

“ Gujarati Handwriting Recognition ”

A PROJECT REPORT

Submitted by

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In partial fulfillment for the award of the degree

Of

DIPLOMA OF ENGINEERING

In

COMPUTER ENGINEERING



GOVERNMENT POLYTECHNIC, PORBANDAR

Gujarat Technological University, Ahmedabad

Academic Year: 2022-23

GOVERNMENT POLYTECHNIC PORBANDAR



COMPUTER ENGINEERING DEPARTMENT

VISION OF THE DEPARTMENT

To achieve excellence in Computer Engineering by imparting technical and problem-solving skills along with ethical value to meet industrial requirements having social and environmental concerns.

MISSION OF THE DEPARTMENT

M1: To provides a learning ambiance to enhance discipline knowledge, technical skill and problem-solving skill.

M2: To motivates students for lifelong learning to adapt challenges in rapidly changing technology.

M3: To induces ethical values and spirit of social commitment.

M4: To provide opportunities to promote leadership skill required in Computer Engineering industry's diverse culture.

Subject: Project 2

Subject Code: 3350707

Course Outcomes:

- C305.1 Identify problem statement by surveying variety of domains.
- C305.2 Identify design methodologies based on requirement analysis.
- C305.3 Apply advanced programming techniques.
- C305.4 Present technical report by applying different visualization tools and Evaluation metrics.



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DECLARATION

We hereby declare that the Reports, submitted along with the Project Report for the project entitled **“Gujarati Handwriting Recognition”** submitted in partial fulfillment for the degree of **Diploma in Computer Engineering** to Gujarat Technological University, Ahmadabad, is a Bona-fide record of the project work carried out at **Government Polytechnic Porbandar** under the supervision of Respected **Kartik Detroja** sir and that no part of any of these reports has been directly copied from any students' reports or taken from any other source, without providing due reference.

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CERTIFICATE

This is to certify that the reports, submitted along with the project entitled **“Gujarati Handwriting Recognition”** has been carried out by **Sonegra Harsh B (206270307079)** under my Guidance in partial fulfillment for the degree of: **Diploma in Computer Engineering** of Gujarat Technological University, Ahmadabad during the academic year 2022-23. These students have successfully completed report activity under my guidance.

Internal Guide
Kartik Detroja Sir

Head of Department
J.M. Pavagadhi



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I am grateful to Mrs. J. M. Pavagadhi head of department of computer engineering for providing me all the facility that was required for the successfully completion of our project. Our special thanks of gratitude to our internal guide Kartik Detroja sir for their valuable guidance and support in completing our project.

I would like to thanks to all professors, parents and friends who helped me a lot in finalizing this project within the limited time frame. Last but not the least we are grateful to authors of the reference and other literatures referred to in this project.

ABSTRACT

The aim of this project was to design and create a machine learning model that gives accurate output to the input from various interfaces. This model allows the input of image that consist of Gujarati handwritten digits and it produces accurate output for that image.

The model interfacing is simple, user friendly and secured after launching it as an API.

The main goal this project is to learn the trending technology and automations. This is to facilitate all people who are in model's use cases.

It has many technical elements and the rules are fairly simple. This simplicity makes it a good choice for learning a new program environment. It covers a range of areas (machine learning, deep learning, mathematics, image processing, etc.) but none too difficult.

Index

- > Identification of problem definition.
- > Learning basics of machine learning.
- > Linear Regression for machine learning.
- > Gradient Decent Algorithm for machine learning.
- > Logistic Regression for machine learning.
- > Neural networks.
- > Project information and data.
- > Conclusion and Future Scope for our project.

Identification of the problem:

As we can see the field of Artificial Intelligence is growing more and more day by day providing accurate result to users with great efficiency and simple user interface, as these models are developed for international languages that are widely used throughout the world like English. We as a computer engineering students of Government Polytechnic Porbandar have chosen project that will identify the images of Gujarati digits. This model will be provided image as an input that will be identified by the model providing accurate output to the given image. This model can be further feed with other characters to solve the problem of translation of images of local languages like Gujarati to text.

