113681-MGT-665-NW2 - Final Project

Gender Classification in Retail: Leveraging CNNs with Azure Custom Vision for Personalized Customer Insights

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113681-MGT-665-NW2 Solving Problems with Machine Learning

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Abstract

This project aims to help retail organizations accurately determine the gender of their clients using Convolutional Neural Networks (CNNs) in Azure Custom Vision. Classifying gender from photographs is crucial for tailored marketing, discounts, and product offerings. This task demonstrates a wide array of implications in demographic analysis, face recognition, biometrics, and security. With image classification technology advancing, especially in industries like e-commerce, automotive, healthcare, and gaming, the need for precise gender prediction from facial images is evident. The project relies on CNNs to build a gender classification system trained on diverse data from Kaggle. It involves model training, evaluation, and deployment, with key performance metrics like Accuracy, Precision, and Recall assessed. The primary aim is to equip retail establishments with a user-friendly and precise gender classification solution, with the intention of enhancing marketing strategies, increasing customer engagement, and ultimately improving sales.

Keywords: Convolutional Neural Networks (CNNs), Azure Custom Vision, Gender classification, Retail marketing, Personalized advertising, Machine learning, Image classification, Deep learning (DL), Neural networks, Training data, Testing data.

Introduction

In the era of personalized marketing, retail companies looking to enhance sales and improve customer engagement must possess a strategy of their clientele demographics. The main goal of this project is to identify gender from images by using the capabilities of Convolutional Neural Networks (CNNs) integrated into Azure Custom Vision. Retail enterprises can enhance their marketing strategies, offer customized discounts, and refine their product advertisements to align with customer preferences by accurately identifying the gender of their client base.

Gender classification is an important visual task for human beings because many social interactions critically depend on the correct gender perception. As visual surveillance and human-computer interaction technologies evolve, it has become imperative for machines to have an automatic and real-time gender identification component. Gender classification systems find use in a wide range of applications demographic data collection, pre-processing step in face recognition systems, biometrics and security surveillance systems and it can also aid in other similar problem domains such as race and ethnicity detection. Hence, gender prediction from facial images has remained an active area of research for the Computer Vision and Machine Learning community.

Recently, image classification is growing and becoming a trend among technology developers especially with the growth of data in different parts of industry such as e-commerce, automotive, healthcare, and gaming. The most obvious example of this technology is applied to Facebook. Facebook now can detect up to 98% accuracy in order to identify your face with only a few tagged images

and classified it into your Facebook's album. The technology itself almost beats the ability of human in image classification or recognition . Image classification has become a major challenge in machine vision and has a long history with it. The challenge includes a broad intra-class range of images caused by color, size, environmental conditions, and shape. It is required big data of labeled training images and to prepare this big data, it consumes a lot of time and cost as for the training purpose only . Deep learning (DL) is a process that consists of a set of methods which classifies the raw data into meaningful information fed into the machine. DL performs classification tasks directly from sound, text, and images. One of the famous algorithms for classification of images in DL is convolutional neural networks (CNN) . While image-preprocessing techniques have improved over the years, they remain susceptible to changes caused by the external environment, and when unexpected changes occur, they usually lose accuracy .

Our project is dependent significantly on neural networks which served as the brain of the gender classification model. We created and optimized neural architectures to learn and extract features from facial images.

Problem Statement

Retail establishments frequently encounter difficulties in precisely determining the gender of their clients, which impedes their capacity to efficiently customize promotional campaigns. In order to overcome this difficulty, this project uses CNNs with Azure Custom Vision to identify people's genders from photos. Retail firms may obtain useful insights into their client demographics and make data-driven decisions to improve customer engagement and boost sales by offering a dependable and automated gender classification solution.

