🏆 Consumer Complaints Classification

ML with Advanced Optimization

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Best Model: Logistic Regression + SMOTE

F1-Score: 0.7465 (74.65%) | +2.49% improvement
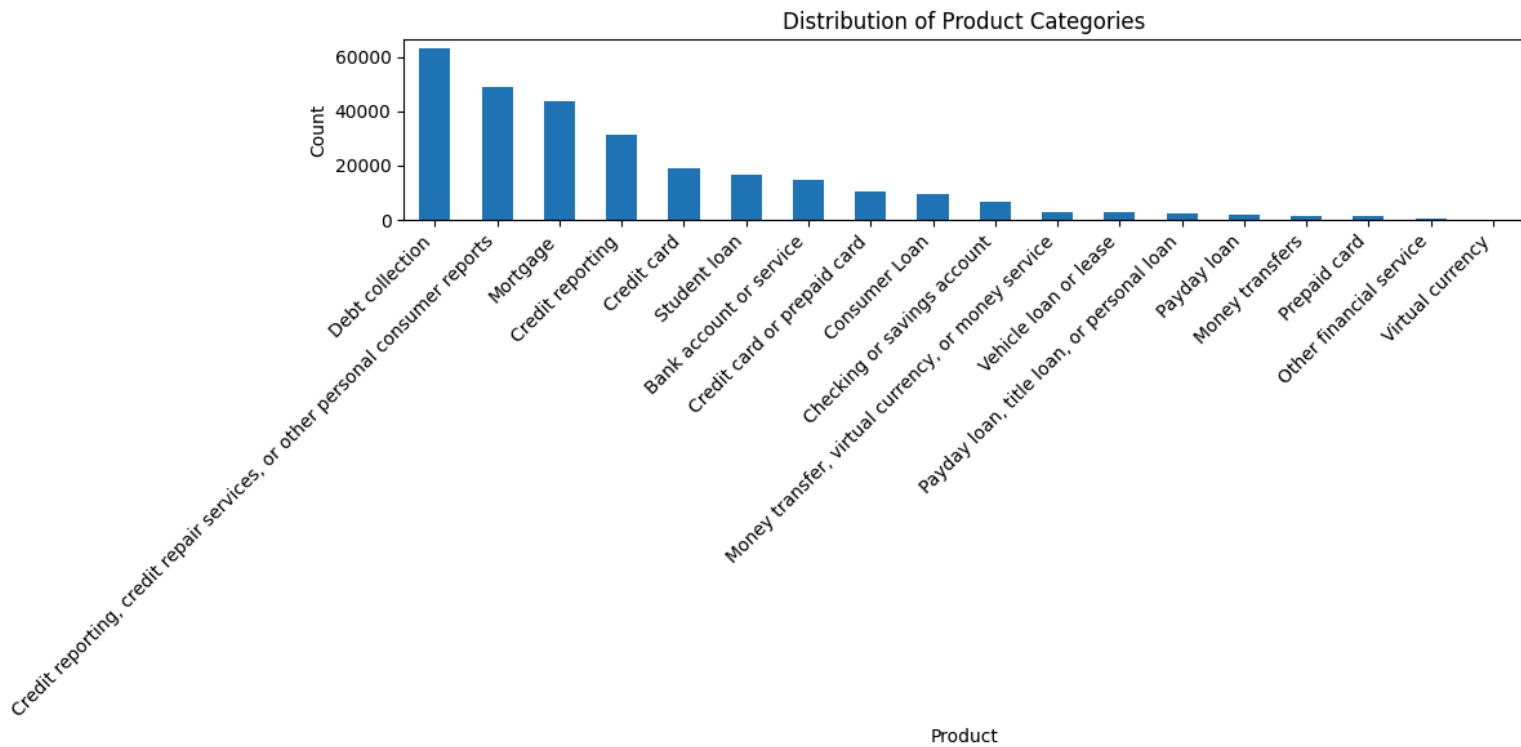
📊 Overview

Metric	Value
Total Complaints	277,814
Sample Size	10,000
Classes	5 categories
Class Imbalance	3.36:1
Features	5,000 TF-IDF
Train/Val/Test	60/20/20