Learning basics of machine learning.

> **Artificial Intelligence**

- Artificial Intelligence is capability of machines that can take decisions by themselves without any human help and interruptions.

> **Machine Learning**

- Machine learning is a way to implement artificial intelligence so that it can learn from the data and take decisions by themselves.
- The model learns from the dataset that is fed into an algorithm.
- There are 3 types of Machine learning.
 - Supervised learning: Data labels are provided
 - Unsupervised learning: Data labels are not provided.
 - Reinforcement learning: Type of learning in which a computer learns from result of particular action it performed.

> **Deep Learning**

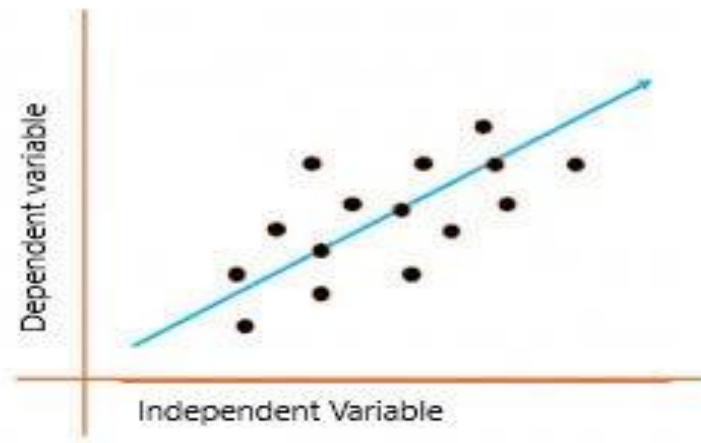
- Deep learning is also a way to implement artificial intelligence so that it can take decisions by themselves.
- Deep learning uses neural networks and deep neural networks to learn from dataset.

We have learnt following aspects to implement our project.

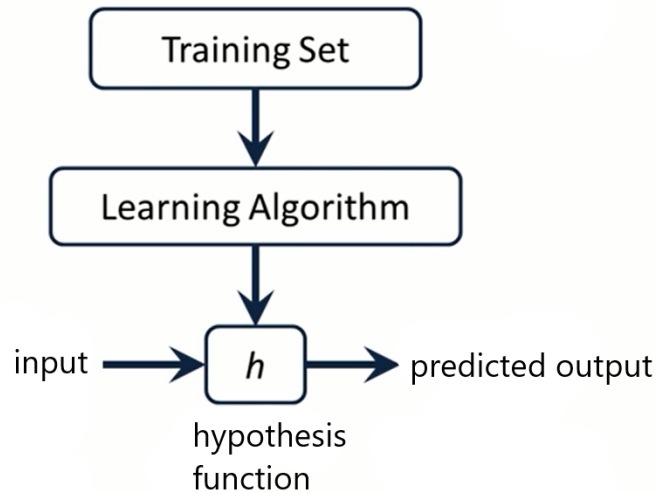
- Python
- Python libraries.
 - Numpy: for matrix, vectors(arrays) calculations.
 - Matplotlib: for data visualization.
 - Pandas: to load the dataset.
 - Seaborn: to load the dataset and provide some inbuilt datasets.
 - Os: for handling file hierarchy for custom dataset.
 - Glob: file handling.
 - Image | PIL: for loading images and converting it into matrixes.
- Image processing
 - Image gray scaling.
 - Image resizing.
 - Image sharpening.
 - Image filtering.
 - Data scaling.
 - Train-test splitting.
- Essential mathematics
 - Linear algebra
 - Scaler, vectors and matrix
 - Statistics
 - Probability

✚ Linear Regression for machine learning.

