Applications of Artificial Intelligence, Machine Learning and Data Science (CSC-40070)

Sangeeth Dev Sarangi
Keele University, UK
x6x03@students.keele.ac.uk

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Demographics Face Recognition using CNN

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Problem Question

- We could see the over the last few decades, image uploads to the Internet have increased at a near-exponential rate.

- Technologies can be used for everything from advising someone to use "tag" in Facebook images to detecting pedestrians in self-driving cars.

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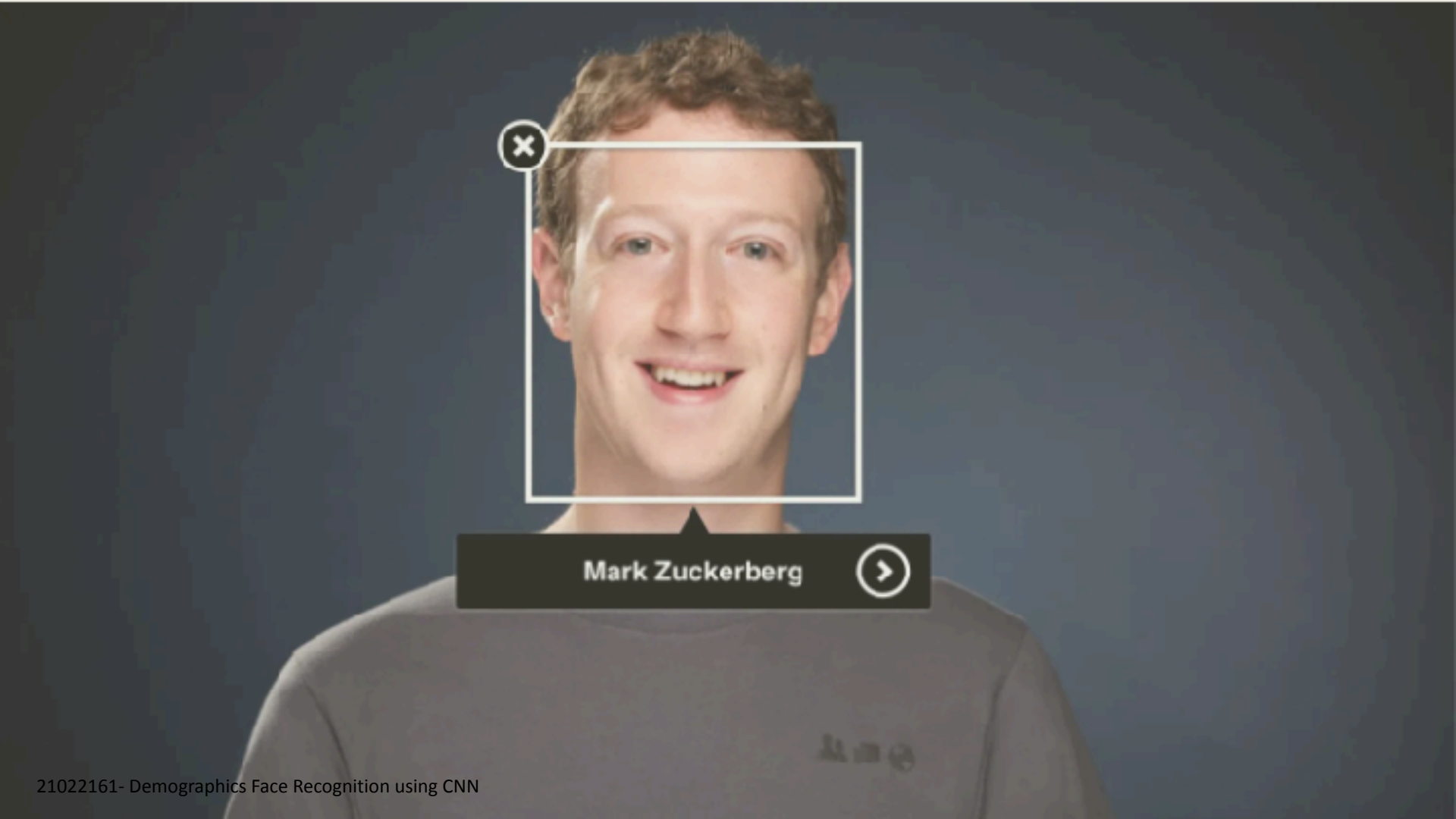
Mark Zuckerberg

- However, building on this work, the next significant step is to ask not only how many faces are in a picture and where they are, but also what qualities those faces have.

- The goal of this project is to classify facial demographic features such as age, gender, and ethnicity in an image.

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Motivation and Challenges

- Age and gender detection systems have a variety of surveillance applications and also aid in Human-Computer Interaction

- But Detecting age and gender from an image is a more difficult challenge than many other computers vision tasks.

