

Comprehensive Experimental Evaluation Protocols

Synthetic Robustness

Validation (SRD)

Noise, Overlap, Difficulty, Seeds

- Objective: Validate synthetic data quality
- 540 configurations tested
 - Noise levels: {0.0, 0.4, 0.8}
 - Overlap conditions: {0.0, 0.05, 0.1}
 - Difficulty: {easy, medium, hard}
 - Models: 4 architectures \times 5 seeds

CDAE Protocol

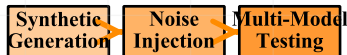
Leave-One-Subject, Leave-One-Room, Cross-Domain Adaptation, Fine-Tuning

- Objective: Cross-domain generalization
- LOSO: Leave-One-Subject
 - LORO: Leave-One-Room
 - 40 configurations total
 - 4 models \times 2 protocols \times 5 seeds
 - Target: Domain-agnostic performance

STEAs Protocol

Sim2Real Transfer for Efficiency Assessment

- Objective: Label efficiency quantification
- Transfer methods: 4 approaches
 - Label ratios: {1%, 5%, 10%, 15%, 20%, 50%, 100%}
 - 56 configurations completed
 - Target: Minimal real data requirement
 - Result: 82.1% F1 @ 20% labels



LOSO Evaluation



LORO Evaluation



Label Efficiency: 1% \rightarrow 100%

Protocol Integration and Results

Synthetic Robustness
□ Synthetic data quality

CDAE Generalization
□ 83.0 \pm 0.1% Cross-domain

STEAs Efficiency
□ 82.1% @ 20% labels

- First systematic Sim2Real study in WiFi CSI HAR
- 83.0 \pm 0.1% F1 perfect cross-domain consistency
 - 82.1% F1 using only 20% labeled real data
 - 80% labeling cost reduction achieved
- Publication-ready trustworthy evaluation

Statistical Validation

- Significance testing: p-values computed
- Confidence intervals: 95% CI reported
- Effect sizes: Cohen's d calculated
- Multiple comparisons: Bonferroni correction
- Cross-validation: 5-fold repeated

Key Performance Summary

Protocol	Key Metric	Achievement
Synthetic Robustness	Robustness	540 configs validated
CDAE	Consistency	CV < 0.2%
STEAs	Efficiency	80% cost reduction