Methodology

In machine learning and cognitive science, artificial neural networks (ANNs) belong to statistical learning algorithms which are inspired by biological neural networks and are used to estimate functions that depend on a large number of inputs and are generally unknown. The hidden layers then link to an 'output layer'. Most ANNs contain some form of 'learning rule' which modifies the weights of the connections according to the input patterns that it is presented with. In a sense, ANNs learn by example as do their biological counterparts; a child learns to recognize dogs from examples of dogs. Although there are many different kinds of learning rules used by neural networks, this demonstration is concerned only with one; the delta rule. The delta rule is often utilized by the most common class of ANNs called 'back propagation neural networks' (BPNNs).

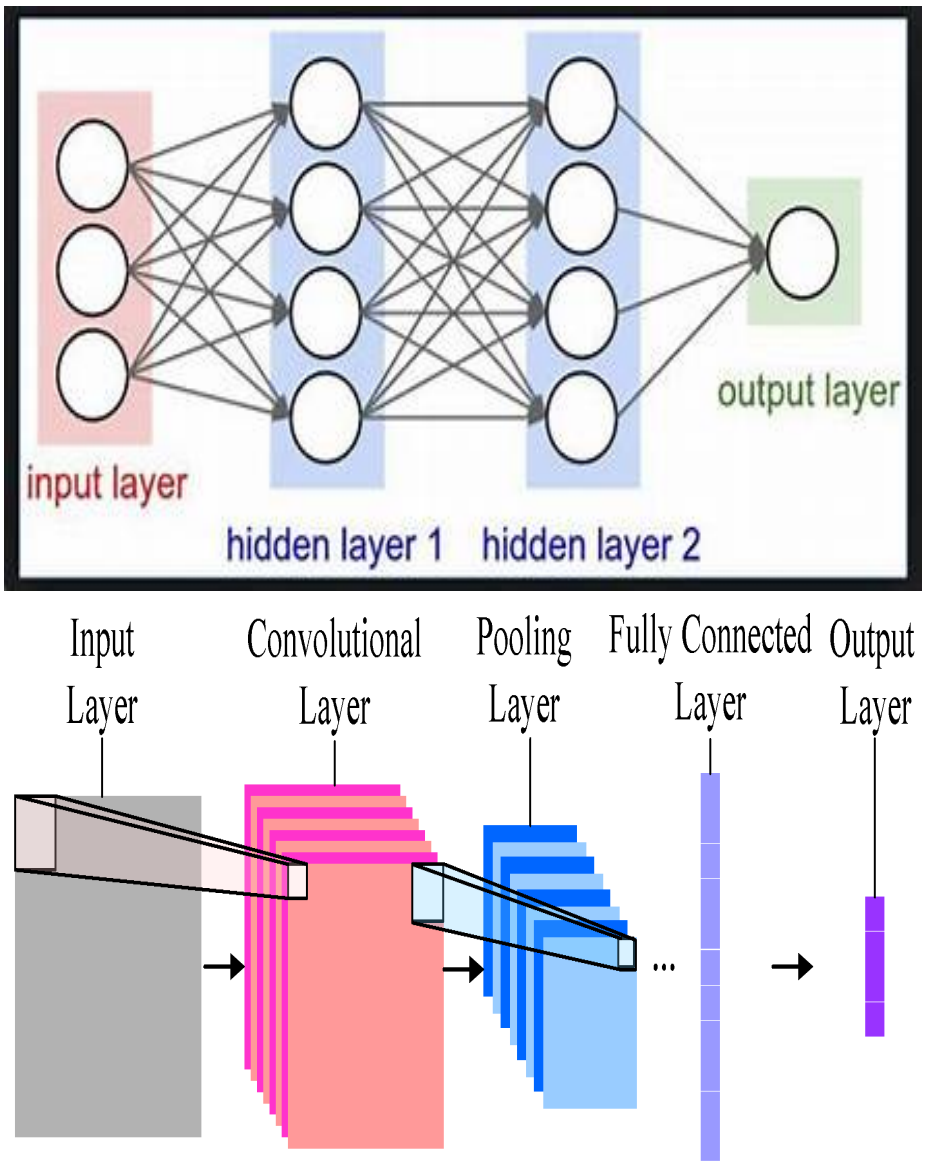

Fig: Neural Networks and Model Architecture

The project classifies genders from photos using image analysis techniques. It makes use of Azure Custom Vision, a user-friendly platform which makes machine learning model development and deployment possible. The process includes gathering and preparing image data, developing and assessing the classification model. This is then used for application in retail settings.

