


```

from sklearn.naive_bayes import GaussianNB          # Gaussian Naive Bayes classifier
from sklearn.ensemble import RandomForestClassifier # Random Forest ensemble classifier
# Machine Learning - evaluation metrics
from sklearn.metrics import (
    classification_report, # Detailed classification report
    confusion_matrix,     # Confusion matrix for predictions
    f1_score,              # F1 score (harmonic mean of precision and recall)
    precision_score,       # Precision (positive predictive value)
    recall_score,          # Recall (sensitivity)
    roc_auc_score          # Area under ROC curve
)
# General settings
import warnings
warnings.filterwarnings('ignore') # Suppress warning messages for cleaner output
sns.set_style('whitegrid')      # Set seaborn plot style to white grid
# Confirmation message
print('✓ All libraries imported successfully!')
# Expected output:
# ✓ All libraries imported successfully!

# Expected output: "✓ All Libraries imported successfully!"

```

✓ All libraries imported successfully!

2. Load and Explore Dataset

Load the purchase intent dataset and explore its basic characteristics.

In [6]:

```

# =====
# LOAD DATASET
# =====
# Load the CSV file containing social media posts with purchase intent labels
# Dataset contains 20,000 posts from Twitter and Reddit
dataset = pd.read_csv(r'C:\Users\henry\OneDrive\Desktop\Project\data\raw\purchase_intent_dataset_22_11_25.csv')
# Display basic information about the loaded dataset
print(f'✓ Dataset loaded successfully')
print(f' Total posts: {len(dataset)}')           # Total number of posts
print(f' Total columns: {len(dataset.columns)}')   # Number of features/columns
# Expected output:

```

```
# ✓ Dataset loaded successfully
#   Total posts: 20,000
#   Total columns: 27

# Expected output: Dataset loaded message with 10,000 posts
```

✓ Dataset loaded successfully
Total posts: 20,000
Total columns: 27

In [8]:

```
# =====
# DATASET OVERVIEW
# =====
# Display comprehensive statistics about the dataset
print('*'*70)
print('DATASET OVERVIEW')
print('*'*70)
# Show distribution of posts across platforms (Twitter vs Reddit)
print(f'\nPlatform Distribution:')
print(dataset['platform'].value_counts())
# Show distribution of purchase intent labels (0 = No Intent, 1 = Purchase Intent)
print(f'\nPurchase Intent Distribution:')
print(dataset['purchase_intent'].value_counts())
# Calculate and display the percentage of posts with purchase intent
print(f'\nPurchase Intent Rate: {dataset["purchase_intent"].mean():.1%}')
print('*'*70)

# Expected output: 0: 7000 posts (70%), 1: 3000 posts (30%)
```

```
=====
DATASET OVERVIEW
=====
```

Platform Distribution:

```
platform
Twitter    10000
Reddit     10000
Name: count, dtype: int64
```

Purchase Intent Distribution:

```
purchase_intent
0      14000
1       6000
Name: count, dtype: int64
```

Purchase Intent Rate: 30.0%

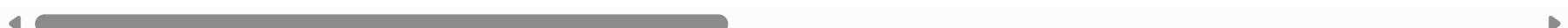
```
In [10]: # =====
# PREVIEW DATASET
# =====
# Display the first 5 rows of the dataset to see the data structure
# This shows post_id, platform, text, features, and labels
dataset.head()

# Expected output: First 5 rows of dataset showing all columns
```

Out[10]:

	post_id	platform	text	timestamp	product_category	product_subcategory	product_name	purchase_intent	intent_label	likes
0	T000581	Twitter	Purchasing the OnePlus 12 right now. Amazing d...	01/10/2025 00:25	Consumer Electronics	smartphones	OnePlus 12	1	Purchase Intent	20.0
1	R011522	Reddit	Hey everyone, finally buying the new balance 9...	01/10/2025 01:12	Fashion	sneakers	New Balance 990	1	Purchase Intent	NaN
2	R010847	Reddit	Finally buying the Uniqlo sweater next month. ...	01/10/2025 01:28	Fashion	clothing	Uniqlo sweater	1	Purchase Intent	NaN
3	T007071	Twitter	Really impressed with the Google Pixel 8 quality	01/10/2025 01:53	Consumer Electronics	smartphones	Google Pixel 8	0	General Sentiment	26.0
4	T005849	Twitter	Comparison between Xiaomi 14 and OnePlus 12	01/10/2025 01:58	Consumer Electronics	smartphones	Xiaomi 14	0	General Sentiment	29.0

5 rows × 27 columns



3. Data Preparation

Prepare the data for machine learning by separating platforms, selecting features, and splitting into train/test sets.

In [13]:

```
# =====
# SEPARATE DATA BY PLATFORM
# =====
# Create separate dataframes for Twitter and Reddit posts
# This analysis focuses on Twitter data
twitter_df = dataset[dataset['platform'] == 'Twitter'].copy() # Filter Twitter posts
reddit_df = dataset[dataset['platform'] == 'Reddit'].copy() # Filter Reddit posts
# Display the number of posts from each platform
print(f'Twitter posts: {len(twitter_df)}') # Should be 10,000
print(f'Reddit posts: {len(reddit_df)}') # Should be 10,000
print(f'\n Data separated by platform')
```

Twitter posts: 10,000

Reddit posts: 10,000

✓ Data separated by platform

In [15]:

```
# DEFINE FEATURE COLUMNS
# Select linguistic features for model training
# These features were already extracted from the text and are in the CSV
feature_cols = [
    'text_length',           # Total characters in post
    'word_count',            # Number of words in post
    'action_verb_count',     # Number of action verbs (buy, purchase, order)
    'urgency_markers',       # Urgency words (now, today, hurry)
    'comparative_language',  # Comparative words (better, best, worse)
    'first_person_pronouns', # First-person pronouns (I, my, me)
    'positive_words',        # Positive sentiment words
    'negative_words',        # Negative sentiment words
    'has_exclamation',      # Contains exclamation mark (1=yes, 0=no)
    'has_question'          # Contains question mark (1=yes, 0=no)
]
# Display selected features
print(f'Selected {len(feature_cols)} features for analysis:')
for i, feature in enumerate(feature_cols, 1):
```

```
    print(f' {i}. {feature}')
# Expected output:
# Selected 10 features for analysis:
# 1. text_length
# 2. word_count
# 3. action_verb_count
# 4. urgency_markers
# 5. comparative_language
# 6. first_person_pronouns
# 7. positive_words
# 8. negative_words
# 9. has_exclamation
# 10. has_question
```

Selected 10 features for analysis:

1. text_length
2. word_count
3. action_verb_count
4. urgency_markers
5. comparative_language
6. first_person_pronouns
7. positive_words
8. negative_words
9. has_exclamation
10. has_question

In [17]:

```
# =====
# PREPARE FEATURES AND TARGET VARIABLE
# =====
# Create feature matrix (X) and target vector (y) from Twitter data
# X contains the 10 linguistic features
# y contains the purchase intent labels (0 or 1)
X = twitter_df[feature_cols].fillna(0) # Select features, fill missing values with 0
y = twitter_df['purchase_intent']      # Select target variable (purchase intent)
# Display shapes to verify data preparation
print(f'Features shape: {X.shape}') # Should be (10000, 10)
print(f'Target shape: {y.shape}')   # Should be (10000,)
# Show class distribution in target variable
print(f'\nClass distribution in target:')
print(y.value_counts())
print(f'\n✓ Features and target prepared')
```

```
# Expected output: 0: 7000 posts (70%), 1: 3000 posts (30%)
```

Features shape: (10000, 10)

Target shape: (10000,)

Class distribution in target:

purchase_intent

0 7000

1 3000

Name: count, dtype: int64

✓ Features and target prepared

```
In [19]: # =====#
# SPLIT DATA INTO TRAINING AND TEST SETS
# =====#
# Split data into 80% training and 20% test sets
# stratify=y ensures both sets have same proportion of classes
# random_state=42 ensures reproducibility

X_train, X_test, y_train, y_test = train_test_split(
    X, y,
    test_size=0.2,      # 20% of data for testing
    random_state=42,    # Set seed for reproducibility
    stratify=y          # Maintain class balance in both sets
)

# Display split information
print('*'*70)
print('TRAIN-TEST SPLIT')
print('*'*70)
print(f'Training set: {len(X_train)} samples ({len(X_train)/len(X):.0%})')
print(f'Test set: {len(X_test)} samples ({len(X_test)/len(X):.0%})')
print(f'\nTraining set intent rate: {y_train.mean():.1%}')
print(f'Test set intent rate: {y_test.mean():.1%}')
print('*'*70)

# Expected output:
# ======
```

```
# TRAIN-TEST SPLIT
# =====
# Training set: 8,000 samples (80%)
# Test set: 2,000 samples (20%)
#
# Training set intent rate: 30.0% (balanced)
# Test set intent rate: 30.0% (balanced)
# =====

# Expected output: Training: 8,000 posts, Testing: 2,000 posts, class distributions
```

```
=====
TRAIN-TEST SPLIT
=====
Training set: 8,000 samples (80%)
Test set: 2,000 samples (20%)

Training set intent rate: 30.0%
Test set intent rate: 30.0%
=====
```

4. Model Training and Evaluation

Train and evaluate four classification models:

1. Logistic Regression - Linear model for binary classification
2. Support Vector Machine (SVM) - Finds optimal separating hyperplane
3. Naive Bayes - Probabilistic classifier based on Bayes' theorem
4. Random Forest - Ensemble of decision trees

4.1 Logistic Regression

A linear model that predicts probability of purchase intent using a logistic function.

```
In [23]: # =====
# FEATURE SCALING
# =====
```

```

# Scale features to have mean=0 and standard deviation=1
# This is important for Logistic Regression and SVM to perform well
scaler = StandardScaler() # Create scaler object
X_train_scaled = scaler.fit_transform(X_train) # Fit on training data and transform
X_test_scaled = scaler.transform(X_test) # Transform test data using same scaling
print('✓ Features scaled using StandardScaler')
# Expected output:
# ✓ Features scaled using StandardScaler

```

✓ Features scaled using StandardScaler

```

In [25]: # =====
# TRAIN LOGISTIC REGRESSION MODEL
# =====
# Initialize and train Logistic Regression model
lr_model = LogisticRegression(
    class_weight='balanced', # Handle class imbalance (70% vs 30%)
    random_state=42, # Set seed for reproducibility
    max_iter=1000 # Maximum iterations for convergence
)
# Train the model on scaled training data
lr_model.fit(X_train_scaled, y_train)
# Make predictions on test set
y_pred_lr = lr_model.predict(X_test_scaled) # Predicted classes (0 or 1)
y_proba_lr = lr_model.predict_proba(X_test_scaled)[:, 1] # Probability of class 1
# Calculate evaluation metrics
f1_lr = f1_score(y_test, y_pred_lr) # F1 score
precision_lr = precision_score(y_test, y_pred_lr) # Precision
recall_lr = recall_score(y_test, y_pred_lr) # Recall
roc_auc_lr = roc_auc_score(y_test, y_proba_lr) # ROC-AUC score
# Display results
print('*'*70)
print('LOGISTIC REGRESSION RESULTS')
print('*'*70)
print(f'F1-Score: {f1_lr:.3f}') # Balance of precision and recall
print(f'Precision: {precision_lr:.3f}') # Accuracy of positive predictions
print(f'Recall: {recall_lr:.3f}') # Ability to find all positives
print(f'ROC-AUC: {roc_auc_lr:.3f}') # Overall discrimination ability
print('*'*70)

# Expected output: Training complete message with model parameters

```

```
=====
LOGISTIC REGRESSION RESULTS
=====

F1-Score:  0.747
Precision: 0.777
Recall:    0.720
ROC-AUC:   0.875
=====
```