- In our case, the images should be labelled with the people's ages, genders, and ethnicity. Because there are so few of them compared to labelled data, finding this type of data is tough.

- The fundamental issue with data labelling is that we do not have access to some personal information about people, such as their date of birth for example.

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Data Set

- For implementing this model, we used UTKFace Kaggle dataset.
- The dataset consists of over 20,000 face images with annotations of age, gender, and ethnicity.
- The images cover large variation in pose, facial expression, illumination, occlusion, resolution etc.
- Dataset link : https://www.kaggle.com/datasets/jangedoo/utkface-new

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UTKFace

Data | Code (74) | Discussion (2) | Metadata

128 | New Notebook

UTKFace (23.7k files)

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Approaches

- Traditional Machine Learning methods like as Support Vector Machine and Random Forest Algorithm could be used to detect age, gender, and race from an image, and have had varying degrees of success.

- The deep learning and neural networks approach, on the other hand, does not necessitate extensive domain knowledge or image processing expertise because no image features must be extracted manually.

- This method also produced significantly better performing models with higher accuracy scores. CNNs can perform faster and produce the best detection results for image under certain conditions too.

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Flowchart

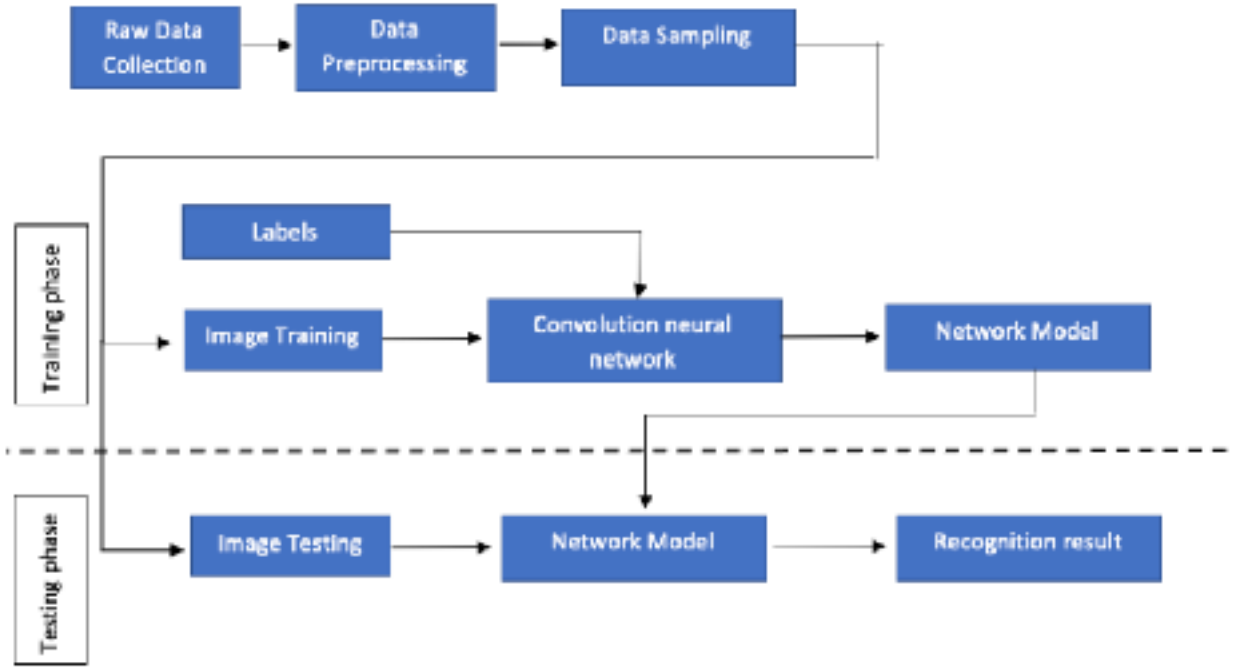

Figure 12: Flowchart of the system.

Preprocessing

- Our Dataset consists of raw images of various faces labelled with demographic details.

- Initially we need to transform this data to generate a dataframe which aids exploratory data analysis. So, we wrote a function to iterate over each file of the UTKFace dataset and returns required demographic attributes.

- We found 3 files in the dataset have invalid labels and these results in null values in the dataframe. So, we eliminated null values using pandas dropna().