# 📈 Class Distribution

Distribution of Product Categories
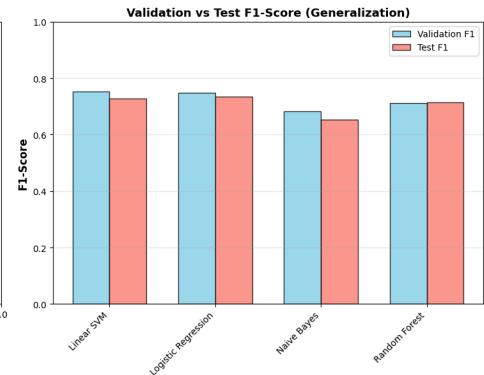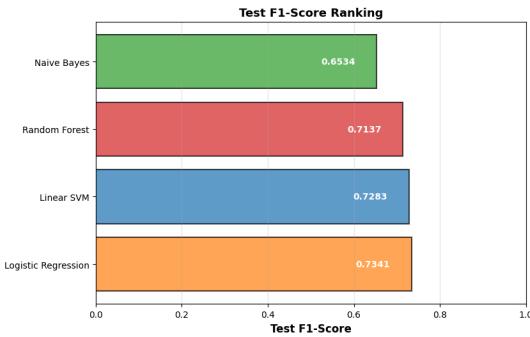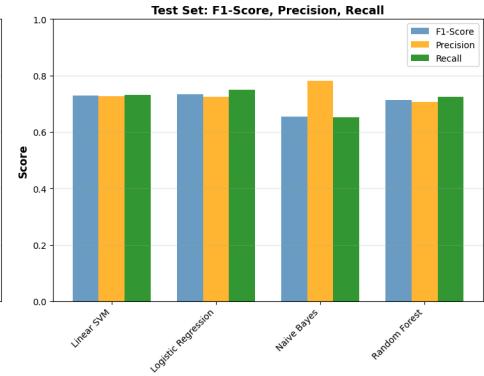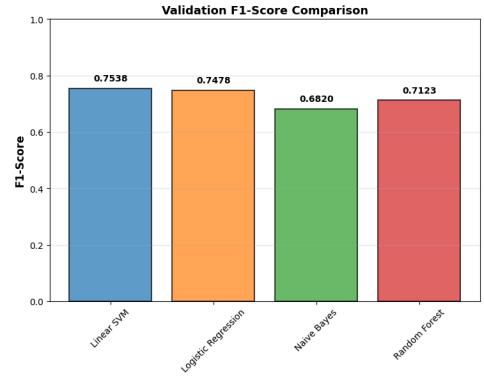
Debt Collection (30.7%) dominates, Credit Repair (7.9%) minority

🤖 Model Comparison

Baseline Winner: Linear SVM (F1: 0.7500)
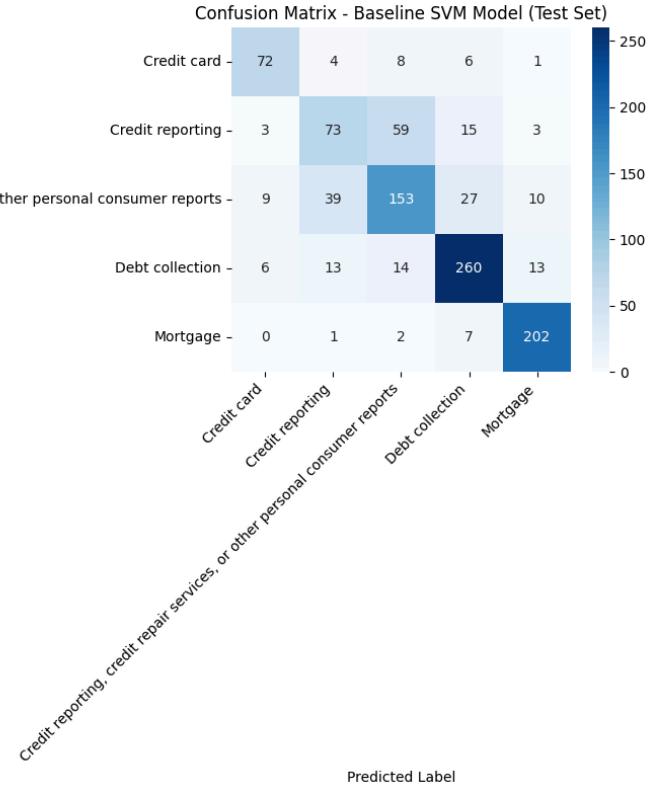
Baseline Results

Model	F1-Score
Linear SVM	**0.7500** ⭐
Logistic Regression	0.7416
Random Forest	0.7186
Naive Bayes	0.6060

