Generative Models

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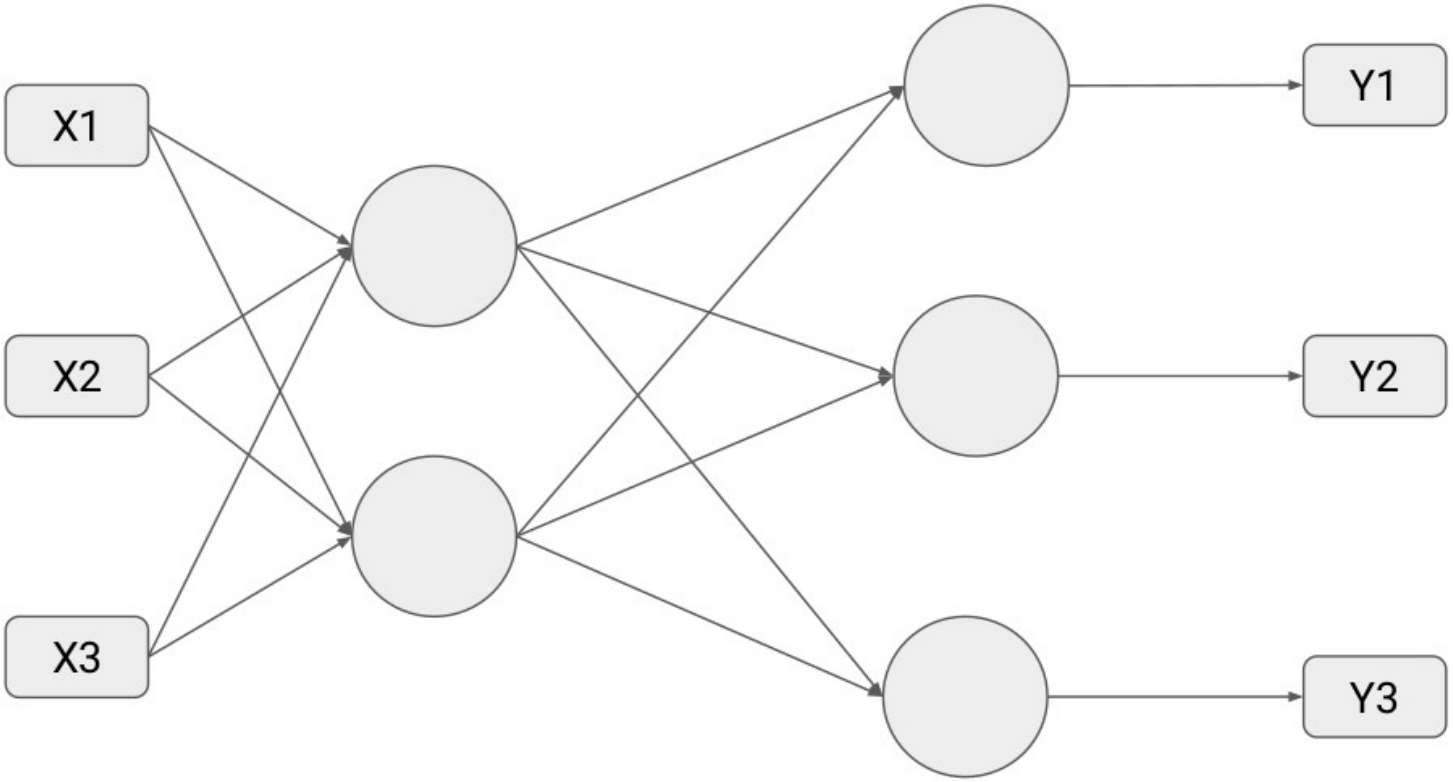
Autoencoders

