Engineering Universe for scientific Research and management
ISSN (Online): 2319-3069
Vol. XV Issue III
March 2023

A Study on Traffic Sign Recognition Using Machine Learning Algorithm

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Abstract

In the case of visual detection, the acquisition of traffic signals and identity is a common application domain. Visual recognition of the involvement and separation of information contained in the panel can be of great help to the driver. Traffic panels direct driver assistance along routes using signals and text strings. Depending on the color and shape factors, a traffic signal is available and recognizable. Several methods have been used to extract the color and appearance of traffic signals. This paper provides a survey of road traffic identification and recognition surveys, detailing the driver's assistance plan to ensure safe travel. A brief review of the latest development techniques used by researchers provided the findings and cognitive stages and brought about the classification of machine learning strategies and their comparisons.

Keywords: *Machine Learning, Data Mining, Statistics, Bayesian algorithm, Traffic Sign*

1. Introduction

With the rapid modernization and increasing car ownership, road safety has become increasingly important worldwide, especially in developed countries. In fact, there are significant numbers of people who lose their lives as a result of road accidents every year and the annual number of such people seems to be increasing. As an integral part of the smart navigation system, the advanced driver assistance system for smart vehicles will inform you of the potential danger, assist the driver with navigation and guidance, and make driving safer and easier. Examples of such a system include flexible navigation control, route warning system, collision avoidance system, night vision, road sign recognition, and so on [1]. Important information about the state of traffic, which is presented to drivers, is usually included as visual aids such as road signs, traffic lights, road markings, etc. In some cases, a number of factors, such as fatigue, alcoholism, and conflict, can affect a person's eyesight. To increase road safety, ADAS must understand the visual language, and communicate information to drivers through a variety of methods including road sign recognition (TSR) [2].

2. Traffic Sign in India

Traffic signs are the noiseless chatterers on the street. Is it the individual overdue the wheel or a unimaginative, having a detailed information about road safety is obligatory for whole previously thumping the streets. Traffic signs stretch information nearby the street environments gaining, proposition instructions to be pursued at the principal crossing or intersections, inform or controller drivers, and sanction proper operational of street traffic. Being unacquainted of street signs is corresponding to chucking attentiveness to the tempest. It can central to penalization of life and property. A person is imaginary to be habituated (get complete a adorned or oral test) with the traffic signs and symbols before locating a driving license in India. Habitually, there are three unalike kinds of street symbols in India.

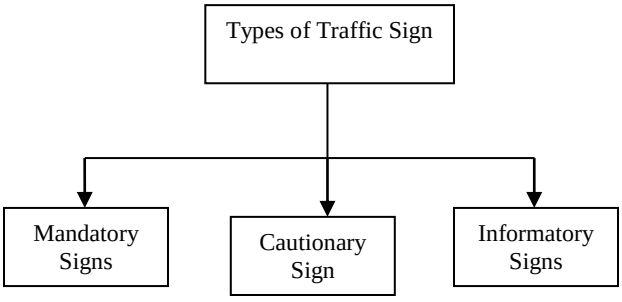

Fig. 1: Types of traffic symbols used in India

Mandatory Signs

As we can appreciate from the name that these are the signs which requirement to be surveyed appropriately experimental it is a delinquency to unfollow them. One might be dispensed challan if he/she fails to monitor them. These signs are used to variety certain the free undertaking of vehicles concluded the road network.[4] The driver made cognizant of the boundaries completed the road with the help of these symbols. Sings Originates under this grouping is like: Stop, Give Way, No entry,

Pedestrian Prohibited, Horn Prohibited, No Parking, No stopping or standing, Speed limit, Right Hand Curve, Left Hand Curve, Right hair Pin Bend, Left Hair Pin Bend, Narrow Road Ahead, Narrow Bridge, Pedestrian Crossing, School Ahead, Round About, Dangerous Dip, Hump or Rough, Barrier Ahead.

