# Automatic Colorization with Autoencoder

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## 1 Introduction

### 1.1 Background

An autoencoder is a type of artificial neural network used to learn efficient data codings in an unsupervised manner.[1] The aim of an autoencoder is to learn a representation (encoding) for a set of data, typically for dimensionality reduction, by training the network to ignore signal "noise". [1]

This is a practical use-case of Autoencoders, that is, colorization of gray-scale images.

## 2 Experiment

### 2.1 Datasets

In this Experiment, we just use cifar10 and cifar100 as our dataset to train and test our model. Cifar10 and Cifar100 are subsets of the 80 million tiny images dataset.

The CIFAR-10 dataset consists of 60000 32x32 colour images in 10 classes, with 6000 images per class. There are 50000 training images and 10000 test images.

The CIFAR-100 dataset consists of 60000 32x32 colour images in 100 classes, with 600 images per class. There are 50000 training images and 10000 test images.

### 2.2 Experiment design

We will use keras function Model API to build Autoencoder, which include Encoder model and Decoder model.

First, Building an Encoder model to process cifar10 or cifar100 images. Encoder model transforms the input into low-dimensional latent vector by using CNNs. It will reduces dimension, so it is forced to learn the most important features of the input. So, the shape of data will transform from (32, 32, 1) to (256, ).

Second, Building a Decoder model to reconstruct the input as much as possible from the latent vector. For that, we use Conv2DTranspose for the decoder section of the autoencoder.So, the shape of data will transform from (256, ) to (32, 32, 3).

Finally, I define a model, called autoencoder which takes and input and then passes it to the encoder followed by passing it through the decoder.

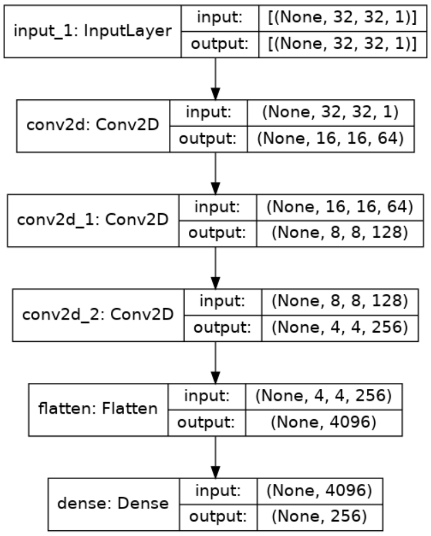


Figure 1: The Summary of Encoder

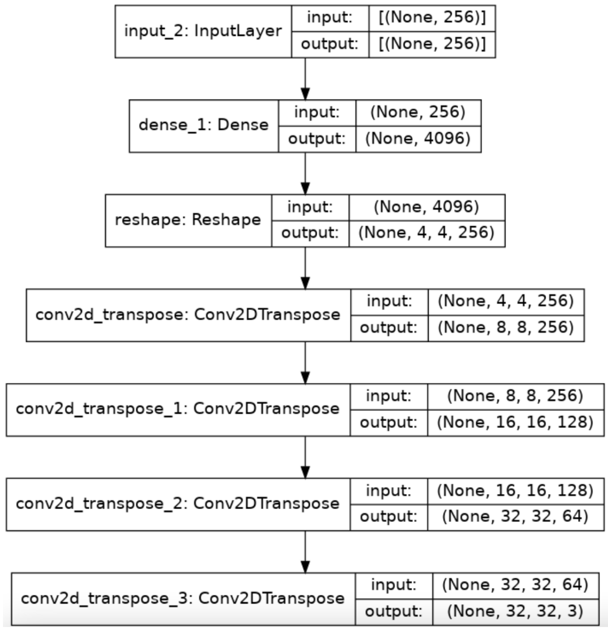


Figure 2: The Summary of Decoder

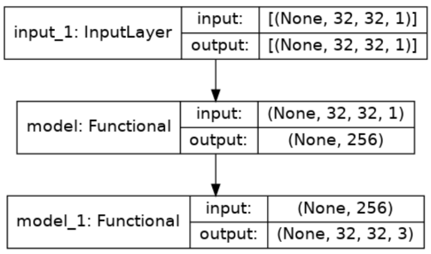


Figure 3: The Summary of AutoEncoder

# 3 Discussion

## 3.1 Training, Validation and Test Performance

```
Epoch 00017: val_loss did not improve from 0.24905
Epoch 18/20
4000/4000 [==============================] - 30s 7ms/step - loss: 0.2563 - accuracy: 0.5101
- val_loss: 0.2557 - val_accuracy: 0.4923

Epoch 00018: val_loss did not improve from 0.24905
Epoch 19/20
4000/4000 [==============================] - 26s 6ms/step - loss: 0.2558 - accuracy: 0.5107
- val_loss: 0.2501 - val_accuracy: 0.5011

Epoch 00019: val_loss did not improve from 0.24905
Epoch 20/20
4000/4000 [==============================] - 26s 7ms/step - loss: 0.2569 - accuracy: 0.5091
- val_loss: 0.2599 - val_accuracy: 0.5091

Epoch 00020: val_loss did not improve from 0.24905
```

Figure 4: The Train and Validation Performance of Cifar10

In the Training Performance and Validation Performance in cifar10 dataset(Figure4), we can find that the accuracy become 0.5091 and loss decrease to 0.2589.

```
313/313 [==============================] - 2s 4ms/step - loss: 0.2546 - accuracy: 0.5086


[0.2546379268169403, 0.5085741281509399]
```

Figure 5: The Test Performance of cifar10 dataset

In the Test Performance in cifar10 dataset(Figure5), we can find that the accuracy is 0.5086 and loss is 0.2546.

```
Epoch 12/20
4000/4000 [==============================] - 27s 7ms/step - loss: 0.2889 - accuracy: 0.5470
- val_loss: 0.2904 - val_accuracy: 0.5688

Epoch 00012: val_loss did not improve from 0.28092
Epoch 13/20
4000/4000 [==============================] - 27s 7ms/step - loss: 0.2882 - accuracy: 0.5498
- val_loss: 0.2900 - val_accuracy: 0.5624
Restoring model weights from the end of the best epoch.

Epoch 00013: val_loss did not improve from 0.28092
Epoch 00013: early stopping
```

Figure 6: The Train and Validation Performance of cifar100 dataset

In the Training and Validation Performance in cifar100 dataset(Figure6), we can find that the accuracy is 0.5498 and loss is 0.2882.
In the Test Performance in cifar100 dataset(Figure7), we can find that the accuracy is 0.5566 and loss is 0.2914

```
313/313 [==============================] - 1s 4ms/step - loss: 0.2914 - accuracy: 0.5566

[0.29144537448883057, 0.5565659403800964]
```

Figure 7: The Test Performance of cifar100 dataset

## References


[1] Wikipedia, *Autoencoder*, Apr. 13, 2021. `https://en.wikipedia.org/wiki/Autoencoder`.