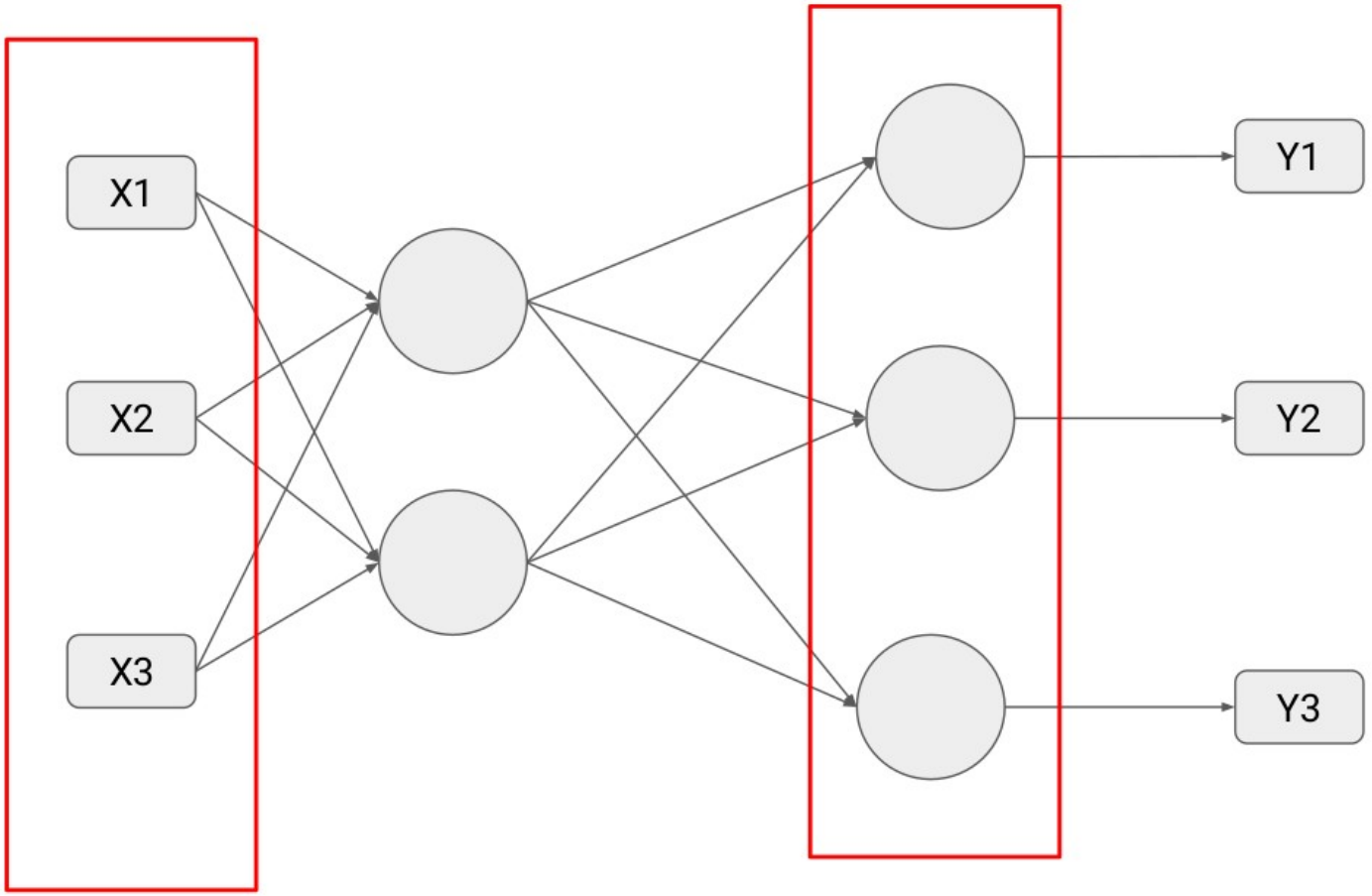


Autoencoders definition

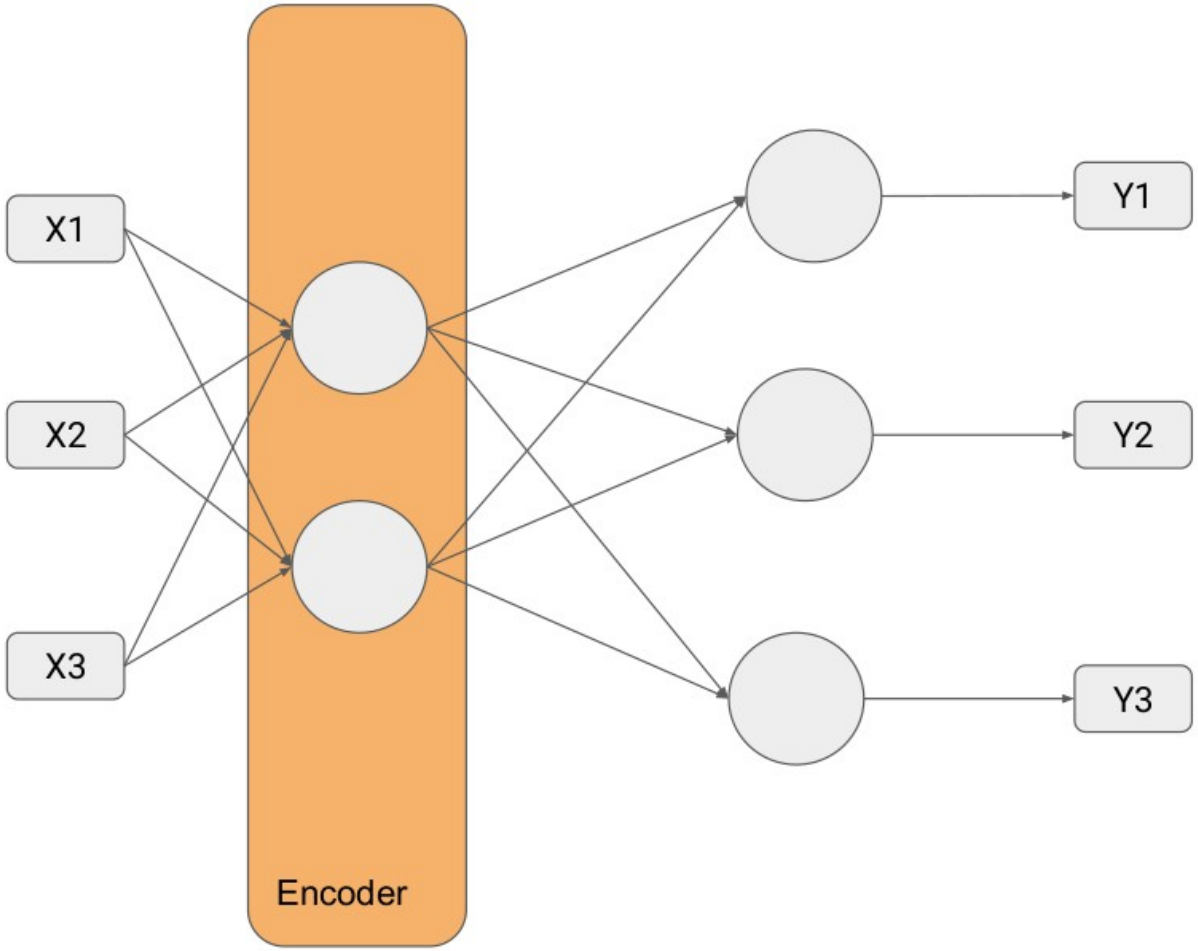
An autoencoder is a type of artificial neural network used to learn data encodings in an unsupervised manner.

The aim of an autoencoder is to learn a lower-dimensional representation (encoding) for a higher-dimensional data, typically for dimensionality reduction, by training the network to capture the most important parts of the input image.

