19CSE445 - CLOUD COMPUTING

ASSIGNMENT 3

TEAM – 16

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PROJECT TITLE : Cloud-Based Medical Imaging Diagnosis Platform

Abstract

The proposed project aims to develop a Cloud-Based Medical Imaging Diagnosis Platform leveraging AWS cloud services to provide an automated, secure, and efficient diagnostic tool for analyzing medical images.The platform will make use of deep learning models to allow users to upload and manage imaging data, obtain real-time analysis, and guarantee conformity to healthcare regulations. It has been designed to be an affordable option that improves diagnostic precision and helps medical staff provide prompt patient care.

It involves AWS Cognito for user authentication, deep learning models on AWS SageMaker for real-time diagnostic analysis, and an easy-to-use interface for uploading images. Ensuring data privacy and security, the platform is built to be HIPAA-compliant with AWS CloudWatch for performance monitoring and AWS S3 for secure data management.

The platform's goal is to be as economical as possible, so it makes use of the AWS Free Tier to reduce running costs. It also has plans to add more analysis power, healthcare professional collaboration features, and mobile access in the future to increase its usefulness and accessibility. This scalable solution represents a significant advancement at the nexus of cloud computing and healthcare, as it aims to support timely patient care in addition to improving diagnostic accuracy.

Objectives

1. Develop a secure, cloud-based platform for medical imaging analysis utilizing AWS services.
2. Implement a user-friendly interface for healthcare professionals and patients to upload and manage medical images.
3. Deploy deep learning models on AWS SageMaker for accurate and automated image diagnosis.
4. Ensure data privacy and security, complying with healthcare regulations like HIPAA.
5. Provide real-time feedback and visualizations of the analysis to assist in medical diagnosis.
6. Establish a monitoring system using AWS CloudWatch for performance tracking and operational logging.
7. Create an administrative dashboard for user management and system oversight.

Problem Formulation

1. Define the scope of medical imaging modalities (e.g., CT, MRI) the platform will support.
2. Identify the deep learning model architectures suitable for medical image classification and anomaly detection.
3. Determine the data privacy requirements and compliance measures necessary for healthcare data.
4. Establish the system's scalability and performance metrics, aligning with AWS Free Tier limitations.
5. Formulate the user interaction flow for image uploading, analysis retrieval, and feedback provision.

Expected Outcomes

1. A fully functional prototype that demonstrates the feasibility of cloud-based medical imaging analysis.
2. A set of reliable deep learning models, trained and validated, with a focus on at least one type of medical imaging modality.
3. Compliance with HIPAA and other relevant regulations, ensuring user data is handled securely.
4. User feedback and system performance data that indicate high accuracy and usability of the platform.
5. Documentation and guidelines for system usage, expansion, and future development plans.

Work done so far:

1) Data Collection and Preprocessing

- **Dataset Acquisition**: Sourced a dataset comprising CT scan images labeled for the presence of lung cancer.
- **Data Cleaning**: Removed corrupt and non-uniform images to ensure data quality.
- **Preprocessing**: Implemented normalization and augmentation techniques to prepare the dataset for training the deep learning model.

2) Model Development

- **Model Selection**: Researched and selected a deep learning architecture suitable for image classification tasks, with a focus on convolutional neural networks (CNNs).
- **Model Training**: Initiated the training of the selected model using the preprocessed dataset, leveraging transfer learning techniques to improve learning efficiency.
- **Hyperparameter Tuning**: Conducted a series of experiments to fine-tune the model's hyperparameters, aiming to optimize performance.

Societal Impact

The societal impact of a Cloud-Based Medical Imaging Diagnosis Platform utilizing deep learning and AWS cloud services is multifaceted, with significant implications for healthcare accessibility, diagnosis accuracy, patient outcomes, data security, and healthcare costs.

