

Integrated Methodology Architecture

1. Data Collection

LOC (n=2,765) | FP (n=158) | UCP (n=131)

2. Preprocessing & Feature Engineering

Missing imputation • Outlier handling • Feature scaling

3a. LOC Model

LOSO (11-fold)

3b. FP Model

LOOCV

3c. UCP Model

10-fold CV

4. Macro-Averaging

$$m_{macro} = (1/3) \times (m_{LOC} + m_{FP} + m_{UCP})$$

5. Unified Performance Metrics

MAE: 12.66±0.85 PM | MMRE: 0.647±0.041