Khelem: AI/ML-Driven Healthcare Optimization in Burkina Faso

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Abstract

Khelem proposes an AI/ML framework to enhance healthcare efficiency in Burkina Faso, a country burdened by long patient wait times, resource misallocation, and limited real-time decision-making. Leveraging both publicly available healthcare datasets and real-time data from local hospitals, our solution uses supervised learning techniques to predict patient inflows and guide resource allocation. This proposal outlines the project's background, where inadequate healthcare infrastructure and low physician-to-patient ratios exacerbate delays and inefficiencies. Prior studies [1], [2], [3] reveal that existing models fail to address real-time adaptability in low-resource settings. Our neural network model, which classifies patient inflows as low, medium, or high, aims to reduce wait times by 20% and improve service delivery. The scalable design of Khelem promises not only to optimize current hospital operations but also to lay the groundwork for a national transformation of healthcare management. (150 words)

Introduction and Motivation

Burkina Faso's healthcare system is challenged by severe resource constraints, with a physician-to-patient ratio of approximately 1:10,000 and chronic overcrowding. This project emerges against a backdrop of persistent inefficiencies where manual scheduling and outdated records hinder effective care delivery. Globally, machine learning has revolutionized healthcare—enabling predictive analytics for patient flow and optimized resource use. Khelem adapts these innovations to a low-resource environment by integrating heterogeneous data sources, thereby providing real-time insights to alleviate delays and improve patient outcomes. The societal impact is significant: improved healthcare efficiency can enhance public health and economic productivity, ultimately saving lives.

Problem Statement

Despite successful ML applications in resource-rich settings, models developed by Rahman et al. [1], Johnson and Smith [2], and Okafor et al. [3] fail to address the dynamic, real-time

challenges of low-resource environments like Burkina Faso. These studies depend on structured digital data and overlook the necessity of integrating manual records prevalent in developing countries. Khelem addresses these gaps by designing a model that combines digital and manual data sources, offering a more accurate prediction of patient inflows and enabling adaptive resource allocation in real time.

Aim

To design and implement an AI/ML solution that predicts patient inflows and optimizes resource allocation, thereby enhancing healthcare delivery in Burkina Faso.

Objectives

1. **Develop a Supervised ML Model:**
   Achieve at least 85% accuracy in classifying patient inflows (low, medium, high) within six months.

2. **Design a Neural Network Architecture:**
   Construct a model with an input layer covering 10 features, two hidden layers (64 and 32 neurons respectively), and a softmax-based output layer.

3. **Integrate Diverse Data Sources:**
   Merge public healthcare datasets with real-time hospital logs to improve data quality and model predictions.

4. **Pilot Implementation:**
   Implement the system in select healthcare facilities, targeting a 20% reduction in patient wait times within 12 months.

Project Scope

Khelem is focused on a pilot deployment in a limited number of healthcare facilities in Burkina Faso. The project covers:

- **Data Collection:** Acquisition of data from public sources (e.g., WHO, World Bank) and local hospital records.

- **Model Development:** Application of supervised learning techniques for patient inflow prediction.

- **Technological Considerations:** Addressing challenges in data digitization and integration with existing hospital systems.

- **Impact Domains:** Enhancing healthcare efficiency, improving patient experiences, and reducing administrative burdens. The project is designed to be completed within a half-trimester pilot phase, setting measurable milestones for subsequent scalability.

Solution Design

Data Sources and Infrastructure

- **Data Sources:**

    1. Public healthcare datasets (e.g., World Bank, WHO).

    2. Real-time hospital logs from local healthcare facilities.

- **Tools and Infrastructure:**
  Python, TensorFlow, Keras, and scikit-learn for model development; Pandas and NumPy for data preprocessing; and cloud platforms (Google Cloud or AWS) for scalable computation.

ML Pipeline Diagram (Overview)

1. **Data Ingestion:**
   Gather and consolidate data from public sources and hospital logs.

2. **Preprocessing:**
   Perform cleaning, normalization, and feature engineering on heterogeneous data.

3. **Model Training:**
   Train a neural network with:

    - **Input Layer:** 10 features.

    - **Hidden Layers:** 64 neurons (ReLU) followed by 32 neurons (ReLU).

    - **Output Layer:** 3-class classification (low, medium, high) using softmax.

4. **Prediction & Decision Support:**
   Use model outputs to generate actionable scheduling and resource allocation recommendations.

5. **Deployment:**
   Integrate the AI system with hospital management systems for real-time operation.

References

[1] M. M. Rahman, R. Smith, and O. Adegbite, "Machine Learning for Predicting Patient Admissions in Resource-Constrained Healthcare Systems," *IEEE Access*, vol. 9, pp. 125678-125690, 2021.
[2] J. Johnson and R. Smith, "Automated Hospital Scheduling Systems Using AI: Challenges and Innovations," *Journal of Healthcare Informatics*, vol. 7, no. 4, pp. 205-218, 2020.
[3] C. Okafor, D. Lee, and A. Patel, "AI-Driven Resource Optimization in Developing Healthcare Systems," *International Journal of Medical AI Research*, vol. 11, no. 2, pp. 55-69, 2022.

Appendices

Lean Canvas

Lean Canvas for Khelem

- **Problem:**
  - Inefficient patient scheduling and resource allocation
  - High wait times and suboptimal resource usage
  - Competitors: Manual scheduling systems and outdated digital records
- **Solution:**
  - An AI/ML model that predicts patient inflows by integrating digital and manual data
  - Real-time recommendations for optimized resource allocation

    - **Unique Value Proposition:** Empowering Burkina Faso's healthcare with real-time, data-driven insights that reduce wait times and improve efficiency.

- **Customer Segments:**
    - Government healthcare departments
    - Urban hospitals seeking operational improvements
    - Pilot facilities ready for digital transformation
- **Revenue Streams:**
    - Licensing fees, subscription models, and government grants
- **Key Metrics:**
    - Prediction accuracy (≥85%), 20% reduction in wait times, adoption rates
- **Channels:**
    - Direct engagement via government initiatives and partnerships, digital marketing
- **Cost Structure:**
    - Development, integration, pilot deployment, and recurring maintenance
- **Unfair Advantage:**
    - Proprietary integration of diverse data sources tailored for low-resource settings and early strategic partnerships