

Enriched AI Agent - Capabilities Overview

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Executive Summary

This document outlines the enhanced capabilities of the **Supply Chain AI Agent**, which has been upgraded with advanced machine learning and analytical tools. The agent now provides deeper insights into demand drivers, model explainability, and complex scenario analysis, moving beyond simple forecasting to become a strategic decision-support tool.

New Capabilities

1. Random Forest Forecasting & Feature Importance

Description:

A new Random Forest forecasting model (`03_random_forest_forecasting.py`) has been added to the pipeline. Unlike traditional time-series models, Random Forest can capture complex, non-linear relationships between demand and various risk factors (geopolitical, trade, commodity, weather).

Key Features:

- **Comprehensive Feature Engineering:** Creates over 30 features, including lags, rolling statistics, trend indicators, and risk interactions.
- **Feature Importance Analysis:** The model calculates and stores the importance of each feature, revealing the primary drivers of demand.
- **SHAP Value Explainability:** Provides detailed explanations for individual predictions, showing how each feature contributed to the forecast.

Agent Tool: `explain_demand_drivers()`

- **Purpose:** Allows users to ask the agent what factors are driving demand.
- **Example Query:** "What are the top 5 factors that influence our demand forecasts?"
- **Output:** A ranked list of demand drivers with business interpretations.

2. Advanced Trend & Pattern Detection

Description:

The agent can now perform sophisticated trend analysis on historical demand data, identifying growth rates, seasonality, volatility, and correlations with external risk factors.

Agent Tool: `detect_trends()`

- **Purpose:** Provides a comprehensive statistical analysis of demand patterns.
- **Example Query:** "Analyze our demand trends over the last year. Are we growing? Is there seasonality?"
- **Output:** A report including:
 - **Growth Trend:** Linear regression analysis with growth rate and R^2 value.
 - **Seasonal Patterns:** Identifies peak and trough months and seasonal amplitude.
 - **Volatility Analysis:** Calculates coefficient of variation and identifies large demand swings.
 - **Risk Correlation:** Measures the correlation between demand and key risk indices.

3. Multi-Model Forecast Comparison

Description:

To improve forecast reliability, the agent can now compare the outputs of all available forecasting models (Prophet, ARIMA, Random Forest) for a given period.

Agent Tool: `compare_forecast_models()`

- **Purpose:** Provides a side-by-side comparison of different forecasting models.
- **Example Query:** "Compare the forecasts from all models for the next quarter. Which one should we trust?"
- **Output:** A table showing each model's forecast, the ensemble average, and the spread (disagreement) between models.

4. Forecast Confidence Scoring

Description:

The agent can now assess and score the overall confidence in a forecast by evaluating multiple factors, providing a more nuanced view of forecast reliability.

Agent Tool: `assess_forecast_confidence()`

- **Purpose:** Calculates a confidence score (0-100) for the demand forecast.
- **Example Query:** "How confident should we be in our demand forecasts for the next 3 months?"

- **Output:** A detailed breakdown of the confidence score, based on:
 - **Historical Stability:** Volatility of past demand.
 - **Trend Consistency:** Strength of the underlying trend (R^2).
 - **Risk Environment:** Stability of external risk factors.
 - **Data Recency:** How up-to-date the input data is.

5. Interactive What-If Scenario Builder

Description:

This powerful new tool allows users to create custom, multi-variable scenarios by adjusting several risk factors simultaneously. The agent then projects the combined impact on demand.

Agent Tool: `build_whatif_scenario()`

- **Purpose:** Simulates the impact of complex, multi-faceted scenarios.
- **Example Query:** "What if geopolitical risk increases by 50%, tariffs go up 25%, and commodity prices rise 15%? What's the combined impact?"
- **Output:** A detailed analysis showing the projected impact of each factor and the total combined effect on demand, with recommended actions.

Enriched Agent Tool Reference

Tool	Description	Example Query
<code>explain_demand_drivers</code>	Analyze feature importance	"What drives our demand?"
<code>detect_trends</code>	Detect patterns and trends	"Are we growing? Any seasonality?"
<code>compare_forecast_models</code>	Compare Prophet/ARIMA/RF	"Which model should we trust?"
<code>assess_forecast_confidence</code>	Assess forecast reliability	"How confident are the forecasts?"
<code>build_whatif_scenario</code>	Custom scenario builder	"What if risks increase by 50%?"
<code>get_demand_forecast</code>	Get demand forecasts	"What's next quarter's forecast?"

detect_anomalies	Find demand anomalies	"Any unusual patterns?"
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Deployment & Usage

1. **Run New Notebook:** Execute the `03_random_forest_forecasting.py` notebook after the main transformation step to generate the necessary feature importance tables.
 2. **Update Job Workflow:** Add the new Random Forest notebook to your Databricks Job.
 3. **Use Enriched Agent:** The `02_agent_tools_enriched.py` notebook contains all the new tools and can be used for interactive analysis or deployed as a Model Serving endpoint.
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Conclusion

The enriched AI agent represents a significant step forward in the platform's analytical capabilities. By incorporating machine learning explainability and advanced scenario analysis, the agent can now provide not just forecasts, but also the context and reasoning behind them. This enables more informed, data-driven strategic decisions for supply chain management.