Gender Detection in Facial Images: A Comprehensive CNN Analysis

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Abstract

This research investigates the construction of a robust gender detection system using facial features and Convolutional Neural Networks (CNNs), exploring the impact of different layer configurations on accuracy and computational efficiency. With a validation accuracy of 91%, findings illuminate the nuanced relationship between precision and computational resources, enriching discussions on facial recognition technologies.

Introduction

Gender detection in facial images has become a pivotal research domain within computer vision and artificial intelligence [1,4]. This study endeavors to construct a robust gender detection system leveraging facial features [3-7]. The application potential spans diverse sectors, including demographic analysis, targeted advertising, security enhancement, personalized user experiences, and medical diagnostics [2,3]. Employing Convolutional Neural Networks (CNNs), this research scrutinizes the impact of varying convolutional and max-pooling layer configurations (ranging from 1 to 5) on accuracy and computational efficiency. The results reveal a validation accuracy of 91%, shedding light on the delicate balance between precision and computational resources [1]. This study enriches the ongoing discourse on facial recognition technologies through tailored considerations and potential research pathways.

Methods

The methodologies encompassed CNN architectures with varying numbers of convolutional and max-pooling layers. The flowchart illustrates the CNN model's architecture, highlighting Convolutional, Max-Pooling, Flattening, and Fully Connected Layers' roles in feature extraction and gender classification.

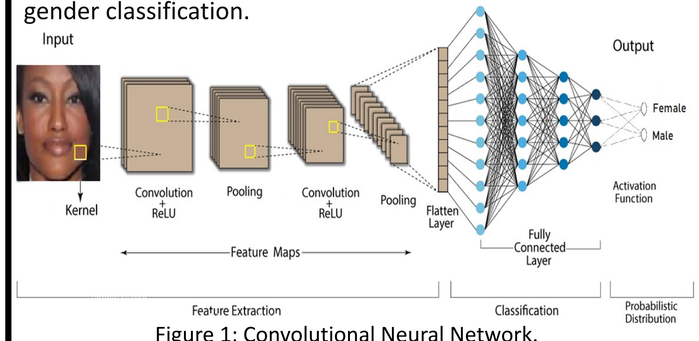

Figure 1: Convolutional Neural Network.

Analysis

The analysis includes a breakdown of the sample dataset by gender, providing insights into the gender distribution. The dataset comprises roughly 24,000 images of individuals with 0-116 years of age, annotated with age, gender and ethnicity. The image shows the dataset consists of around 52.3% males and 47.7% females, which means the gender distribution is almost balanced.

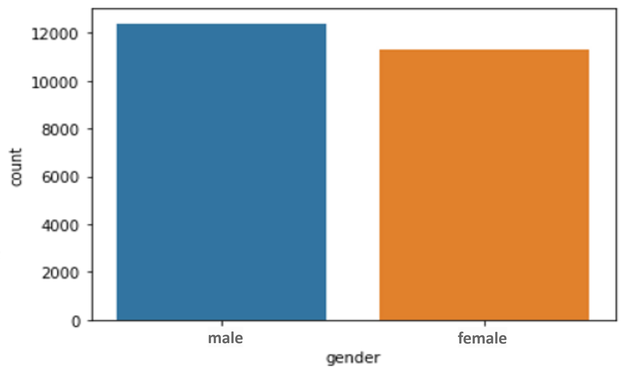

Figure 2: Gender Distribution.

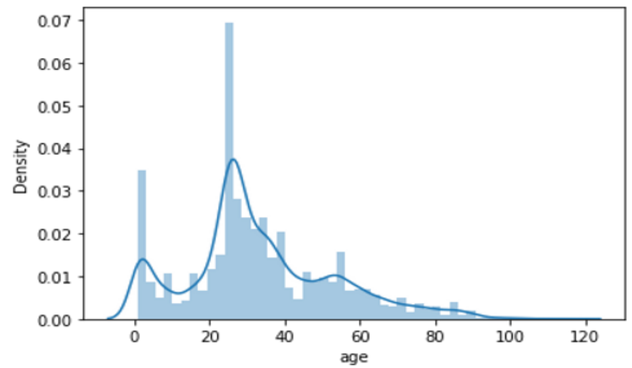

Figure 3: Age Distribution.

