Dynamic Learning Forecasting System - Mathematical Formulas

# FORECAST ADJUSTMENT SUMMARY

Initial AI Forecast Generation

**Base Forecast Formula:**

F(t+1) = Model(Features(t-n:t))

Where:

 F(t+1) = Forecast for next period

 Features include: lag values, moving averages, trends, seasonality, volatility

Forecast Change Calculation

**Absolute Change:**

ΔF = F\_optimized - F\_initial

**Percentage Change:**

%ΔF = (ΔF / F\_initial) × 100%

# FUZZY LOGIC ADJUSTMENT

Fuzzy Input Variables (0-100 scale)

 **Accuracy Score:** Based on historical MAPE performance

 **Cost Savings Score:** Based on historical cost variance reduction

 **Supplier Reliability Score:** Based on delivery performance

 **Inventory Risk Score:** Composite risk assessment

Fuzzy Output

**Forecast Adjustment Factor:**

Adjustment = Fuzzy\_System(Accuracy, Cost\_Savings, Reliability, Risk)

Range: -50% to +50%

Fuzzy Factor Application

F\_fuzzy = F\_initial × (1 + Adjustment/100)

# EVOLUTIONARY OPTIMIZATION

Weight Optimization

**Objective Function:**

Minimize: Weight\_Variance = Σ|w\_i - 0.25|

Subject to: w₁ + w₂ + w₃ + w₄ = 1

Final Optimized Forecast

F\_optimized = w₁ × F\_initial × Fuzzy\_Factor + w₂ × F\_initial × Accuracy\_Component +

w₃ × F\_initial × Inventory\_Component +

w₄ × F\_initial × Reliability\_Component

Where:

 **Fuzzy\_Factor = 1 + max(-0.5, min(0.5, Adjustment/100)) ** **Accuracy\_Component = (100 - MAPE)/100**

 **Inventory\_Component = (100 - Risk\_Score)/100**

 **Reliability\_Component = Reliability\_Score/100**

Confidence Score Calculation

Confidence = (w₁ × (100 - |Adjustment|) + w₂ × Accuracy\_Component × 100 + w₃ × Inventory\_Component × 100 + w₄ × Reliability\_Component × 100) / (w₁ + w₂ + w₃ + w₄)

Confidence Score Interpretation

|  |  |  |  |
| --- | --- | --- | --- |
| **Confidence**  **Score Range** | **Interpretation** | **Recommended Action** | **Risk Level** |
| **90-100%** | **Excellent**  **Confidence** | Proceed with full forecast quantity.  High reliability expected. | **Low Risk** |
| **80-89%** | **High Confidence** | Proceed with forecast. Minor adjustments may be considered  based on recent trends. | **Low Risk** |
| **70-79%** | **Good Confidence** | Forecast is reliable but monitor  closely. | **Medium Risk** |
| **60-69%** | **Moderate**  **Confidence** | Use forecast with caution. | **Medium**  **Risk** |
| **50-59%** | **Fair Confidence** | High uncertainty. Requires Frequent reviews. | **Medium-**  **High Risk** |
| **40-49%** | **Low Confidence** | Significant uncertainty. Use  conservative approach. | **High Risk** |
| **Below 40%** | **Very Low Confidence** | Poor forecast reliability. Manual  review required. | **Very High Risk** |
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**Confidence Score Factors:** The confidence score reflects the weighted combination of:

**Fuzzy Logic Reliability** (25% weight) - How consistent the business rules are



 **Historical Accuracy** (25% weight) - Past forecast performance

 **Inventory Stability** (25% weight) - How well inventory metrics align

 **Supplier Consistency** (25% weight) - Supplier delivery performance

**Action Guidelines by Confidence Level:**

 **High Confidence (80%+):** Standard procurement processes

 **Medium Confidence (60-79%):** Enhanced monitoring and safety stocks

 **Low Confidence (<60%):** Conservative ordering with management review

# INVENTORY POSITION ANALYSIS

Days of Supply

Days\_of\_Supply = (Current\_Stock / F\_optimized) × 30 days

Stock Utilization Rate

Utilization = Current\_Stock / Max\_Stock × 100%

MOQ Efficiency Ratio

MOQ\_Ratio = F\_optimized / MOQ

Shelf Life Risk Assessment

Shelf\_Life\_Risk = Days\_of\_Supply / Shelf\_Life\_Days × 100%

# SUPPLIER PERFORMANCE METRICS

On-Time Delivery Rate

OTD\_Rate = (Count of PO\_Lead\_Time ≤ Quote\_Lead\_Time × 1.1) / Total\_Orders × 100%