- > Linear regression is a quiet and the simplest statistical regression method used for predictive analysis in machine learning. Linear regression shows the linear relationship between the independent(predictor) variable i.e. X-axis and the dependent(output) variable i.e. Y-axis, called linear regression. If there is a single input variable **X** (independent variable). such linear regression is called **simple linear regression or univariate linear regression.**
- > If the **Y** is dependent variable to predict the value of then the formula to predict the **Y** is following:
$$Y = X * \text{Weight} + \text{Bias}$$



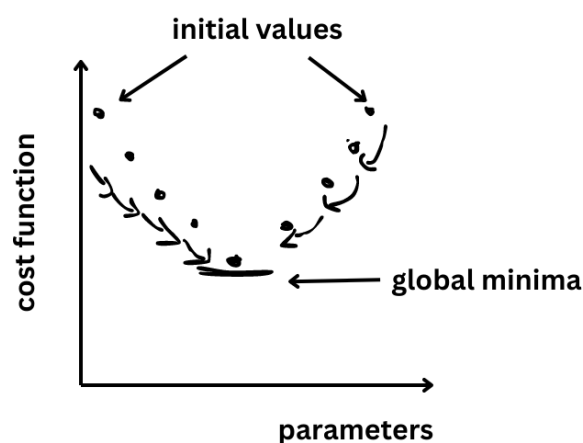
- > The above graph presents the linear relationship between the output(y) variable and predictor(X) variables. The blue line is referred to as the *best fit* straight line. Based on the given data points, we attempt to plot a line that fits the points the best.
- > **The Weight** and **The Bias** are known as the parameters of model.
- > The Dataset is fed into a model that changes the value of the weight and the bias is changed repeatedly to acquire maximum accuracy.
- > The value of parameters is changed by a loss function and gradient descent algorithm.



- > The hypothesis function is a trained model that gives output to an unidentified input.
- > Hypothesis function for linear regression: $X \cdot \text{weight} + \text{bias}$.
- > This function is trained as per Cost function that is commonly denoted by J .
- > $J(\text{Weight}, \text{Bias}) = \frac{1}{2m} \sum (h(x) - y)^2$.
- > Where $h(x)$ is value the model is now predicting and Y denotes the original value of label during training.
- > The goal is to minimize the value of cost function.

Gradient Descent Algorithm

- > The Gradient Descent Algorithm minimize the cost of $h(x)$.
- > It is an optimizing algorithm that changes the value of parameters while training the model.



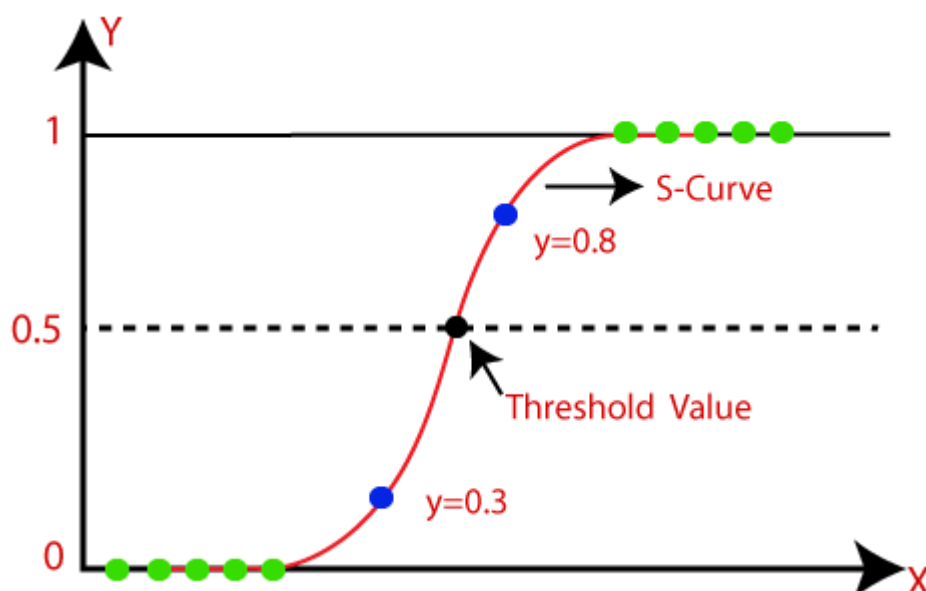
- > To update the parameters, we update the weight and bias as per the model is trained with the data.
- > The value of Weight and Bias will be changed as per following.

