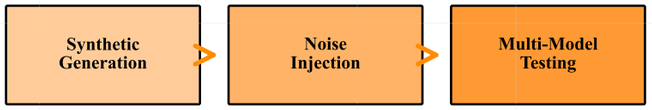
# Comprehensive Experimental Evaluation Protocols

## D2 Protocol

*Synthetic Data Validation*

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 × 5 seeds

**D2: Robustness Analysis**

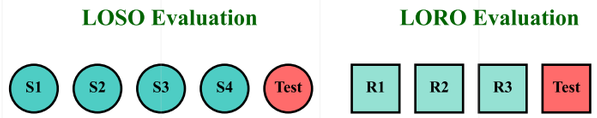



## CDAE Protocol

*Cross-Domain Adaptation Evaluation*

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

**CDAE: Cross-Domain Excellence**

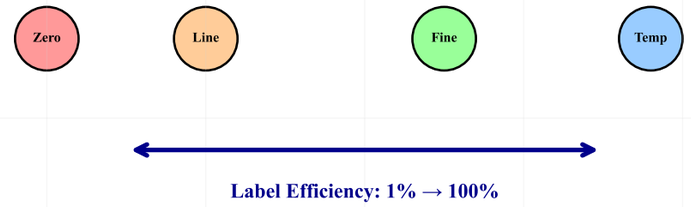



## STEA Protocol

*Sim2Real Transfer 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

**STEA: Transfer Efficiency**




## Protocol Integration and Results

**D2 Validation**
**□ Synthetic data quality**

**CDAE Generalization**
**□ 83.0±0.1% Cross-domain**

**STEA Efficiency**
**□ 82.1% @ 20% labels**

□ 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 |
|---|---|---|
| D2 | Robustness | 540 configs validated |
| CDAE | Consistency | CV < 0.2% |
| STEA | Efficiency | 80% cost reduction |