Healthcare Accessibility and Efficiency

- **Global Reach**: By leveraging the cloud, this platform can make advanced diagnostic tools available to healthcare providers regardless of geographical location, potentially democratizing access to state-of-the-art medical image analysis.
- **Speed of Diagnosis**: The use of automated deep learning models for image analysis can significantly reduce the time between imaging and diagnosis, leading to faster treatment decisions.

Diagnosis Accuracy and Patient Outcomes

- **Enhanced Diagnostic Accuracy**: Deep learning models, especially when trained on large and diverse datasets, can potentially match or exceed the accuracy of human radiologists in identifying pathologies, which could lead to more accurate diagnoses.
- **Early Detection**: The ability of deep learning models to detect subtle patterns in medical images may facilitate the early detection of diseases such as cancer, improving patient outcomes.

Data Security and Patient Privacy

- **Data Privacy**: With stringent data security measures in place and compliance with healthcare regulations such as HIPAA, patients' privacy can be adequately protected while utilizing the cloud platform.
- **Trust in Technology**: As the platform shows its reliability and security, it can foster greater trust among patients and healthcare providers in using technology for sensitive health information.

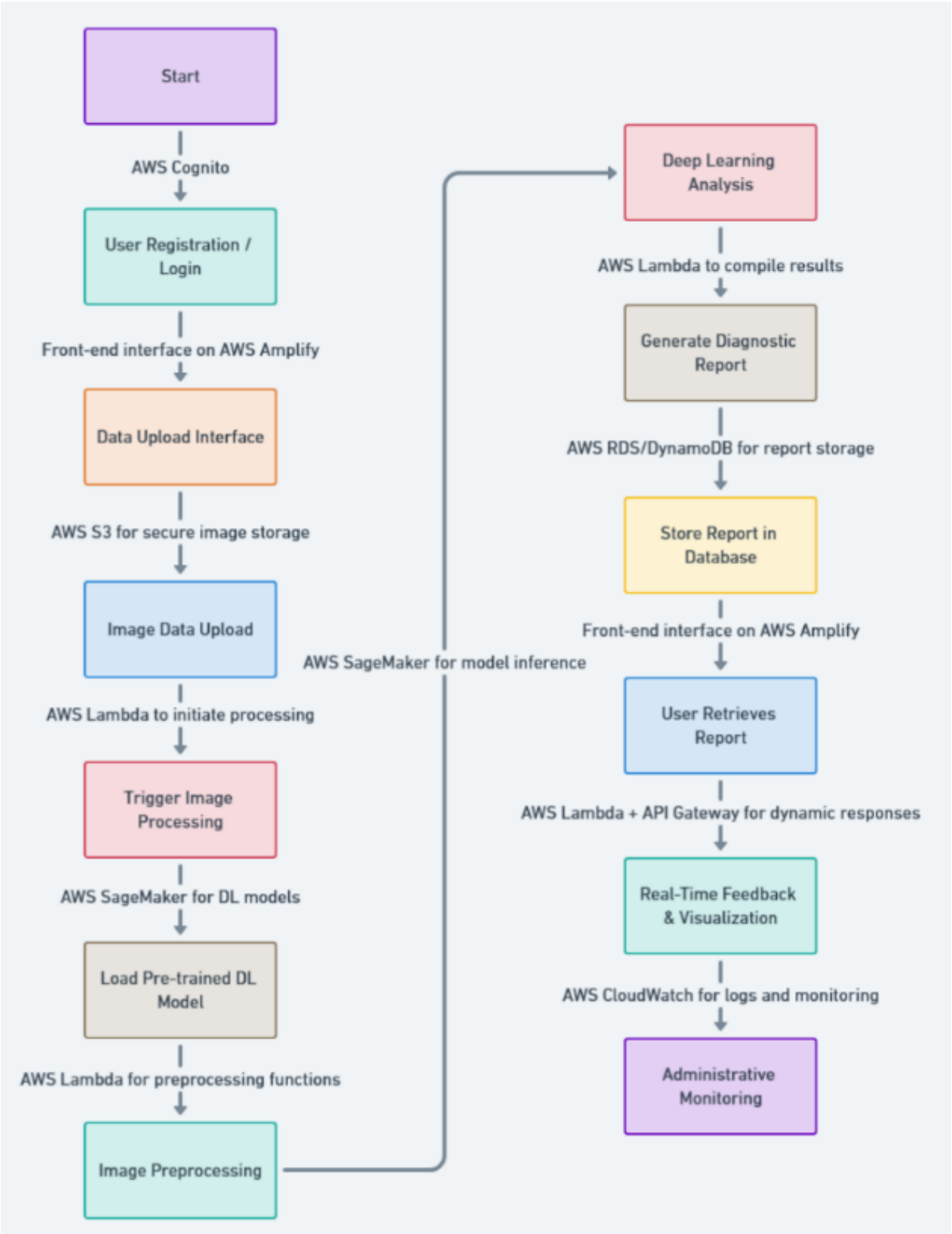
Cost-Effectiveness and Resource Allocation

