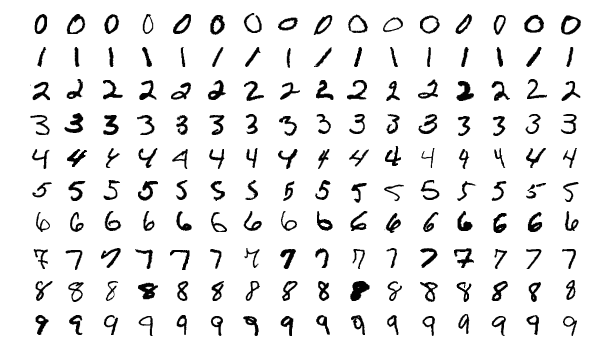
1. Problem definition

**1.1 Task definition**

Our goal is to classify hand-written digits, using moments (centroid) of the image. We will use MNIST Dataset for this project. MNIST dataset contains 60,000 training examples. Each example is 28x28 pixel image, with each pixel having a value in range from 0 to 255. Our goal is to classify this image as which digit it represents (from 0 to 9).

Input: 28x28 pixel image

Output: digit label



MNIST Handwritten Digits Dataset (Source: [Wikipedia](https://commons.wikimedia.org/wiki/File:MnistExamples.png)(

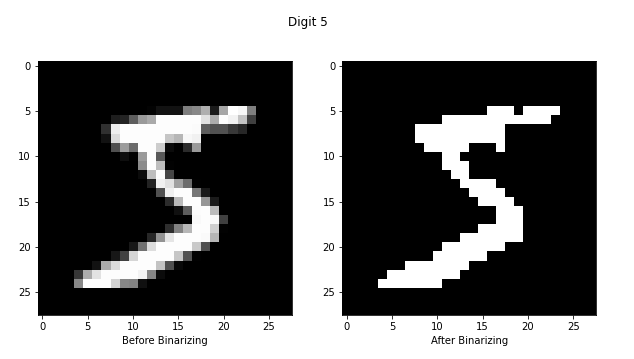
**1.2 Algorithm definition**

We will be using a simple KNN model to classify the digits, but our main goal is to extract useful features from the image, using the moments of the image.

2. Feature extraction

**2.1 Image Preprocessing**

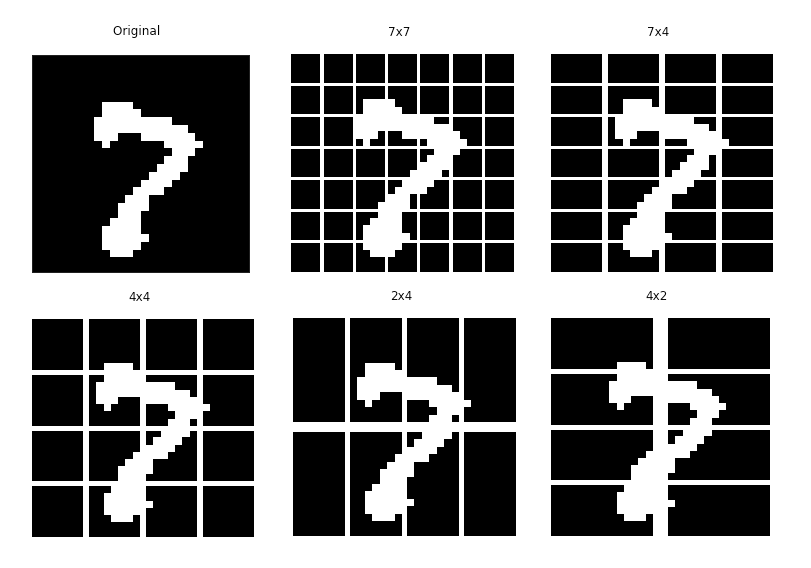
Each pixel in the image has a value in range from 0 to 255, We will binarize the image in order to make each pixel black or white, no in between.



For our goal, binarizing the image would not cost us a lot of lost information.

**2.2 Splitting the image**

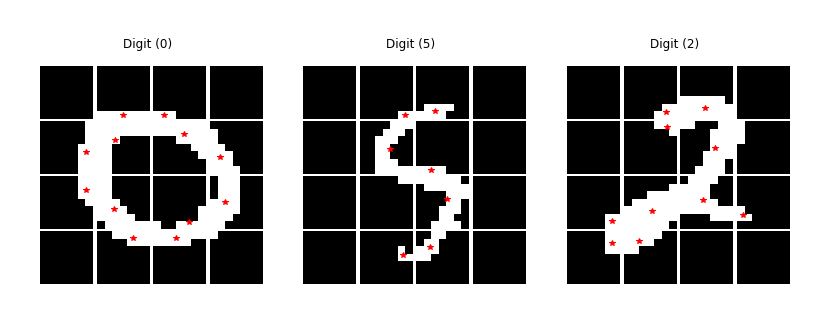
Our next step is to split the image into smaller ones, we can define how we want to split he image by the size of the grid. (X×Y). Here’s an example with different grid size.



**2.3 Calculating the moments (centroid)**

After splitting the image into smaller parts, we will start calculating the centroid of each part, Informally, the centroid is the point at which a cutout of the shape could be perfectly balanced on the tip of a pin. Mathematically, for our purpose, we would define it as:

Here is an example of the output (x, y) of calculating the centroid for different examples:



*Note: The red star represents the centroid for each small image.*

3. Building the model

We will build our model using a KNN classifier, KNN stands for K-nearest neighbors, it basically looks for K nearest class and classifies the input based on the most nearest neighbors of the same class. We will fit our model with different sample size, different K, and also different grid size to see the impact of each of those on the model. We will be measuring the performance of our model by the accuracy (% of correctly classified images).

4. Conclusion