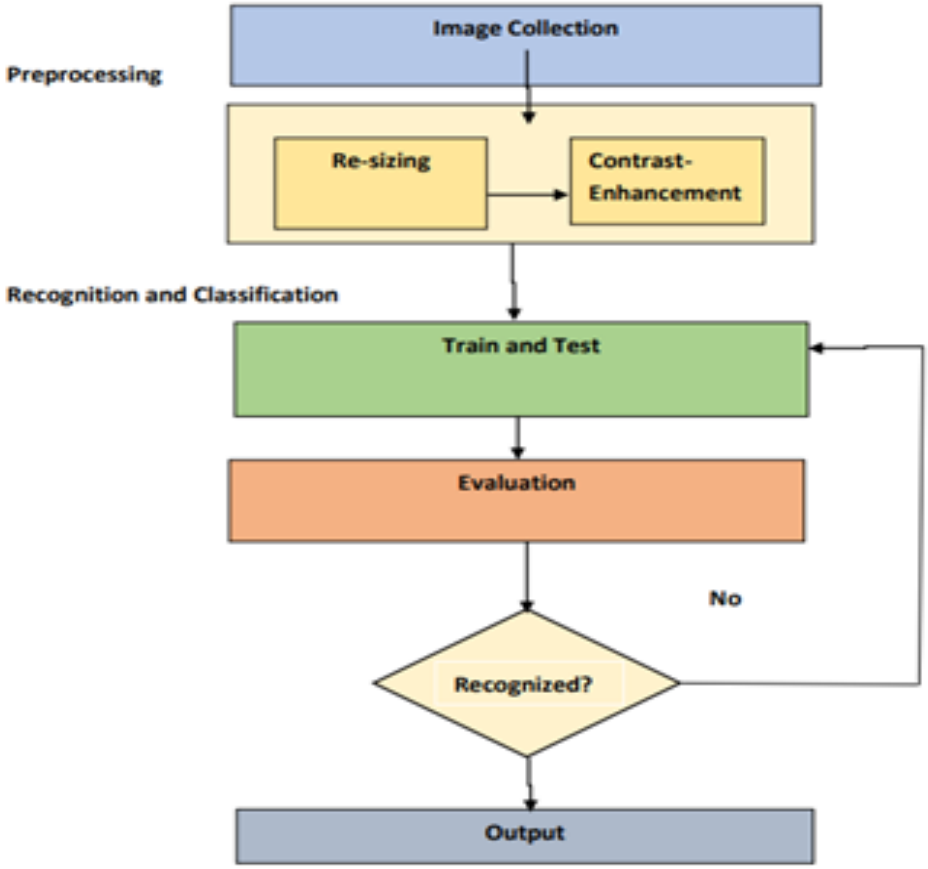

Fig: Risdin, Pronab, & Hassan, 2020

Experiments and Results

We have taken the dataset from **Kaggle**. The data set consists of 962 Male images and 727 Female images. This forms the foundation of the gender classification model, providing the necessary labeled images for training and testing purposes. This dataset comprises a diverse collection of images representing individuals across different genders, including Male, Female. Each image in this dataset is associated with a corresponding gender. This enables the model to learn the visual characteristics of each gender. The dataset is carefully consisting of a wide range of variations in terms of gender presentation, ethnicity, age, to ensure the model's robustness.

Fig: Data set of Male and Female from Kaggel

Once the training is done, we have taken images from open media (e.g., Google) in order to test the model to assess its ability to identify the gender in the image.

