AI-Driven Drug Expiry Prediction System

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# 1. Objective

Drug expiry mismanagement in the pharmaceutical supply chain leads to significant economic losses and limited access to essential medicines. This project proposes a focused AI-driven system that accurately predicts the risk of drug expiry at the inventory level, allowing pharmaceutical companies to take proactive action in stock management, thereby reducing waste and ensuring better healthcare availability.

# 2. Background & Context

Inefficient stock rotation and poor demand forecasting result in excessive drug expiries. While several advanced AI models can contribute to solving this problem, this project hones in on predictive analytics—the foundation of any intelligent redistribution strategy. A reliable prediction of expiry risk is a prerequisite to any further logistical or supply-demand optimization.

# 3. Methodology & Approach

Step 1: Data Collection & Preparation

- Data Sources: Pharma inventory logs, historical sales data, and storage duration.

- Features: Drug ID, batch number, manufacturing date, shelf life, turnover rate, seasonality, and demand trends.

- Data Cleaning: Remove duplicates, handle missing values, normalize date formats.

Step 2: Model Development – Predictive Expiry Detection

- Model Choice: Gradient Boosted Trees (e.g., XGBoost or LightGBM), known for handling tabular data effectively.

- Target: Binary classification – will a batch expire within X months? (yes/no).

- Validation: Use k-fold cross-validation and test on a held-out dataset.

- Metrics: Precision, recall, F1-score (especially for classifying high-risk batches).

Step 3: Deployment Prototype

- Expiry Risk Dashboard: Visualize drug batches at high risk of expiry.

- Alert System: Trigger early alerts for batches needing attention.

- Actionable Insights: Stock movement recommendations to reduce potential losses.

# 4. Key Deliverables

- Predictive Expiry Model (XGBoost-based) with over 85% accuracy.

- Real-time dashboard showing risk-labeled inventory.

- Monthly report generator for near-expiry items.

- Framework for scaling to redistribution modules in the future.

# 5. Risks & Mitigation

- Data Quality Issues: Use outlier detection and imputation methods.

- Model Bias: Monitor performance across product categories.

- Resistance to Use: Conduct training workshops with supply chain managers.

# 6. Expected Outcomes

- Up to 30–40% reduction in drug wastage in pilot regions.

- Improved forecasting for purchase and distribution planning.

- Foundation built for future supply chain optimization (e.g., redistribution).

# 7. Conclusion

By perfecting expiry risk prediction through a single robust model, this project lays the groundwork for a smarter pharmaceutical supply chain. It allows for early interventions that reduce waste, lower costs, and improve drug availability—without being bogged down by the complexity of implementing multiple advanced models simultaneously.