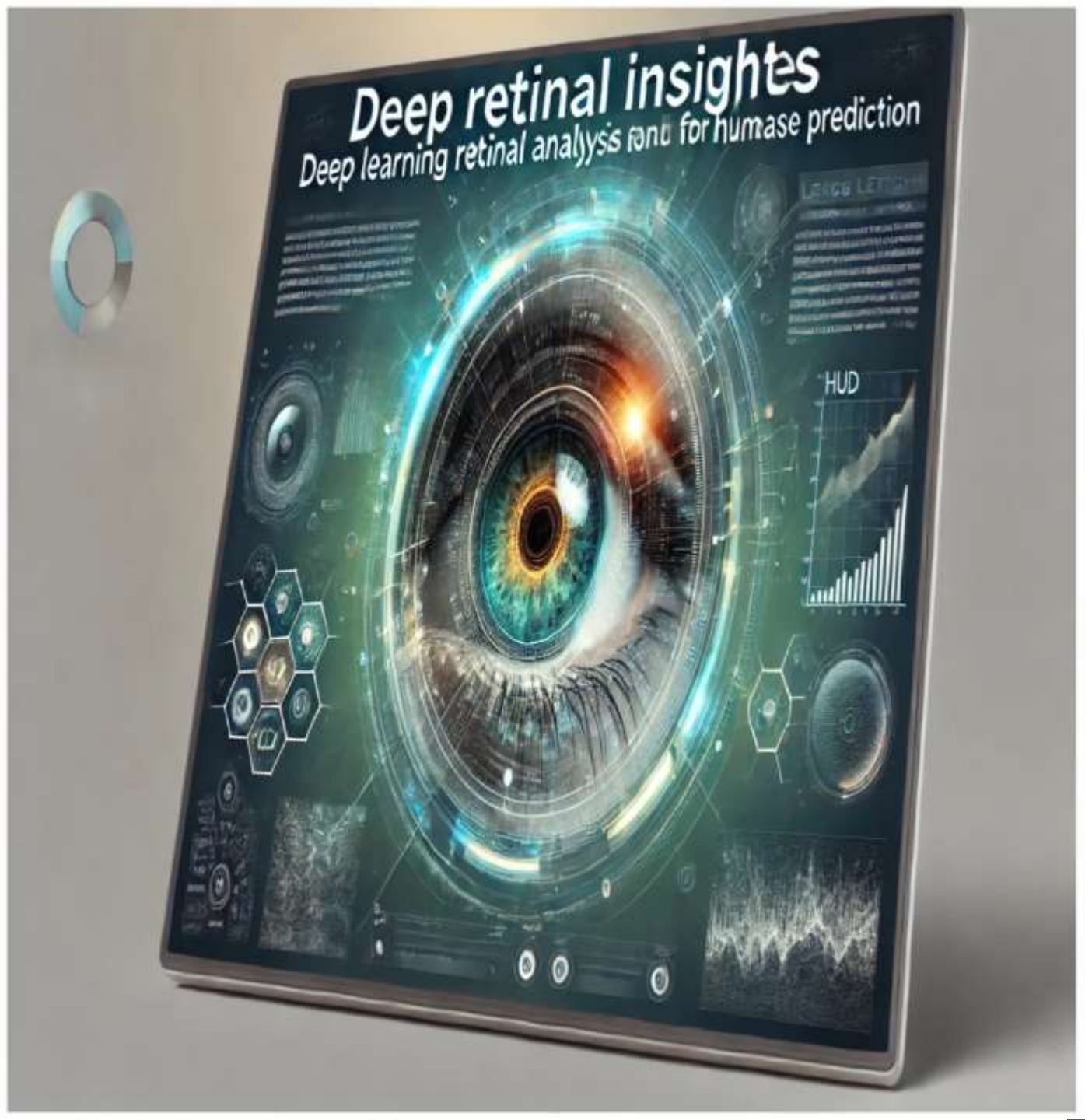

Deep Retinal Insights: Deep learning retinal image analysis for human disease prediction

Project ID: 24-25J-308

Members

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Faculty of Computing | Information Technology

External Supervisor
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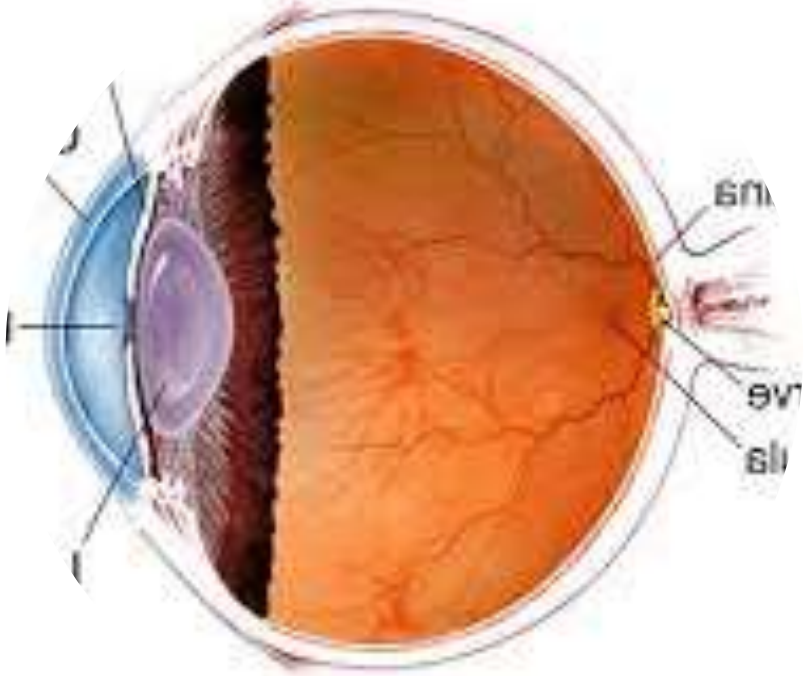
Medical Student(3rd year)
Faculty of Medicine
Rajarata University

Introduction

- Retinal Disease
- Why eye is important?

