“CortexX Demand Forecasts”

Technical Documentation & Project Specifications

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1. Project Overview

1.1 Purpose & Vision

CortexX is an enterprise-level sales forecasting and demand prediction platform designed to help businesses accurately predict sales, analyze trends, and optimize inventory and staffing decisions using advanced machine learning techniques. The platform transforms raw sales data into actionable insights through automated pipelines and interactive visualization.

1.2 Project Objectives

- Build a scalable, modular forecasting tool adaptable to various business domains
- Offer multiple ML models (XGBoost, LightGBM, Prophet, ensembles) for flexible forecasting
- Provide comprehensive exploratory data analysis and automated feature engineering
- Deliver an interactive Streamlit dashboard for real-time insights and reporting
- Support automated model training, retraining, and performance monitoring
- Ensure maintainability through clean code architecture and comprehensive documentation

1.3 Scope & Deliverables

Functional Scope

- Data ingestion and pre-processing of sales and inventory data from CSV/Excel sources
- Automated feature creation for time-series forecasting including lag features and rolling statistics
- Training, evaluation, and comparison of sophisticated ML models with hyperparameter tuning
- Interactive visualization and reporting with export capabilities
- Flexible date handling and data validation for diverse business scenarios

Key Deliverables

- Installation and setup scripts for seamless deployment
- Well-documented data pipeline and model training modules
- Real-time dashboard with data upload, analysis, and forecasting capabilities
- Exportable forecast reports and model performance documentation
- Comprehensive API documentation and user guides

2. Technical Architecture

2.1 System Overview

CortexX follows a modular microservices architecture with clear separation of concerns. The system is organized into distinct modules for data processing, feature engineering, model training, and visualization, enabling independent development and testing.

2.2 Technology Stack

Component	Technologies
Backend & ML	Python, Scikit-learn, XGBoost, LightGBM, Prophet, Pandas, NumPy
Visualization	Streamlit, Plotly, Matplotlib, Seaborn
Data Processing	Pandas, NumPy, SciPy for statistical operations
Development	Git, Poetry for dependency management, Pytest for testing
Deployment	Docker, Streamlit Cloud compatible

3. Stakeholder Analysis

Effective stakeholder management is crucial for project success. The following table outlines key stakeholders, their roles, and communication strategies.

Stakeholder	Role & Responsibilities	Communication Plan
Project Manager	Oversees project delivery and timeline	Weekly status meetings, email updates, milestone reviews
Data Scientist	Develops ML models and feature engineering	Daily stand-ups, JIRA tickets, Slack coordination
Software Developer	Implements dashboard and backend services	Code reviews, sprint demos, Slack channels
Business Analyst	Defines business requirements and success metrics	Requirement workshops, status reports, email communication
End Users	Utilize forecasting platform for business decisions	Training sessions, feedback collection, user support channels

Communication Strategy: Scheduled meetings for formal updates, Slack channels for daily coordination, and email for official documentation and decision tracking.

4. Data Flow Design

CortexX employs a flexible file-based data ingestion system designed for rapid prototyping and deployment without complex database infrastructure requirements.

Data Sources & Structure

- Primary data source: CSV files (retail_store_inventory.csv)
- Supported formats: CSV, Excel with flexible schema adaptation
- Key columns: Date, Store ID, Product ID, Category, Region, Inventory Level, Units Sold, Demand Forecast, Price, Discounts

Data Processing Pipeline

1. Data Ingestion: Flexible CSV/Excel parsing with automatic date detection
2. Pre-processing: Handling missing values, outliers, and data validation
3. Feature Engineering: Automated creation of time-series features (lags, rolling statistics, seasonal patterns)
4. Model Training: Multiple algorithm support with automated hyperparameter tuning
5. Inference & Reporting: Forecast generation with confidence intervals and performance metrics

5. UI/UX Design

5.1 Design Concept

- Intuitive navigation through sidebar-based workflow progression
- Consistent visual language using Plotly with clean, business-appropriate themes
- Progressive disclosure of complexity - simple defaults with advanced options
- Real-time feedback and validation throughout user interactions

5.2 User Flow

6. Data Upload: Upload CSV/Excel or generate sample data for testing
7. Configuration: Auto-detection or manual selection of date and value columns
8. Exploration: Perform EDA with interactive visualizations and statistical summaries
9. Feature Engineering: Automated feature creation with customization options
10. Model Training: Configure and train forecasting models with selectable algorithms
11. Forecasting: Generate and visualize sales forecasts with confidence interval