Cautionary Signs

These symbols are recycled to cognizant the driver nearby the threats on the road ahead. These symbols are similarly used to cognizant the driver nearby the safety hazards ahead or on the road. These symbols are used to make drive aware and take proper action over them else accident may happen. So, the driver follows these to avoid a personal loss as well as the loss of the infrastructure.[4] These symbols aware the driver so that he/she is able to tackle the upcoming situation. Signs comes under this category is like: Right Hand Curve, Left hand Curve, Right Hand Pin Bend, Left Hand Pin Bend, Right Reversal bend, Left Reversal Bend, Steep Ascent, Steep Descent, Narrow Road Ahead, Road Wideness Ahead, Narrow Bridge, Slippery Road, Loose Gravel, Cycle Crossing, Pedestrian Crossing, School Ahead, Men At Work, Cattle, Falling Rocks, Ferry.

Informatory Signs

These symbols afford further material to the road users. These symbols communicate the employer nearby the road's basic material such as terminus. These are not required signals but are used to support the road users. [4] The symbols come below this grouping is like: Public Telephone, Petrol Pump, Hospital, First Aid Post, Eating Place, Light Refreshment, Resting Place, Through Road, Through Side Road, Park This Side Parking Lot Scooter & Motor Cycle, Parking Lot Cycle, Parking Lot Cars.

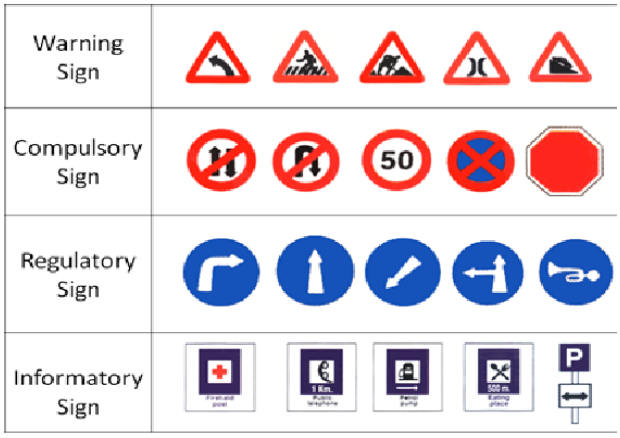

Fig.2: Traffic Sign used in India

3. Related Work

José Ramón García Oya et al. (2018) presented a system with location functionalities for the inventory of traffic signs based on passive RFID technology. The proposed system simplifies the current video-based techniques, whose requirements regarding visibility are difficult to meet in some scenarios, such as dense urban areas. In addition, the system can be easily extended to consider any other street facilities, such as dumpsters or traffic lights. Furthermore, the system can perform the inventory process at night and at a vehicle's usual speed, thus avoiding interfering with the normal traffic flow of the road. Moreover, the proposed system exploits the benefits of the passive RFID technologies over active RFID, which are typically employed on inventory and vehicular routing applications. Since the performance of passive RFID is not obvious for the required distance ranges on these in-motion scenarios, this paper, as its main contribution, addresses the problem in two different ways, on the one hand theoretically, presenting a radio wave propagation model at theoretical and simulation level for these scenarios; and on the other hand experimentally, comparing passive and active RFID alternatives regarding costs, power consumption, distance ranges, collision problems, and ease of reconfiguration. Finally, the performance of the proposed on-board system is experimentally validated, testing its capabilities for inventory purposes.[4] *Kh Tohidul Islam and Ram Gopal Raj (2017)* presented a system which is based on two stages, one performs the detection and another one is for recognition. In the first stage, a hybrid color segmentation algorithm has been developed and tested. In the second stage, an introduced robust custom feature extraction method is used for the first time in a road sign recognition approach. Finally, a multilayer artificial neural network (ANN) has been created to recognize and interpret various road signs. It is robust because it has been tested on both standard and non-standard road signs with significant recognition accuracy. This proposed system achieved an average of 99.90% accuracy with 99.90% of sensitivity, 99.90% of specificity, 99.90% of f-measure, and 0.001 of false positive rate (FPR) with 0.3 s computational time. This low FPR can increase the system stability and dependability in real-time applications.[5] *Kwangyong Lim et al.(2017)* presented a General Purpose Graphics Processing Unit (GPGPU) based real-time traffic sign detection and recognition method that is robust against illumination changes. There have been many approaches to traffic sign recognition in various research fields; however, previous approaches faced several limitations when under low illumination or wide variance of light conditions. To overcome these drawbacks and improve processing speeds, they proposed a method that 1) is robust against illumination changes, 2) uses GPGPU-based real time traffic sign detection, and 3) performs region detecting and recognition using a hierarchical model. This method produces stable results in low illumination environments. Both detection and hierarchical recognition are performed in real-time, and the proposed method achieves 0.97 F1-score on our collective dataset, which uses the Vienna convention traffic rules (Germany and South Korea).[6] *Andrzej Ruta*