$$\text{Bias} = \text{Bias} - \text{Rate of change} * 1/m * (h(x_i) - y_i)$$

$$\text{Weight} = \text{Weight} - \text{Rate of change} * 1/m * (h(x_i) - y_i) * x_i$$
- > For multivariate hypothesis of linear regression
 - $h(x) = \text{Weight-1} * X1 + \text{Weight-2} * X2 + \text{Bias}$
 - $Y = w_1x_1 + w_2x_2 + \dots + \text{Bias}$

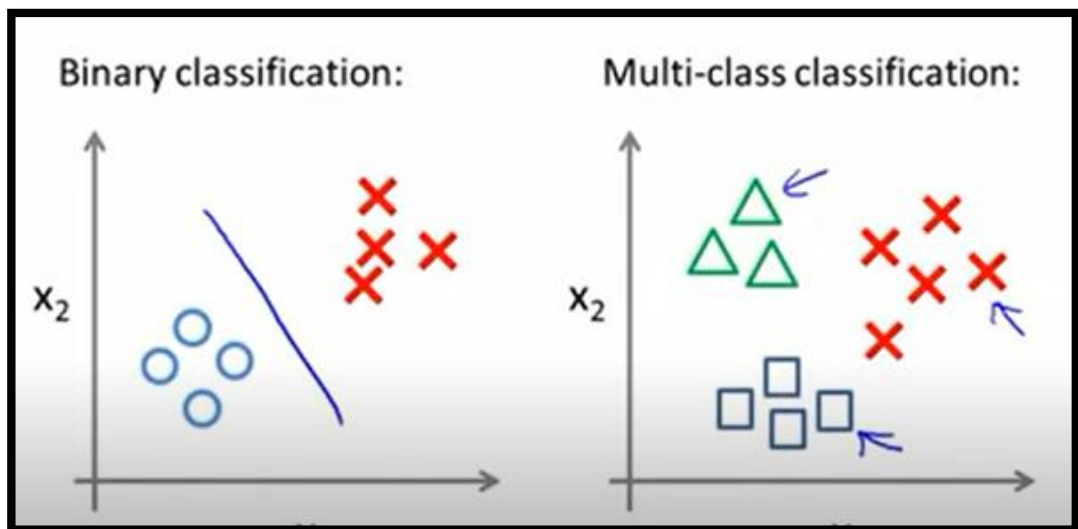
Logistic Regression for machine learning.

- > The Logistic Regression is a supervised type of machine learning algorithm that is used for predicting the categorical dependent variable using a given set of independent variables.
- > Logistic regression predicts the output of a categorical dependent variable. Therefore, the outcome must be a categorical or discrete value. It can be either Yes or No, 0 or 1, true or False, etc. but instead of giving the exact value as 0 and 1, **it gives the probabilistic values which lie between 0 and 1.**
- > Logistic Regression is much similar to the Linear Regression except that how they are used. Linear Regression is used for solving Regression problems, whereas **Logistic regression is used for solving the classification problems.**



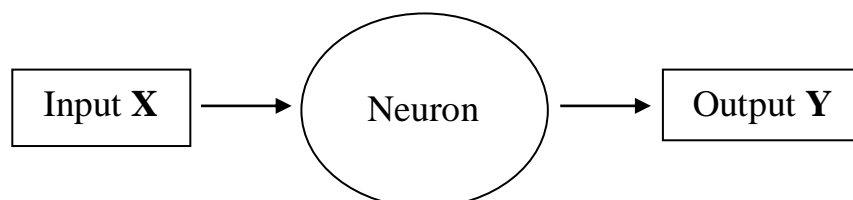
Logistic Function (Sigmoid Function):

- The sigmoid function is a mathematical function used to map the predicted values to probabilities.
- It maps any real value into another value within a range of 0 and 1.
- The value of the logistic regression must be between 0 and 1, which cannot go beyond this limit, so it forms a curve like the "S" form. The S-form curve is called the Sigmoid function or the logistic function.
- In logistic regression, we use the concept of the threshold value, which defines the probability of either 0 or 1.

