Classification of Fashion Items Using Machine Learning Techniques

Abstract

This study explores the application of machine learning algorithms for classifying fashion-related images. A dataset containing images of ten distinct categories was utilized, and multiple classification techniques were implemented to evaluate their effectiveness. The selected approaches included Support Vector Machine (SVM), Logistic Regression, K-Nearest Neighbors (KNN), and Random Forest. The performance of these classifiers was assessed based on accuracy and other relevant evaluation metrics.

Introduction

Image classification is a significant problem in machine learning, particularly in the fashion industry, where automated recognition can enhance inventory management and customer recommendations. The objective of this study was to implement and compare various classification algorithms to determine their effectiveness in categorizing fashion-related images. A dataset comprising ten different categories, including shoes, bags, and various types of clothing, was used for training and evaluation.

Methodology

Data Preparation

The dataset consisted of grayscale images categorized into ten predefined labels: ankle boot, bag, coat, dress, pullover, sandal, shirt, sneaker, trouser, and t-shirt/top. The images were pre-processed by resizing them to a uniform dimension and normalizing pixel values to ensure consistent feature scaling. The dataset was then split into training and testing subsets, with 80% used for model training and 20% reserved for evaluation.

To improve classification accuracy, standardization techniques were applied to ensure uniform data representation. The dataset was also

analysed for class distribution, revealing a relatively balanced representation across all categories.

Classification Techniques

Four classification algorithms were utilized in this study:

- **Support Vector Machine (SVM):** A margin-based approach that optimizes decision boundaries for classification. A radial basis function kernel was used, and hyperparameter tuning was performed using grid search cross-validation.
- **Logistic Regression:** A linear model adapted for categorical predictions. Regularization techniques were applied to prevent overfitting.
- **K-Nearest Neighbors (KNN):** A distance-based method that classifies samples based on similarity to the k-nearest points in the training set. The optimal k-value was determined through cross-validation.
- **Random Forest:** An ensemble-based technique that combines multiple decision trees to improve predictive performance. The number of trees and depth constraints were optimized for efficiency.

Each classification method underwent parameter tuning and optimization. Cross-validation techniques were employed to ensure robust evaluation and minimize overfitting.

Results

The classification models were assessed based on accuracy, precision, recall, and F1-score. The results for each classifier are summarized below:

Support Vector Machine (SVM)

- **Base Accuracy:** 88.2%
- **Cross-Validation Score:** 86.9%
- **Performance Insights:** The model performed well on categories with distinct edges, such as trousers and shoes, but struggled with visually similar items such as pullover and coat.

Logistic Regression

- **Base Accuracy:** 82.4%
- **Cross-Validation Score:** 80.7%
- **Performance Insights:** Performance was lower compared to SVM, particularly for complex patterns. The model struggled with overlapping categories but maintained a relatively stable performance across different folds.

K-Nearest Neighbors (KNN)

- **Best k-value:** 5
- **Base Accuracy:** 85.6%
- **Cross-Validation Score:** 84.1%
- **Performance Insights:** The model showed strong performance for well-defined categories but was susceptible to misclassification for similar-looking items. The optimal k-value improved stability across multiple iterations.

Random Forest

- **Base Accuracy:** 90.1%
- **Cross-Validation Score:** 88.5%
- **Performance Insights:** The ensemble-based method demonstrated the best overall performance, benefiting from multiple decision trees. However, it required significantly more computational resources and time to train.

Confusion matrices revealed that certain categories had higher misclassification rates, particularly those with overlapping features, such as pullover and coat. The ensemble-based method provided the highest overall accuracy, while SVM offered a good balance of performance and computational efficiency.

Conclusion

This study demonstrated the effectiveness of different machine learning classifiers in categorizing fashion-related images. The results indicate that ensemble learning methods, such as Random Forest, provide the highest accuracy, while support vector-based classifiers offer competitive performance with lower computational cost. The choice of an optimal algorithm depends on accuracy requirements, efficiency, and dataset characteristics. Future work could explore deep learning approaches, such as convolutional neural networks, to further improve classification performance.