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Heart Attack Types Classification Using Machine Learning

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ABSTRACT: Heart attacks and other cardiovascular illnesses continue to be the leading cause of death globally. Deciding who is at risk for a heart attack and taking appropriate prophylactic action are essential for better patient care. MRI data may now provide a comprehensive assessment of cardiac anatomy, function, and tissue qualities thanks to the development of advanced imaging techniques and machine learning algorithms. This enables the early detection of minute abnormalities connected to impending heart attacks. The objective behind the proposed research is to combine state-of-the-art predictive models with MRI-derived data to build a dependable and accurate heart attack prediction system. To ensure that identify complicated patterns that traditional risk assessment methods could miss, the work uses a broad dataset that includes anonymized MRI scans, clinical histories, and patient outcomes. The paper outlines several key tactics for accomplishing this objective. Preprocessing techniques are first employed to ensure data uniformity and quality across the MRI scans. Next, relevant metrics are extracted from the MRI data for scar tissue presence, tissue perfusion, cardiac thickness, and ventricular sizes. The predictive model's training and assessment phases are built around these features. To make the model more robust, clinical variables such as sex and age, blood pressure, cholesterol, and family history are added.

KEYWORDS: Imaging techniques, MRI, Machine Learning, Heart attack.

I. INTRODUCTION

Thanks to advances in medical imaging and machine learning, it is now possible to predict and detect heart-related disorders early on, which has revolutionized the field of cardiovascular healthcare. Magnetic resonance imaging (MRI) is among these; it offers detailed insights into the anatomy and physiology of the heart and has grown as a potent diagnostic tool. The methodology presented in this research employs MRI data to produce a detailed risk assessment for heart attacks through a series of sequential steps. The foundation of this study was the assembly of a sizable and diverse dataset from Kaggle, a library of anonymized MRI scans from an assortment of individuals. Because these images display the intricate features of heart architecture, they are an invaluable resource for the advancement of prediction models.

A thorough classification framework founded on varying degrees of heart attack risk is applied to the raw dataset's images. Several clinical factors, such as patient history, demographics, and outcomes, are used in this classification method. The ensuing model's ability to precisely differentiate between several risk groups is a result of the data's classification. The third and most crucial stage is building a trustworthy training data model. This is accomplished by using neural networks with convolutions (CNNs) with deep learning, like VGG16 or VGG19. These pre-trained architectures, which are well-known for their capacity for photo categorization, are refined by using 80% of the training dataset and 20% for testing. The model becomes more sensitive to features necessary for heart attack prediction as a consequence of this iterative process.

At the heart of the predictive model's efficacy is its ability to identify important features in MRI images. During this intricate process, signals are sent back and forth via the model's layers. This technique, also known as feed forward and back propagation, creates a feature map matrix that captures the intricate patterns typical of cardiac problems. The outcome of training is a trained model that integrates the knowledge acquired from the collection. This particular model is contained within a h5 file, a repository of learned weights and architecture. This file serves as an essential resource

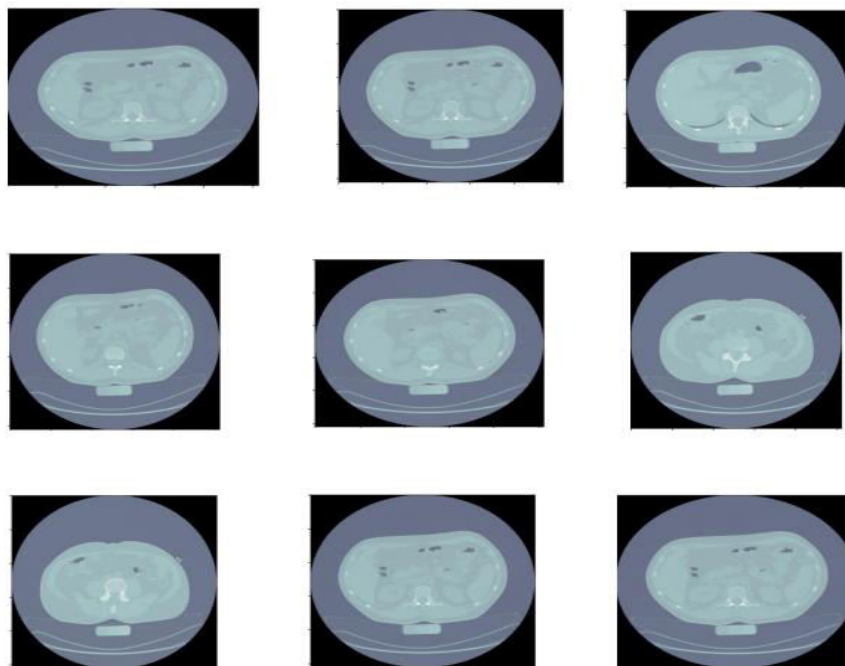
for anyone attempting to forecast the future. First, a test image depicting a heart attack case is provided to assess the model's prediction capabilities.