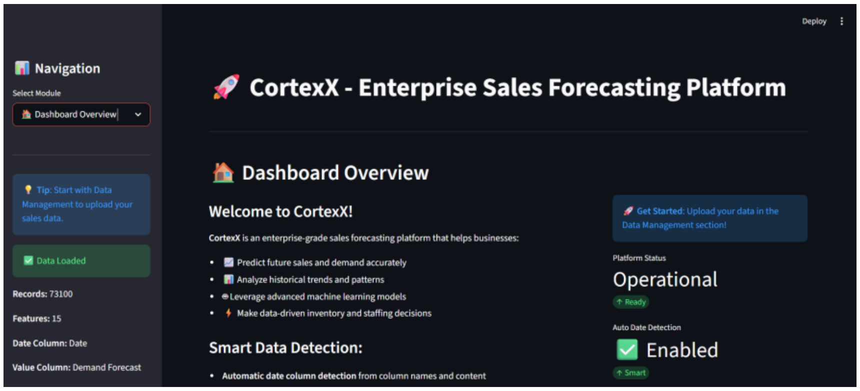
5.3 Wireframes Overview

- Grouped navigation tabs for logical workflow progression
- Dynamic sidebar displaying data state and session information
- Interactive data preview tables with sorting and filtering capabilities
- Multiple Plotly graph types supporting detailed exploratory analysis
- Model configuration panels with preset and custom options
- Export functionality for forecasts, charts, and performance reports

Design Rationale

- Streamlit enables rapid development cycles and delivers intuitive user interfaces without complex frontend development
- Plotly provides enterprise-grade interactive visualization suitable for business intelligence applications
- Modular codebase supports maintainability, extensibility, and collaborative development practices
- Responsive design ensures accessibility across different devices and screen sizes

5.4 Sample Output:



💡 Tip: Start with Data Management to upload your sales data.

✅ Data Loaded

Records: 73100

Features: 15

Date Column: Date

Value Column: Demand Forecast

🚀 CortexX - Enterprise Sales Forecasting Platform

🏠 Dashboard Overview

Welcome to CortexX!

CortexX is an enterprise-grade sales forecasting platform that helps businesses:

- 📈 Predict future sales and demand accurately
- 📊 Analyze historical trends and patterns
- Leverage advanced machine learning models
- ⚡ Make data-driven inventory and staffing decisions

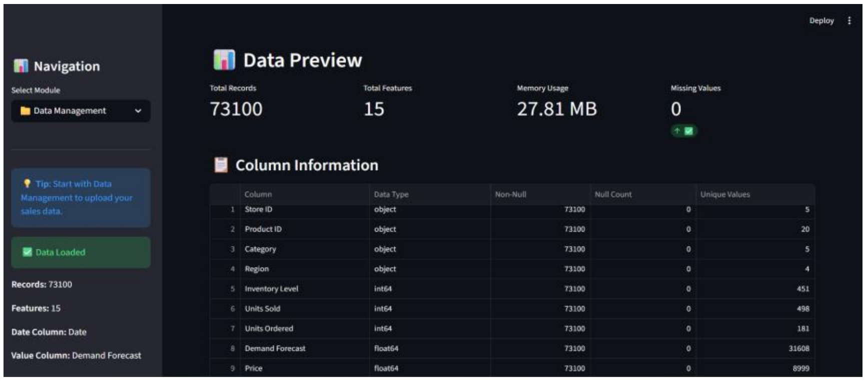
Smart Data Detection:

- **Automatic date column detection** from column names and content

🚀 **Get Started:** Upload your data in the Data Management section!

Platform Status: Operational (↑ Ready)

Auto Date Detection: ✅ Enabled (↑ Smart)



💡 Tip: Start with Data Management to upload your sales data.

✅ Data Loaded

Records: 73100

Features: 15

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📊 Data Preview

Total Records	Total Features	Memory Usage	Missing Values
73100	15	27.81 MB	0 ↑ ✅

📋 Column Information

	Column	Data Type	Non-Null	Null Count	Unique Values
1	Store ID	object	73100	0	5
2	Product ID	object	73100	0	20
3	Category	object	73100	0	5
4	Region	object	73100	0	4
5	Inventory Level	int64	73100	0	451
6	Units Sold	int64	73100	0	498
7	Units Ordered	int64	73100	0	181
8	Demand Forecast	float64	73100	0	31608
9	Price	float64	73100	0	8999

6. Implementation Plan

Development Phases

Phase	Deliverables
Phase 1: Core Infrastructure	Data pipeline, basic ML models, foundational dashboard
Phase 2: Advanced Features	Ensemble models, advanced EDA, performance optimization
Phase 3: Production Ready	Error handling, comprehensive testing, documentation
Phase 4: Deployment & Training	User training, deployment scripts, support materials

Success Metrics

- Model Accuracy: MAPE < 15% on validation datasets
- Performance: Dashboard load time < 3 seconds for standard datasets
- Usability: User satisfaction score > 4.0/5.0
- Reliability: System uptime > 99.5% in production environment

GitHub Repo: https://github.com/Elgeneral200/CortexX