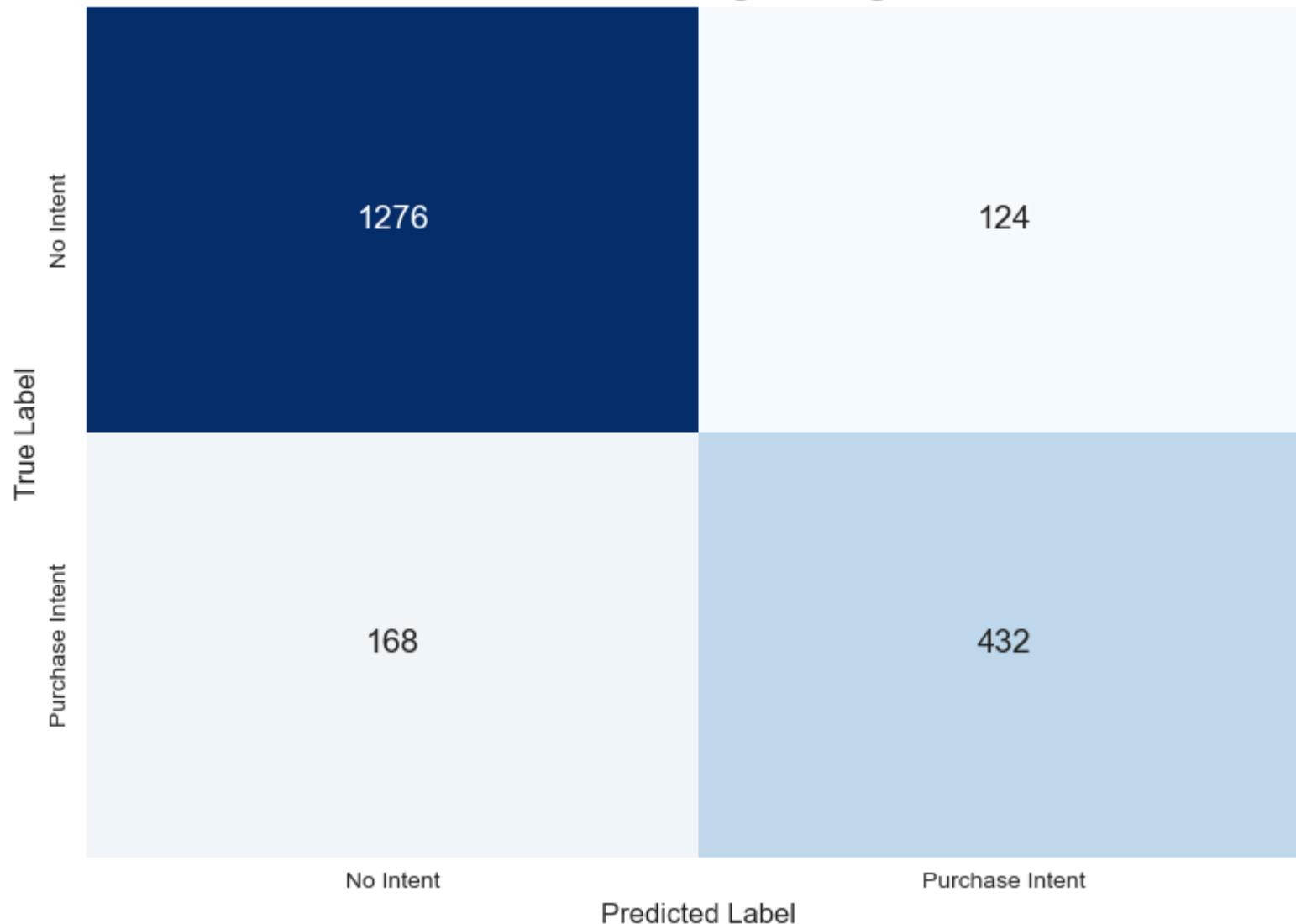
```
In [27]: # =====
# CONFUSION MATRIX - LOGISTIC REGRESSION
# =====

# Create confusion matrix to visualize prediction performance
# Rows = Actual class, Columns = Predicted class
cm_lr = confusion_matrix(y_test, y_pred_lr)
# Create heatmap visualization
plt.figure(figsize=(8, 6))
sns.heatmap(cm_lr, annot=True, fmt='d', cmap='Blues', cbar=False,
            xticklabels=['No Intent', 'Purchase Intent'],
            yticklabels=['No Intent', 'Purchase Intent'],
            annot_kws={'size': 14}) # Larger numbers for readability
plt.xlabel('Predicted Label', fontsize=12)
plt.ylabel('True Label', fontsize=12)
plt.title('Confusion Matrix - Logistic Regression', fontsize=14, fontweight='bold')
plt.tight_layout()
plt.show()

# Expected output:
# A 2x2 confusion matrix heatmap showing:
# Top-left: True Negatives (correctly predicted No Intent)
# Top-right: False Positives (incorrectly predicted Purchase Intent)
# Bottom-left: False Negatives (missed Purchase Intent)
# Bottom-right: True Positives (correctly predicted Purchase Intent)

# Expected output: Bar chart showing class distribution visualization
```