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```
In [146]: df.head()
```

Out[146]:

	age	gender	race	file
0	9.0	female	asian	UTKFace/9_1_2_20161219204347420.jpg.chip.jpg
1	36.0	male	black	UTKFace/36_0_1_20170117163203851.jpg.chip.jpg
2	86.0	female	white	UTKFace/86_1_0_20170120225751953.jpg.chip.jpg
3	26.0	female	white	UTKFace/26_1_0_20170116171048641.jpg.chip.jpg
4	1.0	female	asian	UTKFace/1_1_2_20161219154612988.jpg.chip.jpg

Figure 2: Dataframe details.

- We did some exploratory data analysis and could see that most of the population is between the age group 20 to 30, Also from the dataframe distribution, we could see that, we got less data for age group above 60, so we did sampling to eliminate data imbalance for better model creation.

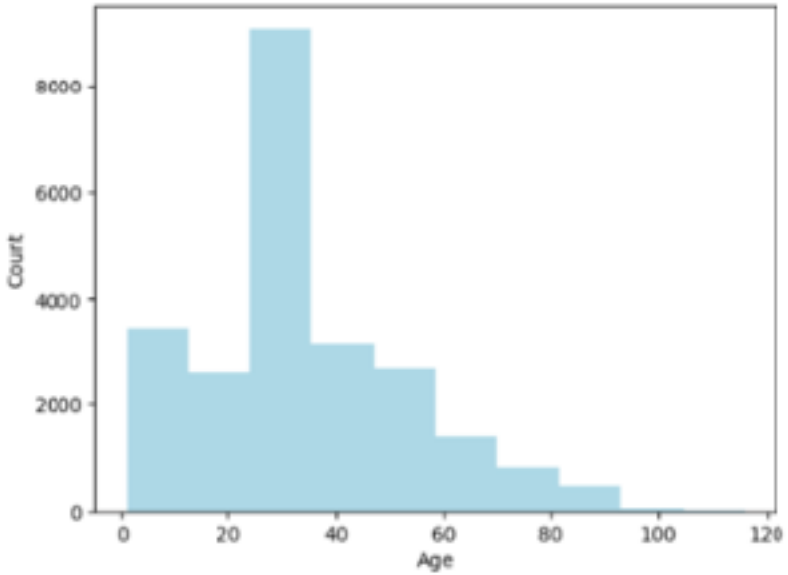

Figure 3: Age distribution on the Dataset.

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- We divided the dataframe for training and testing CNN model. We are using 80% for Training and 20% for Testing.We split a portion of training data to get hold of validation set.

- Since we are using categorical data for gender and race columns in the dataframe, we used One hot encoding to convert it into numerical format.

- We created batches of data, which will be utilised to feed both the images and their labels into the Kera's multi-output model rather than loading the entire dataset into memory at once, which could result in an out of memory error.

- Before we feed the image data to the CNN model, we are re-scaling the size and performing a normalisation process.

Feature Extraction

- The main advantage of using CNN over its alternative approaches is that it automatically detects prominent features without the need for human intervention.

- A CNN model is made up of two parts: the feature extraction part and the classification part. The feature extraction is done by the convolution and pooling layers.

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Implementation

- Our proposed network architecture is used throughout our experiments to classify people based on Demographics features.

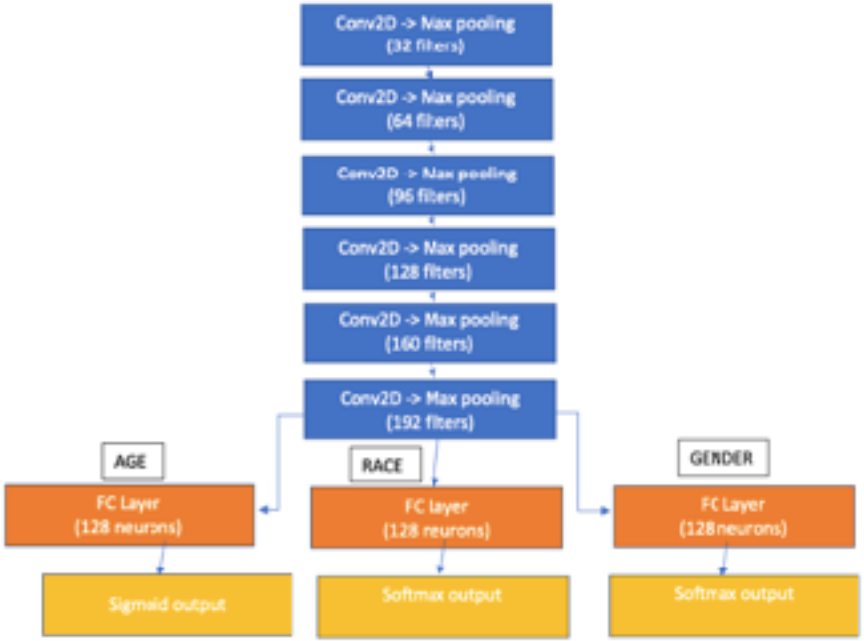

Figure 5: CNN Network Architecture

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- We trained the model from scratch by using our own tuned network architecture

- We configured other training parameters like the number of epochs to train as 10 and batch size as 64.

- We trained the model using various optimisers and starting learning rates. We used standard gradient descent and RMSprop as optimisers.