et al.(2009) addressed the problem of traffic sign recognition. Novel image representation and discriminative feature selection algorithms are utilized in a traditional three-stage framework involving detection, tracking and recognition. The detect or captures instances of equiangular polygons in the scene which is first appropriately filtered to extract the relevant colour information and establish the regions of interest. The tracker predicts the position and the scale of the detected sign candidate overtime to reduce computation. The classifier compares a discrete-colour image of the observed sign with the model images with respect to the class-specific sets of discriminative local regions. They are learned off-line from the idealized template sign images, in accordance with the principle of one-vs-all dissimilarity maximization. This dis- similarity is defined based on the so-called Colour Distance Transform which enables robust discrete-colour image comparisons. It is shown that compared to the well-established feature selection techniques, such as Principal Component Analysis or AdaBoost, our approach offers a more adequate description of signs and involves effortless training. Upon this description we have managed to build an efficient road sign recognition system which, based on a conventional nearest neighbor classifier and a simple temporal integration scheme, demonstrates a competitive performance in the experiments involving real traffic video.[7] *Sandy Ardianto et al.(2017)* designed and implemented a real time traffic sign recognition system implemented on Advantech ARK-2121, a small computer mounted on car. The entire process is divided into two parts, the detection step and the classification step. In the detection step, they adopt color filtering, Laplacian and Gaussian filter to enhance an acquired image. Then, they detected the sign based on the contours. The recognition algorithm is accelerated by dividing an input frame into multiple blocks and process them in parallel. They improved the detection accuracy by enhancing input image before the recognition step. The SVM and HOG features are the major techniques in the recognition step. Their detection accuracy is around 91% and the classification accuracy is higher than 98% on the average.[8] *H. Fleyeh, M. Dougherty (2016)* presented an overview of the road and traffic sign detection and recognition. It describes the characteristics of the road signs, the requirements and difficulties behind road signs detection and recognition, how to deal with outdoor images, and the different techniques used in the image segmentation based on the colour analysis, shape analysis. It shows also the techniques used for the recognition and classification of the road signs. Although image processing plays a central role in the road signs recognition, especially in colour analysis, but the paper points to many problems regarding the stability of the received information of colours, variations of these colours with respect to the daylight conditions, and absence of a colour model that can led to a good solution. This means that there is a lot of work to be done in the field, and a lot of improvement can be achieved. Neural networks were widely used in the detection and the recognition of the road signs. The majority of the authors used neural networks as a recognizer, and as classifier. Some other techniques such as template matching or classical classifiers were also used. New techniques should be involved to increase the robustness, and to get faster systems for real-time applications.[9] *U. Zakir et al.(2012)* described an efficient approach towards road sign detection and recognition. The proposed system is divided into three sections namely; Colour Segmentation of the road traffic signs using the HSV colour space considering varying lighting conditions, Shape Classification using the Contourlet Transform considering occlusion and rotation of the candidate signs and the Recognition of the road traffic signs using features of a Local Energy based Shape Histogram (LESH). We have provided three experimental results and a detailed analysis to justify that the algorithm described in this paper is robust enough to detect and recognize road signs under varying weather, occlusion, rotation and scaling conditions using video stream.[10] *Amal Bouti et al.(2017)* implemented and tested a system of detection and recognition of road signs. The approach taken in this work consists of two main modules: a sensor module, which is based on color segmentation and shape detection where we converted the images to the HSV color space, then labeled the detected regions and tested for their shape. The recognition module, Template Matching, whose role is to match the detected object with a priori models signs. Tests carried out on a set of RGB images taken by a traffic camera shows the performance of the system currently being developed. Finally, they did a comparison.[11]*Paweł Forczmański and Krzysztof Małecki (2013)* proposed appearance-based approaches, employing template matching. In most cases they work on color images (or videos) and deal with all types of signs, regarding their shape and color. On the other hand, commercial systems, installed in higher-class cars, detect only the round speed limit signs and overtaking restrictions found all across Europe. The main disadvantage of visual recognition of traffic signs is associated with difficult conditions of image acquisition and hence problems with noise, blurring, scale and orientation changes should be solved. They presented a classification of signs visual recognition methods and discuss their advantages and disadvantages. They compared them with an RFID approach.[12] *Zainal Abedin et al.(2017)* proposed and approach for TSR system where detection of traffic sign is carried out using fuzzy rules based color segmentation method and recognition is accomplished using Speeded Up Robust Features(SURF) descriptor ,trained by artificial neural network (ANN) classifier . In the detection step, the region of interest (sign area) is segmented using a set of fuzzy rules depending on the hue and saturation values of each pixel in the HSV color space, post processed to filter unwanted region. Finally, the recognition of the traffic