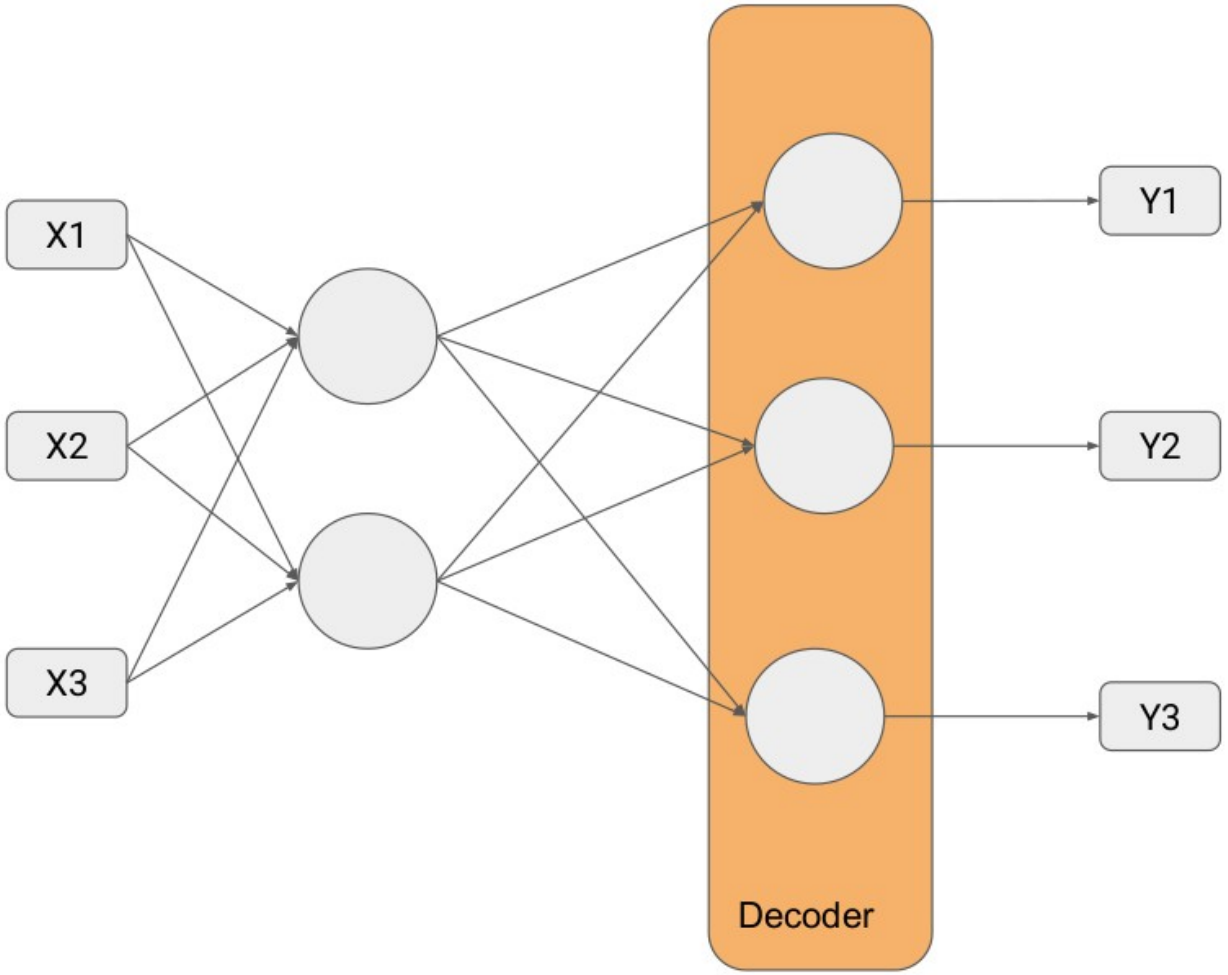
Basic note



encoder



decoder



Very important notation

An autoencoder neural network is an unsupervised learning algorithm that applies backpropagation, setting the target values to be equal to the inputs. I.e., it uses y(i)=x(i).