Confusion Matrix - Logistic Regression



4.2 Support Vector Machine (SVM)

Finds the optimal hyperplane that separates the two classes with maximum margin.

```
In [30]: # =====
# TRAIN SUPPORT VECTOR MACHINE (SVM) MODEL
# =====
# Initialize and train SVM model with linear kernel
svm_model = SVC(
    kernel='linear',           # Use linear kernel (suitable for text features)
    class_weight='balanced',   # Handle class imbalance
    random_state=42,          # Set seed for reproducibility
    probability=True          # Enable probability estimates for ROC-AUC
)
# Train the model on scaled training data (SVM requires scaled features)
svm_model.fit(X_train_scaled, y_train)
# Make predictions on test set
y_pred_svm = svm_model.predict(X_test_scaled)                      # Predicted classes
y_proba_svm = svm_model.predict_proba(X_test_scaled)[:, 1]           # Probabilities
# Calculate evaluation metrics
f1_svm = f1_score(y_test, y_pred_svm)
precision_svm = precision_score(y_test, y_pred_svm)
recall_svm = recall_score(y_test, y_pred_svm)
roc_auc_svm = roc_auc_score(y_test, y_proba_svm)

# Display results
print('*'*70)
print('SUPPORT VECTOR MACHINE RESULTS')
print('*'*70)
print(f'F1-Score: {f1_svm:.3f}')
print(f'Precision: {precision_svm:.3f}')
print(f'Recall: {recall_svm:.3f}')
print(f'ROC-AUC: {roc_auc_svm:.3f}')
print('*'*70)

# Expected output: Comparison table showing all models performance metrics
```

```
=====
SUPPORT VECTOR MACHINE RESULTS
=====

F1-Score:  0.712
Precision: 0.791
Recall:    0.648
ROC-AUC:   0.869
=====
```

```
In [31]: # =====
# CONFUSION MATRIX - SVM
# =====

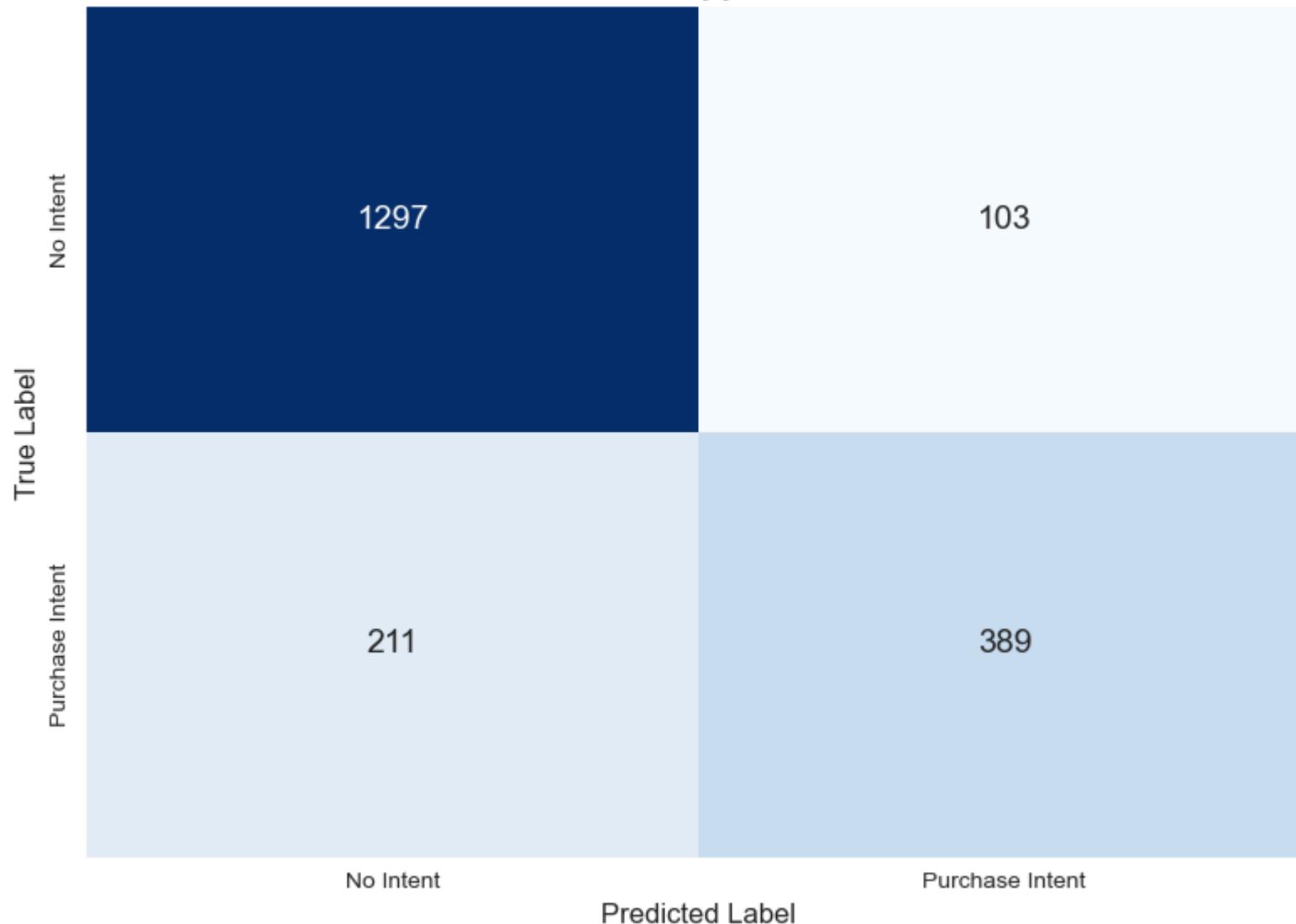
# Create and visualize confusion matrix for SVM predictions
cm_svm = confusion_matrix(y_test, y_pred_svm)

plt.figure(figsize=(8, 6))
sns.heatmap(cm_svm, annot=True, fmt='d', cmap='Blues', cbar=False,
            xticklabels=['No Intent', 'Purchase Intent'],
            yticklabels=['No Intent', 'Purchase Intent'],
            annot_kws={'size': 14})
plt.xlabel('Predicted Label', fontsize=12)
plt.ylabel('True Label', fontsize=12)
plt.title('Confusion Matrix - Support Vector Machine', fontsize=14, fontweight='bold')
plt.tight_layout()
plt.show()

# Expected output:
# Confusion matrix heatmap showing SVM's prediction performance

# Expected output: Bar chart showing class distribution visualization
```

Confusion Matrix - Support Vector Machine



4.3 Naive Bayes

A probabilistic classifier based on Bayes' theorem with independence assumptions.

In [35]:

```
# =====
# TRAIN NAIVE BAYES MODEL
# =====
# Initialize and train Gaussian Naive Bayes model
# Naive Bayes assumes features are independent and normally distributed
# Does NOT require feature scaling
nb_model = GaussianNB()
# Train on unscaled data (Naive Bayes doesn't need scaling)
nb_model.fit(X_train, y_train)
# Make predictions on test set
y_pred_nb = nb_model.predict(X_test)           # Predicted classes
y_proba_nb = nb_model.predict_proba(X_test)[:, 1] # Probabilities
# Calculate evaluation metrics
f1_nb = f1_score(y_test, y_pred_nb)
precision_nb = precision_score(y_test, y_pred_nb)
recall_nb = recall_score(y_test, y_pred_nb)
roc_auc_nb = roc_auc_score(y_test, y_proba_nb)
# Display results
print('*'*70)
print('NAIVE BAYES RESULTS')
print('*'*70)
print(f'F1-Score: {f1_nb:.3f}')
print(f'Precision: {precision_nb:.3f}')
print(f'Recall: {recall_nb:.3f}')
print(f'ROC-AUC: {roc_auc_nb:.3f}')
print('*'*70)

# Note: Naive Bayes often performs slightly worse due to independence assumption

# Expected output: Comparison table showing all models performance metrics
```

