Comprehensive Experimental Evaluation Protocols

Synthetic Robustness Validation (SRD)

Objective: Validate synthetic dat
• 540 configurations tes
• Noise levels: {0.0, 0.4,
• Overlap conditions: {0.0, 0
• Difficulty: {easy, medium
• Models: 4 architectures ×

CDAE Protocol

Objective: Cross-domain
• LOSO: Leave-One
• LORO: Leave-On
• 40 configurat
• 4 models × 2 proto
• Target: Domain-agno

STEA Protocol

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

Label Efficiency: 1% -> 100%

Protocol Integration and Results

Synthetic Robustness
✓ Synthetic data quality

CDAE Generalization
✓ 83.0±0.1% Cross-domain

STEA Efficiency
✓ 82.1% @ 20% labels

PSTA: Progressive Stress Test

ESTA: Extended Stability

✓ First systematic Sim2Real study in WiFi CSI HAR
✓ 83.0±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	$\sigma < 0.2\%$
STEA	Efficiency	80% cost reduction