Early Prediction of Chronic Kidney Disease Using Machine Learning

Milestone 1: Project Initialization and Planning Phase

This project aims to create a machine learning model for early prediction of chronic kidney disease (CKD) in urban hospitals. By analyzing patient data with advanced algorithms, the model will improve upon current diagnostic methods that are often slow, leading to delayed detection. Traditional risk assessments may overlook subtle CKD indicators, but our approach seeks to uncover these patterns for quicker and more precise identification of at-risk patients. This tool will assist nephrologists in taking timely preventive actions, potentially enhancing patient outcomes. Key features include complex data analysis, seamless integration with hospital systems, and actionable insights for early intervention. By addressing the challenges of late detection, this project aims to significantly improve CKD management and patient care in urban hospital settings.

Activity 1: DefineProblem Statement

Problem Statement: As a nephrologist in a large urban hospital, identifying patients at high risk of developing chronic kidney disease (CKD) early is crucial. However, current diagnostic methods are time consuming and often lead to late detection. Traditional risk assessment may miss subtle patterns indicative of early-stage CKD, causing frustration and concern about missed opportunities for early intervention. Implementing machine learning algorithms to analyze patient data could potentially enable faster and more accurate identification of at-risk individuals, allowing for timely preventive measures and improved patient outcomes.

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Activity 2: ProjectProposal (Proposed Solution)

The project will focus on developing and implementing the machine learning system within the nephrology department of the urban hospital. It will include data collection, model development, testing, integration with existing systems, and training for healthcare providers.This concise proposal outlines a targeted solution to address the challenge of early CKD detection, potentially improving patient outcomes through timely intervention.

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Activity 3: Initial Project Planning

Initial Project Planning for the CKD prediction system in a large urban hospital involves defining objectives, scope, and stakeholders. It includes setting timelines, allocating resources, and determining the strategy for developing the machine learning model. The team establishes an understanding of available patient data, formulates analysis goals to address current CKD detection limitations, and plans the data processing workflow. This phase involves key nephrologists and identifies healthcare professionals who will use or benefit from the system. Effective planning ensures the development of a tool that can detect early-stage CKD patterns, enabling faster identification of at-risk patients and improving outcomes through timely interventions.

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Milestone 2: Data Collection and Preprocessing Phase

The Data Collection and Preprocessing Phase involves executing a plan to gather relevant medical data from Kaggle, ensuring data quality through verification and addressing missing values. Preprocessing tasks include cleaning, encoding, and organizing the dataset for subsequent exploratory analysis and machine learning model development.

Activity 1: Data Collection Plan, Raw Data Sources Identified, Data Quality Report

The dataset for "Early Prediction of Chronic Kidney Disease Using Machine Learning" is sourced from Skill wallet(Kaggle). It incorporates applicant details and medical data integrity metrics. Data quality is assured through meticulous verification, addressing missing values, and upholding ethical standards, establishing a dependable foundation for predictive modeling in healthcare.

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Activity 2: Data Quality Report

The dataset utilized for "Early Prediction of Chronic Kidney Disease Using Machine Learning" originates from Skill wallet (Kaggle), encompassing applicant particulars and metrics ensuring the fidelity of medical data. Thorough verification procedures guarantee data quality by rectifying missing values and adhering to ethical standards. This meticulous methodology establishes a dependable groundwork for predictive modeling in healthcare.

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Activity 3: Data Exploration and Preprocessing

Data Exploration involves analyzing the dataset to understand patterns, distributions, and outliers. Preprocessing includes handling missing values, scaling, and encoding categorical variables. These crucial steps enhance data quality, ensuring the reliability and effectiveness of

subsequent analyses in the disease prediction project.

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Milestone 3: Model Development Phase

The Model Development Phase entails crafting a predictive model for disease prediction. It encompasses strategic feature selection, evaluating and selecting models (Random Forest, Decision Tree, KNN, Logistic), initiating training with code, and rigorously validating and assessing model performance for informed decision-making in the lending process.

Activity 1: Feature Selection Report

The Feature Selection Report identifies three key predictors for the chronic kidney disease (CKD) model: Age, Albumin, and Sugar. Age was chosen for its strong correlation with CKD risk, Albumin as an indicator of kidney function, and Sugar for its link to diabetes, a major CKD contributor. Other features like ID, blood pressure, and various urine components were excluded due to redundancy or lack of specificity to CKD. This focused selection balances predictive power with model simplicity, ensuring efficient and accurate CKD risk assessment.

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Activity 2: Model Selection Report

The Model Selection Report details the rationale behind choosing Random Forest, Decision Tree, Logistic Regression, and KNN models for chronic kidney disease (CKD) prediction. It considers each model's strengths in handling complex relationships, interpretability, adaptability, and overall predictive performance, ensuring an informed choice aligned with project objectives.

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Activity 3: Initial Model Training Code, Model Validation and Evaluation Report

The Initial Model Training Code employs selected algorithms on the chronic kidney disease (CKD) dataset, setting the foundation for predictive modeling. The subsequent Model Validation and Evaluation Report rigorously assesses model performance, employing metrics like accuracy and precision to ensure reliability and effectiveness in predicting CKD outcomes. This process establishes a robust framework for early detection and risk assessment of chronic kidney disease, potentially improving patient care and management strategies.

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Milestone 4: Model Optimization and Tuning Phase

The Model Optimization and Tuning Phase involves refining machine learning models for peak performance. It includes optimized model code, fine-tuning hyperparameters, comparing performance metrics, and justifying the final model selection for enhanced predictive accuracy and efficiency.

Activity 1: Hyperparameter Tuning Documentation

The Random Forest model was further refined and selected for its superior performance, exhibiting high accuracy during hyperparameter tuning. Its ability to handle complex relationships, minimize overfitting, and optimize predictive accuracy aligns well with the project objectives. The model's ensemble approach, combining multiple decision trees, contributes to its robustness and generalization capabilities. Additionally, the Random Forest's built-in feature importance mechanism provides valuable insights into the most influential variables, enhancing the interpretability of the results. These characteristics, coupled with its outstanding predictive power, solidify the Random Forest as the ideal choice for our final model.

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Activity 2: Performance Metrics Comparison Report

The Performance Metrics Comparison Report contrasts the baseline and optimized metrics for our four models: Random Forest, Decision Tree, Logistic Regression, and K-Nearest Neighbors (KNN). This assessment provides a clear understanding of each model's predictive capabilities, both before and after hyperparameter tuning. The report specifically highlights the superior performance of the Random Forest model, which demonstrated the highest accuracy among all tested models. This comprehensive comparison enables us to quantify the improvements achieved through optimization and solidifies our decision to select the Random Forest as our final model for its exceptional predictive power.

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Activity 3: Final Model Selection Justification

The Random Forest model was selected for its outstanding 97% accuracy during hyperparameter tuning. Its ensemble approach excels at handling complex data relationships while reducing overfitting. The model's ability to provide feature importance rankings, coupled with its robust performance, aligns perfectly with the project's objectives for high predictive accuracy and interpretability.

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Milestone 5: Project Files Submission and Documentation

For project file submission in Github, Kindly click the link and refer to the flow.

Click Here

Milestone 6: Project Demonstration

In the upcoming module called Project Demonstration, individuals will be required to record a video by sharing their screens. They will need to explain their project and demonstrate its execution during the presentation.

https://drive.google.com/file/d/16C7s8MnfHsK5ZJSi7GgrJbgSs4WJSmVj/view?usp=sharing