**Title Page**

* Title: *Expert's Eye: Machine Learning Framework in Frailty Evaluation*
* Author: Matthieu Ndumbi Lukuenya
* Supervisor(s): Leontios ChatziLeontiadis
* Institution: Aristotle University of Thessaloniki, Department of Electrical and Computer Engineering

**Abstract**

* Summary of objectives, methods, and key findings.

**Table of Contents**

### **1. Introduction**

* 1.1 Background on Frailty and Clinical Challenges
* 1.2 Importance of Early Detection and Intervention
* 1.3 Machine Learning's Role in Frailty Prediction
* 1.4 Challenges Addressed in the Thesis
  + 1.4.1 Irregular Measurements and Missing Data
  + 1.4.2 Data Scarcity and Patient Dropouts
  + 1.4.3 Lack of Standardized Frailty Scoring
  + 1.4.4 Harmonizing Multimodal Data Representations
* 1.5 Objectives of the Study
  + 1.5.1 Personalization for Clinical Decision-Making
  + 1.5.2 Explainability and Expert Integration
  + 1.5.3 Addressing Dataset Limitations

### **2. Literature Review**

* 2.1 Machine Learning in Healthcare
  + 2.1.1 Predictive Modeling in Medicine
  + 2.1.2 Challenges with Medical Data
* 2.2 Longitudinal Data Analysis in Clinical Studies
* 2.3 Multimodal Data Integration and Feature Discrepancy
* 2.4 Explainable AI and Expert-in-the-Loop Systems
  + 2.4.1 Techniques for Explainability (e.g., SHAP, LIME)
  + 2.4.2 Expert Feedback in Model Training
* 2.5 Previous Work in Frailty Prediction
  + 2.5.1 Conventional Methods
  + 2.5.2 ML Approaches and Limitations

### **3. Dataset and Preprocessing**

* 3.1 Overview of Dataset
  + 3.1.1 Data Sources and Acquisition Methods
  + 3.1.2 Variables (Posture, Gait, Socio-economic, Psychological, etc.)
* 3.2 Preprocessing and Data Cleaning
  + 3.2.1 Handling Missing and Irregular Data
  + 3.2.2 Harmonizing Multimodal Features
* 3.3 Ethical Considerations in Data Use

### **4. Methodology**

* 4.1 Machine Learning Framework
  + 4.1.1 Model Selection and Justification
  + 4.1.2 Incorporating Expert Criteria
  + 4.1.3 Personalization Mechanisms
* 4.2 Longitudinal Data Modeling
  + 4.2.1 Handling Follow-up Irregularities
* 4.3 Explainable AI Integration
  + 4.3.1 Visualization Tools for Experts
* 4.4 Evaluation Metrics
  + 4.4.1 Quantitative Performance Metrics
  + 4.4.2 Expert Feedback Integration

### **5. Implementation**

* 5.1 Tools and Technologies
  + 5.1.1 Development Environment (Python, Libraries, etc.)
  + 5.1.2 Hardware Specifications
* 5.2 Model Development and Training
  + 5.2.1 Preprocessing Pipelines
  + 5.2.2 Training and Hyperparameter Tuning
* 5.3 Explainability Module Implementation

### **6. Results**

* 6.1 Model Performance and Validation
  + 6.1.1 Quantitative Metrics
  + 6.1.2 Comparative Analysis with Existing Approaches
* 6.2 Explainability Insights
  + 6.2.1 Case Studies with Expert Feedback
  + 6.2.2 Visualization of Key Features
* 6.3 Implications for Clinical Use

### **7. Discussion**

* 7.1 Interpretation of Results
* 7.2 Recommendations for Clinical Practice

### **8. Conclusion**

* 8.1 Summary of Contributions
* 8.2 Limitations of the Study
* 8.3 Directions for Future Work

### **Appendices**

* Documentation