# Main task:

The task is designing a neural network that learns how to label the housing numbers.

# Pre-processing steps.

The input is a 4D matrix which its last dimension indicated the number of images. We need to change the order of the input dimensions in a way that the number of images is the first and the number of channels is the last dimension. We used the transpose function from the Numpy library to rearrange the input matrix.

Moreover, to prepare the data, we changed the data from color to grayscale by using the inner product of the images with a vector. This will reduce the size of the images and increase the learning time. Also, images are normalized by dividing by 255. For the labes, firstly we change the label 10 to 0 as label ten is indicating the number 0. Secondly, we use a Keras function to make the labels categorical.

# Network architecture:

In this assignment, we harvest the power of the convolutional neural networks to achieve very high accuracy. We do this by preprocessing the data, using ... convolutional layers and one fully connected layer. Also, we use normalization methods to cope with the overfitting problem.

Here is the structure of the model:

## ...Model summary

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type of layers, activation function, regularization

better make a table:

. A depiction of the network structure is provided below.

## Use flowchart

# Why this model:

One can use many different architectures for the model, yet not all of them provide a reasonable solution. In our design, we need to consider several points. First, we need to develop a model which can fit our training data with high accuracy. Second is the issue of overfitting. That is if we do not use proper methods to control overfitting, our test accuracy will be unacceptable even though the training error is minimal. The third issue is the problem of the time and resources that we need to train our model. Using many layers might lead to a higher accuracy but for this assignment, our time and computational power are limited. For example, the model that Goodfellow et al., (2013) designed took six days to get trained. Here are our justifications for selecting the mentioned model considering the issues discussed above.