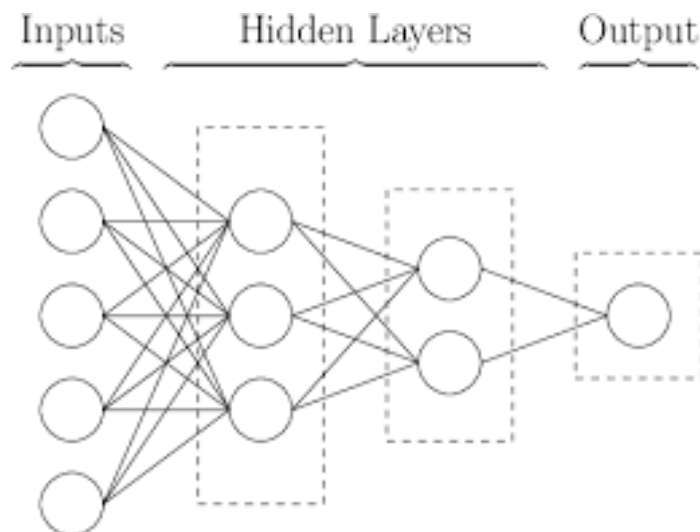


Neural Networks (Deep learning).

- > A neuron is a simple function that gives a value as an output for a particular input.
- > As shown in figure a neuron can be a small function that gives output Y based on it has trained on dataset on any input X.



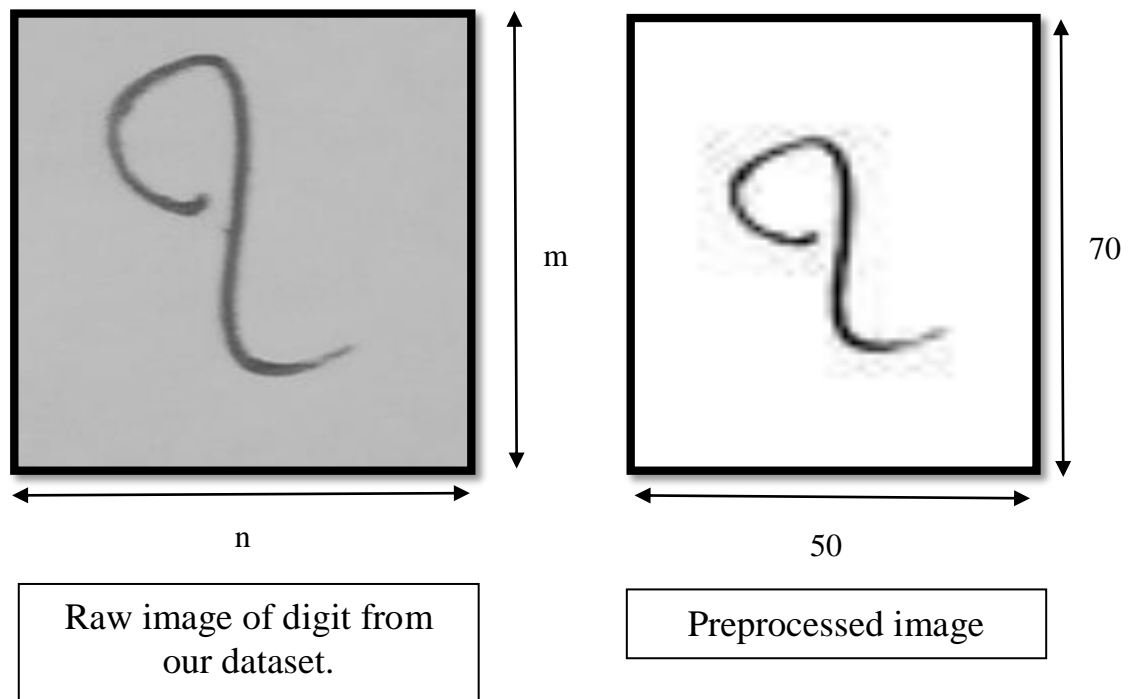
- > The number of these neurons are combined to form a neural network that can provide accurate output on any specific inputs.