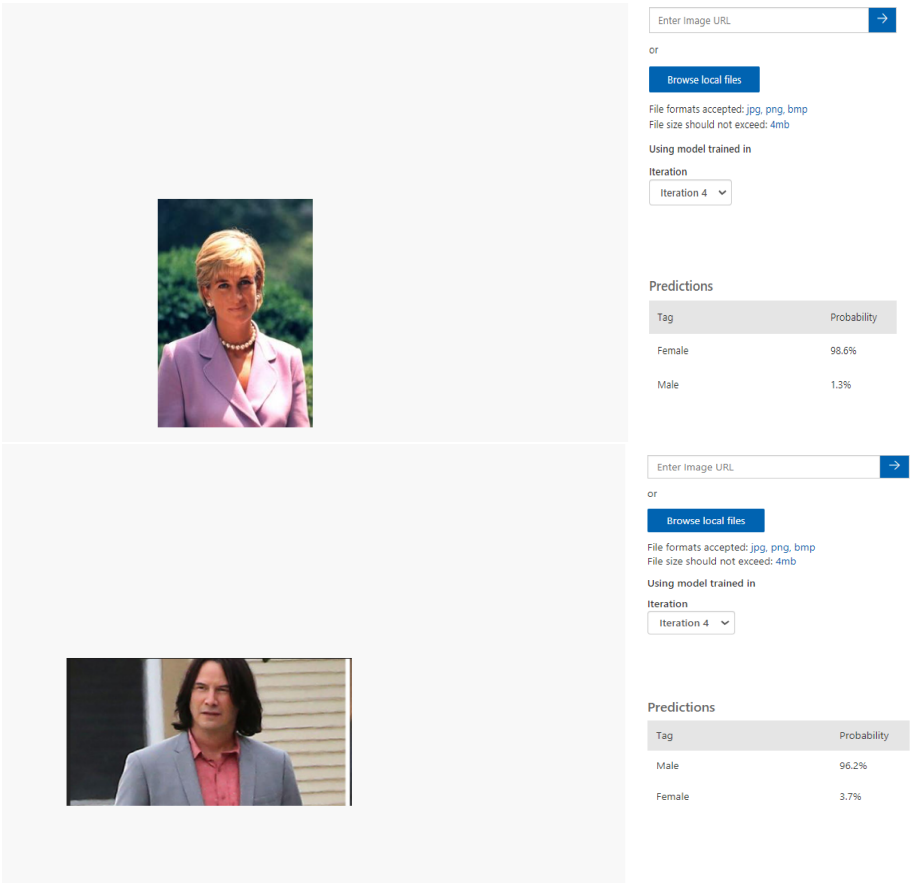

Fig: Output

Here we can see that the chosen images are of two individuals with unique features i.e., Princess Diana who is traditionally feminine in demeanor, her facial features, hairstyle, and attire occasionally defied stereotypical gender norms, making her an intriguing subject for our evaluation; and Keanu Reeves who is also well known for his distinct facial features. For this testing purpose, we have chosen an image of him with long hair and without a beard or moustache. By doing this, we introduced an additional layer of complexity, as hairstyle often serves as a primary cue for gender classification algorithms. Our model has exhibited a remarkable accuracy in predicting the gender of these two individuals.

