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AI-based Mechanism to Authorise Beneficiaries at Covid Vaccination Camps using Deep Learning

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Abstract - *Authorisation for the Covid-19 vaccination drive in India currently involves an Aadhaar card or any other type of valid identification. it's possible that people have forgotten their Aadhaar or lost their legitimate documents as a result of the lockdown. This is where a Facial Recognition device comes in as a solution. The goal of the paper is to create a deep learning model and integrate it into a system that would allow individuals in India to register for covid vaccinations and then log in to reserve their slots using the "Real-time face recognition" approach. Presently, any kind of valid id evidence is required for verification for the Covid-19 immunization initiative. Since such identification techniques need touch and a frontline worker, it's preferable to make the process contactless and quick. Facial recognition will assist to alleviate the concern of unintentional infections at vaccination centers by making the operation contactless. For the procedure to work, eligible persons will need to register for the Covid-19 immunization setup using the Co-WIN platform on the Aarogya Setu app. During registration, users can link their mobile numbers. When users who have chosen to validate their identification using Aadhaar information come to a vaccination booth, the facial recognition technology will immediately check them. The system proposed in this paper achieved a 98.34% accuracy in a real-time approach which makes it effective enough to replace the primitive methods.*

Key Words: Covid-19, CNN, Feature Extraction, Facial landmarks, Image processing, Hash encoding, Data Augmentation.

1.INTRODUCTION

The Covid-19 outbreak – and the contemporary world it has revealed – has thrown many technologies and lives into disarray. In what has become a severe failure, contact biometric systems may not only be outmoded but also potentially lethal, given the risk of virus transmission. It is vital to vaccinate the whole population against the SaRS.-CoV-2. virus, as vaccination will be the most effective strategy for limiting the pandemic. This is a significant problem since we must first develop a safe and effective vaccine before producing, distributing, and giving it to the susceptible population promptly. It is difficult to develop a COVID-19 vaccine that is both effective and safe, but operations, transportation, and production of the vaccine could pose significant challenges, especially in developing countries where the vaccination will be injected and to assure its efficacy and usefulness, cold storage is necessary. Looking through the history of face recognition, it can be seen that it has been the subject of numerous research papers. [1-6]. Human face image processing has been a popular and exciting study topic for many years. Because human features are very detailed, numerous issues have piqued people's attention and have been widely investigated. In recent years, a variety of feature extraction and pattern categorization approaches have been developed. Surveillance, facial recognition, video indexing, and developing market surveys are just a few of the sectors where this study topic has a lot of promise. Some challenges are there in this solution such as pose variation, lighting, and facial expression changes that happen from time to time as in references mentioned in the references section [7-14]. The obvious benefit of utilizing facial recognition in a vaccination campaign is that it reduces the number of contact points between people across the circuit. Face recognition with cameras located at a distance eliminates the need for customers to repeatedly tap the same fingerprint authenticator, which has been the major driver of Covid-19's global development. One of the issue statements explored here is de-duplication. Given the limited amount of vaccines available, it is the government's responsibility to deliver them in a timely and organized manner that each person receives the appropriate amount. another issue statement that has a high likelihood of being seen at a vaccination location is a violation of the COVID-19 preventative procedures, such as wearing suitable masks and maintaining social distance. It's unlikely that keeping track of everyone will be done manually. Overcrowding can occur at times, needing attention to the issue for the benefit of protection and better management, Hence more complicated facial characteristics can be extracted using deep learning as referenced in papers [15-27].

2. LITERATURE SURVEY

About paper [28], Joint face detection & alignment using Multitask cascaded convolutional networks (Kaipeng Zhang, Zhanpeng Zhang, Zhifeng Li)

In this paper, the system employs a three-network cascade configuration: first, the image is rescaled to a variety of sizes (known as an image pyramid), then the first model (Proposal Network or P-Net) suggests the target facial features of R-Net filters the feature vectors, and the third model (Output Network or O-Net). MTCNN is the most

precise and produces the most accurate findings. It detects five major points in addition to detecting the face. They first employ a convolutional network to gather target frames and their input vector regression vectors, and then they employ Non- maximum suppression to overlap the strongly conflicting targets (NMS). The members are then passed to a second CNN, which filters out a large no. of false outcomes and calibrates bounding boxes.