Results

The results showcase the validation accuracy and training time for CNN models with different convolutional layer and max pooling layer configurations.

A comparative analysis reveals nuanced insights into the trade-offs between accuracy and computational efficiency. A visual comparison highlights the performance of CNN models ranging from one to five convolutional and max-pooling layers. This comparison elucidates the impact of model complexity on gender recognition accuracy.

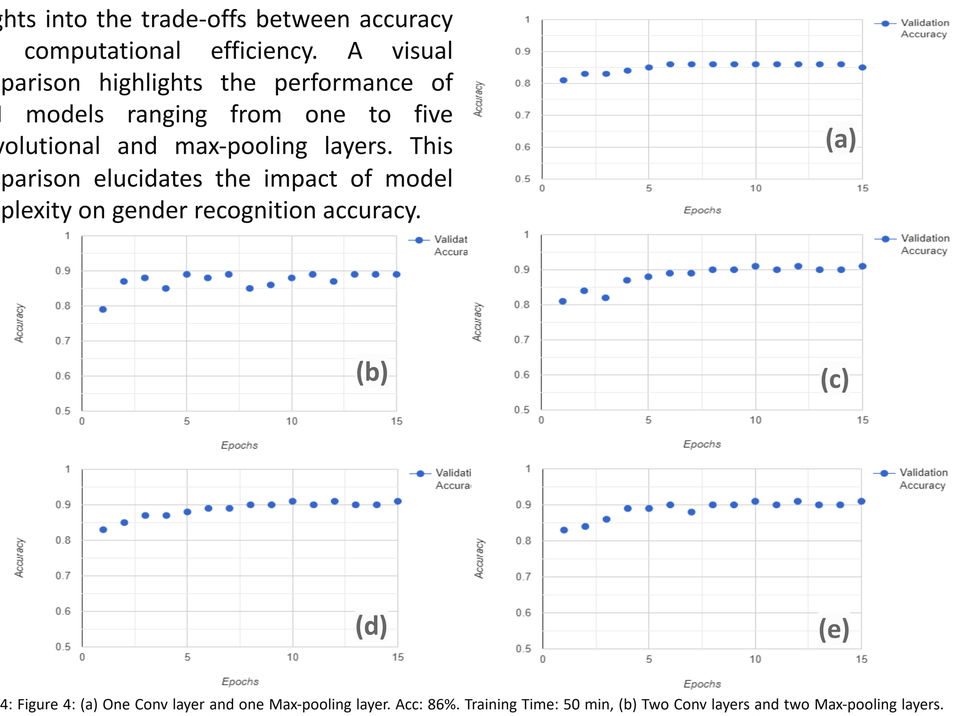

Figure 4: Figure 4: (a) One Conv layer and one Max-pooling layer. Acc: 86%. Training Time: 50 min, (b) Two Conv layers and two Max-pooling layers. Acc: 89%. Training Time: 88 min, (c) Three Conv layers and three Max-pooling layers. Acc: 91%. Training Time: 95 min, (d) Four Conv layers and four Max-pooling layers. Acc: 91%. Training Time: 103 min, (e) Five Conv layers and five Max-pooling layers. Acc: 91%. Training Time: 176 min.

Conclusions

This study underscores the significance of CNNs in gender recognition from facial images. Findings suggest that CNN models with three convolutional layers and max pooling layers offer optimal performance, achieving a validation accuracy of 91% after 12 epochs. Considerations for future research include exploring hybrid architectures and transfer learning strategies to enhance model performance further.

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