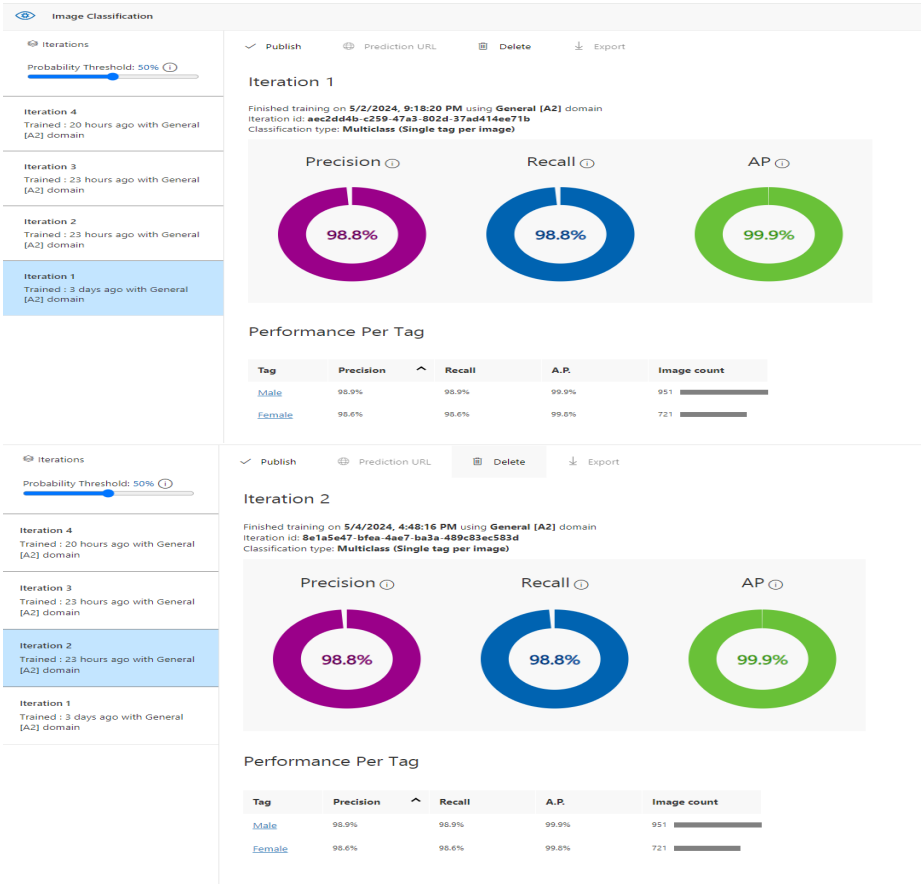

Fig: Iterations

We have also performed several iterations. Iterations are crucial in order to improve the overall performance of the model and play a vital role in development process i.e., for Continuous improvement, adaptability, error analysis, optimization, validation and verification, feedback loop.

Conclusion

In this project, we delved into creating a Microsoft Azure Custom Vision project for gender classification using images. Utilizing the capabilities of Azure Custom Vision, we started on a journey to build a strong model that can accurately classify individuals based on their gender from visual data. Following a methodical approach, we set up a Custom Vision resource in the Azure Portal, customized it to meet our needs, and initiated a new project customized specifically for gender classification. We carefully selected and labeled a varied dataset, ensuring equal representation of both male and female. Subsequent to this procedure, the model underwent training using the provided data. Subsequently, upon completion of the training phase, the model underwent testing utilizing a variety of novel images to assess its efficacy in generating precise predictions. The deployment phase involves implementing the trained gender classification model into a user-friendly interface for integration into retail environments. The deployed model should be capable of accepting input images from various sources, such as surveillance cameras or customer-facing devices, and providing real-time predictions regarding the gender of individuals. In summary, this project highlights the efficiency of Microsoft Azure Custom Vision in tackling real-world issues like gender classification through images. By leveraging artificial intelligence and cloud computing, we have showcased the potential for innovative solutions that have a significant impact across various fields. As we utilize machine learning and data science, Azure Custom Vision stands as a reliable partner, empowering us to translate vision into reality.

References

1. Fouzia Risdin, Pronab Kumar Mondal and Kazi Mahmudul Hassan. (2020). Convolutional Neural Networks (CNN) for Detecting Fruit Information Using Machine Learning Techniques.
`https://encr.pw/Fyvsd`

2. Mohd Azlan Abu, Nurul Hazirah Indra , Abdul Halim Abd Rahman, Nor Amalia Sapiee and Izanoordina Ahmad. (2019). A study on Image Classification based on Deep Learning and Tensorflow.
`https://rb.gy/u8ccd2`

3. Kiran Seetala, William Birdsong & Yenumula B. Reddy. (2019). Image Classification Using TensorFlow.
`https://rb.gy/pea39h`

4. Gabriel Temidayo Adekunle, Adebukola Catherine Aladeyelu. (2023). Image Classification Of Automobiles Using Deep Learning In Tensorflow.
`https://rb.gy/1cma5v`