About paper [29] Facial expression recognition using feature additive pooling and progressive fine-tuning of CNN (Yu, C.1 Lee, S. W. in 2018)

According to this paper, A VGGface- based facial live expression detection network is being used, which is the VGG16 version trained on the VGGface dataset. To accommodate the difficulty, the VGGface network's last completely integrated (FC) layer with 2622 channels is substituted by an FC layer with six/ seven channels. To solve the challenge of picking the proper layers to be retrained, they presented a network architecture built of convolution block branches from the five VGGface models that were trained on facial characteristics data with varied fine-tuning degrees. The five Conv5 blocks in the five VGGface kinds and three FC layers are also added element by element. as demonstrated in this paper, they developed a CNN algorithm for facial emotion detection based on a progressive hyper-tuning methodology and an adaptive feature pooling procedure. The results show that the proposed methodology outperforms state-of-the-art techniques, better performance when information distributions between training and test data change considerably.

About the paper [30] Deep Face Recognition for Biometric authentication (Maheen Zulfiqar, Fatima Syed, Muhammad Jaleed Khan, Khurram Khurshid in July 2019)

In this paper, they've introduced a face recognition system based on CNN that identifies faces in an input picture using the Viola-Jones object detection and identifies characteristics from discovered faces using a pre-trained CNN for recognition. avast, a library of subject facial photographs is built, which is then supplemented to increase the number of photos per topic and to include diverse light and noise conditions. For deep facial recognition, an ideal pre-trained CNN model and a set of hyperparameters are extracted empirically. The usefulness of deep facial recognition in automated biometric assessment systems is demonstrated in promising testing findings, with an overall accuracy of 98.76 percent.

3. RESEARCH GAP

As previously reported, de-duplication is one of the statements of the issues discussed. It is currently achieved with the aid of an Aadhaar. It's possible that people have left their Aadhaar cards behind or lost them as a result of the lockout. This might be the case for the people in rural India. While E-Aadhaar cards exist, this poses a problem when it comes to children, as they do not have Aadhaar cards. another option is to use biometrics, but this requires physical contact which may result in the virus spreading. as a result, a solution with minimal physical processes will be beneficial. An Iris-based authentication system can't be used in this use case because one of the symptoms of covid is that your eye might turn red and swollen and here the system can fail.

4. SUGGESTED APPROACH

This is where the Facial Recognition model comes in as a workaround, the system is designed in a way as when the user comes to the portal, he gets two options i.e. if he's already registered, he can log in and book his slots and if he's new, he can register himself. Now if the user goes to register, the user can enter his/her email id, and an image is captured on a live stream video. After loading the captured photo, the proposed model measures various facial features, referred to as landmarks mentioned in the paper referenced in [31-35] or nodal points. including the distances between both the eyes, the thickness of a nose, the distance from its forehead to the chin area, etc. In an ideal condition, It's possible to gather up to 80 distinct parameters. This evaluated data is then converted into a formula that reflects the distinctive facial identity. And the data. pickle file contains this encrypted signature. Similarly, When the user visits the login page, the algorithm confirms the user's identity by encoding the newly acquired image into a facial signature and comparing it to hashes of known faces in the pickle file to see if there is a match. The goal of this research is to improve the efficiency of the Covid-19 vaccine administration procedure. This is designed by combining several Machine Learning and Artificial Intelligence models into a system that the government or another commercial organization may use.

5. METHODOLOGY

Deep Neural Networks -

A deep neural network is a system that employs several layers of neural networks. Nodes are used to derive high-level functions from input data. It involves repurposing data into something more conceptual and creative

Convolution Neural Network (CNN) -

Convolutional Neural Network (Conv Net/CNN) is a well-known Deep Learning technique/algorithm that takes a photo as the input and further assigns importance (learnable weights and biases) to different aspects of the photo which is later used to distinguish between photos. A Convolutional layer requires far less pre-processing than other classification techniques. Primitive approaches need hand-engineering of filter classes, while with ConvNets,

the model learns to identify these filters /characteristics. Image identification is the most common use of convolutional neural networks (CNN), with audio recognition being an exception. The results of each verification are then transmitted through a convolutional layer, which connects certain data elements while leaving others unconnected. Based on the input, the machine will produce the verification results and infer what is in the frame.

