Image Classification with Convolutional Neural Network

Problem Statement

In the realm of e-commerce and fashion, efficiently categorizing products is crucial for enhancing user experience, streamlining inventory management, and enabling effective recommendation systems. Traditional methods of manually labeling products are time-consuming and may not scale well with large datasets. This project addresses the challenge of automating the categorization of fashion product images using a Convolutional Neural Network (CNN).

Recent advances in deep learning, particularly CNNs, have demonstrated remarkable capabilities in image classification tasks. Leveraging these advancements, we aim to create a model capable of accurately categorizing fashion products into master categories such as Apparel, Accessories, Footwear, Personal Care, Free Items, and Sporting Goods. The classification model not only provides insights into the product inventory but also serves as a foundation for building recommendation systems based on image similarities.

The primary objectives of this project include:

- Developing a CNN model for image classification using transfer learning with the VGG16 architecture.
- Improving model robustness and accuracy through hyperparameter tuning.
- Building a recommendation system that suggests similar products based on image features.
- Exploring the potential challenges, such as misclassification of minority classes, and devising strategies for enhancement.

Through this project, we aim to contribute to the automation of product categorization in the fashion industry, providing a scalable and efficient solution for businesses dealing with extensive product catalogs.

Data Sources

- Datasets: Fashion Product Images Dataset (kaggle.com)

Overview

This project focuses on classifying fashion product images using a Convolutional Neural Network (CNN). The dataset, sourced from Kaggle, contains 44k+ product images with corresponding catalog information. The goal is to categorize products into master categories, such as Apparel, Accessories, Footwear, Personal Care, Free Items, Sporting Goods, and Home.

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1. Data Wrangling

- The dataset was obtained from Kaggle, comprising product images and a catalog spreadsheet.
- A subset of the dataset was chosen due to computing constraints, with a focus on majority and minority categories.
- Catalog information was used to label images with their respective master categories.

2. Data Processing

- Images were resized and converted into a 4D numpy array compatible with the VGG16 model.
- Target features were transformed into categorical arrays for training.

3. Modeling

- Transfer learning was applied using the VGG16 pre-trained CNN model.
- Two fully connected dense layers were added, followed by the output layer for classification.
- The model was trained with an 80/20 train-test split, achieving an overall accuracy of 95.85%.

4. Hyperparameter Tuning

- Hyperparameters, including the number of neurons and learning rate, were tuned using Keras Tuner.
- Despite good performance, the tuned model showed a decrease in accuracy and misclassification of the "Sporting Goods" class.

5. Recommendation System

- A recommendation system was built using feature extraction from the VGG16 model.
- Cosine similarity scores were calculated to provide recommendations based on image similarities.

6. What's Next

- Future plans include testing the model on the entire dataset using cloud-based resources.
- Improving model robustness, modularity, and portability for broader adoption.
- Experimenting with additional hyperparameters and model architectures.
- Comparing the performance of different pre-trained models.
- Starting a new project involving regression with deep neural networks.

7. How to Use

- Clone the repository: `git clone https://github.com/your-username/your-repo.git`

- Install dependencies: `pip install -r requirements.txt`
- Open and run the Jupyter Notebook for detailed analysis and model implementation.

8. Contributors

- Hongling Yang (https://github.com/hyang78227)

Project Structure

```
|-- data/
|   |-- raw_data/
|   |-- cleaned_data/
|-- Proposal/
|-- Classification/Notebooks/
|-- Recommendation/Notebooks/
|-- Presentation/
|-- Documentation/
|-- requirements.txt
|-- README.md
```

Current Questions

This project addresses several key questions:

- How well can a Convolutional Neural Network (CNN) classify fashion product images into master categories?
- What is the impact of data preprocessing, transfer learning, and hyperparameter tuning on the model's accuracy and performance?
- How effective is the recommendation system based on cosine similarity scores derived from the CNN's feature extraction?
- What are the limitations of the model, especially in dealing with minority classes like "Sporting Goods"?

Why and Who Cares?

Understanding and classifying fashion product images have significant real-world applications and implications:

- **E-commerce Platforms:** Improved image classification can enhance product categorization on e-commerce platforms, providing users with better search and recommendation experiences.
- **Retail Industry:** Accurate classification helps retailers organize their inventory efficiently, optimize product placements, and tailor marketing strategies.
- **User Experience:** Enhancing the accuracy of fashion product classification contributes to a more personalized and enjoyable online shopping experience for consumers.
- **Future Developments:** This project serves as a foundation for exploring and improving deep learning techniques for image classification, with potential applications in diverse fields beyond fashion.