



# Hand Written Equation Solver Using Convolution Neural Networks

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**Abstract:** Machine learning and deep learning have become increasingly important as a result of technological advancement. Handwriting recognition, robotics, artificial intelligence, and many more industries are now using machine learning and deep learning approaches. Such systems require data training, allowing our machine to learn and make the necessary predictions. In this research, a Handwritten Equation solver with a respectable accuracy of 98 percent is demonstrated. It was trained on handwritten digits and mathematical symbols using a Convolutional Neural Network and certain image processing techniques. The images of the digits 0 to 9, plus and minus signs (+), and handwritten symbols \* make up the dataset. For the purpose of extracting the features, we shall use contour extraction. In this Project we build the model using convolutional neural network and train the model to evaluate the equations written by hand in this we use the dataset of numbers and operators written by hand. The input image of hand written equation is given the image is converted into gray background for this we use contour extraction for obtaining the features. The output is produced by the model by evaluating the equation

## I. INTRODUCTION

Almost all branches of science, including physics, engineering, medicine, economics, etc., heavily rely on mathematics. Today's primary research issue is the analysis and comprehension of digital documents. OCR (optical character recognition) can produce more accurate recognition of English characters and numbers in electronic books. Recognizing handwritten mathematical expressions is still a very difficult task in the field of Computer vision. The correction rate of symbol segmentation and recognition still falls short of meeting its actual criteria because of the two-dimensional nesting assembly and various sizes. Segmenting the characters and subsequently classifying them are the two main tasks for the recognition of mathematical expressions. One of the most popular categorization models in the field of computer vision is the convolutional neural network (CNN). In comparison to other models now in use, CNN is one of the most favoured models and provides the most precise capabilities for image captioning, object recognition, human activity analysis, picture super resolution, object detection, and scene understanding. When it comes to classifying photos, CNN performs better than any other classification method. CNN employs a number of techniques to extract features from the image.

## II. LITERATURE

With manually calculating equations for handwritten data or numbers, the current system employs. Only those with extensive experience in solving complex equations can use this time-consuming strategy to solve an equation quickly. Disadvantages of Existing System: Manually solving an equation becomes difficult as data amounts increase. Data loss as a result of poor vision. The current system operates at a relatively slow pace. We don't have as many experts as humans to solve difficult equations. Proposed System: Convolutional Neural Networks are used to solve equations and recognize digits. The CNN model is implemented in the Python programming language's Keras module. Libraries for the Python programming language are likewise focused on the CNN model's implementation. Advantages: We propose a system where we use Convolutional Neural Networks to recognize digits. Noise is removed by applying binarization to it. The proposed system uses contour extraction to recognize boundaries of digits. The output is more effective using CNN

## III. METHODOLOGY:

First, noise from the original input image is reduced using our proposed system by binarizing it. also, from the input image, we use compact vertical protuberance to member each line of equation. also, for posterior processing, we treat each member of the segmented image as a full image. We also look for certain characteristics in the form of affiliated factors for each line of equation image. After that, each segmented character is fed into a convolutional neural network model for character categorization. The performing character, which is CNN's affair, is also employed to produce a character string that looks like the original equation. The medication of the dataset is the most important aspect of this design. The borders of characters like the English numeric, symbols and alphabets can all be directly defined. As a result, we begin by preparing the dataset with the loftiest precedence given to its edges, i.e., illumine the edges. The procedure of changing and modifying the input image to make it suitable for recognition is known as preprocessing. Image enhancing ways are: 1) Conversion of RGB to Gray- Scale Because character discovery on a colored image is more delicate than on a grayscale image, this colored image is first turned into a conventional Gray- scale image and represented

through a single matrix. 2) Binarization is the process of converting pixel data into 0s and 1s by opting a threshold value. In this study, 1s indicate black pixels and 0s represent white pixels in the vertical protuberance calculation. Binarization thresholds can be approved in two ways overall threshold and partial threshold. Otsu's system is grounded on picture statistical parcels and is 11 an overall threshold system. 3) Noise Reduction, noise refers to the presence of too numerous pixels in an image. swab and pepper noise and Gaussian noise are two types of noise. Low pass filtering is used to remove Gaussian noise from the image, and Salt and Pepper noise doesn't need to be filtered because it's fairly low in comparison to Gaussian noise.