sign is implemented using ANN classifier upon the training of SURF features descriptor. The proposed system simulated on offline road scene images captured under different illumination conditions. The detection algorithm shows a high robustness and the recognition rate is quite satisfactory. The performance of the ANN model is illustrated in terms of cross entropy, confusion matrix and receiver operating characteristic (ROC) curves. Also, performances of some classifier such as Support Vector Machine (SVM), Decision Trees, Ensembles Learners (Adaboost) and KNearest Neighbor (KNN) classifier are assessed with ANN approach. The simulation results illustrated that recognition using ANN model is higher than classifiers stated above.[13] *Rubén Laguna et al.(2014)* described a software application for traffic sign recognition (TSR). The application works in four stages. First, an image preprocessing step and the detection of regions of interest (ROIs), which involves a series of steps that include transforming the image to gray scale and applying edge detection by the Laplacian of Gaussian (LOG) filter. Secondly, the potential traffic signs detection, where the ROIs are compared with each shape pattern. Thirdly, a recognition stage using a cross-correlation algorithm, where each potential traffic signs, if validated, is classified according to the data-base of traffic signs. Finally, the previous stages can be managed and controlled by a graphical user interface, which has been specially designed for this purpose. The results obtained show a good performance of the developed application, taking into account acceptable conditions of size and contrast of the input image.[14] *Wahyono et al. (2014)* addressed the traffic sign detection and recognition. First, the input image is converted into normalize red and blue color space, as traffic sign usually appear with red and blue color. Second, maximally extremal stable region is then performed for extracting candidate region. Using heuristic rule of geometry properties, the false region will be excluded. Third, histogram of oriented gradient method is applied in order to extract feature from candidate region. Lastly, cascade support vector machine classifier is then processed to classify region belong to certain class of traffic sign. The extensive experiment would be carried out over German traffic sign recognition database and video. The experimental results demonstrated the effectiveness of their systems.[15] *Hengliang Luo et al (2017)* proposed a new data-driven system to recognize all categories of traffic signs, which include both symbol-based and text-based signs, in video sequences captured by a camera mounted on a car. The system consists of three stages, traffic sign regions of interest (ROIs) extraction, ROIs refinement and classification, and post-processing. Traffic sign ROIs from each frame are first extracted using maximally stable extremal regions on gray and normalized RGB channels. Then, they are refined and assigned to their detailed classes via the proposed multi-task convolutional neural network, which is trained with a large amount of data, including synthetic traffic signs and images labeled from street views. The post-processing finally combines the results in all frames to make a recognition decision. Experimental results have demonstrated the effectiveness of the proposed system.[16] *Md. Zainal Abedin et al.(2016)* proposed a new approach for TSR system using hybrid features formed by two robust features descriptors, named Histogram Oriented Gradient(HOG) features and Speeded Up Robust Features(SURF) and artificial neural network (ANN) classifier . In the detection step, the region of interest (sign area) is segmented using color based thresholding algorithm, post processed to filter the unwanted region. Next robust features vector named Distance to Borders (DtBs) of the segmented blob is formed to verify the shape of the traffic sign. Finally the recognition of the traffic sign is implemented using ANN classifier upon the training of hybrid features descriptor. The proposed system simulated on offline road scene images shows a high classification rate in the recognition stage. The performance of the ANN model is illustrated in terms of cross entropy, confusion matrix and receiver operating characteristic (ROC) curves. In addition, the performance of hybrid feature descriptor is compared with recognition based on HOG and SURF descriptor respectively. Also, performances of some classifier such as Support Vector Machine (SVM), Decision Trees, Ensembles Learners (Adaboost) and K-Nearest Neighbor (KNN) classifier are assessed with ANN approach. The simulation results illustrates that recognition using hybrid feature descriptor outperforms in all classifier and the recognition accuracy of ANN is higher than classifier stated above.[17] *Safat B. Wali et al.(2019)* provides a comprehensive survey on traffic sign detection, tracking and classification. The details of algorithms, methods and their specifications on detection, tracking and classification are investigated and summarized in the tables along with the corresponding key references. A comparative study on each section has been provided to evaluate the TSDR data, performance metrics and their availability. Current issues and challenges of the existing technologies are illustrated with brief suggestions and a discussion on the progress of driver assistance system research in the future. This review will hopefully lead to increasing efforts towards the development of future vision-based TSDR system.[18].

