

A Hybrid Fuzzy Logic–Random Forest Model to Predict Psychiatric Treatment Order Outcomes: An Interpretable Tool for Legal Decision Support

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Supplementary Material 2: Pseudocode

Pseudocode: Fuzzy + Hybrid Treatment Order Prediction Model

1. Load and Preprocess the Dataset

- Load dataset from Excel
- Drop identifier columns
- Convert categorical variables to numeric format
- Normalize continuous variables (e.g., age, time requested)
- Extract semantic flags from text fields:
 - Severity_Flag = 1 if diagnosis suggests serious mental illness
 - Compliance_Flag = 1 if symptoms suggest non-compliance

2. Create Composite Feature: Burden Score

- For each case:
 - Burden_Score = weighted average of:
 - 35% * Severity_Flag
 - 30% * Compliance_Flag
 - 20% * Time Requested
 - 15% * Substance Use

3. Apply Fuzzy Logic Rules to Generate Expanded Score

- For each case:
 - Initialize score = 0, weights = 0
 - Apply expert rules.
 - Expanded_Score = weighted average of all rule outputs

4. Split Dataset (70/30) for Training and Testing

- Use train_test_split() to split data into:
 - 70% training set
 - 30% testing set (hold-out for evaluation)

5. Apply k-Fold Cross-Validation

- Use StratifiedKFold from sklearn with k=10
- For each fold:
 - - Split training data into sub-train and validation
 - - Compute Burden_Score and Expanded_Score
 - - Train RandomForestClassifier on sub-train
 - - Validate on the fold and collect performance metrics
- Aggregate metrics across all folds

6. Train Final Random Forest Classifier

- Train on the entire training set using all features:
 - - Age, Sex, Legal Aid, Substance Use
 - - Time Requested, Time Granted
 - - Severity_Flag, Compliance_Flag
 - - Burden_Score, Expanded_Score

7. Evaluate on Test Set

- Predict labels and probabilities for test cases
- Compute evaluation metrics:
 - - Accuracy, Precision, Recall, F1 Score, ROC
 - - Confusion Matrix
- Generate visualizations (heatmaps, feature importances)

8. Interpret Predictions

- Use feature_importances_ to understand model decision logic
- Trace fuzzy rule activation per case for transparency
- Compare predicted labels to true outcomes for clinical validation

Summary

- This hybrid pipeline integrates explainable fuzzy logic with high-performing machine learning to predict mental health treatment order outcomes.
- It ensures interpretability, reproducibility, and empirical accuracy through structured rule logic and cross-validation.