**GA Model Output Explanation**

This output represents the **recommended price decision** generated by a **Genetic Algorithm (GA)** model. It combines price optimization, demand prediction, and profit estimation based on historical sales data, competitor pricing, and market trends.

**🔹 Recommended Pricing & Profitability**

* **Recommended Price:** **₹95.45**  
  → The GA model suggests setting today’s product price at ₹95.45 for optimal balance between sales volume and profit.
* **Best Price (Raw):** **₹96.68**  
  → The model initially found ₹96.68 as the highest profit point, but after adjustment for competition and business rules, the recommendation is slightly lower at ₹95.45.
* **Predicted Sales Volume:** **14,562 units (approx.)**  
  → Expected demand at the recommended price.
* **Expected Profit:** **₹1,40,958 (approx.)**  
  → Profit estimated after considering cost, demand, and competitor pricing.

**🔹 Market & Cost Context (Today’s Snapshot)**

* **Date:** 31st December 2024
* **Yesterday’s Price:** ₹94.45
* **Cost per Unit:** ₹85.77
* **Competitor Price Mean:** ₹95.31  
  → The suggested price is slightly **above yesterday’s price** and **in line with competitor average**.

**🔹 Model Performance (Accuracy of Predictions)**

The GA model was trained and tested on historical data. Performance metrics are given below:

**Training Data (historical fit)**

* **MAE:** 201.68 → On average, predictions differ from actuals by ~202 units.
* **RMSE:** 256.87 → Average prediction error magnitude.
* **R²:** 0.919 → Very strong fit (91.9% variance explained).
* **MAPE:** 1.45% → Low average percentage error.

**Test Data (future/generalization)**

* **MAE:** 566.84 → Larger average error in test data.
* **RMSE:** 733.50 → Higher deviation on unseen data.
* **R²:** 0.355 → Weak generalization (only 35.5% variance explained).
* **MAPE:** 4.05% → Average error ~4%, acceptable but less accurate than training.

⚠️ **Interpretation:** The model fits past data very well, but test performance shows room for improvement. Still, prediction error remains within a manageable business tolerance (~4%).

**🔹 Key Features Used by the Model**

The GA selected the most important variables influencing demand and pricing:

1. **dow** – Day of Week (e.g., weekday vs. weekend effect)
2. **price\_gap\_mean** – Avg. price difference vs. competitors
3. **volume\_roll7** – 7-day moving average of sales volume
4. **volume\_lag7** – Sales volume from 7 days ago
5. **margin** – Profit margin per unit
6. **price\_gap\_mean\_lag1** – Yesterday’s competitor price difference
7. **dayofyear** – Seasonal trend (e.g., year-end, festivals)
8. **price\_lag7** – Price 7 days ago
9. **price\_lag1** – Yesterday’s price
10. **cost** – Unit cost of product
11. **comp\_spread** – Competitor price spread (market competition intensity)
12. **price\_roll7** – 7-day average price trend

✅ These features show that the model heavily relies on **competitor pricing, recent sales trends, seasonality, and margin** when recommending prices.

**📌 Final Business Insight**

* The **recommended price is ₹95.45**, which aligns well with competitor pricing and ensures healthy margins above cost (₹85.77).
* **Profit potential is strong (~₹1.41 lakh)** with estimated sales of ~14,562 units.
* While the model is very accurate on training data, testing results indicate some uncertainty in unseen situations — pricing managers should combine this recommendation with **business judgment and market signals**.