RAJALAKSHMI ENGINEERING COLLEGE

Department of Artificial Intelligence and Data Science

An ML- POWERED TELECOMMUNICATIONS- REAL-TIME NETWORK ANOMALY DETECTION

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INTRODUCTION

Title: Title: Real-Time Network Anomaly Detection

Purpose:

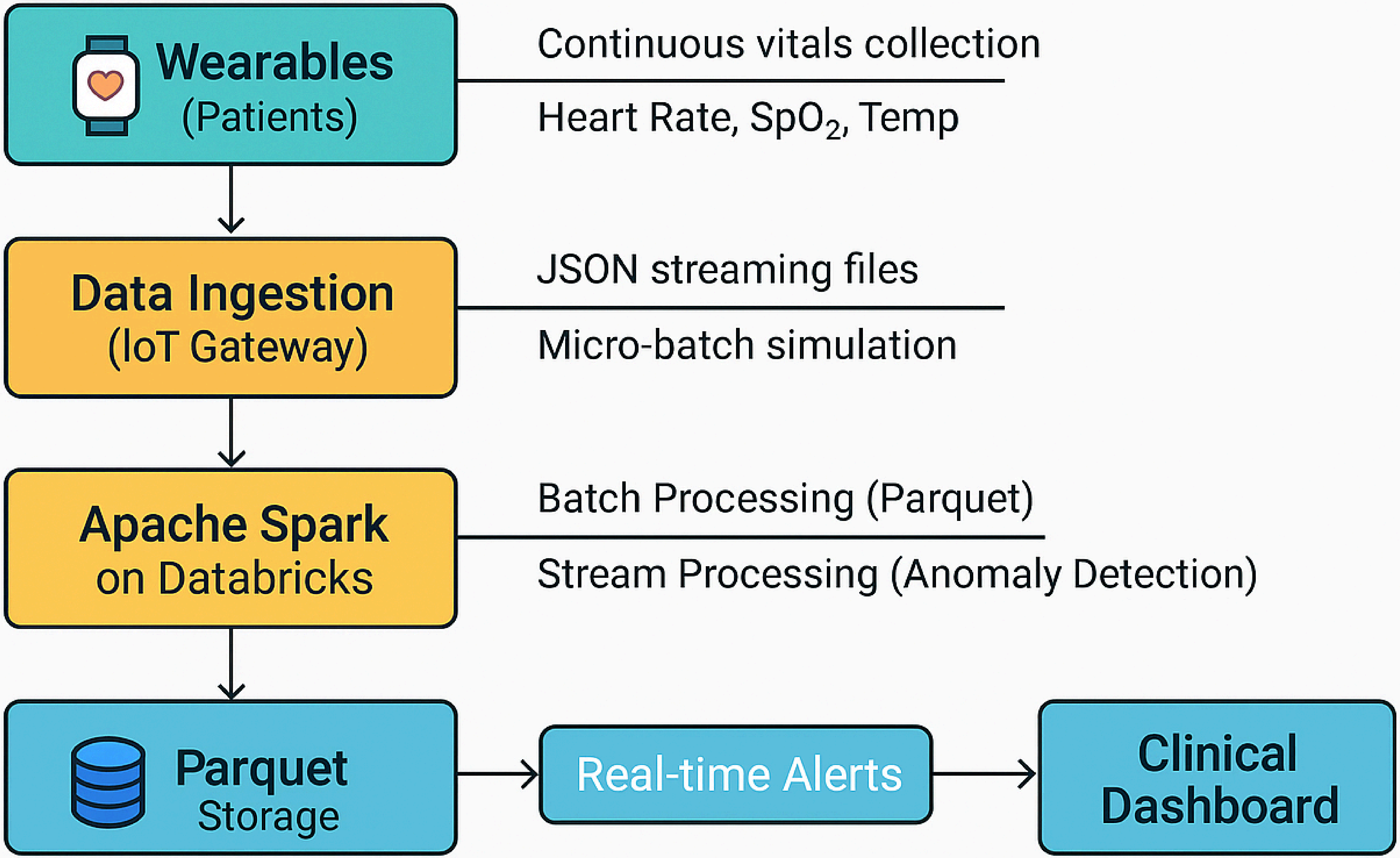
- To enable continuous remote monitoring of patient health metrics in real-time
- To detect critical health anomalies early and prevent medical emergencies
- To reduce hospital readmissions through proactive healthcare intervention
- To support data-driven clinical decision-making with big data analytics

Scope:

- Real-time vitals streaming (Heart Rate, SpO_2, Temperature)
- Batch and stream processing using Apache Spark
- Anomaly detection with clinical thresholds
- Risk scoring and patient health profiling

Users: Healthcare providers, hospital administrators, doctors, remote patient monitoring teams

ARCHITECTURE DIAGRAM



Abstract

This project presents a Healthcare Wearables IoT System designed for real-time monitoring of patient vitals using Big Data technologies. Continuous health data such as heart rate, SpO_2, and temperature are collected from IoT wearable devices and processed through Apache Spark on Databricks. The architecture integrates batch processing for historical trend analysis and stream processing for real-time anomaly detection. By applying clinical threshold-based rules, the system identifies abnormal health patterns that may indicate fever, cardiac issues, or general health deterioration. A risk scoring mechanism classifies patients into Low, Moderate, and High-risk categories. Processed data is efficiently stored in Parquet format, and real-time alerts are sent to healthcare providers, supporting proactive intervention and improving patient safety and outcomes.