- **Reduced Healthcare Costs**: Automating part of the diagnostic process can lower costs associated with medical imaging analysis, which might translate into savings for patients and healthcare systems.
- **Resource Optimization**: By aiding radiologists and reducing the time required for image analysis, the platform can help optimize healthcare resources, allowing medical professionals to focus on patient care rather than routine image reviews.

Education and Research

- **Educational Tool**: The platform can serve as a learning aid for medical students and trainees, providing them with a vast array of case studies and the opportunity to compare their diagnostic skills against the deep learning models.
- **Research Advancement**: With the accumulation of imaging data and diagnostic results, the platform could become a valuable research tool for furthering medical knowledge and improving diagnostic algorithms.

Approach and Methodology:



1) **User Registration/Authentication**:
    - AWS Cognito for secure user sign-up/sign-in.
2) **Image Data Upload**:
    - AWS S3 for storing medical images securely.
3) **Data Management**:
    - AWS Lambda for data processing and orchestration.
4) **Image Processing**:
    - AWS SageMaker for running deep learning models.
5) **Analysis and Feedback**:
    - AWS Lambda and AWS API Gateway for real-time results presentation.
6) **Data Security**:
    - AWS KMS for key management and encryption.
7) **Performance Monitoring**:
    - AWS CloudWatch for system health checks and logging.
8) **Administrative Dashboard**:
    - AWS Amplify combined with AWS Lambda and S3 for dashboard functionalities.

References

[1] Y. Pan, M. Fu, B. Cheng, X. Tao and J. Guo, "Enhanced Deep Learning Assisted Convolutional Neural Network for Heart Disease Prediction on the Internet of Medical Things Platform," in IEEE Access, vol. 8, pp. 189503-189512, 2020, doi: 10.1109/ACCESS.2020.3026214.

[2] W. Lie, B. Jiang and W. Zhao, "Obstetric Imaging Diagnostic Platform Based on Cloud Computing Technology Under the Background of Smart Medical Big Data and Deep Learning," in IEEE Access, vol. 8, pp. 78265-78278, 2020, doi: 10.1109/ACCESS.2020.2988563.

[3] F. Milletari, J. Frei, M. Aboulatta, G. Vivar and S. -A. Ahmadi, "Cloud Deployment of High-Resolution Medical Image Analysis With TOMAAT," in IEEE Journal of Biomedical and Health Informatics, vol. 23, no. 3, pp. 969-977, May 2019, doi: 10.1109/JBHI.2018.2885214.

[4] S. Y. Siddiqui et al., "IoMT Cloud-Based Intelligent Prediction of Breast Cancer Stages Empowered With Deep Learning," in IEEE Access, vol. 9, pp. 146478-146491, 2021, doi: 10.1109/ACCESS.2021.3123472.