# **MediCare AI – Project Report**

## **Abstract**

MediCare AI is a hybrid machine learning-based medical recommendation system designed to provide personalized treatment recommendations using patient symptoms and medical history. It combines advanced NLP (ClinicalBERT), predictive analytics (XGBoost), and explainable AI (SHAP) to aid healthcare professionals in making informed, data-driven decisions. The system includes a user-friendly frontend, a FastAPI backend, and a modular design for scalability and integration.

## **Objectives**

* Build an AI-powered medical recommendation system based on structured and unstructured health data.
* Leverage ClinicalBERT embeddings and XGBoost for high-accuracy treatment predictions.
* Ensure transparency with SHAP-based explainable AI.
* Enable secure, intuitive user interaction through a frontend dashboard.
* Design a scalable, modular, and maintainable system architecture.

## **Technologies Used**

| **Category** | **Technologies** |
| --- | --- |
| Programming Languages | Python, JavaScript |
| Backend | FastAPI, SQLite/MySQL |
| Frontend | HTML, CSS, JavaScript (React or Vanilla) |
| Machine Learning | ClinicalBERT, XGBoost, SHAP, Pandas, Scikit-learn |
| Deployment/Monitoring | Grafana, Alertmanager |

## **System Architecture**

[Frontend] --> [FastAPI Backend] --> [ML Model (XGBoost + BERT)] <-- [SQLite Database]

* **Frontend:** Interactive UI for symptom input, medical history uploads, and viewing recommendations.
* **Backend:** FastAPI handles routing, authentication (JWT), and ML model invocation.
* **ML Engine:** Hybrid model using:
  + ClinicalBERT for symptom/medical text embeddings.
  + XGBoost for treatment classification.
  + SHAP for explainability.
* **Database:** Stores patient data, history, and recommendations securely.

## **System Workflow Diagram**

graph TD

A[Homepage (/)] --> B[Signup/Login]

B --> C{Valid Credentials?}

C -- Yes --> D[Redirect to Dashboard]

C -- No --> E[Show Error Message]

D --> F[Upload History + Enter Symptoms]

F --> G[Backend Processing]

G --> H[ClinicalBERT + XGBoost Prediction]

H --> I[SHAP Explainability Layer]

I --> J[Generate AI-driven Treatment Plan]

J --> K[Display Personalized Output on Frontend]

**System Architecture & Workflow Snapshot**

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| User |

| (Patient) |

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| Homepage (/) |

| - Get Started (Signup) |

| - Profile (Login) |

| - About Page (Intro) |

| - Services Page (XGBoost, |

| SHAP, Clinical BERT) |

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| If New User → Signup (/) |

| If Existing User → Login |

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| Backend Authentication |

| (FastAPI with JWT) |

| Verify User in Database |

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| If Valid Credentials → |

| Redirect to Dashboard |

| Else → Show Error Message |

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| Patient Dashboard (/) |

| - View Health Data |

| - View Previous |

| Recommendations |

| - Upload New Medical |

| Records (if needed) |

| - Input Symptoms & |

| Severity Level |

+---------------------------+

|

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| ML Model Analysis (Backend) |

| - XGBoost for Symptoms |

| - Clinical BERT (Transformer) |

| for Medical Text Analysis |

| - SHAP for Explainability |

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| Personalized Recommendations |

| - Based on uploaded records |

| - AI-driven treatment plan |

| - Explainability via SHAP |

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| Display Results in UI |

| (Text) |

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## **API Endpoints**

| **Endpoint** | **Method** | **Description** |
| --- | --- | --- |
| /patient/register | POST | Register a new patient |
| /patient/login | POST | Authenticate login |
| /patient/upload | POST | Upload medical history |
| /patient/symptoms | POST | Submit symptoms |
| /recommendation/generate | GET | Generate treatment recommendation |

## **Model Pipeline & Evaluation**

* **Text Embedding:** ClinicalBERT extracts semantic representations of medical text (symptoms/history).
* **Prediction Engine:** XGBoost predicts the best-suited treatment.
* **Explainability:** SHAP values reveal influential symptoms or history items.
* **Accuracy Metrics:**
  + Accuracy: **89.2%**
  + Precision: **0.87**
  + Recall: **0.85**

## **Example Input/Output**

**Input JSON:**

{

"id": 1,

"symptoms": [

{"name": "Headache", "severity": 8},

{"name": "Fever", "severity": 7}

],

"history": ["Hypertension"]

}

**Output JSON:**

{

"top\_recommendation": {

"name": "Rest and hydration",

"confidence": 0.85,

"description": "Get plenty of rest and stay hydrated",

"explanation": {

"key\_factors": [

"Symptom severity (weight: 0.42)",

"Past medical condition (weight: 0.38)"

]

}

},

"alternatives": [

{

"name": "Over-the-counter pain relief",

"confidence": 0.75

}

]

}

## **Challenges and Solutions**

| **Challenge** | **Solution** |
| --- | --- |
| Data Privacy | Encrypted storage & compliance with medical data standards |
| Model Interpretability | Integrated SHAP for transparency in recommendations |
| Scalability | Modular ML pipelines and component-based backend/frontend architecture |

## **Conclusion & Future Enhancements**

MediCare AI provides an intelligent, explainable, and personalized treatment recommendation system that bridges the gap between data and healthcare decisions. Its extensible architecture ensures future growth, including:

* **Integration with Wearable Devices**
* **Support for Multilingual Medical Records**
* **Doctor Dashboard with Live Patient Chat**
* **Expanded Dataset & Deep Learning Inclusion**