#### IV. ALGORITHMS

Convolutional neural network (CNN) is a class of artificial neural network most generally applied to dissect visual imagery. CNNs use a fine operation called complication in place of general matrix addition in at least one of their layers. They're specifically designed to reuse pixel data and are used in image recognition and processing. They've operations in image and videotape recognition, recommender systems, image bracket, image segmentation, medical image analysis, natural language processing, brain – computer interfaces, and fiscal time series. CNNs are also known as Shift Invariant or Space Invariant Artificial Neural Networks (SIANN), grounded on the participated- weight armature of the complication kernels or pollutants that slide along input features and give restatement- equivariant responses known as point charts. Counter-intuitively, utmost convolutional neural networks aren't steady to restatement, due to the down slice operation they apply to the input. CNNs are formalized performances of multilayer perceptrons. Multilayer perceptrons are generally completely connected networks, that is, each neuron in one subcaste is connected to all neurons in the coming subcaste. The " full connectivity" of these networks make them prone to overfitting data. Typical ways of regularization, or precluding overfitting, include chastising parameters during training (similar as weight decay) or trimming connectivity CNNs take a different approach towards regularization they take advantage of the hierarchical pattern in data and assemble patterns of adding complexity using lower and simpler patterns embossed in their pollutants. CNN use the hierarchical structure of the data they're recycling. rather of trying to reuse the entire image or input at formerly, CNNs break it down into lower, simpler features, which are represented by pollutants. These pollutants are applied to different regions of the input to prize the applicable information. As the network progresses through the layers, these features are combined and assembled into more complex patterns, allowing the network to learn decreasingly abstract representations of the input. This hierarchical approach allows CNNs to efficiently learn complex patterns in data, while minimizing the threat of overfitting. thus, on a scale of connectivity and complexity, CNNs are on the lower minimum. Convolutional networks were inspired by natural processes in that the connectivity pattern between neurons resembles the association of the beast visual cortex. Individual cortical neurons respond to stimulants only in a confined region of the visual field known as the open field. The open fields of different neurons incompletely lap similar that they cover the entire visual field. CNNs use fairly little pre-processing compared to other image bracket algorithms. This independence from previous knowledge and mortal intervention in point birth is a major advantage.

#### V. IMPLEMENTATION:

The real show for the turning points that determine whether it will succeed or fail is perpetration phase. The installation and operationalization of the system or system variations in a product terrain is appertained to as the performance step. keras is a high-position, deep knowledge API developed by Google for administering neural networks. Pandas is a Python library used for assaying datasets. It has functions for assaying, drawing, exploring, and manipulating data Libraries / Algorithms Used:

NUMPY  
KERAS  
PANDAS

#### DATASET

Source: Google Data Set Information: The preparation of the dataset is the most important in this project. English alphabets and symbols of operators should be written accurately. It should not contain errors. As a result, we begin by preparing the dataset with the highest priority given to its edges, i.e., illumine the edges. We created our own datasets and used a modified version. We used a 32x32 grey level image in our dataset. For the training of the network, we use 150 data items for each category. And in the majority of cases, our network training was accurate to the tune of 98 percent.

Example 1:

36754 + 80 x 27

Example 2:

75 x 42 + 83 - 95

**PROCEDURE/ALGORITHM:**

- > Start
- > CREATING A CONVOLUTION NEURAL NETWORK MODEL
  - { IMPORTING LIBRARIES; DATA COLLECTION AND ANALYSIS
  - {
  - loading the data from csv file to Data Frame; Normalization Of data (To get accurate values removing inconsistent values); }
  - DATA PRE-PROCESSING {
  - Separating the Symbols, alphabets& Target; Splitting the data to test data & Training data; } Data Standardization;
  - Model Training; Evaluation of Model
  - {
  - calculating accuracy of train dataset
  - }
  - }
- > BUILDING A CNN SYSTEM
  - {
  - user\_data(image);
  - user\_input\_data to data frame;
  - standardization of data; data = scaler-transform(input data);
  - results=model(data) #model calculates data
  - }
- > End Results (Accuracy) / Output Screens

```

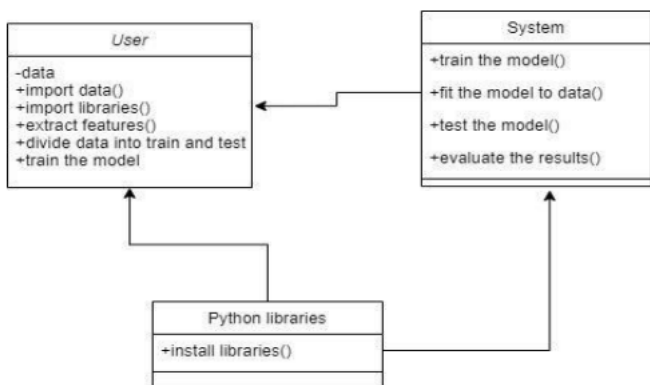
Results:
36754+80*27
eval(st)
38914

R
75*42+83-95
[0]: eval(st)
[0]: 3138
    
```