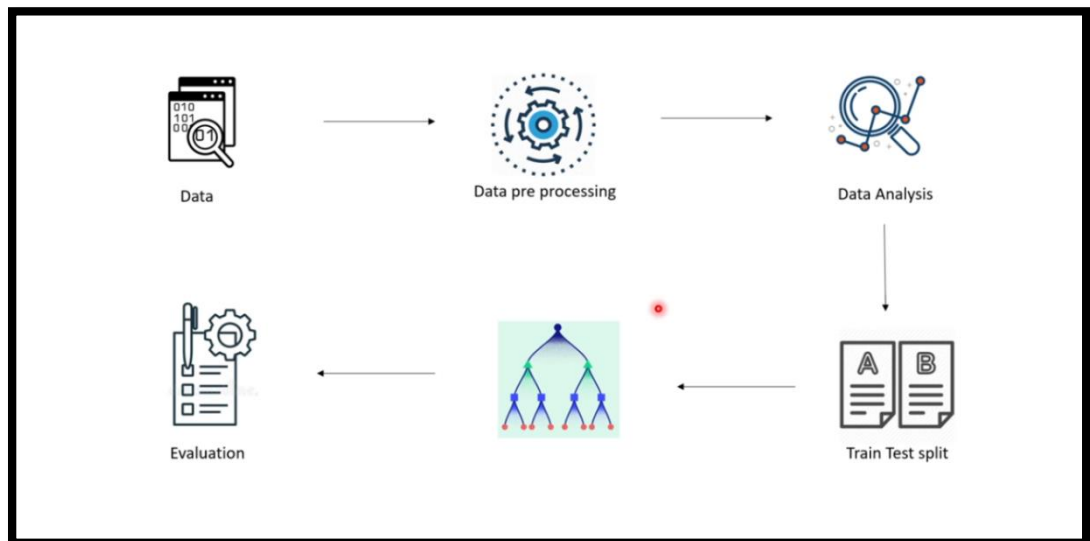
- > Number of neurons can be there in a neural network as per the size of dataset.
- > These neurons can be further extended to other next level of neurons providing better computing power to give accurate output with greater efficiency.
- > Neural networks provide highly accurate output and hence used mostly in the field of AI.

Project Information and Data.

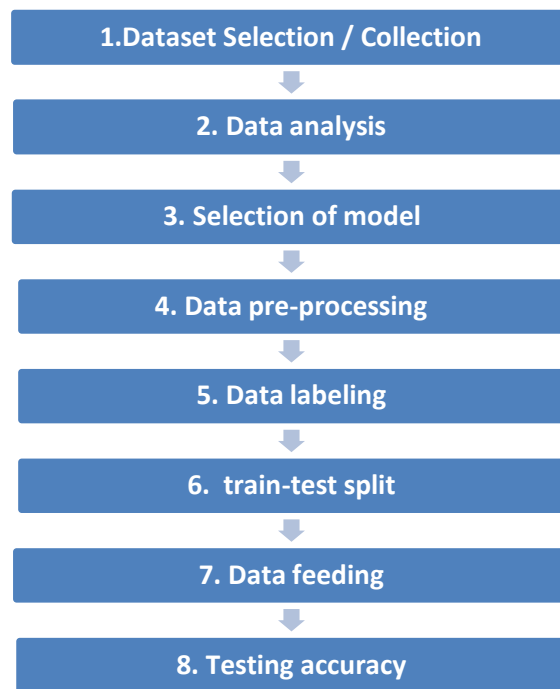
- > As there is no dataset available for Gujarati digits we have manually collected the dataset of our model.
- > The dataset collected are handwritten digits of 0-9 Gujarati language.
- > We have clicked and cropped individual image of digits manually.
- > There are 130 images of individual digits in our dataset leading to total 1300 images of images.
- > Then we have preprocessed the whole dataset by gray scaling the images, Sharping the images, filtering the images into absolute black and white pixels and then resize them to a same dimension.
- > After that we have implemented the model and tested the accuracy of the model.
- > The accuracy turned out to be in range of 75-81 percentage based on various test case ratios of train-test split.