4. Machine Learning Techniques

Machine Learning has turn into one of the mainstays of information technology. With the still increasing sum of data becoming obtainable there is good quality reason to consider that smart data study will become still more persistent as a needed component for technological purposes. A great deal of the science of machine learning is to explain those trouble and supply good guarantees for the resolution. [19, 20].There is diverse ways an algorithm can reproduction a crisis based on its communications with the familiarity or environment or

input data. For this, complete initially we have to accept a learning approach that an algorithm can accept. There are merely few main learning models that an algorithm can encompass .The technique of organizing machine learning algorithms is practical because it armed forces to think in relation to the roles of effort data and the model of training process and selecting the one which is most appropriate for predicament for target results. An application where machine learning facilitates is named thing gratitude. Let's converse the diverse learning styles in machine learning algorithms and its diverse parts.

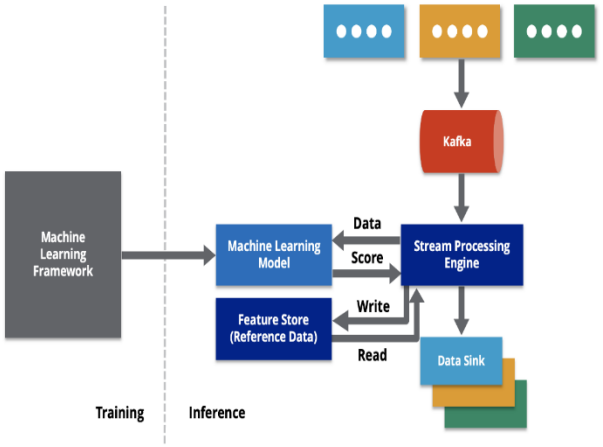

Fig 3: Machine Learning Flow Diagram [20]

Supervised learning: In Supervised learning we study an objective function that can be used to forecast the values of a separate class feature as accepted or not- accepted. Machine learning algorithm makes predictions on agreed set of example whereas supervised learning algorithms searches for model within the charge labels assigned to data points. This algorithm consists of an ending changeable which is to be predicted starting, a specified set of predictor's i.e. sovereign variables. Using these set of variables, we produce a purpose that map input to wanted outputs. The training procedure continues awaiting the model achieves stage of accurateness on the training data. This complete procedure helps in decrease of spending on physical review for significance and coding. Examples of supervised learning: Neural Networks, Regression, Decision tree, KNN, Logistic Regression, SVM, Naive Bayes etc. So largely it is divided into 2 parts:
Learning (training): Learn a model by means of the training data. Testing: Test the model using unknown test data to assess the model correctness. Itself repeatedly using trial and error. This machine learns from its precedent experience and tries to arrest the best promising acquaintance to make correct business decisions Such as Markov Decision Process. It learns to select an achievement to maximize payoff. Appropriate the algorithm changes its policy to learn well again and the best judgment and precision. [21]

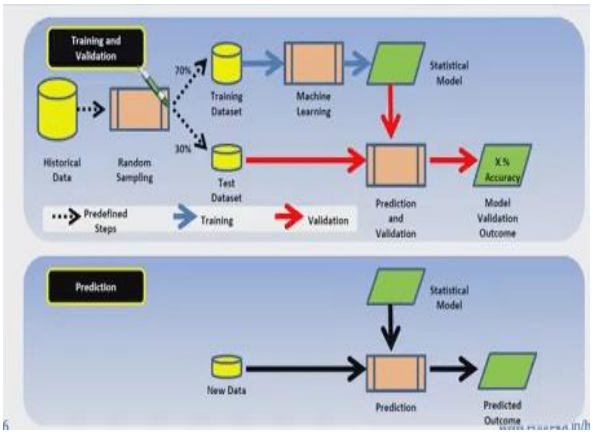

Fig.4: Supervised Learning [21]