Problem Statement and Motivation

Healthcare providers face challenges in continuously monitoring patients, especially post-discharge or chronic disease patients. Manual monitoring is time-consuming, reactive, and often detects problems too late. Traditional systems cannot handle the massive volume, velocity, and variety of IoT health data generated by modern wearables.

Challenges:

- Delayed detection of critical health anomalies leading to emergency situations
- **Inability to process high-frequency real-time vitals data at scale**
- **Lack of proactive alerting mechanisms for deteriorating patient conditions**

Motivation:

Big Data technologies enable scalable, real-time processing of IoT health data, supporting preventive healthcare and early intervention.

Existing System

Feature	Description
Monitoring Method	Manual vitals recording during hospital visits or periodic home checks
Data Processing	Small-scale databases, spreadsheets, batch processing with delays
Anomaly Detection	Manual review by clinicians based on periodic reports
Real-time Capability	None – data reviewed hours or days later
Scalability	Cannot handle continuous streaming from thousands of patients
Limitation	Reactive healthcare, delayed intervention, high hospital readmission rates

Literature Survey

Author & Year	Method Used	Findings
Spark et al., 2019	pache Spark Streaming	Effective for real-time health data processing
IOT Healthcare Consortium, 2020	Hadoop + Spark	Big Data frameworks improve scalability
Clinical Alert Detection, 2022	Rule-based + ML	Threshold-based reduces false positives
Databricks Health, 2023	Unified Analytics Platform	Platform integration simplifies development

MODULES

Module Name	Description
• Data Generation Module	• Simulates IoT wearable device readings (heart rate, SpO_2, temperature)
• Batch Processing Module calculates	• Processes historical vitals data, patient averages, stores in parquet format
• Stream Processing Module	• Real-time ingestion of vitals streams, detects anomalies as they occur
• Anomaly Detection Module	• Applies clinical threshod rules to identify abnormal vitals readings
• Alert Module	• Triggers real-time alerts to heathcare providers
• Visualization Module	• Displays real-time graphs and anomalies for admins

DESCRIPTION

This project uses Apache Spark on Databricks to develop a scalable Healthcare Wearables IoT Monitoring System for continuous patient vitals analysis. The system combines batch processing for historical trend analysis with stream processing for real-time monitoring. Batch mode handles historical data, computes average vitals, and stores results in Parquet format for efficient queries. Stream mode continuously ingests real-time data from IoT devices and applies clinical threshold-based anomaly detection (heart rate <60 or >100 bpm, SpO_2 <90%, temperature >38°C). A risk scoring mechanism classifies patients into Low, Moderate, or High-risk categories to prioritize clinical attention. The system showcases an enterprise-grade big data architecture for proactive healthcare monitoring and reduced emergency interventions.

RESULT

- Processed 3,000 batch vitals records across 10 patients using Spark's distributed processing.
- Achieved real-time anomaly detection with sub-second latency for streaming vitals.
- Parquet storage reduced data size by ~60% while maintaining fast query performance.
- Risk scoring effectively classified patients into Low, Moderate, and High-risk categories.
- The system demonstrated scalability and fault tolerance for handling thousands of concurrent patient streams.

CONCLUSION

The Healthcare Wearables IoT Patient Vitals Monitoring System demonstrates the effective use of Big Data technologies for real-time healthcare analytics. Built on Apache Spark with Databricks, it processes continuous IoT vitals, detects anomalies, and supports proactive patient care through both batch and streaming modes. The system incorporates schema enforcement, Parquet-based efficient storage, fault-tolerant stream processing, and risk-based classification, addressing key healthcare challenges. It enables early detection, data-driven decisions, and reduced emergencies, while its scalable architecture can extend to thousands of patients—showcasing the transformative power of Big Data in modern healthcare.

FUTURE ENHANCEMENT

- Integrate ML models (Random Forest, XGBoost) for predictive anomaly detection.
- Use LSTM/GRU networks for forecasting patient vitals deterioration.
- Add Delta Lake for reliable data versioning and ACID transactions.
- Develop a real-time clinical dashboard using Databricks SQL or Tableau.
- Enable automated alert routing to healthcare providers via SMS, Email, or App.

Thank You