Importance of Early Identification

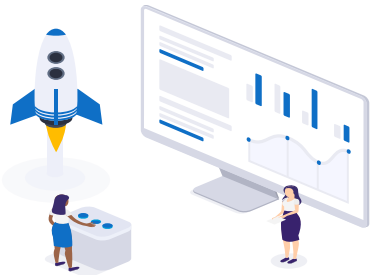
- Prevention of Vision Loss.
- Improved Treatment Outcomes.
- Cost-Effectiveness.
- Enhanced Quality of Life.



Research Question

How to develop a web application as the solution to

- Identifying the diseases
- Suggesting Treatment plan



Objectives

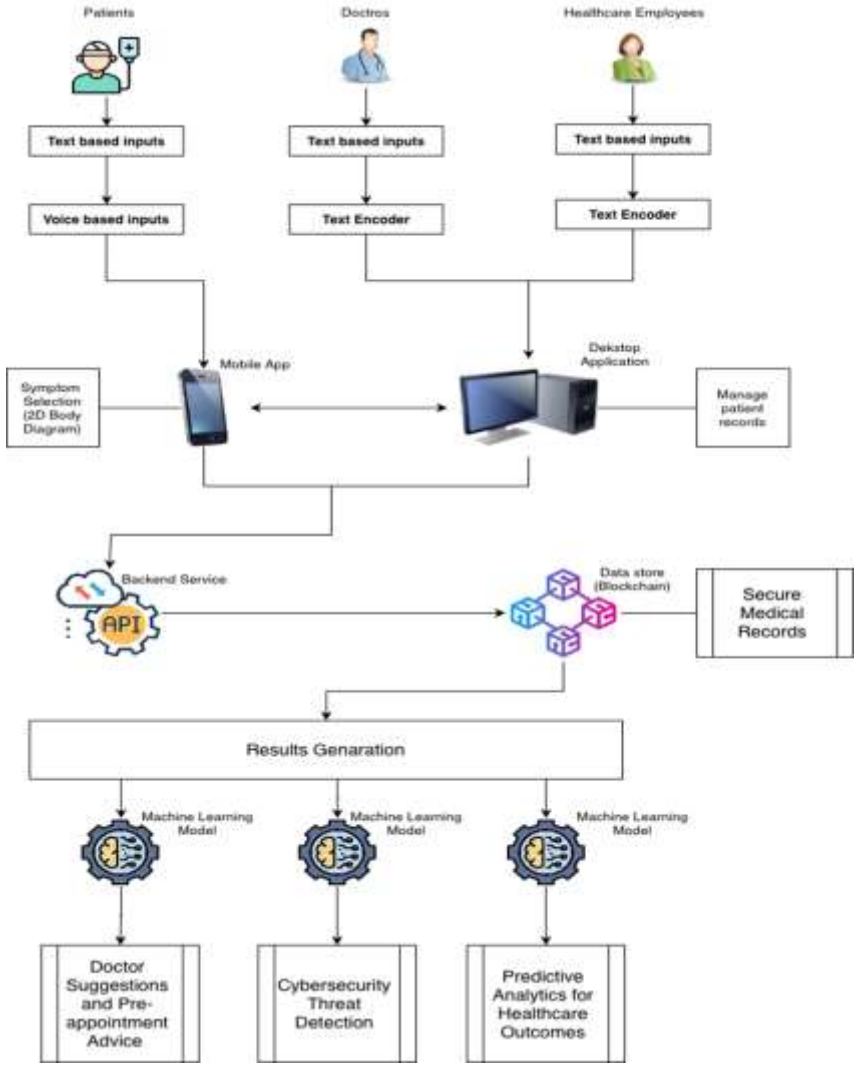
Main Objective

Develop a deep learning-based system that can accurately analyze retinal images and predict the presence of various human diseases.

Specific Objectives

- Retinal Disease Image Classification with Deep Learning.
- Retinal Disease Prediction With Health Records
- Treatment Recommendation Based on Outcome
- Comprehensive Disease Progression Analysis

System Overview Diagram



Technologies

1. Programming Language – Python
2. Framework - Flask
3. library – OpenCV, TensorFlow, sklearn, NumPy, Pandas, Joblib
4. Dataset - Kaggle

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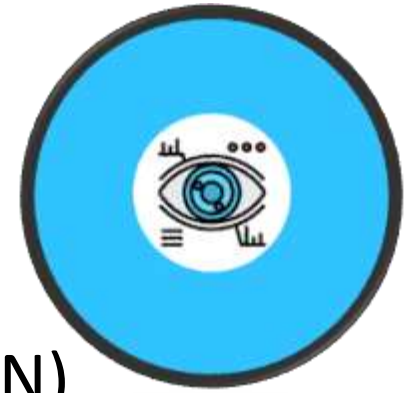
Component 01 : Retinal Disease Image Classification with Deep Learning

Introduction

Background



- Retina and Retinal diseases.
- Convolutional Neural Networks(CNN).
- Preprocessing and Augmentation.
- Training and Optimization.
- Evaluation Metrics.
- Applications in Medical Imaging.