Basic work flow (very very important)

Suppose we have 3 input features x1,x2,x3 , design an auto encoder to predict the features x1,x2,x3 ?

1st step x1,x2,x3 → shape (3 units)

2nd step encoder uses downsampling or what is known as compression technique so , shape will be (2 units)

3rd step decoder uses upsampling , or decompression (2units input coming from the encoder will be transformed into → 3units to match the input of the network)

Check colab auto-encoder example 1

Task 2

Build a simple autoencoder to generate handwritten MNIST dataset

Steps

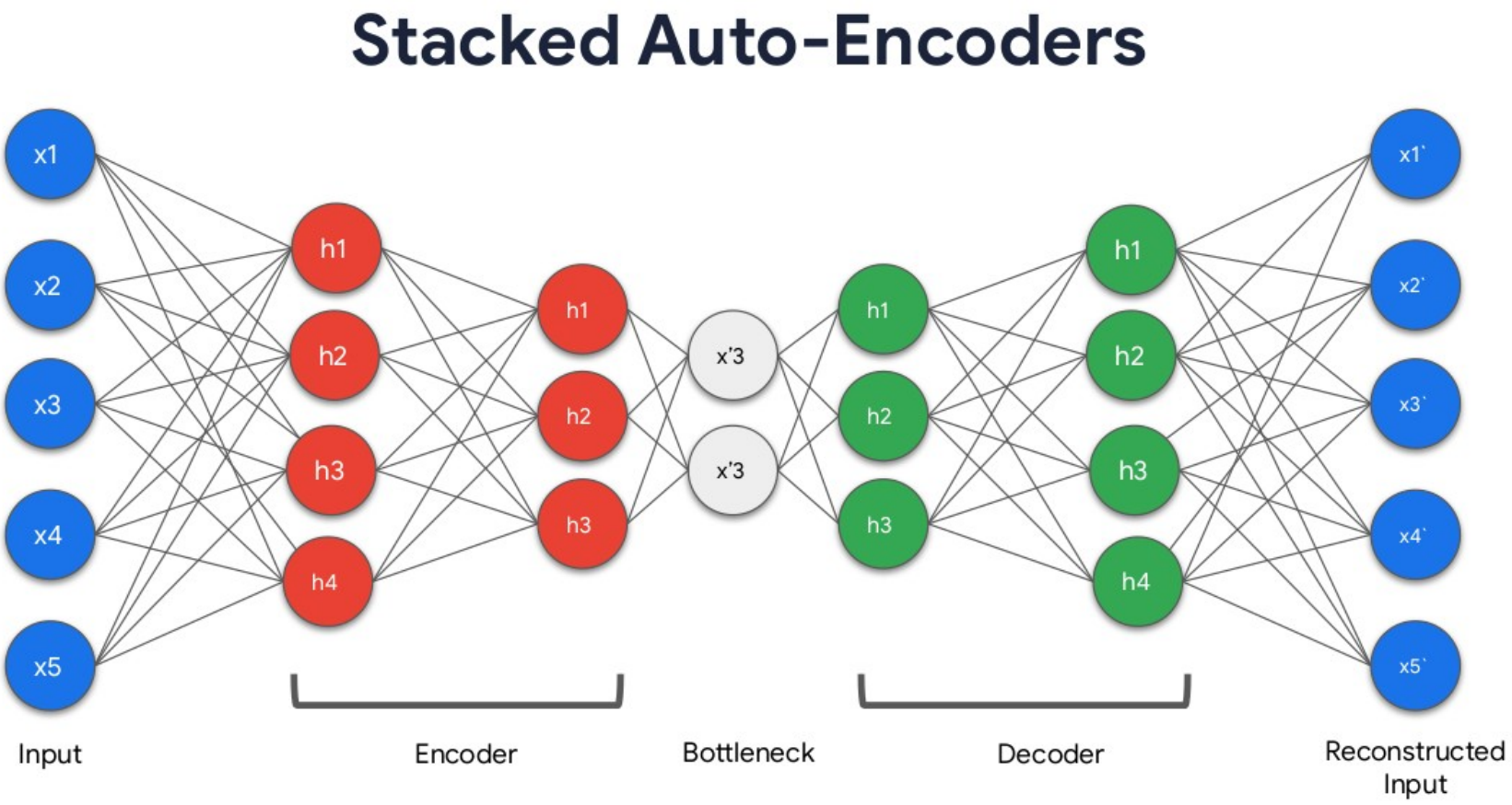
1-load mnist dataset using tfds(tensorflow datasets module)

