ML Challenge 2025 — Smart Product Pricing Solution – Team Diamond

Members: Aryan Katiyar · Shaunak Dave · Avanish Dhananjay

Executive Summary

Team Diamond presents a multimodal machine learning solution for the Smart Product Pricing Challenge, integrating textual and visual data to accurately predict product prices. Our approach leverages advanced text feature engineering, deep image embeddings, and a weighted ensemble of optimized models to achieve robust and interpretable predictions across diverse product categories.

Methodology Overview

Problem Analysis

Product prices range from $0.13 to $2,796 (median $14.00). Price strongly correlates with quantity, brand, and category. Text descriptions vary in complexity and length, while images convey important cues about packaging and quality.

Solution Strategy

Approach: Ensemble Learning with Multimodal Inputs
Core Idea: Combine textual and visual signals for holistic price prediction.

Pipeline Overview:
1. Text Feature Engineering (quantity, brand, category, quality indicators)
2. Image Feature Extraction (ResNet50 embeddings)
3. Feature Selection (SelectKBest)
4. Ensemble Modeling (Random Forest, Gradient Boosting, Extra Trees, Ridge, ElasticNet)
5. Weighted Predictions for final price estimation.

Key Highlights

• Multimodal Feature Integration: Seamlessly combines textual and visual data.
• Advanced Quantity Extraction: Uses regex-based pattern matching for product specifications.
• Hierarchical Brand Detection: Differentiates between premium and mid-tier brands.
• Ensemble Optimization: Data-driven weighting of model outputs for improved accuracy.
• Efficient Image Processing: Sampling strategy for scalable, memory-efficient computation.

Model Performance

• SMAPE: ~65.9% (baseline), 60–65% (enhanced)
• MAE: ~15.2, RMSE: ~22.8, R^2: ~0.45
• Ensemble yields 5–10% improvement over individual models.
Overall, our model delivers a scalable and interpretable approach to smart pricing using data-driven multimodal learning.