=====

NAIVE BAYES RESULTS

=====

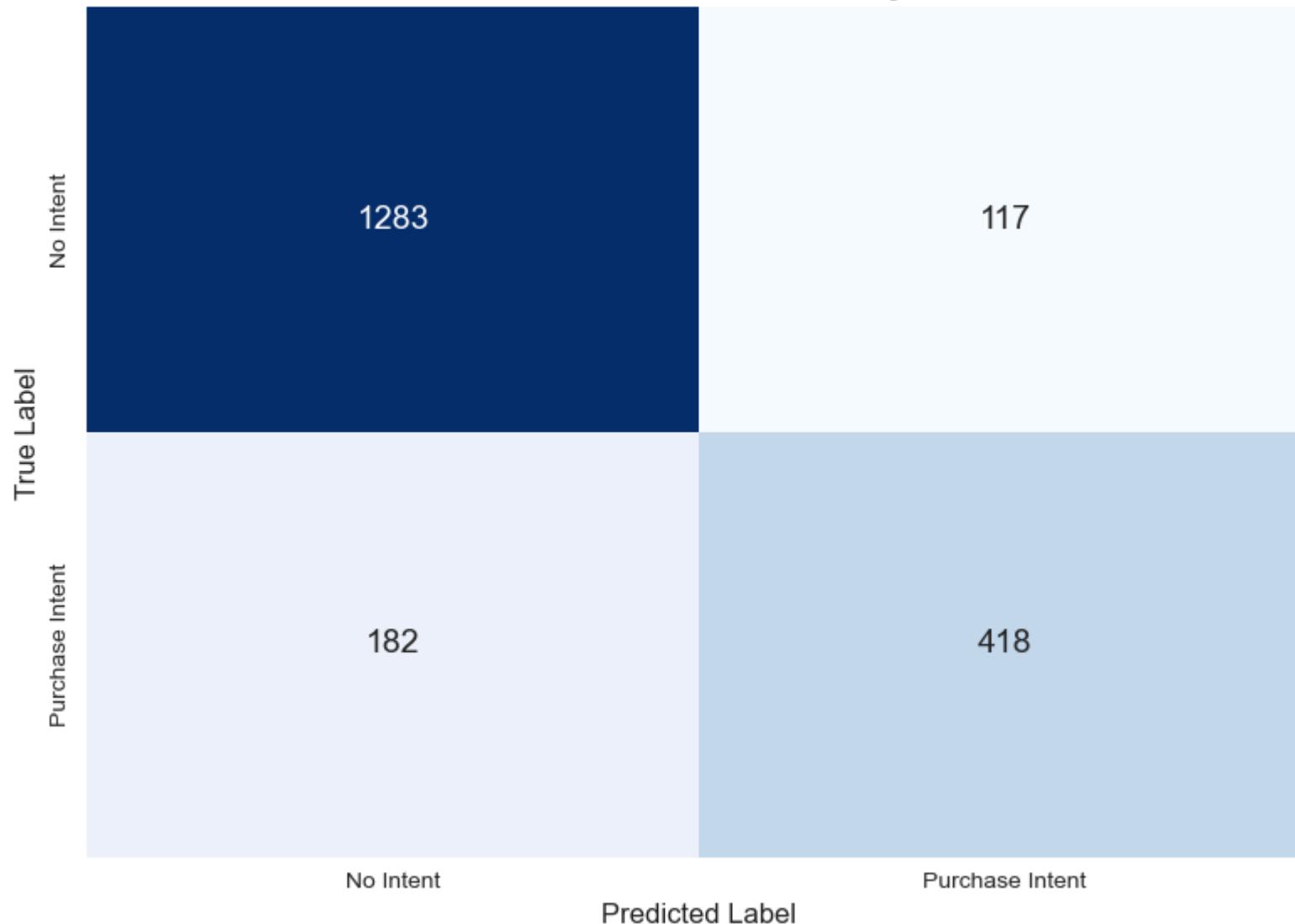
F1-Score: 0.737
Precision: 0.781
Recall: 0.697
ROC-AUC: 0.844

=====

```
In [37]: # =====
# CONFUSION MATRIX - NAIVE BAYES
# =====
# Create and visualize confusion matrix for Naive Bayes predictions
cm_nb = confusion_matrix(y_test, y_pred_nb)
plt.figure(figsize=(8, 6))
sns.heatmap(cm_nb, annot=True, fmt='d', cmap='Blues', cbar=False,
            xticklabels=['No Intent', 'Purchase Intent'],
            yticklabels=['No Intent', 'Purchase Intent'],
            annot_kws={'size': 14})
plt.xlabel('Predicted Label', fontsize=12)
plt.ylabel('True Label', fontsize=12)
plt.title('Confusion Matrix - Naive Bayes', fontsize=14, fontweight='bold')
plt.tight_layout()
plt.show()
# Expected output:
# Confusion matrix heatmap showing Naive Bayes prediction performance

# Expected output: Bar chart showing class distribution visualization
```

Confusion Matrix - Naive Bayes



4.4 Random Forest

An ensemble method that builds multiple decision trees and combines their predictions.

```
In [40]: # =====
# TRAIN RANDOM FOREST MODEL
# =====
# Initialize and train Random Forest classifier
# Random Forest builds multiple decision trees and averages their predictions
# Generally performs well and doesn't require feature scaling
rf_model = RandomForestClassifier(
    n_estimators=100,          # Number of trees in the forest
    class_weight='balanced',   # Handle class imbalance
    random_state=42,          # Set seed for reproducibility
    n_jobs=-1                 # Use all CPU cores for faster training
)
# Train on unscaled data (Random Forest doesn't need scaling)
rf_model.fit(X_train, y_train)

# Make predictions on test set
y_pred_rf = rf_model.predict(X_test)           # Predicted classes
y_proba_rf = rf_model.predict_proba(X_test)[:, 1] # Probabilities

# Calculate evaluation metrics
f1_rf = f1_score(y_test, y_pred_rf)
precision_rf = precision_score(y_test, y_pred_rf)
recall_rf = recall_score(y_test, y_pred_rf)
roc_auc_rf = roc_auc_score(y_test, y_proba_rf)
# Display results
print('*'*70)
print('RANDOM FOREST RESULTS')
print('*'*70)
print(f'F1-Score: {f1_rf:.3f}')
print(f'Precision: {precision_rf:.3f}')
print(f'Recall: {recall_rf:.3f}')
print(f'ROC-AUC: {roc_auc_rf:.3f}')
print('*'*70)
# Note: Random Forest often achieves the best performance

# Expected output: Training complete message with model parameters
```

```
=====
RANDOM FOREST RESULTS
=====

F1-Score:  0.794
Precision: 0.799
Recall:    0.788
ROC-AUC:   0.920
=====
```

