GENDER DETECTION FROM IMAGE OF FACE USING NEURAL NETWORK MODEL

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JUNE 1, 2023

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Introduction

In our deep learning project that focuses on the fascinating task of gender detection from human facial images. With advancements in computer vision and artificial intelligence, we have harnessed the power of deep learning algorithms to develop an accurate and efficient model that can automatically determine the gender of an individual based solely on their facial features.

The ability to infer gender from facial images has numerous real-world applications, ranging from market research and targeted advertising to biometric identification and law enforcement. Our project aims to provide a robust and reliable solution to this task, leveraging state-of-the-art deep learning techniques and large-scale datasets.

The core of our project lies in convolutional neural networks (CNNs), which have proven to be highly effective in extracting discriminative features from images. By training a CNN on diverse and comprehensive datasets comprising facial images of individuals across different age groups, ethnicities, and cultural backgrounds, we have enabled our model to learn intricate patterns and subtle cues that characterize gender.

To achieve accurate gender detection, our model undergoes an extensive training process. We carefully curate a labelled dataset of facial images, where each image is annotated with the corresponding gender. This dataset serves as the foundation for training the deep learning model, allowing it to learn the complex relationships between facial features and gender attributes.

Once trained, our gender detection model can swiftly analyse a new facial image and provide a prediction with high accuracy. The model's performance is continuously refined and optimized through rigorous evaluation and fine-tuning processes, ensuring its robustness and adaptability across diverse real-world scenarios.

We believe that our deep learning project holds immense potential in various domains, including social sciences, marketing, and security. By automating the gender detection process, we aim to contribute to a more efficient and data-driven decision-making framework while fostering advancements in computer vision and artificial intelligence research.

The Dataset

For the project we have used a large-scale face dataset named as UTK Face Large scale dataset. The dataset could be found in the following link –

Dataset link: https://www.kaggle.com/datasets/jangedoo/utkface-new

We can learn more details about the dataset in the following website –

https://susanqq.github.io/UTKFace/

The dataset is a large-scale face dataset with long age span (range from 0 to 116 years old). The dataset consists of over 23,708 face images with annotations of age, gender, and ethnicity. The images cover large variation in pose, facial expression, illumination, occlusion, resolution, etc. This dataset could be used on a variety of tasks, e.g., face detection, age estimation, age progression/regression, landmark localization, etc. Some sample images are shown in the Figure 1-

Figure 1: Sample images of the dataset

Labels

The labels of each face image are embedded in the file name, formatted like "[age]_[gender]_[race]_[date&time].jpg"

- [age] is an integer from 0 to 116, indicating the age
- [gender] is either 0 (male) or 1 (female)
- [race] is an integer from 0 to 4, denoting White, Black, Asian, Indian, and Others (like Hispanic, Latino, Middle Eastern).
- [date&time] is in the format of yyyymmddHHMMSSFFF, showing the date and time an image was collected to UTKFace

We are going train our model based on the given dataset.

Objective

In this project our objective is to build up a machine learning model that will be able to take input of the face image and detect the gender of the face in the image. We'll going to use the Deep-Learning methods to build up the model. To fulfil this objective, we have to undergo the following processes-

- Pre-process the image dataset and extract numeric values of the images in the form of the array with corresponding labels regarding whether an image is a male or a female
- Split the dataset into train and test dataset
- Use the train dataset to train the deep learning model and update the model until a satisfactory level of accuracy in the testing dataset is gained
- Build a function that can detect all the faces that are present in a given image and use the pre-trained model that can detect gender of the faces

Pre-Processing

In the next step we are going to pre-process the images so that they will be appropriate to be inserted into the model. For these we undergo the following stages of the pre-processing –

Filtering the good images

In the first step of pre-processing we have filtered those images out of the 23,708 images; that has captured the full face of the subject. For this we have defined a good image as the images that has both the eyes of the subject, visible.

To filter out these good images we have used the inbuilt HARCASCADE eye detector offered be "cv2" package in python. This eye detection model is known as harcascade_eye, it is used to detect all the eyes in the image. We have only selected those images in our model training that has both the two eyes of the subject in the image.

In the end of this process only 16,786 images are found to be good. We have used these filtered images to train our model.

Forming input array and labels

In the next step we have extracted the images as the series of (100 X 100 X 3) array of numbers ranging from 0 to 255. The images arrays are stored s X. Since There are 16,786 images therefore the shape of X will be (16.786 X 100 X 100 X 3). Here all the images are forcefully resized to (100 X 100) shape, using the "cv2" package. Also, from the name of the images, the gender, have been extracted and stored in y. Here the length of y will be 16,786.

Scaling the images

The input array of images that is X, contains value in between 0 and 255. To scale it we divide the array by 255. Then all the values of the array we come between 0 and 1. Now this input array is ready for training the model.

The Model Building

We have used a neural network model as the classification model. The steps of the model building process are given below.