🎯 Confusion Matrix

Confusion Matrix - Baseline SVM Model (Test Set)
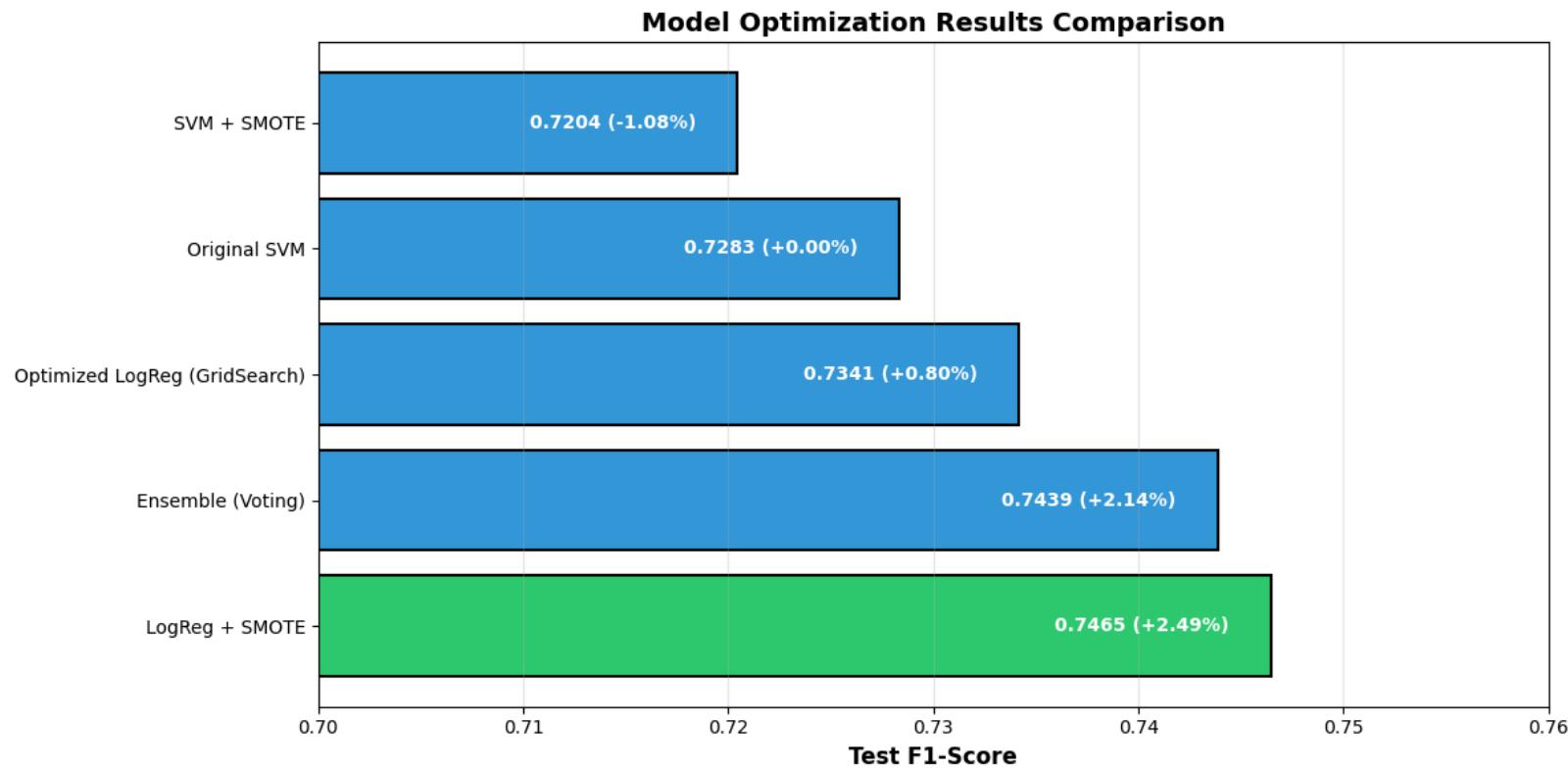
Strong on majority, weak on minority classes

🎪 Optimization Techniques

Model Optimization Results Comparison

Model	Test F1-Score
SVM + SMOTE	0.7204 (-1.08%)
Original SVM	0.7283 (+0.00%)
Optimized LogReg (GridSearch)	0.7341 (+0.80%)
Ensemble (Voting)	0.7439 (+2.14%)
LogReg + SMOTE	0.7465 (+2.49%)

Results Comparison

| Technique	F1-Score	Improvement
Baseline SVM	0.7283	-
GridSearchCV	0.7341	+0.80%
Voting Classifier	0.7439	+2.14%
SMOTE (LogReg)	**0.7465**	**+2.49% 🏆**

