

# Face Encryption

SDS3386 Data Science Lab

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## Team TensorOverflow

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## 1 Introduction

Recent reports (Smith, Szongott, Henne, & von Voigt, 2012) confirm the privacy risks associated with big data in public social media. The amount of user-generated content uploaded to the internet is increasing rapidly, but large corporations such as Google and Facebook have been misusing it without their knowledge (Esteve, 2017). When consumers upload sensitive facial photographs, it is difficult to preserve their privacy. The company may use these pictures to develop their machine learning algorithms, which could result in privacy breaches. **How can we protect privacy when sharing facial images?**

In this research, we offer a viable privacy-protecting solution based on adversarial attacks and facial recognition technology. After detecting a face in a picture using a facial recognition model, we encrypt the face with noise generated by adversarial attacking model. The composed image may appear as clear as the original, but the facial recognition software will recognise a different individual in it.

## 2 Dataset

### 2.1 CelebA

CelebA is a large-scale face attributes dataset with more than 200K celebrity images, each with 40 attribute annotations. The images in this dataset cover large pose variations and background clutter. CelebA has large diversities, large quantities, and rich annotations, including **5,000 celebrity identities**, **202,599 face images**, and **40 binary attributes** annotations per image. The dataset can be employed as the training and test sets for the following computer vision tasks: face attribute recognition, face detection, landmark (or facial part) localization, and face editing/synthesis.



Figure 1: CelebA dataset

CelebA is utilised as the face recognition model's dataset set in this project. The training set has 4429 photos while the test set has 1267 images.

### 2.2 Private Dataset

The private dataset consists of photos collected by team members. The photos were taken in SITE and feature various facial expressions.

This dataset is utilized to perform adversarial attacking on the face recognition model. The training set has 121 photos while the test set has 15 images.

## 3 Methodology

### 3.1 Adversarial Attacks

Adversarial attacking is a technique that can be used to fool machine learning models. It is a type of attack that aims to change the input data in a way that the model will misclassify it. The adversarial attacking technique is based on the fact that machine learning models are vulnerable to small perturbations in the input data. The perturbations are usually imperceptible to the human eye, but they can cause the model to misclassify the input data.

Adversarial examples are hard to defend against because it is difficult to construct a theoretical model of the adversarial example crafting process. Adversarial examples are solutions to an optimization problem that is non-linear and non-convex for many ML models, including neural networks. Because we don't have good theoretical tools for describing the solutions to these complicated optimization problems, it is very hard to make any kind of theoretical argument that a defense will rule out a set of adversarial examples.

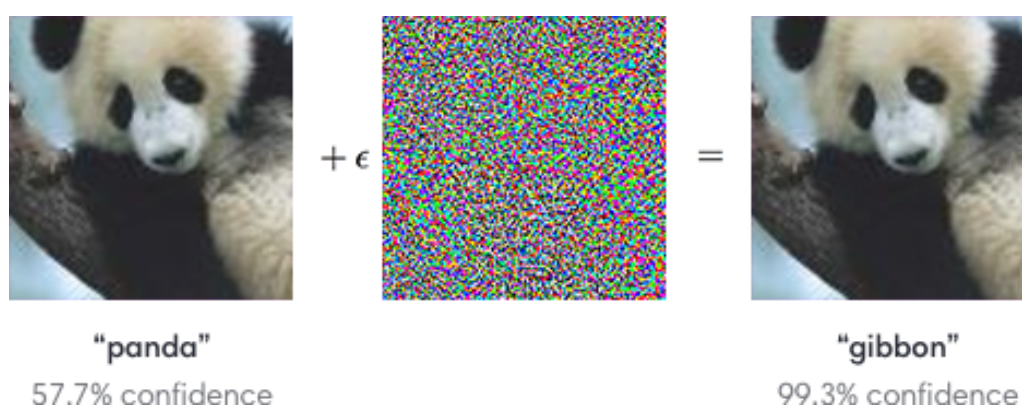


Figure 2: An adversarial input, overlaid on a typical image, can cause a classifier to miscategorize a panda as a gibbon.

Another reason is they require machine learning models to produce good outputs for every possible input. Most of the time, machine learning models work very well but only work on a very small amount of all the many possible inputs they might encounter. (Goodfellow, 2020)

### 3.2 Backbone Model: ResNet-18

ResNet-18 is a convolutional neural network (CNN) that is used as a backbone model in this project. The architecture can be illustrated as figure 3 (Ramzan et al., 2019). It is a 18-layer deep neural network that is trained on the ImageNet dataset. The ImageNet dataset is a large dataset that contains 1.2 million images with 1000 classes. The ResNet-18 model is trained on the ImageNet dataset to classify the images into 1000 classes.

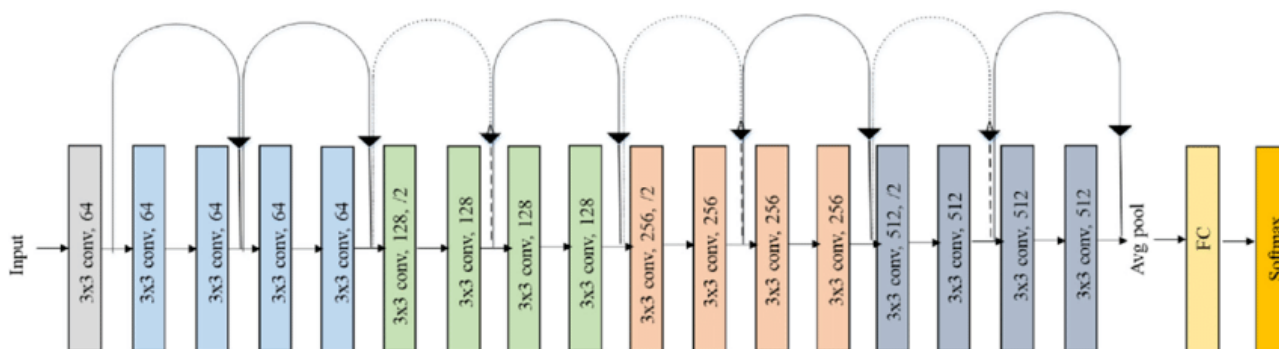


Figure 3: ResNet-18 Architecture

## 4 Data Wrangling

### 4.1 Faces extraction from recorded video

After capturing three videos, OpenCV2 is used to sample 40 frames from each video. The faces are then rotated 180 degrees to accommodate package mediapipe's face detection model. Then, we crop the faces from the frames using the centre of the bounding box's coordinates. The faces are then saved in a folder named `private_dataset` and added to `CelebA_HQ_facial_identity_dataset`.

This process is done in `Data_generation.ipynb.ipynb`.

### 4.2 Associate id with name

After downloading the CelebA dataset from the official website, we utilise `CelebA-HQ-to-CelebA-mapping.txt` to generate a map `hq_A_mapping` from an id to the image file name, such as 5: `000615.jpg`. Then, we use `list_identity_celeba.txt` to generate the second map `id_name_mapping` from a file name to its corresponding identity's name, for instance: `000615.jpg: Martha Hunt`.

The benefit of this process is that we can now use the id to determine an identity's name. By example, we may use the following code: `id_name_mapping[hq_A_mapping['5']]` to determine the name of the individual with id = 5.

This process is done in `Preprocessing.ipynb`.

### 4.3 Transforming the dataset

We resized the images to 224x224 because their original size was too large for our model, which could cause performance issues. After that, we augment the tensor by giving it a random horizontal flip as part of the transformation.

This process is a part of `simple_model.ipynb`.

## 5 Modelling

## References

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