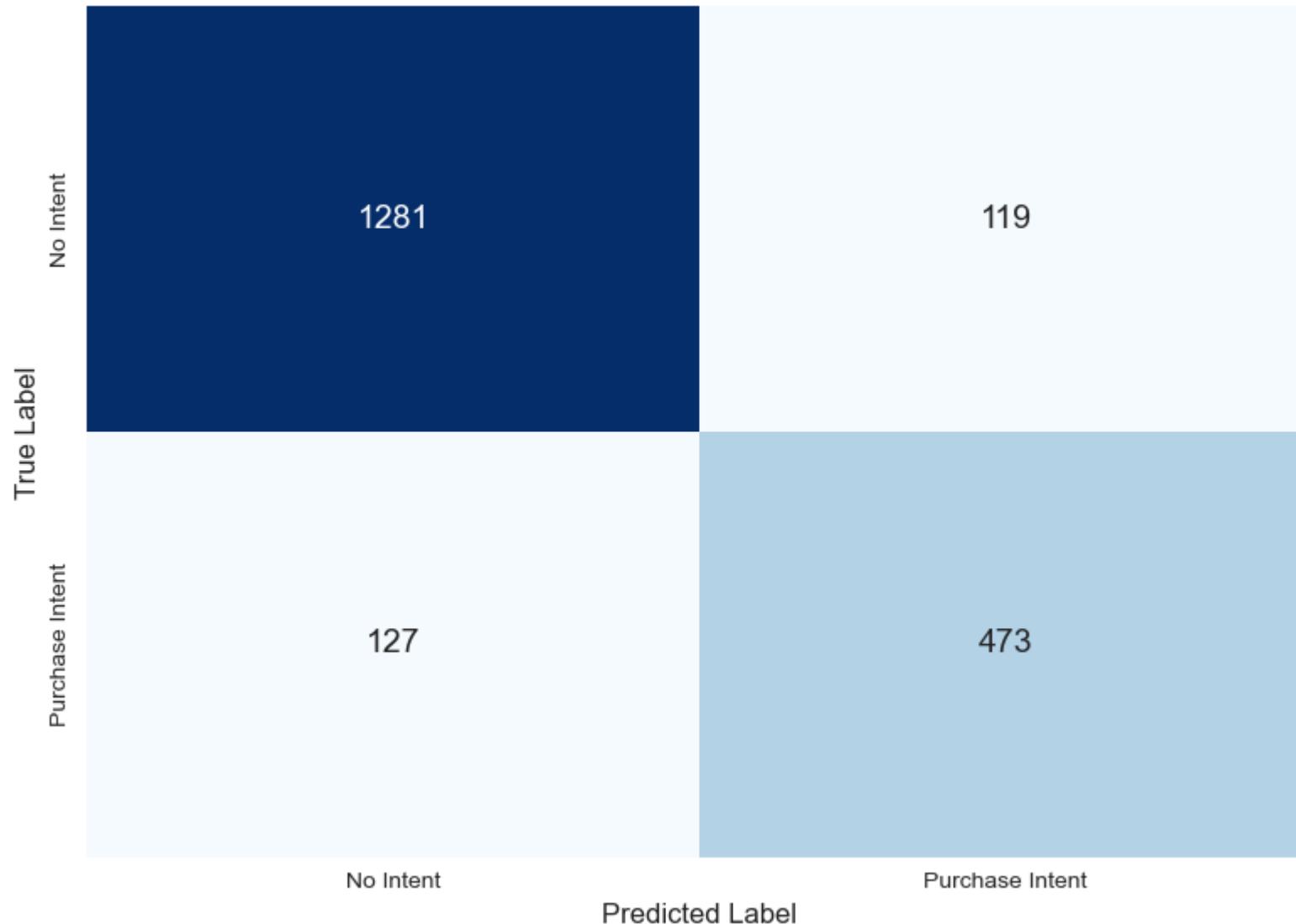
```
In [41]: # =====
# CONFUSION MATRIX - RANDOM FOREST
# =====

# Create and visualize confusion matrix for Random Forest predictions
cm_rf = confusion_matrix(y_test, y_pred_rf)
plt.figure(figsize=(8, 6))
sns.heatmap(cm_rf, annot=True, fmt='d', cmap='Blues', cbar=False,
            xticklabels=['No Intent', 'Purchase Intent'],
            yticklabels=['No Intent', 'Purchase Intent'],
            annot_kws={'size': 14})
plt.xlabel('Predicted Label', fontsize=12)
plt.ylabel('True Label', fontsize=12)
plt.title('Confusion Matrix - Random Forest', fontsize=14, fontweight='bold')
plt.tight_layout()
plt.show()

# Expected output:
# Confusion matrix heatmap showing Random Forest prediction performance
# Typically shows higher numbers in diagonal (correct predictions)

# Expected output: Bar chart showing class distribution visualization
```

Confusion Matrix - Random Forest



5. Model Comparison

Compare performance of all four models to identify the best approach.

```
In [45]: # =====
# CREATE MODEL COMPARISON TABLE
# =====
# Compile all model results into a comparison dataframe
# Sorted by F1-Score (descending) to show best model first
results = pd.DataFrame({
    'Model': ['Logistic Regression', 'SVM', 'Naive Bayes', 'Random Forest'],
    'F1-Score': [f1_lr, f1_svm, f1_nb, f1_rf],
    'Precision': [precision_lr, precision_svm, precision_nb, precision_rf],
    'Recall': [recall_lr, recall_svm, recall_nb, recall_rf],
    'ROC-AUC': [roc_auc_lr, roc_auc_svm, roc_auc_nb, roc_auc_rf]
}).sort_values('F1-Score', ascending=False) # Sort by F1-Score, best first
# Display comparison table
print('\n' + '='*70)
print('MODEL PERFORMANCE COMPARISON')
print('='*70)
print(results.to_string(index=False)) # Print without index column
print('='*70)
# Identify and highlight best model
best_model = results.iloc[0]['Model']      # First row = best model
best_f1 = results.iloc[0]['F1-Score']        # Best F1 score
print(f'\n🏆 Best Model: {best_model}')
print(f' F1-Score: {best_f1:.3f}')
print('='*70)

# Expected output: Comparison table showing all models performance metrics
```