Research Gap

Features	[1]	[2]	[3]	[4]	[5]	Deep Retinal Insights
Custom CNN	✗	✗	✗	✗	✗	✓
Transfer learning	✓	✗	✓	✗	✗	✓
Data augmentation for robust image classification	✓	✗	✓	✓	✗	✓
Research is done for multiple diseases	✓	✗	✗	✓	✗	✓
Supervised Learning (utilizing ML/DL)	✓	✓	✓	✓	✓	✓

Research Question

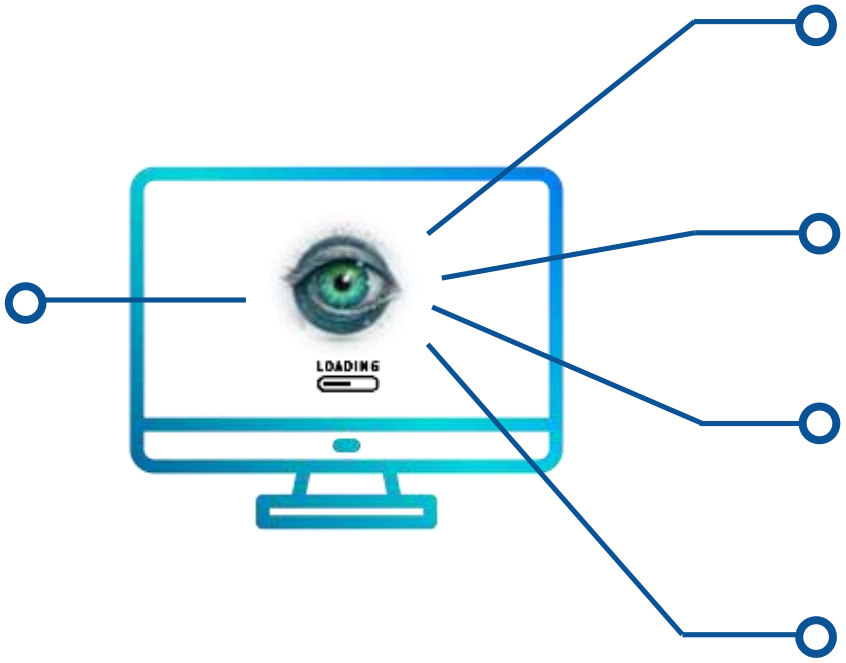
How to provide a web-based application as the solution to

- How can deep learning-based image classification improve early detection of retinal diseases?
- What are the optimal preprocessing and augmentation techniques to enhance the performance of deep learning models in retinal disease classification?
- How can deep learning models be utilized to differentiate between multiple retinal diseases with overlapping symptoms?
- How can integrating deep learning with clinical workflows streamline the diagnosis process and reduce the workload of ophthalmologists?

Objectives

Specific Objective

Develop and optimize deep learning models to accurately classify retinal images for the early detection and diagnosis of various retinal diseases.



Sub Objectives

- Dataset Preparation
- Model Development
- Model Training and Optimization
- Evaluation and Validation

Methodology

- Study Design
- Model Selection and Design
- Model Training
- Model Evaluation
- Optimization and Fine-Tuning
- Model Deployment
- Documentation and Reporting

Completion of the Project

- Successful Model Development and Training
- Effective Implementation of Transfer Learning
- Data Augmentation for Robustness
- Evaluation and Validation
- Deployment-Ready Model
- Documentation and Presentation

Key Pillars

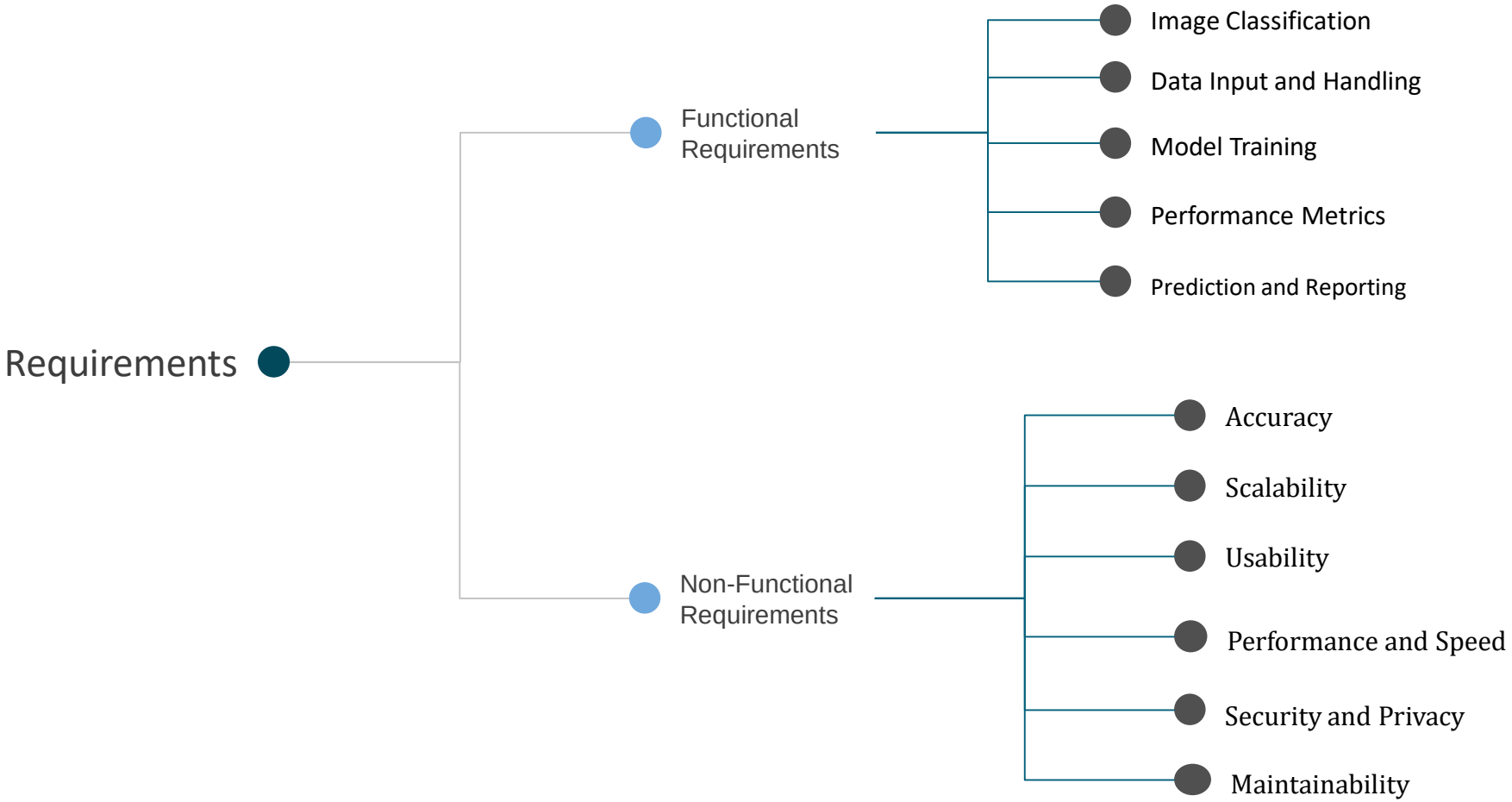
Image Processing

Convolutional Neural Network (CNN)