Image Data augmentation -

Image augmentation was established to produce training data from an existing dataset to avoid the expensive expense of acquiring thousands of training photos. Picture augmentation is the process of altering pictures already in a training dataset to generate several changed versions of the same image. This not only provides additional images to practice with but also improves the stability of the classifier used by exposing it to a larger range of lighting and color situations.

Pooling layer -

Pooling layers decrease the number of parameters when the pictures are excessively huge. Pooling activities are additionally called downsampling, which decreases the dimensionality of each feature map, however, it holds significant data. Pooling activities can be of various types

· Max pooling

· Average pooling

· Sum pooling

Max pooling takes the largest component from the newly configured feature map. Average pooling returns the average of the multitude of values from the piece of the picture covered by the kernel. The amount of all components in the element map is called sum pooling. The pooling layer reduces the computational power expected to deal with the information through dimensionality reduction.

ReLu layer -

ReLu represents Rectified Linear Unit for a nonlinear activity. The result is f(x)= max(0,x). ReLu's motivation is to bring nonlinearity into the ConvNet. In real-world basedscenarios, the ConvNet is expected to be trained well enough to learn non-negative direct qualities. There are other non-linear functions as well, for example, tanh or sigmoid which might have been utilized rather than ReLu. ReLu is prevalently utilized and even execution wise ReLu is superior to the other two as issues like Vanishing Gradient are additionally tackled with it.

Softmax layer

Softmax checks out the result of the last layer and the number of classes. This recognizes what significant level elements generally unequivocally correspond to a specific class and has specific weights, when the items between the weights and the previous layer are computed, the right probabilities for the various classes are determined.

OpenCV –

Framework/library that contains numerous computer vision algorithms.

Flask -

It is a very popular Python web framework, which is a third-party Py toolkit for constructing online web applications.

Postman -

Postman is an API developer collaboration platform. Postman's capabilities streamline collaboration and simplify each stage of the API development process, allowing you to design better APIs quicker.

Face Detection -

The core objective of this is to identify whether or not a photo contains any faces. Face detection is perhaps the most important stage in image recognition, which is used to find faces in pictures. It's a part of the object detecting process.

Face Recognition -

The procedure of validating a person's identity by examining their appearance. Face recognition software can recognize people in photos, videos, and real-time situations.

THE PROPOSED ALGORITHM

Image: The base image is captured from the webcam in real-time.

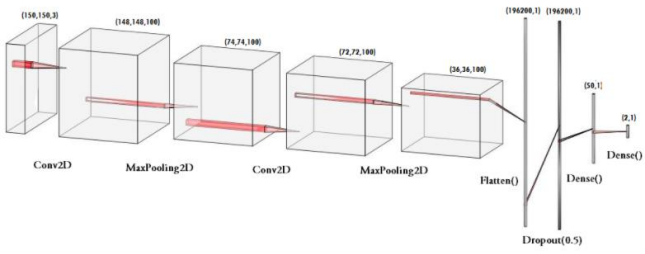
Face Detection: From the image, this step aims to detect the face. In the proposed model this is being done by the convolution step itself. The step is prepared to perceive faces, so when a picture is embedded, the convolution step utilizes its past information to test where the appearances may be. The math, is, to put it plainly, multiplying every pixel in the component by the value in the comparing pixel in the picture. The responses are then divided by the gross pixels in the picture. Each matching pixel brings about a value of 1 so whatever else is there, it is - 1. The CNN does this straightforward math again and again until it matches the features to an area on the picture. After the convolution step finishes once, that step is done

recursively until it has the given number of potential areas is reduced.

Pre-processing: Pre-processing techniques like resizing, normalization, and augmentation were done. Augmentation helped in increasing the currently existing dataset significantly. More images were produced using the ImageDataGenerator from Keras. Variations were produced by moving the images horizontally, vertically, and rotating them. This step helped to provide more variant data instead of simple linear data and thus, helped to train the proposed model with even more accuracy.

Feature Extraction: The relevant and important features (having high variance) are extracted.