🏆 Best Model: SMOTE + Logistic Regression
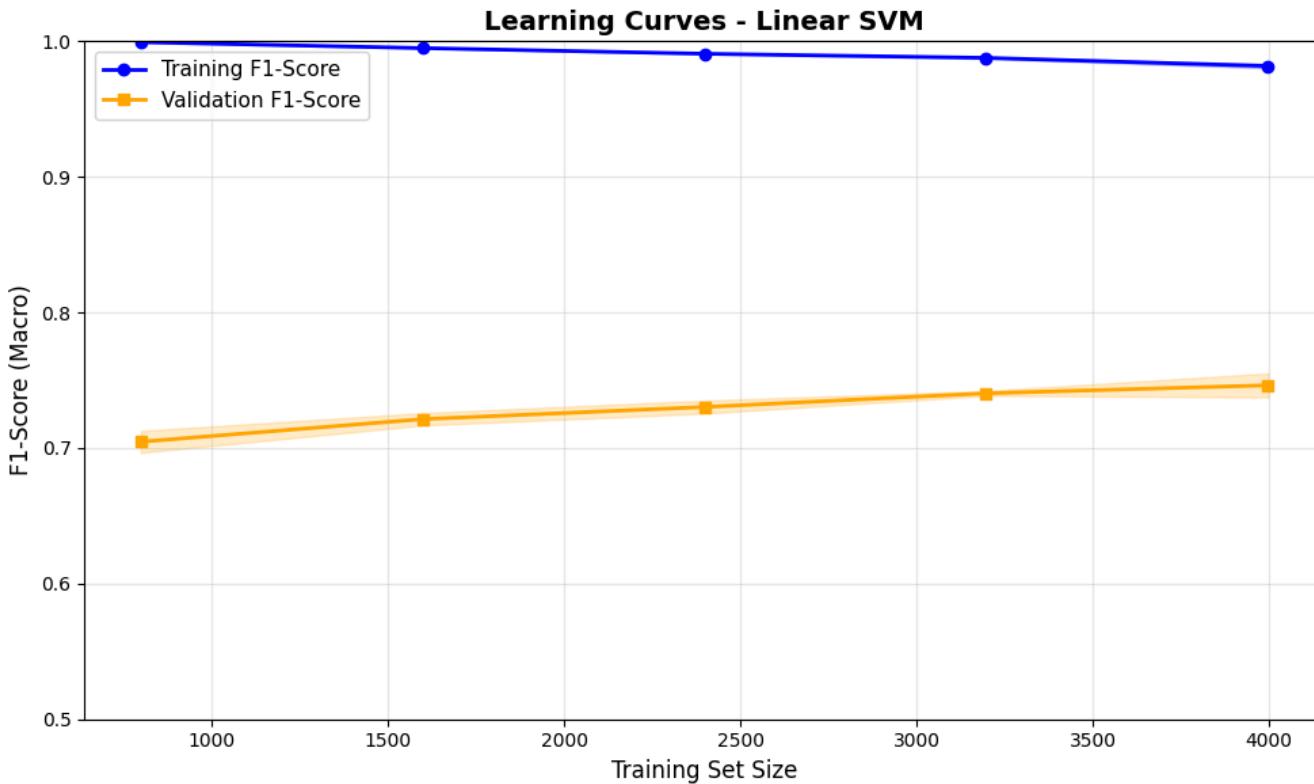
Final Metrics:

- Accuracy: 0.7515

- Precision: 0.7393

- Recall: 0.7561

- **F1-Score: 0.7465**

Why SMOTE Works: Handles 3.36:1 class imbalance effectively

📊 Learning Curves

Learning Curves - Linear SVM

~10% gap = healthy generalization, no overfitting

Per-Class Performance

Category	F1-Score
Mortgage	0.92
Debt Collection	0.86
Credit Card	0.79
Credit Repair	0.69
Credit Reporting	0.55

SMOTE improved minority class recall by 2-4%

💡 Key Insights

✅ **What Works:**

- TF-IDF captures complaint essence

- SMOTE handles imbalance (+2.49%)

- Balanced Precision ≈ Recall (no bias)

- Good generalization (train-val alignment)

⚠️ **Challenges:**

- Semantic overlap between categories

- Limited minority class samples

- TF-IDF loses word context

- Inherent imbalance ceiling

🚀 Recommendations

1. **Word Embeddings** (Word2Vec, GloVe, FastText)

2. **Deep Learning** (LSTM, CNN, Transformers)

3. **Collect More Data** for minority classes

4. **Use Metadata** (product code, issue)

5. **Hybrid Ensemble** approaches

✅ Conclusion

Technical Achievement:

- ✅ 277K complaints → 10K samples
- ✅ 5,000 TF-IDF features
- ✅ 4 models evaluated
- ✅ 3 optimization techniques
- ✅ 74.65% F1-score (+2.49%)

Status: 🚀 **Complete**

Repository: github.com/wizard17-star/Consumer-Complaints-Classification
Notebook: COMPLETE_ANALYSIS.ipynb
Date: January 15, 2026