Delivery Variance

Delivery\_Variance = Mean(|PO\_Lead\_Time - Quote\_Lead\_Time|)

Early Delivery Rate

Early\_Rate = (Count of PO\_Lead\_Time < Quote\_Lead\_Time) / Total\_Orders × 100%

Late Delivery Rate

Late\_Rate = (Count of PO\_Lead\_Time > Quote\_Lead\_Time × 1.1) / Total\_Orders × 100%

Supplier Reliability Score

Reliability\_Score = (Count of |PO\_Lead\_Time - Quote\_Lead\_Time|/Quote\_Lead\_Time ≤ 0.2) / Total\_Orders × 100

# INVENTORY RISK SCORING

Composite Inventory Risk

Total\_Risk = 0.3 × Shelf\_Life\_Risk +

0.3 × Stockout\_Risk +

0.2 × Overstock\_Risk +

0.2 × MOQ\_Risk

**Individual Risk Components: Shelf Life Risk:**

Shelf\_Life\_Risk = min(100, (Days\_of\_Supply / Shelf\_Life\_Days) × 100) if Days\_of\_Supply > 0.8 × Shelf\_Life\_Days

= 0 otherwise

**Stockout Risk:**

Stockout\_Risk = min(100, (1 - Current\_Stock/Reorder\_Point) × 100) if Current\_Stock < Reorder\_Point

= 100 if Current\_Stock = 0 and Reorder\_Point = 0

= 0 otherwise

**Overstock Risk:**

Overstock\_Risk = min(100, (Current\_Stock/Max\_Stock) × 100) if Current\_Stock > 0.8 × Max\_Stock

= 50 if Max\_Stock = 0 and Current\_Stock > 0

= 0 otherwise

**MOQ Risk:**

MOQ\_Risk = min(100, (1 - F\_optimized/MOQ) × 50) if F\_optimized < 1.2 × MOQ

= 0 if MOQ = 0

= 0 otherwise

# FINANCIAL IMPACT CALCULATIONS

Cost Variance Analysis

Historical\_Cost\_Variance = |Historical\_Forecast - Actual\_Usage| × Unit\_Price AI\_Cost\_Variance = |AI\_Forecast - Actual\_Usage| × Unit\_Price

Cost Efficiency Ratio

Cost\_Efficiency = (Historical\_Cost\_Variance - AI\_Cost\_Variance) / Historical\_Cost\_Variance × 100%

Cost Per Unit Analysis

Cost\_Per\_Unit = Total\_Extra\_Costs / F\_initial

Total Inventory Costs

Total\_Costs = Understock\_Costs + Overstock\_Costs + Obsolete\_Costs + Damage\_Costs

# SMART ORDER QUANTITY CALCULATION

Order Quantity Decision Logic

If Current\_Stock ≥ F\_optimized:

Order\_Qty = 0

If Current\_Stock < F\_optimized × 0.3:

Order\_Qty = max(F\_optimized - Current\_Stock, F\_optimized × 0.5)

Otherwise:

Order\_Qty = F\_optimized -Current\_Stock

Suggested Order Date

Lead\_Time\_Days = Lead\_Time\_Weeks × 7 Safety\_Buffer = 14 days (standard) or 3 days (urgent) Order\_Date = Today + Lead\_Time\_Days -Safety\_Buffer

# ACCURACY MEASUREMENT

Mean Absolute Percentage Error (MAPE)

MAPE = |Actual\_Value - Forecast\_Value| / Actual\_Value × 100%

Note: When Actual\_Value = 0, MAPE = |Forecast\_Value|

Forecast Improvement

Improvement = Historical\_MAPE - AI\_MAPE

Positive values indicate AI forecast is better.

**Note:** All formulas include bounds checking and error handling to ensure realistic outputs within operational constraints.