- > We have resized each images in 50x70 dimension.
- > Work flow of model.



- Data: we've to build our own dataset for this project.
- Pre-processing: We've to process the data in following ways
 - Grayscale
 - Absolute B/W filtering
 - Sharpening
 - Resizing
- Analysis: get the properties of images and analysis of it.
- Split the set into two set of getting accuracy of model.
- Feed dataset to neural network.
- Evaluate the dataset for various models to get best accuracy.



1. Data collection

- Data collection / selection include the dataset selection from available set of data
- Here, we have collected Gujarati digits by ourselves.

2. Data analysis

- Data analysis includes getting insights of the dataset.
- It means how the images are arranged.
- Whether they are in same size or not.
- Whether they are grayscale or not.
- Whether the images are in same folder or in different folder. Whether the training and testing folders are given. What is the directory structure of the Dataset?
- In our data analysis we have found that the images are colored, the images are not in grayscale and they are not of the same size. Also they arranged folder wised i.e. images of 0 are in folder named 0 and so on.
- Also there are total 1300 images that contains 130 images of all 10 digits.

3. Selection of model

- After data analysis based on the data we've to decided which model to choose it must give high accuracy and optimum results.
- We've chose neural networks to implement our model because it gives high accuracy on classification on unstructured data.

4. Data pre-processing

- In data pre-processing we process on the dataset before feeding it into model for better accuracy.
- We have resized the images to 50x70 pixels.
- We have gray scaled the images.
- We have filtered those images to absolute black and white.

5. Data labeling:

- The data for the classification (supervised learning) needs labels to predict the class / output name of the given input.
- Sometimes the dataset already gives us labels but we found that we had no labels for this set in our data analysis.
- We've labeled the pre-processed set as 0 as label 0 and 1 to label 1 and so on.

6. Train – test split:

- In our data analysis we found that there are no separate folders for testing and training.
- So, we've separated the pre-processed set into 2 sub-sets which are training set and testing set along with the labels of individual records.
- We've split the pre-processed set that consist of 1300 images of digits into 260 testing images which is 20% of whole set.
- After train test split we have 1040 images of training digits and 260 images for testing. So there are 1040 images for training and 260 for testing.

7. Data feeding:

- Data is then feed to model we've chose to train the model.
- We've converted all the images into equivalent images and scaled the matrix into value between 0-1 by dividing the matrix values with 255.
- Then these scaled image metrics are feed into model with epoch=10.
- It means we've trained the model 10 times with the 1040 images.

8. Testing accuracy of model:

- After training the model is testing with the testing set with equivalent labels.
- We've tested the model with 260 testing records and the accuracy of our model is 75 percentages.
- It means our model predicts 75 images correct out of 100 images and it predicted 195 images correct out of 260 testing set.

Conclusion and future scope

- > We will now try to increase the dataset size and try different and more complex models to improve the accuracy and efficiency of our model.
- > We will provide an interface to this model by hosting it on a server so that any client from anywhere can use the model remotely.
- > We will open source the dataset we have collected for Gujarati digits on various platforms so that it can be accessible throughout the internet and get benefits of this dataset.