2-normalize all images by dividing by 255.0

3-build simple auto encoder

4-here loss function is BCE

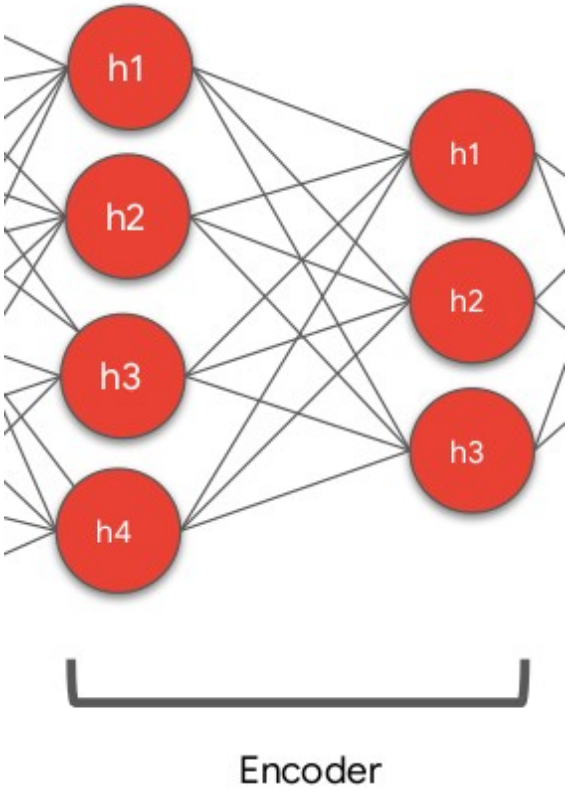
Deep autoencoders



deepautoencoder

1. Encoder: A module that compresses the input data into an encoded representation that is typically several orders of magnitude smaller than the input data.

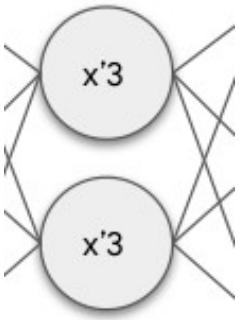
encoder



Bottle neck

Bottleneck: A module that contains the compressed knowledge representations and is therefore the most important part of the network.