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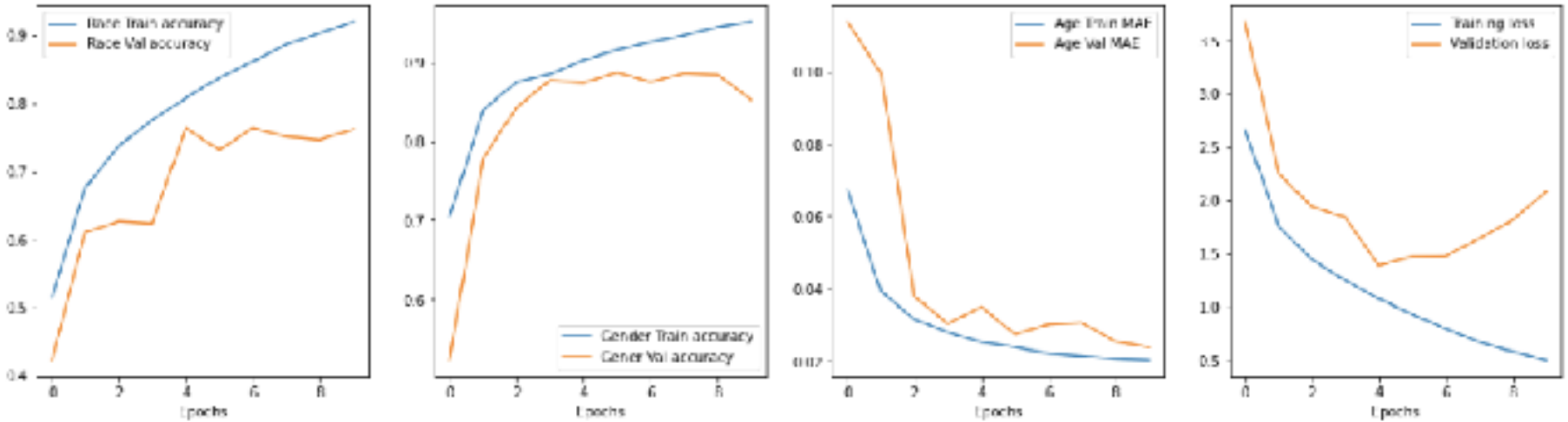

Figure 7: Plot of Model Accuracy and Loss on Train and Validation Datasets.

Results

- From the training history, we can see that the accuracy of training and validation data of gender and race parameters improves over time. For age attribute we could see Mean Absolute Error is decreasing over time.

- Also, we could notice that the validation loss decreases but then begins to rise again. This typically indicates that the model is starting to overfit and is unable to generalise to new data.

- In our model, gender feature got accuracy of 86% whereas race feature got 75%

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- These are the confusion matrix for our gender and race classification results.

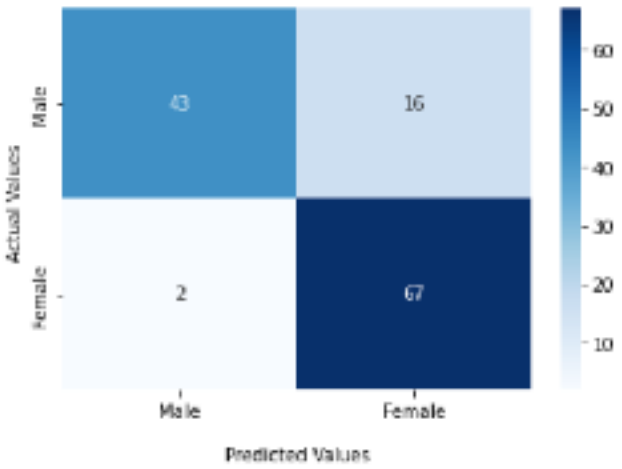

Figure 9: Confusion Matrix on Gender Attribute.

Figure 10: Confusion Matrix on Race Attribute.

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- Using the test data, we predicted demographic features successfully. The final output of the model is depicted here.

Figure 11: Final Output of the model.

Methods for improving the CNN Model

- Tune Parameters
- Image Data Augmentation
- Deeper Network Topology
- Properly Handling Overfitting and Underfitting problems

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Conclusion and Future Work

- Even though there are fewer labelled images available for demographic details, CNN can be used to provide better age and gender detection results.
- The performance of this system can be marginally improved by using more training data and running it on a high performance computational system.
- Running this complex model was bit challenging, since it consumes more time on training the data.
- Future scope work in this area will include the use of face demographics, human expression classification to aid in facial disease detection

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Ethics

- To disclose any personal information like date of birth for example to a third party or for studies related to this project without the person's consent is serious breach of trust and ethics.

- Current System will fail to classify the gender of non-binary or genderqueer people.Predicting wrong gender information will bring discrimination in gender inclusivity language.

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Thank You