Dataset: As and when the system is used, the images captured, trigger the pipeline and automatically store the image in the database as an encoded hash and is parallelly sent to the model, for retraining purposes. Initially, the Labeled Faces in the Wild (LFW) dataset is used to feed sample faces to the model. This dataset has face photographs designed for studying the problem of unconstrained face recognition. The dataset is considered a public benchmark for face verification, also known as pair matching. The size of the dataset is 173MB and it consists of over 13,000 images of 5749 unique faces collected from the web. Therefore, this LFW dataset, along with the new set of images that are updated in the database every time a user comes and registers in the app. The proposed CNN model has a loss function termed "binary cross-entropy" to locate responses in hidden layers for the pictures in this paper (Log-loss). Initially, a dataset of 13000 pictures is utilized. This is then input into a multi-column CNN with the preferred loss function. For each input picture, a conditioned algorithm is built to forecast filters with rankings. The correctness of the input set is determined by the assessment subset.



Fig,1 Layers in the proposed CNN model

The model is trained using the Keras sequential library API. This allows us to gradually add more elements to the proposed model. The layers employed in the proposed model are shown in Figure 1. The first layer that is embedded in the model is Conv2D, which consists of 100 unique filters with a 3X3 dimension. Then, the 'ReLu' activation mechanism is employed in the first step. If the input is positive, the Rectified Linear Unit (ReLu) function outputs it directly, else it returns zero. For all the photos to be created and evaluated for this model, the input scale is similarly set to 150X150X3.

The MaxPooling2D is utilized in the second layer for a pool capacity of 2X2. Following that is another Conv2D layer, this time with 100 unique filters having the same dimensions that are (3X3) with the previously used ReLu activation function. Following the Conv 2D layer, another 2-Dimensional MaxPooling layer with a pool size of 2 X 2 is used. The Flatten layer is added later to blend the above-mentioned layers onto one single 1-dimensional layer. From a huge number of positive and negative pictures, a cascade mechanism is learned in this stage. after then, it's utilized to find items in other pictures. The Face Detection Cascade Classifier was employed as the cascade classifier in this experiment. In this experiment, a model is built that has been pre-trained using frontal facial traits and is used to recognize faces in dynamic conditions or in real-time.

There are two stages to this method's UI development. A) Setting up a Flask server for the deep learning model mentioned in reference [22] and B) Creating a React login app, are two of these steps. The inbuilt typescript framework could connect with the deep learning model via the Flask API. It will send an image of a person to the model, who will subsequently reveal the individual's genuine identity. Web-App needs a model that can recognize faces in photos and convert facial information into a 128-dimensional vector that the system will use for facial recognition or authentication later. This is done by constructing a test database containing user IDs. The recognition module will use the picture to encode and create a 128-dimensional vector that the app can store as a value in a database record with the identified person as the key. The system will trigger the feature automatically that searches the database for the individual in the pictures identify. It will calculate the proper distance for all database entries and the new picture by determining the distance. The individual entry is not recorded if the minimal distance is larger than the upper limitation; nonetheless, the identification with the least distance is returned. Finally, the Flask server will perform two functions: 1) If the user isn't already registered, add them to the server list. 2) Determine the person's identity based on the inputs of the user with appropriate exceptions.

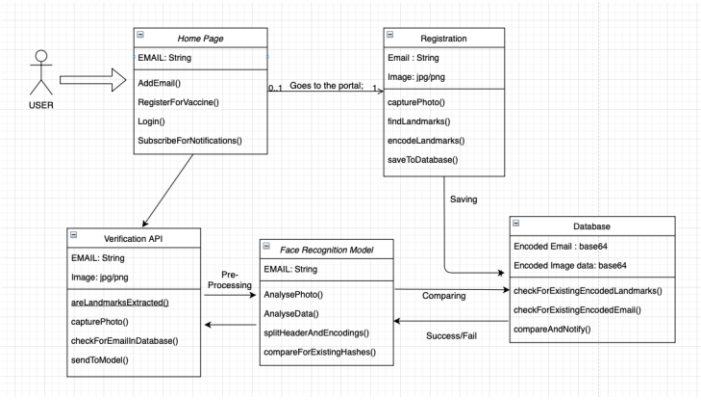


Fig -2: Class Diagram

The classes that are integrated into the proposed model are shown in Figure 2. Routes for the login API have been created that take an object to identify the receiver and then return that identity. This route will receive base64 data from the app at a specific time and will either return the user's identity if the user is registered or offer a hint if the user is not signed up then the app knows when to log in. Through the second channel, the new person will be added to the database. The user's name and the user's picture's base64 data will be obtained from the app. The 128-dimensional vector of the picture will be generated and saved in the database. If the user has been successfully enrolled, it'll submit the status enrolled. code of 200 otherwise it will send the 500 status code (internal error). The use cases for the end-user are shown in Figure 3.