Bottle neck

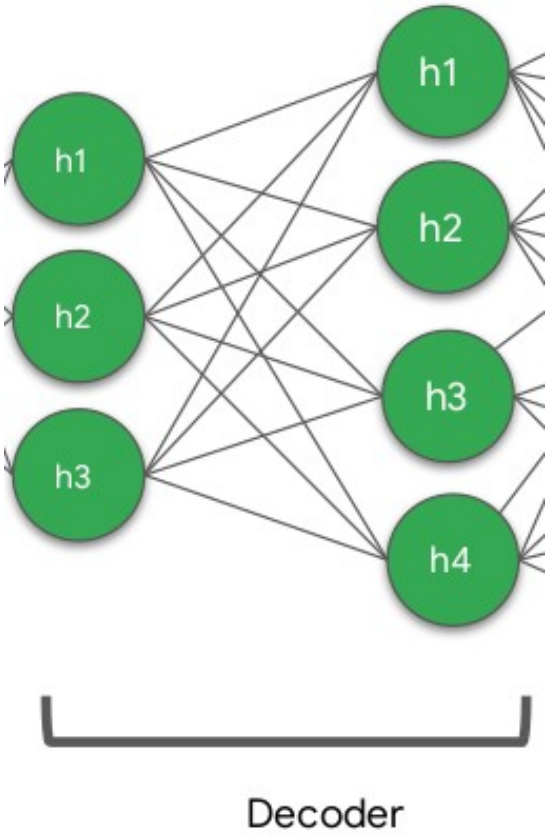


Bottleneck

decoder

Decoder: A module that helps the network“decompress” the knowledge representations and reconstructs the data back from its encoded form. The output is then compared with a ground truth.

decoder

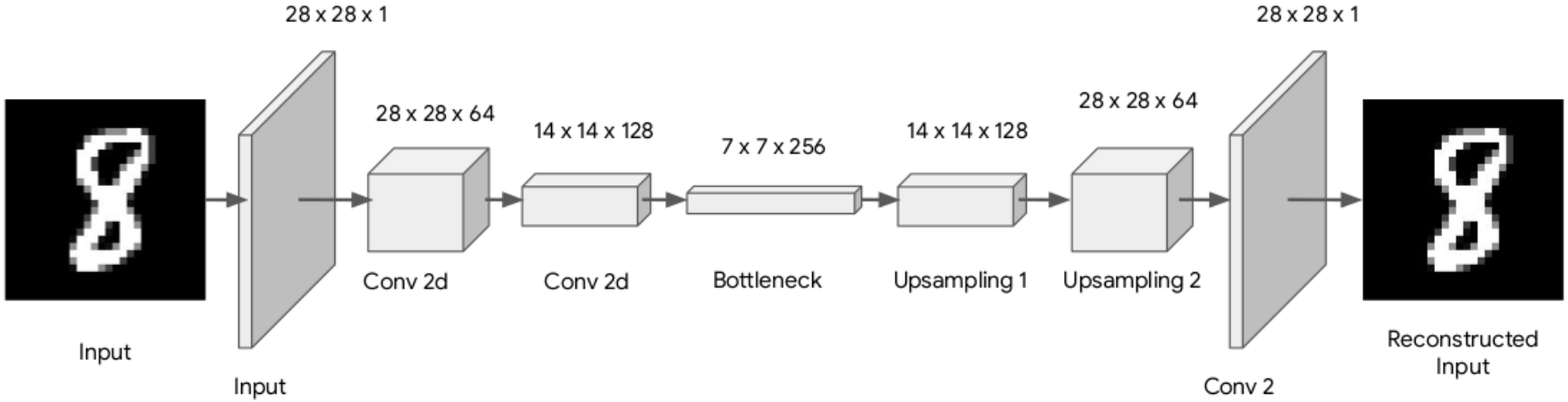


Convolutional auto encoders

The convolution operator allows filtering an input signal in order to extract some part of its content. Autoencoders in their traditional formulation do not take into account the fact that a signal can be seen as a sum of other signals. Convolutional Autoencoders, instead, use the convolution operator to exploit this observation. They learn to encode the input in a set of simple signals and then try to reconstruct the input from them.

CAE

Convolutional Auto-Encoders



CAE approach

Instead of using typical or random dense layers at the encoder , we will use Conv2D layers and maxpooling for visual pixel extraction and downsampling

Since we are using downsampling approach at the encoder , so the encoder will return maxpool layer only !

Bottle neck

Bottle neck here will use encoder output after maxpooling where the filters of the last conv2d layer of the encoder will be multiplied by 2

Note in the colab notebook

We have added an extra layer called encoder_visualization just to visualize the latent representation as a visual model that doesn’t have any impact to the original model just a visualization utility