II. PROPOSED SYSTEM

The creation of a deep learning-based system for the accurate categorization of heart diseases from magnetic resonance imaging (MRI) images is the primary goal of the project. To enhance patient care, The aim is to create a reliable, automated technology that helps physicians detect cardiac problems. Architecture will be utilized since CNNs have shown to perform superbly in image classification applications. To demonstrate their accuracy, we'll also employ other algorithms.

The system will be trained using a labeled dataset of magnetic resonance imaging (MRI) images that covers an assortment of cardiac diseases, such as NSTEMI, stable angina, unstable angina, and coronary artery spasm (Prinzmetal's angina). The dataset will be preprocessed using methods including scaling, normalization, and augmentation in order to increase the robustness of the model. The following action is to build the model, which will combine many convolutional layers, pooling layers, and fully connected layers to extract relevant information from MRI (magnetic resonance imaging) pictures and identify patterns that are able to differentiate between different heart conditions.

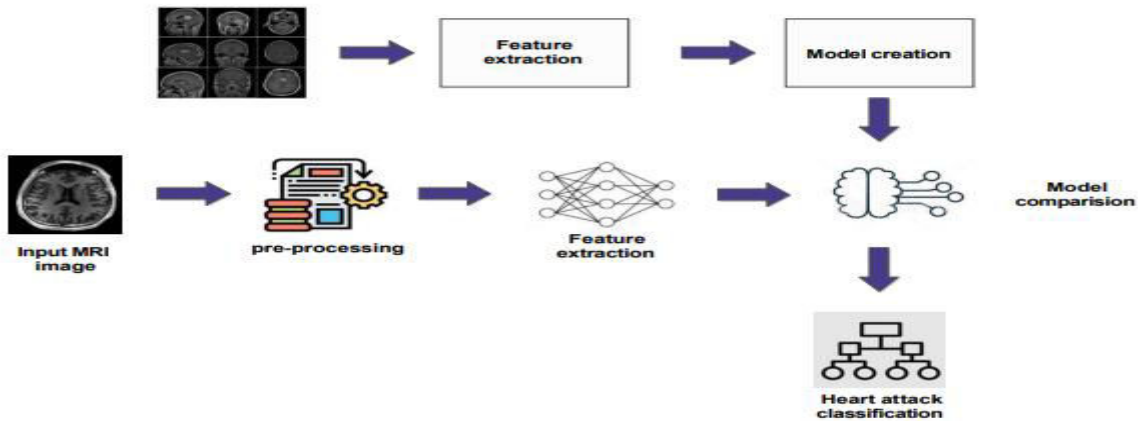
III. DATASET



IV. SYSTEM ARCHITECTURE

The heart attack classification system processes and classifies medical pictures quickly using a hierarchical architecture. Using user-uploaded photos, several operations are completed, beginning with image preparation to enhance quality and standardize formats. Next, using image segmentation, the cardiac region is isolated, and feature extraction is accustomed to retrieve significant attributes. In a model comparison phase, Different machine learning models are compared to see that is the most effective. The chosen Heart Attack Model is then trained on the obtained information to differentiate between heart attack and non-heart attack cases. Numerous datasets are employed in validation, which gives the model resiliency. The comprehension of results is made easier by visualization tools.

This architecture allows medical specialists to make well-informed decisions fast and ensures a logical progression from raw data to accurate classification. It emphasizes modularity and adherence to privacy rules around medical data, which eventually leads to a reliable diagnostic tool.



V. IMPLEMENTATIONS

We used the Visual Studio Code IDE to write Python code in order to carry out our investigation. Python is a high-performance language used in technical computing. Here, basic mathematical notations and functions are employed to explain the problems and their answers. Dimensions are not necessary because the fundamental data type is an array. The Python libraries enable us to research and use specific technologies. Python libraries are collections of Python functions that offer tools and interfaces to solve specific kinds of problems. Python offers functions, data structures, input/output, control flow statements, and object-oriented programming tools. It enables the utilization of both small and large programming to create intricate, feature-rich application applications. This project uses a amount of functions from the Python libraries.