Structure of the neural network

The neural network has the structure, shown in Figure 2-

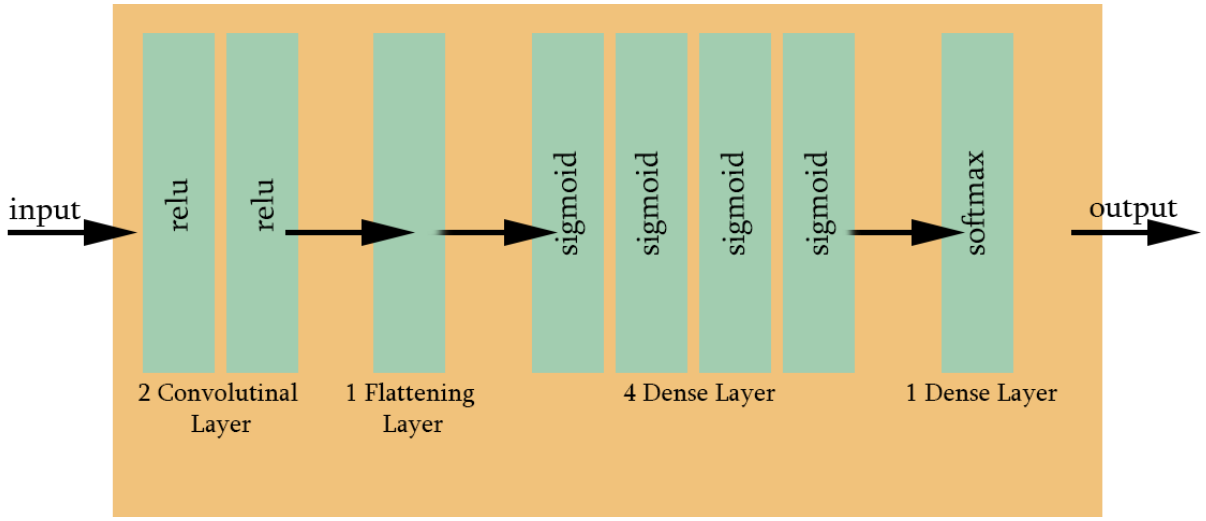

Figure 2: Structure of the designed neural network

The neural network has 2 convolutional layers, that used to reduce the dimension of the images., 1 flattening layer that are used to flatten the reduced dimension of the image array into to an array of single row, then it is added with 5 dense layers, 4 with sigmoid as activation function and 1 with soft-max as activation function.

For each of the input face the model returns a 2-d tuple like (p1, p2). Here p1 and p2 can be thought as a probability score to the support of male and female respectively. Also, here p2 = 1 – p1. We classify the inserted face as male if and only if p1 > p2 otherwise we classify it as female.

Model Accuracy

We have split the dataset in 80-20 ratio to get the training and testing datasets. We used the training dataset to build the classification model using neural network. Now we calculated the accuracy of the model using the testing dataset.

The accuracy is given in the form of the following classification report shown in Table 1.

Classification	Precision	Recall	F1-score	Support
Male	0.92	0.81	0.86	1584
Female	0.85	0.93	0.89	1773
Accuracy				0.88

Table 1: Table showing the accuracy of the classification

From a glance on the Table 1, its clear the model performs very well. The precision score and recall score for both male and female classification is very high (near 90% on an average) with a satisfactory level of support. The overall accuracy of the classification is 88%. That means on an average out of 100 predictions the model predicts 88 predictions correctly.

We have saved this model separately.

A function for classification

Lastly, we have built a function, whose task is to detect all possible face from a given image, and detect the gender of each of the detected faces.

For detection of the face we have used a pre-trained face detection model - HARCASCADE_FRONTAL_FACE available in “cv2” library of python.

Conclusion

In conclusion, our deep learning project focused on the task of gender detection from human facial images has demonstrated the remarkable potential of artificial intelligence in computer vision. Through the utilization of convolutional neural networks and large-scale datasets, we have developed a robust and accurate model capable of inferring gender from facial features.

The project's success is a testament to the power of deep learning algorithms in extracting meaningful patterns and subtle cues from images. By training the model on diverse datasets, we have enabled it to learn and generalize gender-related characteristics across various demographic groups, enhancing its applicability in real-world scenarios.

The impact of our gender detection model extends beyond academic research. It offers practical applications in market research, targeted advertising, biometric identification, and law enforcement. The ability to automatically determine gender from facial images can assist in tailoring products and services to specific demographics, improving security systems, and streamlining various decision-making processes.

However, like any research endeavour, our project has its limitations. The model's performance may vary in challenging scenarios, such as low-quality images, extreme lighting conditions, or diverse cultural contexts. Continued research and refinement are necessary to address these challenges and improve the model's robustness and generalizability.

In conclusion, our deep learning project in gender detection from human facial images showcases the potential of AI-powered computer vision in various domains. It represents a significant step towards automated and accurate gender inference, offering valuable insights and possibilities for businesses, security systems, and society as a whole. As technology advances, we anticipate further breakthroughs in this field, opening new avenues for understanding and utilizing visual data in increasingly sophisticated ways.

We have built a simple web app using python flask utilizing this trained model. All the important links are given below.

References

The important links are given below

1. Dataset Link - https://www.kaggle.com/datasets/jangedoo/utkface-new
2. Link to the website - https://susanqq.github.io/UTKFace/
3. Link to the project - https://github.com/sayandas1302/Gender-Detection-From-Image