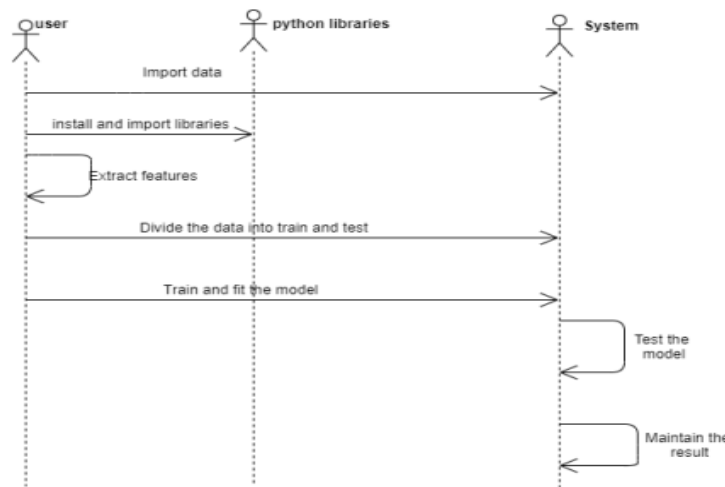


**UML DIAGRAMS**

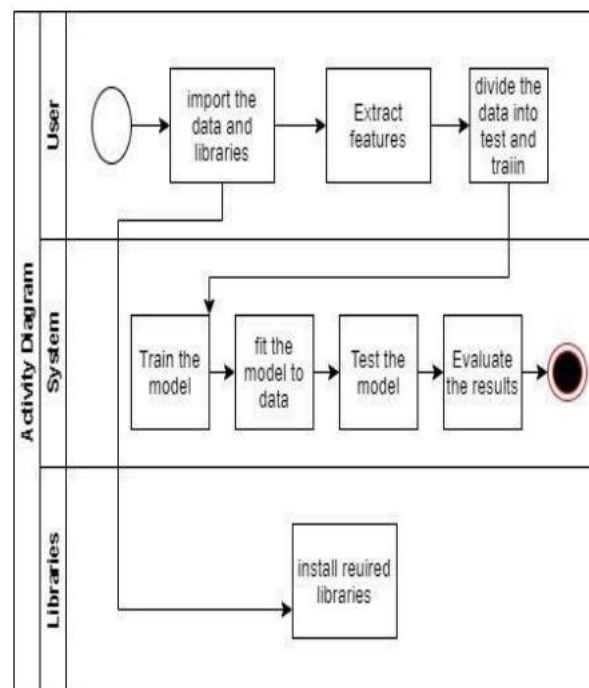
Class Diagram : Class diagrams are the main structure blocks of every object-acquainted system. The class diagram illustration can be used to show the classes, connections, interface, association, and collaboration. UML is formalized in class diagrams. Since classes are the structure block of an operation that's grounded on OOPs.



Sequence Diagram: This cooperative design tends to time-based message asking. It consists of a group of components as well as the messages that each group of parts has sent and received. This chart is used to discuss the structure's dynamic perspective. A succession roadmap shows query communications planned according to timing. Three articles are collaborating with one another in the graph below. Each protest has a vertical dashed line that indicates that there is a question over an ambiguous time period.



Activity Diagram: Activity state is another name for an activity in the activity diagram. It is used to denote the beginning of an operation, which is a stage in a full business process. On an activity diagram, the accomplished activities can be grouped by the same actor using swim lanes.



**ADVANTAGES OF THE SYSTEM:**

The suggested system uses a much more straight forward and effective method. The usage of an easy to use Framework makes the system simpler. It has fewer complicated database setups and a more effective algorithm. Due to its platform independence, the system is more effective.

**CONCLUSION**

This project can also be used to create other complex projects, such as online calculators that can compute the answer to an equation from its image alone without the assistance of a human being. This has a lot of benefits, but the primary one is that it saves time when solving these kinds of equations. This will undoubtedly be helpful for many fields that now have schedules that account for the time lost while solving and parsing these kinds of equations. we consider a single quadratics and also series of quadratics for the recognition. Projection analysis specially compact horizontal projection is used for the segmentation of each line of quadratics. Connected component which has very high success rate is used for character segmentation . Improved version of connected component feature extraction the is used for the symbol like ‘=’ detection which is a single symbol combined with two distinct connected component most complicated part of classification. Moreover with some predefined feature about handwritten it is difficult

to recognize handwritten. Convolutional Neural Network the most powerful classification model is used in the classification part.

#### **FUTURE ENHANCEMENT**

The main goal in the coming days will be to try to improve the precision level, create a segmentation system that can successfully segment two connected digits, and boost the dataset's performance..

#### **ACKNOWLEDGEMENT**

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