Unsupervised learning: Learning valuable formation with-out characterized classes, optimization condition, feedback signal, or any former information further than the raw data is referred as unverified learning. In this algorithm, we don't have any objective unpredictable to approximation means here we don't have several labels linked with data points or we can speak class label of education data are indefinite. This algorithm is used for organizing the data into the group of bunches to explain its arrangement i.e., cluster the data to disclose significant partitions and hierarchies. It creates data look easy and prepared for analysis. Examples: K-means, Fuzzy clustering, Hierarchical clustering. Input data is not labelled and doesn't have a identified result. A model is equipped by deducing construction current in the input data. This may be to remove broad rules. It may during a mathematical procedure to methodically reduce dismissal.

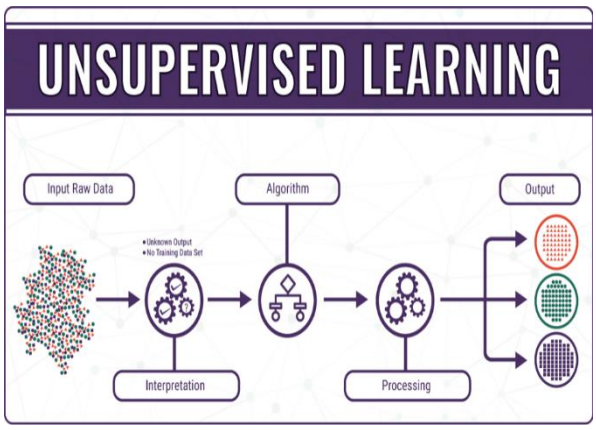

Fig 5: Unsupervised Learning

Reinforcement learning: Using this algorithm, the machine is qualified to make explicit decisions. These algorithms prefer an exploit, based on every data point and later learn how superior the decision was in this the machine is showing to an environment where it trains.

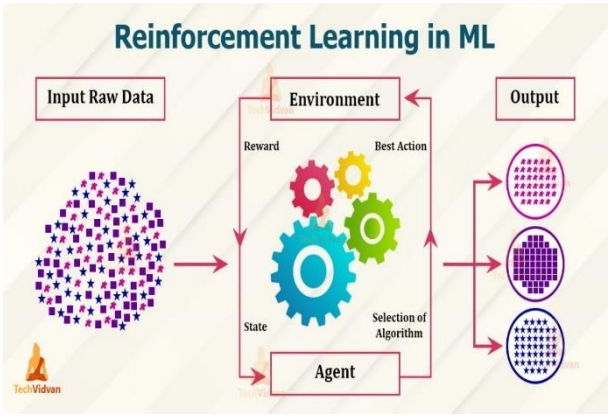

Fig 6: Reinforcement Learning [21]

Comparison between supervised, unsupervised and reinforcement learning

Criteria	Supervised Learning	Unsupervised Learning	Reinforcement Learning
Definition	The machine learns by using labeled data	The machine is trained on unlabeled data without any guidance	An agent interacts with its environment by performing actions & learning from errors or rewards
Type of problems	Regression & classification	Association & clustering	Reward-based
Type of data	Labeled data	Unlabeled data	No predefined data
Training	External supervision	No supervision	No supervision
Approach	Maps the labeled inputs to the known outputs	Understands patterns & discovers the output	Follows the trial-and-error method

Fig. 7: Comparison between supervised, unsupervised and reinforcement learning

5. Conclusion

The acquisition/detection of traffic signs and visions is very important in the Driver Assistance Program to ensure a safe journey. The changing lighting conditions in the external environment have made it difficult for the detection phase to detect signal. This paper discusses the review of various techniques used recently to detect and identify signs on a road panel also presented the literature work done in traffic sign recognition by various authors. However, other potential problems can be solved by developing strategies that are more effective. In future, we need to design ensemble approach that will improve the quality of sign and recognition of traffic sign effectively.

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