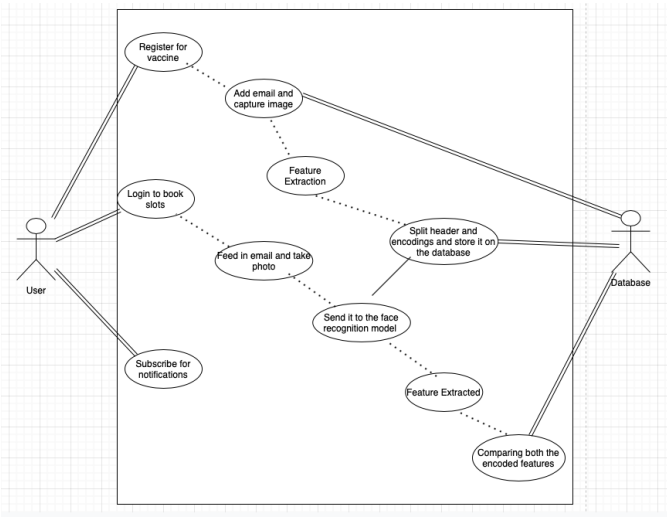


Fig -3: Use Case Diagram

6. ALGORITHM

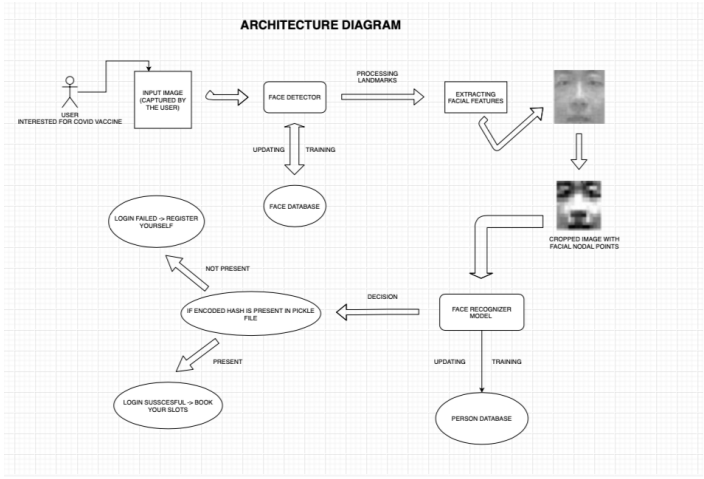


Fig 4: Architecture Diagram

The complete architecture of the proposed model is depicted in figure 4. When the user visits the "/register" API the email id and a live image is captured. After the form is submitted, all of the data is stored in the server database. The registration page is shown in figure 5.

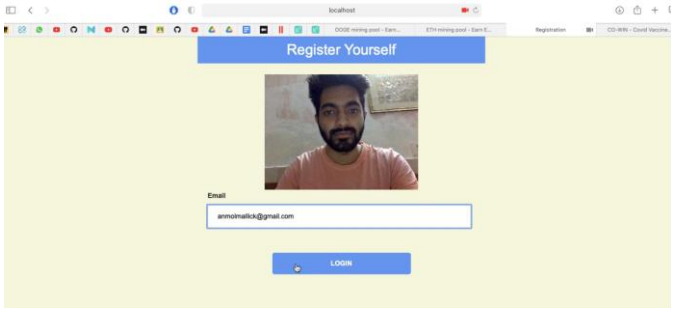


Fig -5: Registration Page

After submission of the form "/success" endpoint is loaded. When an Existing User Tries To Register again - "You are already registered" is displayed on the page and in data.pickle its corresponding encoded hash is present as shown in figure 6.