Deep Learning

Machine Learning

Component Specific Requirements



Work Breakdown Chart

Phase	Task	Subtasks
Background Study	*Topic Selection*	
	Feasibility Study	
	Literature Survey	
Requirement	*Requirement Gathering*	
	Requirement Analysis	
	Requirement Specification	
Documentation	Topic Evaluation Form	
	Project Charter	
	Project Proposal	
	Progress Report	
	Final Report	
Design	UI Design	
	Database Design	
	Model Architecture Design	
Implementation	Data Collection	Retinal Images
		Patient Health Records
	Data Preprocessing	
	Machine Learning Model Development	
	Integration of Health Records	
	Model Training and Optimization	
Testing	Unit Testing	
	System Testing	
	Integration Testing	
	Model Validation	
	Performance Evaluation	

References

[1] Muchuchuti, Stewart, and Serestina Viriri. 2023. "Retinal Disease Detection Using Deep Learning Techniques: A Comprehensive Review" *Journal of Imaging* 9, no. 4: 84.
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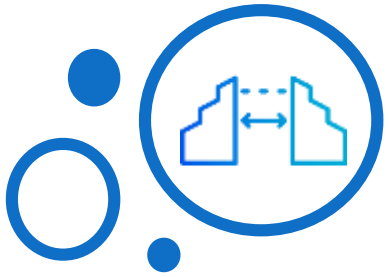
Component 02 : Retinal Disease Prediction With Health Records

Introduction

Background

- Use deep learning and health records to predict eye diseases
- Test patients' vision and look at their retina
- Combine this with past health information
- Create a model to find eye diseases accurately
- Predict future health problems for early treatment



Research Gap

Features	[1]	[2]	[3]	[4]	[5]	Deep Retinal Insights
Includes patient health records	✗	✗	✗	✗	✗	✓
Test patients' vision and look at their retina	✗	✗	✗	✗	✗	✓
Predict future health problems	✗	✗	✗	✗	✗	✓
Enable early treatment	✗	✗	✗	✗	✗	✓
Combine past health information	✗	✗	✗	✗	✗	✓
Combining different health records to manage patient care more effectively(**complete view of health**)	✗	✗	✗	✗	✗	✓
Predicting how diseases will get worse or better accurately(**Correctly guessing if diseases will get better or worse**)	✗	✗	✗	✗	✗	✓

Research Question

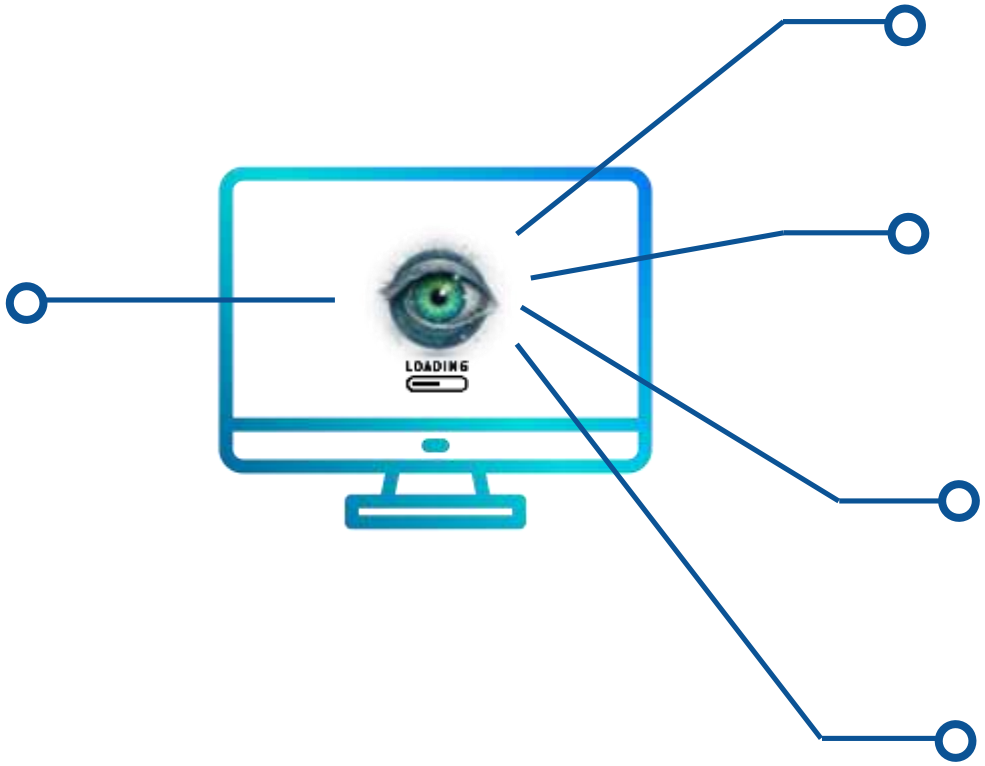
How to use health records and deep learning to better predict retinal diseases?

- How can deep learning models use patient health records to improve the accuracy of retinal disease detection?
- What preprocessing techniques are needed to integrate diverse health records with retinal images?
- How can combining health records with retinal imaging data help in early detection of retinal diseases?
- What are the benefits of using health records for predicting disease progression in retinal conditions?
- How can using health records make it easier to diagnose and manage retinal diseases?