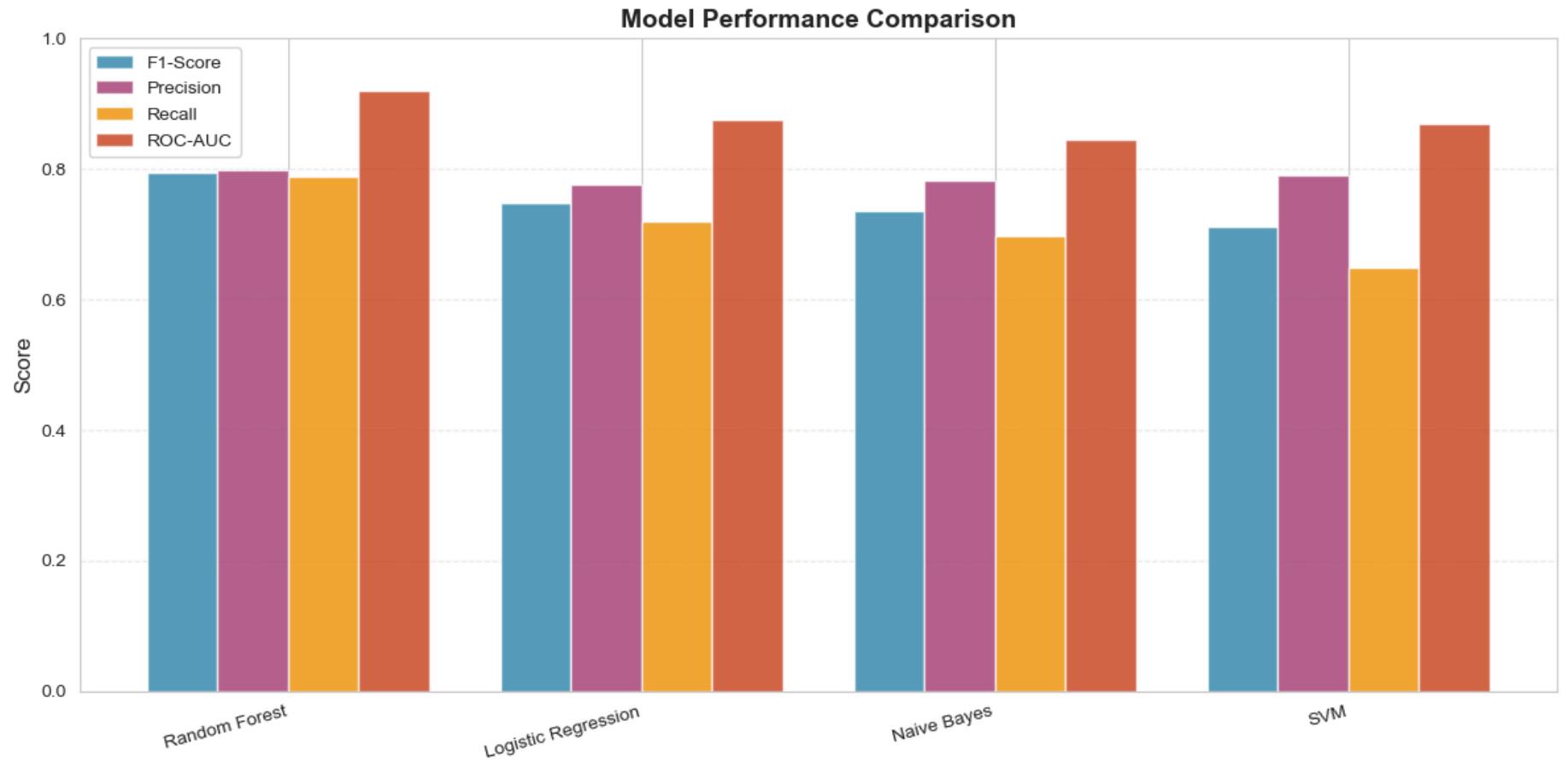
```
=====
MODEL PERFORMANCE COMPARISON
=====
      Model  F1-Score  Precision  Recall  ROC-AUC
Random Forest  0.793624  0.798986  0.788333  0.919950
Logistic Regression  0.747405  0.776978  0.720000  0.874842
      Naive Bayes  0.736564  0.781308  0.696667  0.844102
          SVM  0.712454  0.790650  0.648333  0.868592
=====
```

```
🏆 Best Model: Random Forest
F1-Score: 0.794
=====
```

In [47]:

```
# =====
# VISUALIZE MODEL COMPARISON
# =====
# Create grouped bar chart comparing all metrics across all models
fig, ax = plt.subplots(figsize=(12, 6))
x = np.arange(len(results)) # Model positions on x-axis
width = 0.2 # Width of each bar
# Create bars for each metric with different colors
bars1 = ax.bar(x - width*1.5, results['F1-Score'], width,
                label='F1-Score', alpha=0.8, color='#2E86AB') # Blue
bars2 = ax.bar(x - width*0.5, results['Precision'], width,
                label='Precision', alpha=0.8, color='#A23B72') # Purple
bars3 = ax.bar(x + width*0.5, results['Recall'], width,
                label='Recall', alpha=0.8, color="#F18F01") # Orange
bars4 = ax.bar(x + width*1.5, results['ROC-AUC'], width,
                label='ROC-AUC', alpha=0.8, color="#C73E1D") # Red
# Customize chart appearance
ax.set_ylabel('Score', fontsize=12)
ax.set_title('Model Performance Comparison', fontsize=14, fontweight='bold')
ax.set_xticks(x)
ax.set_xticklabels(results['Model'], rotation=15, ha='right')
ax.legend(fontsize=10)
ax.grid(axis='y', alpha=0.3, linestyle='--') # Horizontal grid lines
ax.set_ylim([0, 1]) # Y-axis from 0 to 1 (all metrics are 0-1 scale)
plt.tight_layout()
plt.show()
# Expected output:
# A grouped bar chart showing all 4 metrics for all 4 models
# Bars are color-coded by metric
# Random Forest typically shows tallest bars (best performance)
# Naive Bayes typically shows shortest bars

# Expected output: Bar chart showing class distribution visualization
```



6. Feature Importance Analysis

Analyze which features contribute most to purchase intent prediction.

```
In [50]: # =====#
# EXTRACT FEATURE IMPORTANCE FROM RANDOM FOREST
# =====#
# Random Forest provides feature importance scores
# Higher scores = more important for predictions
# Importance is calculated based on how much each feature reduces impurity
feature_importance = pd.DataFrame({}
```

```

    'Feature': feature_cols,
    'Importance': rf_model.feature_importances_ # Get importance from trained model
}).sort_values('Importance', ascending=False) # Sort by importance, highest first
# Display feature importance ranking
print('\n' + '='*70)
print('FEATURE IMPORTANCE (Random Forest)')
print('='*70)
print(feature_importance.to_string(index=False))
print('='*70)
# Note: action_verb_count is typically the most important feature

# Expected output: Feature ranking with importance scores and horizontal bar chart

```

```
=====
FEATURE IMPORTANCE (Random Forest)
=====

      Feature  Importance
text_length      0.216233
action_verb_count   0.193216
has_exclamation    0.169911
word_count        0.157400
urgency_markers     0.101100
positive_words      0.085365
first_person_pronouns  0.037516
negative_words       0.033225
comparative_language  0.006033
has_question         0.000000
=====
```