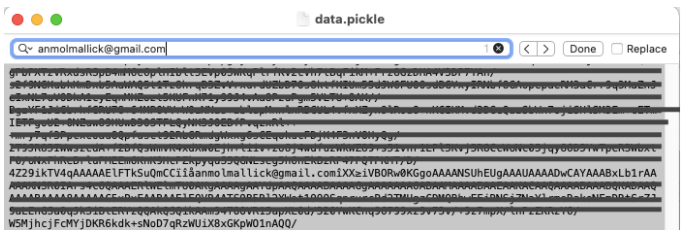


Fig -6: Encoded Hash Present in Data.pickle file

If the captured image is not clear, and the Face Recognition Module is Not able To capture Face Encodings Properly, it says "Image not clear! Please try again."

Now when the user is registered and tries to log in, the algorithm verifies the user's face by encoding the newly captured image into a facial signature and comparing it with existing hashes of known faces in the existing data.pickle file, looking whether there is a match.

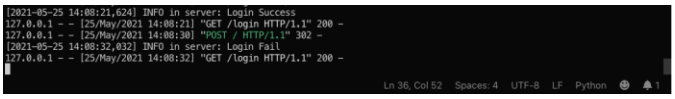


Fig -7: HTTP responses in our application

"/success" endpoint rendered with status as successfully logged in if a user is authorized as shown in figured 8, it will show "Failed to login". HTTP responses are shown in figure 7.

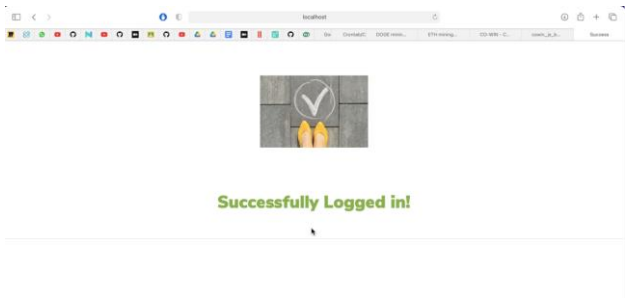


Fig -8: "Successfully logged in" template rendered

7. RESULT

The training of the CNN model is an iterative process. After a new user is registered successfully, its facial landmarks are extracted and parallelly, sent to the dataset for retraining of the model in real-time. The model has its custom dataset on which it performs deep learning algorithms and helps authorize beneficiaries in no time. The proposed model resulted in an accuracy of 98.34% as shown in figure 9. The system can correctly identify the users, on which the network has been trained. The graph between Training loss/Accuracy and the number of epochs is shown in figure 10.

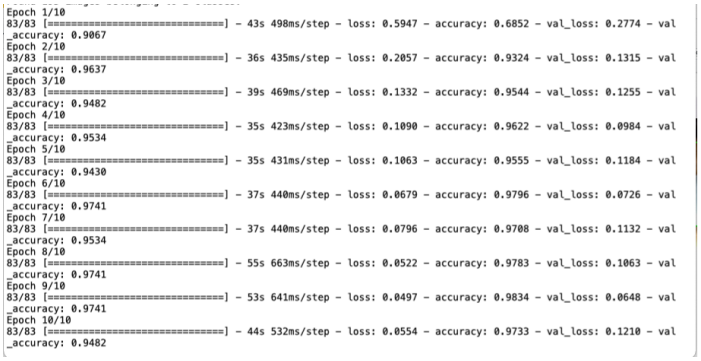


Fig -9: Face recognition model accuracy for 10 epochs

Fig -10: Accuracy & loss graph

8. CONCLUSION

Given the complexity of the challenge and the necessity for the model to execute accurately and effectively, the application of software engineering best practices was extremely beneficial. Software engineering artifacts helped guide the model's evolution and keep track of its development. The built-in mechanism is set up in a way where users may come in and register for the Covid vaccination and then reserve their slots at a later time. Validation for the Covid-19 immunization campaign presently requires an Aadhaar card or similar form of acceptable identification. Because such identification methods necessitate physical contact, it's conceivable that people have forgotten their Aadhaar numbers or misplaced their legal papers as a result of the shutdown. Here's when a Facial Recognition device comes in handy. Different machine learning models may be used. In future investigations. For facial recognition, Advanced Convolutional Neural Networks techniques (CNNs) are quite popular and accurate. Because CNNs require a substantial quantity of training data, they have struggled with emotion identification tasks. Using face landmarks might expand the size of a training dataset to the point where a CNN may be used.

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