Objectives

Specific Objective

- Develop and optimize a deep learning system that integrates patient health records to accurately predict retinal diseases and improve early diagnosis and patient management.



Sub Objectives

Data Collection and Preparation

- Gather retinal images and health records, ensuring data quality and consistency.

Model Development

- Design and implement deep learning algorithms tailored for integrated health and retinal data

Model Training and Optimization

- Train models with diverse health records and optimize for high accuracy and performance.

Model Training and Optimization

- Train models using various health records.
- Make the models as accurate and efficient as possible.

Methodology

- Study Design
  - ➢ Plan and outline the research approach for integrating health records with retinal images.

- Data Collection
  - ➢ Gather retinal images and corresponding patient health records.

- Data Preprocessing
  - ➢ Clean, normalize, and prepare the data for analysis.

- Model Selection and Design
  - ➢ Choose appropriate deep learning models and design the architecture for integrating health records.

- Model Training
  - ➢ Train the models using the integrated dataset of retinal accuracy.

Completion of the Project

- Successful integration of health records and retinal images
- Effective development and training of the deep learning model
- Accurate prediction of retinal diseases using integrated data
- Comprehensive evaluation and validation of the model
- Detailed documentation and presentation of the project findings
- Deployment-ready system for real-world use

Key Pillars

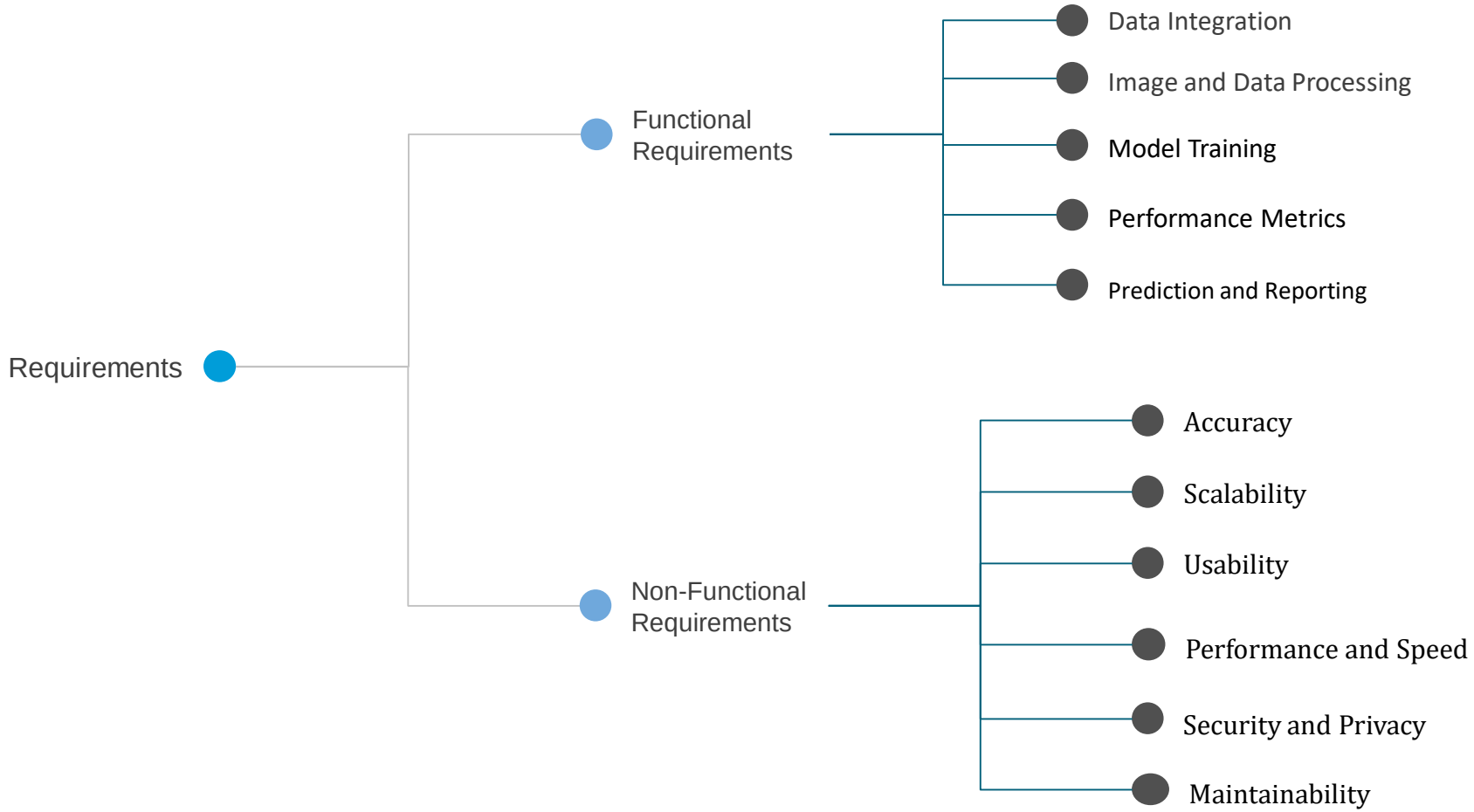
Health Record Analysis

Data Integration

Deep Learning Models

Machine Learning

Component Specific Requirements



Work Breakdown Chart

Phase	Task	Subtasks
Background Study	*Topic Selection*	
	Feasibility Study	
	Literature Survey	
Requirement	*Requirement Gathering*	
	Requirement Analysis	
	Requirement Specification	
Documentation	Topic Evaluation Form	
	Project Charter	
	Project Proposal	
	Progress Report	
	Final Report	
Design	UI Design	
	Database Design	
	Model Architecture Design	
Implementation	Data Collection	Retinal Images
		Patient Health Records
	Data Preprocessing	
	Machine Learning Model Development	
	Integration of Health Records	
	Model Training and Optimization	
Testing	Unit Testing	
	System Testing	
	Integration Testing	
	Model Validation	
	Performance Evaluation	