Used Algorithms:

1. CNN

Deep learning algorithms such as The primary application of convolutional neural networks (CNNs) is in image processing. and recognition applications. It has demonstrated outstanding success across several computer vision applications, such as object identification, image classification, and segmentation. It is inspired by the visual processing mechanism from the human brain.

Step 1: Dataset Preparation

Step 2: Model Architecture

Step 3: Model Training

Step 4: Model Evaluation

Step 5: Fine-tuning and Architecture Exploration

2. KNN

KNN (K-Nearest Neighbors) is not frequently used for picture classification tasks like the one described in the general context, in contrast to CNN (Convolutional Neural Network).

A simple and easy-to-understand tool for regression and classification applications is the KNN algorithm. It functions on the tenet those data points that exhibit comparable properties are probably members identical to class. Since KNN ignores the spatial patterns and hierarchical information present in pictures, which are essential for accurate image identification, it would not be instantly applicable in the classification of magnetic resonance imaging-related cardiac disease (MRI).

Step 1: Data Collection and Preparation

Step 2: Choose the Value of K

Step 3: Distance Calculation

- Step 4: Identify K Nearest Neighbors
- Step 5: Determine the Majority Class
- Step 6: Classification
- Step 7: Model Evaluation

3. VGG16 and VGG19

The specialized CNN architectures VGG16 and VGG19 were created by the University of Oxford's Visual Geometry Group (VGG). These designs are widely applied to image classification tasks, including the medical field's usage of magnetic resonance imaging (MRI) to classify heart problems.

With transfer learning, a VGG16 or VGG19 already-trained model that was developed using large image dataset (such as ImageNet) can be improved for the particular cardiac illness dataset. By using this technique, the model may use its comprehension of ImageNet's low-level features to categorize heart illnesses.

Fine-tuning a pre-trained VGG model can be particularly useful when there's a limited amount of training data available, as it already possesses a robust collection of learned features. To sum up, the CNN designs VGG16 and VGG19 are useful for categorizing magnetic resonance imaging (MRI) in heart illness.

VGG16

- Step 1: Load and preprocess the data
- Step 2: Load the VGG16 model without the top classification layer
- Step 3: Add custom classification layers on top of VGG16
- Step 4: Compile the model
- Step 5: Train the model
- Step 6: Evaluate the model

VGG19

- Step 1: Load and preprocess the data
- Step 2: Load the VGG19 model without the top classification layer
- Step 3: Add custom classification layers on top of VGG19

4. RNN

Recurrent neural networks (RNNs) have shown enormous promise in processing MRI image datasets, particularly when working with sequential or temporal data. RNNs' sequential structure and the way MRI data is stored as a series of images over time are complementary by nature. The procedure often begins with data preprocessing, which entails actions like scaling, normalization, and sequence arrangement to capture the temporal element of the data.

Regarding model construction, each MRI picture can have its spatial properties extracted using a combination of 2D and 3D Convolutional Neural Networks (CNNs), and sequence analysis can then be performed using RNNs. The choice is depending on the specific task and the dataset's characteristics. Labeled data may be used, along with an appropriate loss function and Backpropagation Through Time (BPTT) for gradient updates, to enable supervised learning during training.

- Step 1: Data Preprocessing
- Step 2: Data Sequencing
- Step 3: Data Splitting
- Step 4: RNN Architecture
- Step 5: Model Training
- Step 6: Model Evaluation
- Step 7: Post-processing
- Step 8: Deployment (Optional)
- Step 9: Monitoring and Maintenance (Optional)

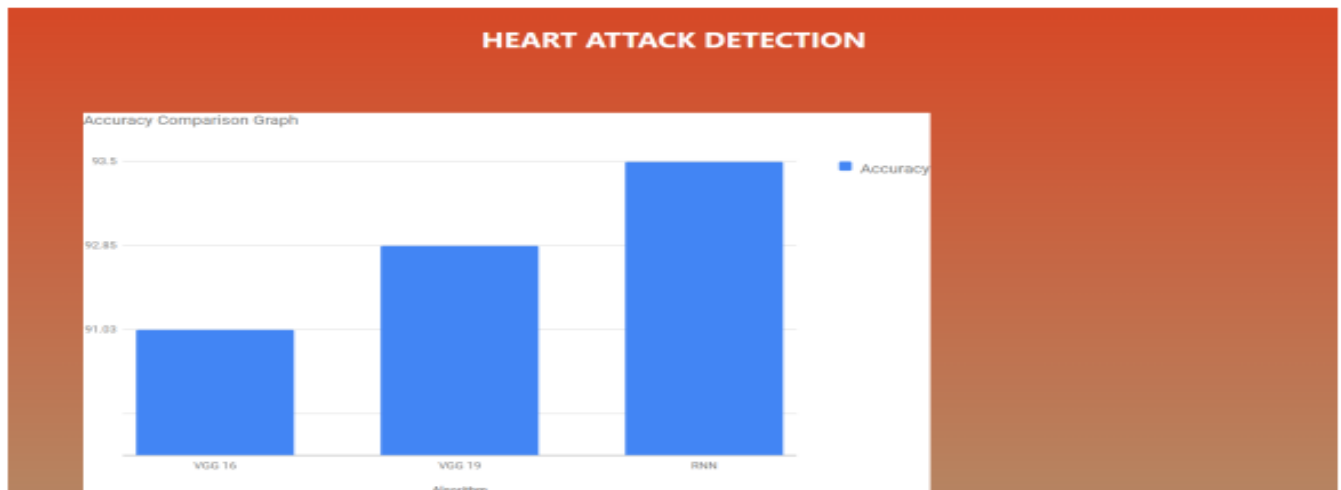
Example code for some of these steps:

- Step 1: Data Preprocessing
- Step 2: Data Sequencing
- Step 3: Data Splitting
- Step 4: RNN Architecture
- Step 5: Model Training
- Step 6: Model Evaluation
- Step 7: Post-processing

Step 8 and 9: Deployment, Monitoring, and Maintenance

VI. RESULTS

Since researching various kinds of heart attacks and developing a method to recognize and anticipate them are the goals of the effort. Understanding the dataset and identifying an effective machine learning algorithm are essential for developing the system. The machine learning algorithm should be able to accurately anticipate the types of heart attacks, learn from them, and perform as expected precisely rate of 93.22%.The top machine learning algorithm for our task is the neural network with recurrent architecture algorithm since it uses the majority vote of the decision trees for both prediction and classification. When 80% of the data was utilized for education and the remaining 20% for model testing, this accuracy score could be reached.



Graph : Accuracy score of each Algorithms.

Algorithm	Train Size(in %)	Test Size(in %)	Accuracy(in %)
Recurrent Neural Network	80	20	93.3
VGG 16	80	20	92.85
VGG 19	80	20	91.03

Table 1: Accuracy Score of each Algorithms.

VII. FUTURE ENHANCEMENT

The completion of the MRI-based heart attack prediction system, which offers a ground-breaking solution that combines state-of-the-art technology with sophisticated medical imaging, marks a significant turning point within the domain of cardiac healthcare. This technique combines data collection, model creation, feature extraction, and clinical prediction in a methodically organized process that has the potential to completely transform the way heart attacks are recognized, assessed, and treated. The laborious first step during the procedure is obtaining a diverse a Kaggle dataset encompassing a variety of cardiac conditions. Being the basis for subsequent stages, this dataset ensures the system's availability of a large quantity of data required for validation and training. The meticulous creation within the dataset, which was organized according to multiple classes, suggests a methodical way to fully address different heart attack risk levels. The system's brain, or training data model is built utilizing the potent VGG16, VGG19, and RNN

architectures. This model learns intricate cardiac features through the utilization of convolutional neural networks and extensive data processing. By integrating an 80% training to 20% testing data ratio, the model ensures robust and reliable predictive abilities. This highlights the significance of validation. To ensure that validation matches real-world applications, users must have access to a test image that represents a heart attack situation. The system is able to better capture the range of features found in cardiac photos utilizing a few feature extraction techniques, such as edge detection, color histograms, and GLCM. The system's accuracy is validated through comparison with the h5 model, emphasizing its diagnostic capabilities.

VIII. CONCLUSION

Future developments in machine learning-based heart attack type classification could greatly boost patient outcomes, diagnostic precision, and healthcare economy. Researchers may create complex models that analyze massive datasets from wearable technology, medical imaging, and electronic health records (EHR) by utilizing cutting-edge approaches like deep learning. These algorithms may be trained to recognize minute patterns and correlations in patient data, which makes it possible to precisely classify the many types of heart attacks and detect them early. Adding NLP, or natural language processing, can enhance the system even more by searching for new insights in unstructured data and clinical notes. Incorporating explainable AI (XAI) methods will also guarantee an interpretable and transparent decision-making process, which will promote patient and healthcare provider trust. These models can adapt to new medical discoveries and shifting patient demographics over time thanks to continuous learning mechanisms made possible by feedback loops and real-time data integration. Working together with interdisciplinary teams and cardiologists will be crucial to validating and improving these machine learning systems and making sure they are stable, dependable, and compliant with clinical best practices.

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