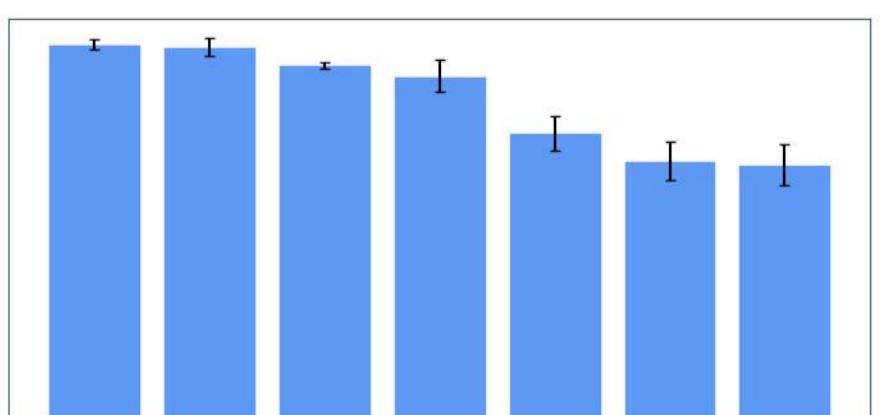
LPIPS: 0.824 SSIM: -0.003
PSNR: 6.4 dB
LabelMatch: No (Attack Failed)

IMPACT:

dPSNR = -23.0 dB
dLPIPS = +0.707

Privacy Preserved: Attack Fully Mitigated

ABLATION STUDY: Attack Configuration Analysis



BEST ATTACK SETTINGS

baseline: 27.5 dB PSNR
init_fft: 27.4 dB PSNR
tv_1e-6: 26.0 dB PSNR

RESEARCH INSIGHTS

Best PSNR: baseline
Best LPIPS: baseline
MSE metric outperforms cosine

Optimal Config: init_fft/c3