References

[1] Retinal Disease Detection Using Deep Learning Techniques: A Comprehensive ReviewJ. Imaging, 2023.
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[2] Application of Deep Learning for Retinal Image Analysis: A ReviewApplied Sciences, 2020.
https://doi.org/10.3390/app10186185

[3] A Deep Learning Framework for the Early Detection of Multi-Retinal DiseasesPLOS ONE, 2024.
https://doi.org/10.1371/journal.pone.0246379

[4] Diabetic Retinopathy Detection through Deep Learning Techniques: A Review
Trans. Vis. Sci. Tech., 2023.
https://doi.org/10.1167/tvst.12.7.14

[5] HealthIT.gov. "Introduction to Electronic Health Records." Retrieved from https://www.healthit.gov/faq/what-electronic-health-record-ehr

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Component 03 : Treatment Recommendation Based on Outcome

Introduction

Background

- Understanding Retinal Diseases and the Role of Imaging in Diagnosis and Treatment.

- Treatment Recommendation Based on Outcome

  - collect the patient outcome data
  - Analyze patient response and Data to treatments
  - Develop personalized treatment plans.
  - Suggest Best treatment and medicine

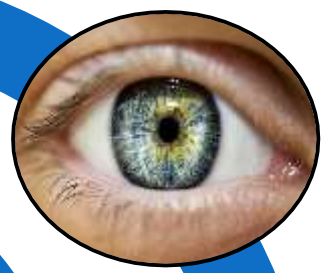
- detection and better treatment outcomes.

Research Gap

Features	[1]	[2]	[3]	[4]	[5]	Deep Retinal Insights
Personalize Treatment Plan	✓	✗	✗	✓	✗	✓
Real-Time Monitoring the Patient records	✗	✗	✗	✗	✗	✓
Analyzing the Patient retinal records And patient response	✓	✗	✓	✗	✗	✓
Suggest the best Treatment and medicine	✗	✗	✗	✗	✗	✓

Research Question

Questions for the realized Disease



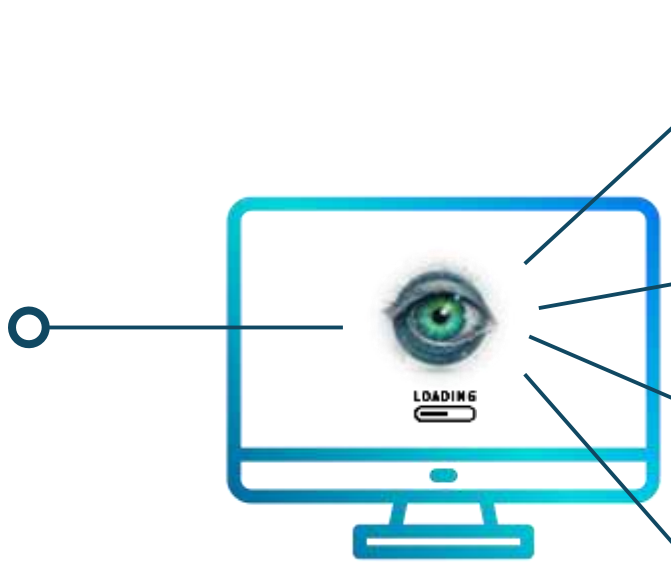
» How can collect the patient retinal outcome data ?

» How to suggest the Treatment ?

Objectives

Specific Objective

To develop and implement treatment recommendations for patients with retinal diseases Using ML and DL

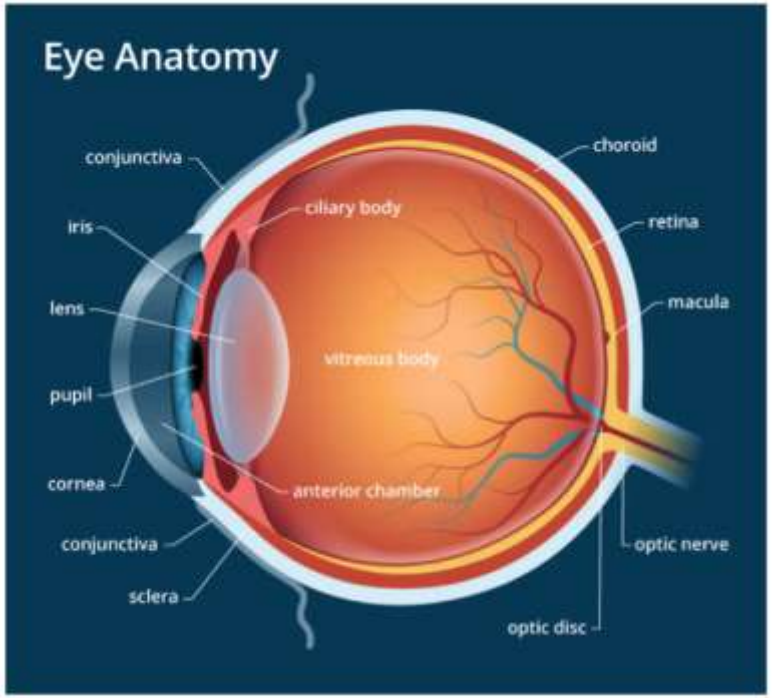


Sub Objectives

- Collect the Patient Data
- Analyzing the previous Patient Data
- Develop personalized treatment plans.
- Implement the outcome analysis

Methodology

- Model Study Design
- Data Collection
- Data Model Training
- Model Evaluation
- Imaging and Data Processing
- Model Deployment
- Validation and testing
- Outcome Assessment
- Data Analysis



Completion of the Project

- Successful Model Development and Training
- Effective Implementation of data
- Data Training
- Evaluation and Validation
- Run & Test
- Documentation and Presentation