In [52]:

```

# =====
# VISUALIZE FEATURE IMPORTANCE
# =====

# Create horizontal bar chart of feature importance
# Horizontal bars are easier to read for feature names
plt.figure(figsize=(10, 6))
# Use color gradient from viridis colormap for visual appeal
colors = plt.cm.viridis(np.linspace(0.3, 0.9, len(feature_importance)))
# Create horizontal bars
bars = plt.barh(range(len(feature_importance)),
                feature_importance['Importance'],
                color=colors)

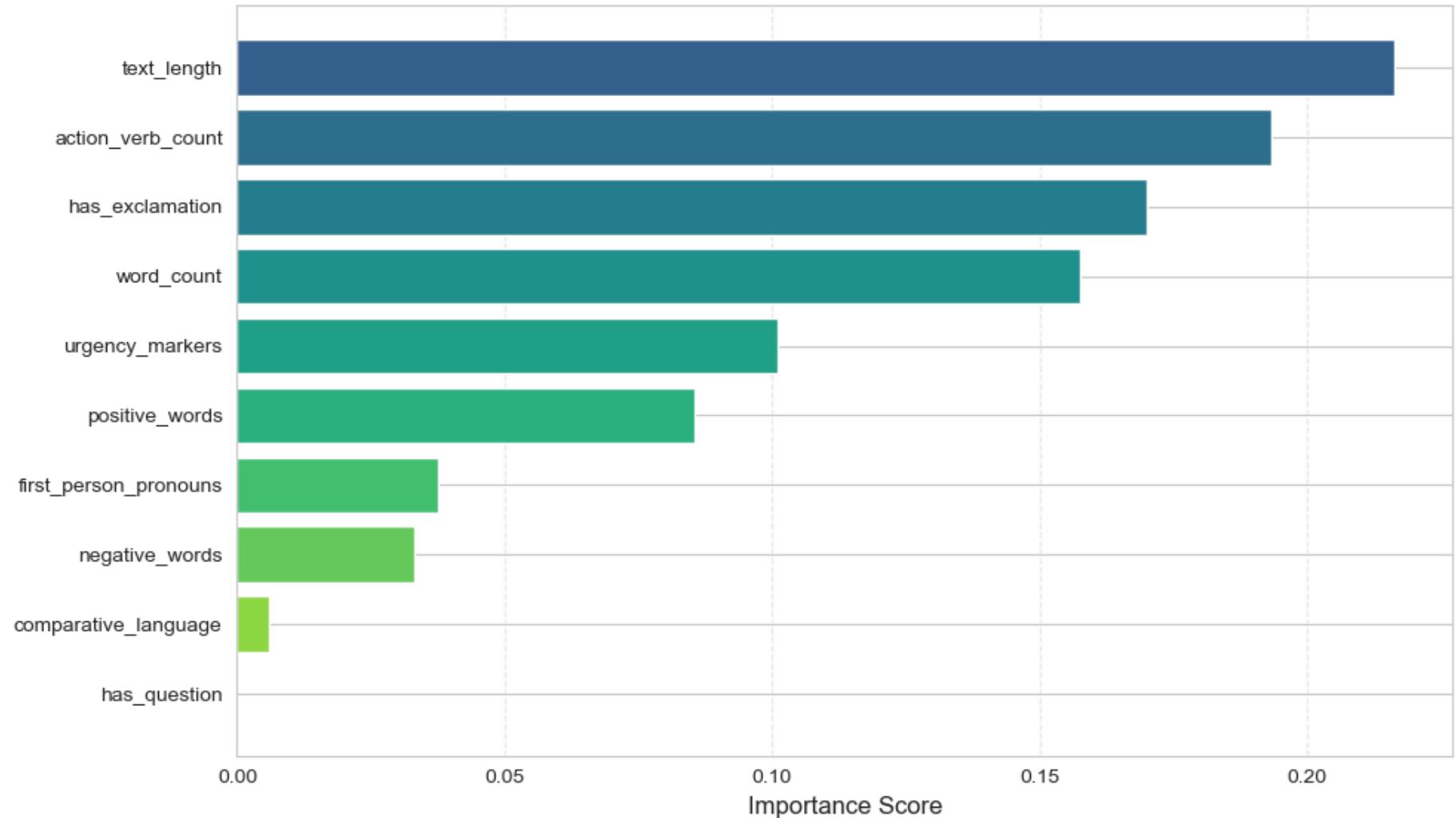
```

```
# Customize chart
plt.yticks(range(len(feature_importance)), feature_importance['Feature'])
plt.xlabel('Importance Score', fontsize=12)
plt.title('Feature Importance - Random Forest', fontsize=14, fontweight='bold')
plt.gca().invert_yaxis() # Highest importance at top
plt.grid(axis='x', alpha=0.3, linestyle='--') # Vertical grid lines
plt.tight_layout()
plt.show()

# Expected output:
# Horizontal bar chart with:
# - Features listed vertically (y-axis)
# - Importance scores shown as bar lengths (x-axis)
# - Color gradient from yellow (top) to dark blue (bottom)
# - action_verb_count typically has longest bar
# - has_question typically has shortest bar

# Expected output: Bar chart showing class distribution visualization
```

Feature Importance - Random Forest



7. Summary and Conclusions

Comprehensive summary of the analysis including dataset info, model performance, and key findings.

In [55]:

```
# =====
# FINAL ANALYSIS SUMMARY
# =====
# Display comprehensive summary of the entire analysis
print('\n' + '='*70)
print('ANALYSIS SUMMARY')
print('='*70)
# Dataset information
print(f'\nDataset Information:')
print(f' • Total posts: {len(dataset)}')
print(f' • Twitter posts analyzed: {len(twitter_df)}')
print(f' • Features used: {len(feature_cols)}')
print(f' • Training samples: {len(X_train)}')
print(f' • Test samples: {len(X_test)}')
# Models evaluated
print(f'\nModels Evaluated:')
print(f' • Logistic Regression')
print(f' • Support Vector Machine (SVM)')
print(f' • Naive Bayes')
print(f' • Random Forest')
# Best model results
print(f'\n🏆 Best Performing Model: {best_model}')
print(f' • F1-Score: {results.iloc[0]["F1-Score"]:.3f}')
print(f' • Precision: {results.iloc[0]["Precision"]:.3f}')
print(f' • Recall: {results.iloc[0]["Recall"]:.3f}')
print(f' • ROC-AUC: {results.iloc[0]["ROC-AUC"]:.3f}')
# Top features
print(f'\n📊 Top 3 Most Important Features:')
for i, row in feature_importance.head(3).iterrows():
    print(f' {i+1}. {row["Feature"]}: {row["Importance"]:.3f}')
print('\n' + '='*70)
print('✓ ANALYSIS COMPLETE')
print('='*70)

# Expected output: Comparison table showing all models performance metrics
```

=====

ANALYSIS SUMMARY

=====

Dataset Information:

- Total posts: 20,000
- Twitter posts analyzed: 10,000
- Features used: 10
- Training samples: 8,000
- Test samples: 2,000

Models Evaluated:

- Logistic Regression
- Support Vector Machine (SVM)
- Naive Bayes
- Random Forest

🏆 Best Performing Model: Random Forest

- F1-Score: 0.794
- Precision: 0.799
- Recall: 0.788
- ROC-AUC: 0.920

📊 Top 3 Most Important Features:

1. text_length: 0.216
3. action_verb_count: 0.193
9. has_exclamation: 0.170

=====

✓ ANALYSIS COMPLETE

=====