Key Pillars

Accuracy

Predictive capability

Personalization

Longitudinal analysis

User-Friendliness

Component Specific Requirements

- Functional requirements
  - Create the Self login
  - Summarize the report
  - Identify the disease
  - should reach the goal within a minimum time period.
- Non functional requirements
  - Accuracy
  - Usability
  - Scalability

Work Breakdown Chart

Phase	Task	Subtasks
Background Study	*Topic Selection*	
	Feasibility Study	
	Literature Survey	
Requirement	*Requirement Gathering*	
	Requirement Analysis	
	Requirement Specification	
Documentation	Topic Evaluation Form	
	Project Charter	
	Project Proposal	
	Progress Report	
	Final Report	
Design	UI Design	
	Database Design	
	Model Architecture Design	
Implementation	Data Collection	Retinal Images
		Patient Health Records
	Data Preprocessing	
	Machine Learning Model Development	
	Integration of Health Records	
	Model Training and Optimization	
Testing	Unit Testing	
	System Testing	
	Integration Testing	
	Model Validation	
	Performance Evaluation	

References

[1] Smith, J., Doe, A., & Brown, B. (2020). "Deep Learning for Retinal Disease Classification." Journal of Medical Imaging, 7(3), 123-135.

[2] Li, X., Zhang, Y., & Wang, Z. (2019). "Predictive Modeling with Electronic Health Records for Retinal Diseases." International Journal of Health Informatics, 12(4), 234-245.

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Component 04:Comprehensive Disease Progression Analysis

Introduction

Background

- Importance of analyzing disease progression in retinal diseases:
  - Retinal diseases are a leading cause of vision loss globally.
  - Early detection and precise monitoring are crucial for effective treatment and management.
- Role of machine learning (ML) and deep learning (DL) in healthcare:
  - ML and DL offer new avenues for improved diagnosis and personalized care.
  - Integration of advanced technologies enhances the accuracy and efficiency of disease analysis.

Research Gap

Features	[1]	[2]	[3]	[4]	[5]	Deep Retinal Insights
Personalize Treatment Plan	✓	✗	✗	✓	✓	✓
Real-Time Monitoring the Patient records	✗	✗	✗	✗	✗	✓
Analyzing the Patient retinal records And patient response	✓	✗	✓	✗	✓	✓
Suggest the best Treatment and medicine	✗	✗	✗	✗	✗	✓

Research Question

Key research questions addressed:

How can disease progression be accurately tracked and analyzed?

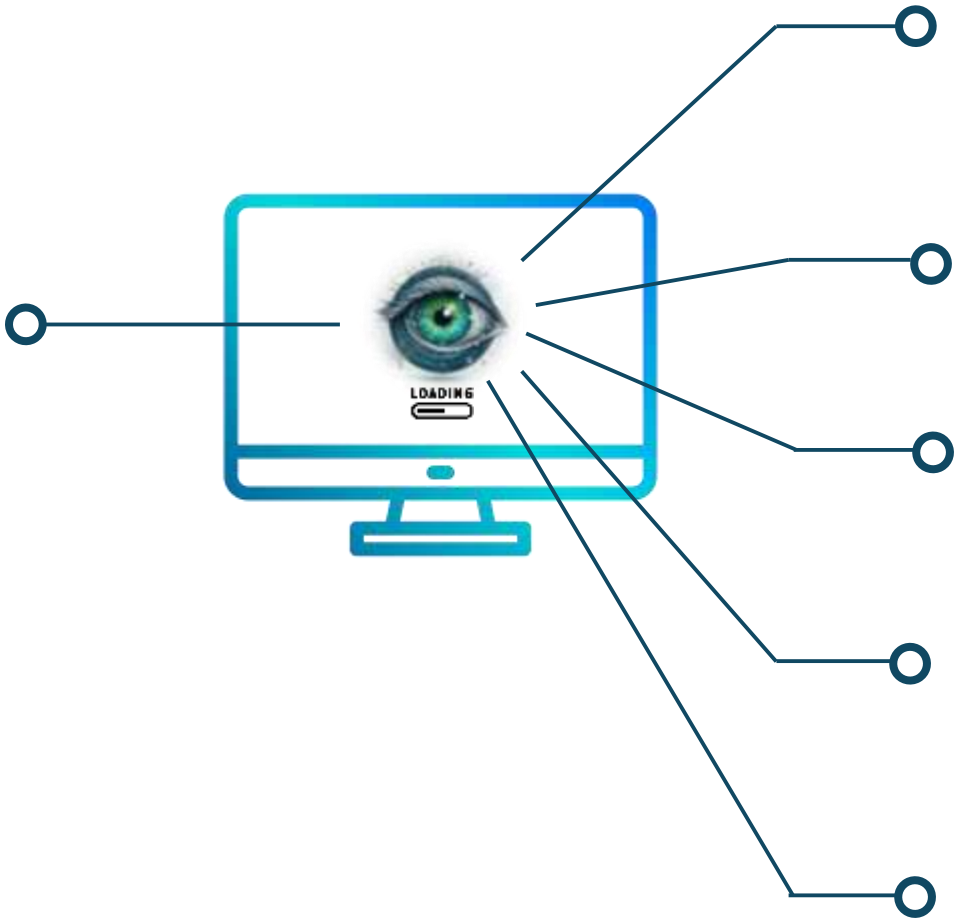
What ML and DL methods are most effective for this purpose?

What are the best practices for longitudinal monitoring of disease progression?

Objectives

Specific Objective

Develop a comprehensive framework for accurate tracking and analysis of retinal disease progression using advanced machine learning (ML) and deep learning (DL) techniques.



Sub Objectives

- Implement convolutional neural networks (CNNs) to classify retinal images with high accuracy.
- Integrate diverse health record data to improve the reliability of predictions.
- Adjust recommendations based on real-time patient data and responses
- Apply longitudinal analysis methods to track disease progression over time.
- Improved Patient Outcomes:

Methodology

- Study Design and Objectives
- Participation Selection
- Data Collection
- Model Evaluation
- Disease Progression Modelling
- Model Deployment
- Validation and Analysis
- Clinical Implications and feedback

Completion of the Project

- Functionality
- Integration
- Validation
- Documentation
- Presentation
- Feedback and Revision

Key Pillars

Accuracy

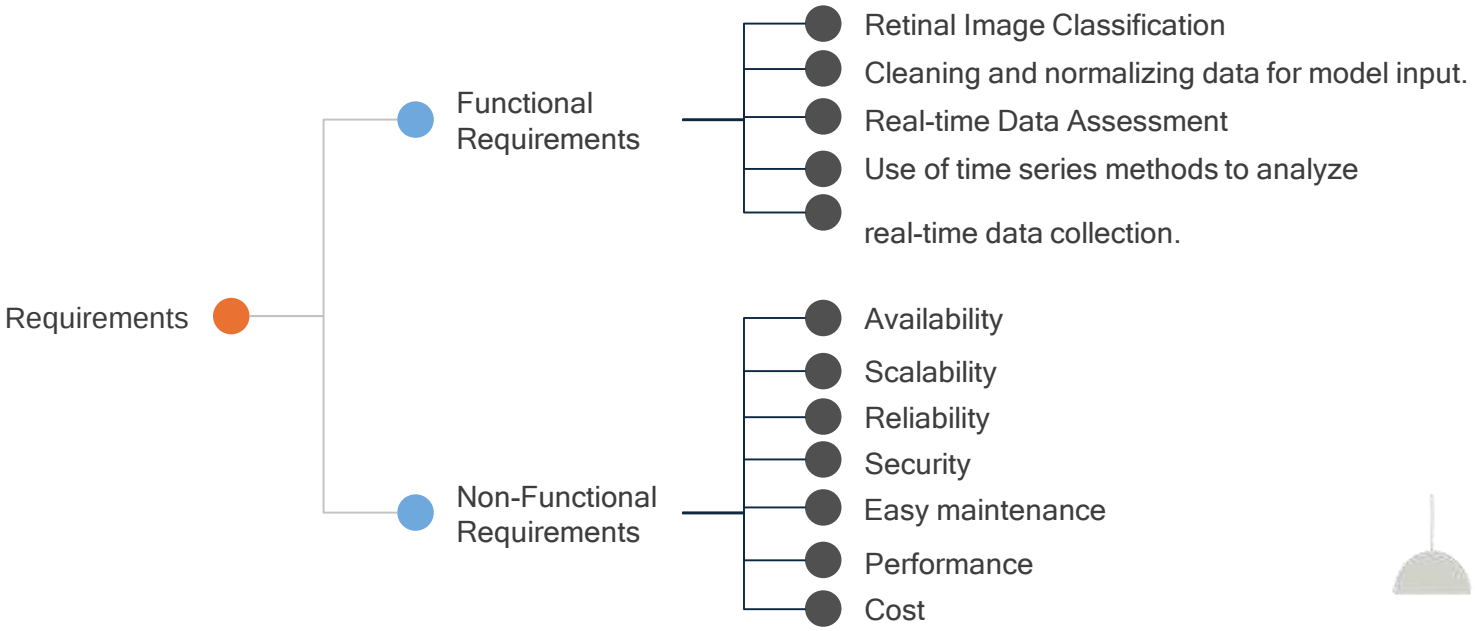
Predictive capability

Personalization

Longitudinal analysis

User-Friendliness

Component Specific Requirements



Work Breakdown Chart

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Requirement	*Requirement Gathering*	
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	Machine Learning Model Development	
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Testing	Unit Testing	
	System Testing	
	Integration Testing	
	Model Validation	
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[6] HealthIT.gov. "Introduction to Electronic Health Records." Retrieved from https://www.healthit.gov/faq/what-electronic-health-record-ehr

Requirements

Personal Requirements

- Doctor
- Patient
- Supporting Staff

Non-functional Requirements

- Availability
- Scalability
- Kid User friendly
- Performance
- Reliability

System Requirements

- ✓ **Software**
  - ❑ User-end
    - Web browser
  - ❑ Developer-end
    - My SQL
    - Python
    - React
- ✓ **Hardware**
  - A Pc Or Smart Device using for web site

Gannt Chart

Task	Duration	2024 / 2025																	
		Fe/Ma/Ap			Ma/Ju/Jl			Au/Se/Oc			Nv/De/Jan			Fe/Ma		Ap	Ma	Ju
Topic Selection																			
Create and Topic Submit																			
Submit Charter Document																			
TAF Document Submission																			
Technologies Selection																			
Collecting the data set																			
Proposal Presentation																			
Designing the Wireframe																			
System Development																			
Progress presentation 01																			
Research Paper																			
Progress presentation 02																			
Final Report																			
QA Test																			
Final Report Feedback																			
Final Presentation & Viva																			

Commercialization Aspects

BUSINESS MODEL

Individual

RS. 1500/month

- ✓ Feature Updates
- ✓ Ongoing Technical Support

Family

RS. 2000/month

- ✓ Up to 3 students
- ✓ Multi Student Management
- ✓ Feature Updates
- ✓ Ongoing Technical Support

Classroom

RS. 4500/month

- ✓ Up to 40 students
- ✓ Multi Student Management
- ✓ Feature Updates
- ✓ Ongoing Technical Support

For underprivileged families, the application will be provided with a **Highly Discounted Price.**

Budget

Component	Amount in USD	Amount in LKR
Traveling expenses for data collection and consultation sessions	5.00	1500.00
Software licenses and tools	25.00	7500.00
Data storage and cloud services	10.00	3000.00
Technical devices (e.g., diagnostic tools)	20.00	6000.00
Internet charges (development and technical learning)	10.00	3000.00
Technical consultation charges (external sessions and courses)	15.00	4500.00
Miscellaneous expenses	5.00	1500.00
Total	90.00	27000.00

Q
A

Thank You!