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Searchious: Locating missing people using an optimised face recognition algorithm

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***Abstract*— Importance of face recognition systems has sped up in the last few decades. Face recognition is a part of biometric processing. Everyday hundreds of people go missing throughout the world. These people are either kidnapped, taken as slaves or forced to work underage, or beg on railway platforms, small shops or compelled into prostitution, human-trafficking or various other illegal activities. The posts of missing people are found in our day to day lives on social media platforms, news channels, newspapers etc. This research wok has been proposed to help them locate missing people in a easier way. The proposed tool, "Searchious" tends to reduce the time taken to trace the person and improve the process of finding the missing person. While Searchious can look for people who are missing, if a new face, which is not present in the database occurs, a new case can be filed for the same. Searchious has an Android application for the common citizens as well as a desktop software built using Python for the police stations by also including a face recognition algorithm based on KNN.**

Keywords*— *Missing people, KNN, Facial points, Kidnap, Lost people, Trace, Face recognition

I. INTRODUCTION

Facial recognition systems have developed tremendously in the past 10 years. Biometrics have become a very vital element whenever it comes to any legal proceedings. In today's world, where kidnapping and human trafficking never fails to grab the headlines, biometrics, especially facial aspects of the person become the most crucial assets to trace the person. Whenever suspicious people are found to be doing laborious tasks in places they should not be, it ignites a spark of doubt in the minds of common citizens that whether the person belongs to that occupation. But due to lack of resources or the proper means of acquiring knowledge about the same, the common citizens fail to turn into vigilant citizens of the nation. This leads to the sacrifice of thousands of people daily due to the sheer negligence of the citizens. If only each citizen had the authority or the privilege of saving these people, the world would have prospered with every citizen taking the charge of every nation.

Despite of the numerous attempts carried out by the government, police force, NGO's and many other entities of the society, there still remain 400 people who remain untraced after they were reported to be missing. And this is a big issue to worry about in a country where the children and the youth formulate 50% of the population. There is an urgency to stop the various cases of kidnapping, trafficking, prostitution and all other illegal activities where people are being forced without any hope of help. This would only become possible if these people could be tracked down quickly and safely. But when these sorts of cases arise, the matters fall into the hands of the police who don't have enough information to carry out the necessary proceedings. If we as citizens take the charge in our hands by using our presence of minds and save these people by posting their pictures on social media or any other media to communicate with the common citizens and the police force of our country, we could reduce the time taken to trace these innocent lives and scale down the burden on the police force to start from scratch.

II. LITERATURE SURVEY

In the paper presented by Madhumita R. Baviskar, faces are identified, tailed and perceived in a video using Hidden Markov Model and K-Nearest Neighbour. Facial feature extraction for tracking and face recognition is performed by using Principal Component Analysis. This process boosts and allows pinpointing and gleaning facial feature regions around the eyes, nose and mouth. Identification of the tracked subject is done by blending pose-discriminant and person-discriminant features over the video. This leads to a booming video-based face recognition system with a modern and novel recognition performance [1].

In the paper presented by Aesha Shah, Kavin Shah, Vidhi Shah and Chintan Shah, the architecture performs the first stage of image processing on mobile devices to reduce the network usage and save the battery consumption of the mobile device before migrating the recognition to the server. Mobile phones are becoming the confluent platform for communication and personal usage such as capturing pictures. Due to this, the practical usage of the digital camera is reduced to quite a considerable extent [2].

In the paper presented by Holger Wiese, Jessica Komes, Simone Tüttenberg, Jana Leidinger and Stefan R. Schweinberger, they studied how within and cross-domain repetition as well as linguistic galvanizing affect familiar face identification, and evaluated both behavioural and

event-related brain probable measures to identify specific processing stages of age-related short-comings [3].

In the paper presented by Pooja Malusare, Shivangi Shewale, Sanika Birla, Shivanjali Ghavate and Mohini Arote, the method they have developed amalgamates methods from computer vision, for face detection and posture assessment, and classification from machine learning. They show that the recognition of a target face can be determined by first presenting faces with similar posture, and then categorizing the face to be determined as one of the identified faces or not [4].

In the paper presented by Ancy Anna Varghese and Devi Murali, it presents a state-of-the-art and effective method for automatic age prediction. It is a combination of two stages. In the first stage, less prominent features are extracted using feature descriptor LPS and these low-level features are fed as the input to the information cleansing stage to generate more precise results. Aging face recognition helps in recognizing the offender, when the system is trained using the dataset of offenders and the personal information gathered helps in comprehending the person [5].

In the paper presented by Faizan Ahmad, Aaima Najam and Zeeshan Ahmed, it assesses various face detection and recognition technologies to provide a fool-proof answer for face detection and recognition with greater precision, advanced feedback rate as the first step for video surveillance. The derived solution is presented on the basis of executed tests on various databases in terms of people, posture, feelings, race and illuminance. The real benefits of facial recognition over other biometrics are oneness and acceptance. Human face being a dynamic object has a high degree of fluctuation in the way it appears, that makes face detection a tougher complexity in computer vision [6].

In the paper presented by Ashu Kumar, Munish Kumar and Amandeep Kaur, states face detection has been exceptional within the topics in the computer vision domain. This paper demonstrates a brief survey of various techniques explored for face detection. Numerous difficulties and usages of face identification are also exhibited in this paper. In the later stages, various databases for face identification are also mentioned with their aspects. Moreover, special discussions on the practical approaches towards the generation of a booming face identification system are made and this paper ends with many encouraging directions for future work [7].

In the paper presented by Shakir F. Kak, Firas Mahmood Mustafa and Pedro Valente, in this work, three major strategies to identify a face for feature extractions are demonstrated. Appearance, model and hybrid methods as attribute extractions techniques are explained as well. The core of good face recognition usages, distribution, distance measurements, and face databases are presented while the eventual recommended methods are shown. The modernization of new approaches of face recognition technologies is a relentless subject to developing more efficient face identification algorithms [8].

In the paper presented by Bharath Darshan Bala, D S Kavya, Chandana M, Anush E, Vishwanath R Hulipalled, it describes the face identification model in their system will try to extract an entry in the database with the help of face encodings. It is accomplished by comparing the face encodings of the uploaded image to the face encodings of the images in the database. If a match is detected, it will be alerted to the police and the people related to the missing person along with the location of where the person is found [9].

In the paper presented by Ni Kadek Ayu Wirdiani et al. they have used KNN for classification and Principal Component Analysis (PCA) to develop their system for face identification. They have used contrast stretching, grayscale and haar cascade segmentation for pre-processing in this research. They have registered faces of 30 people, each person had 60:40 ratio used for training and testing. The outcome generated from several test of k values gives the best accuracy is 81% with k=1 [10].

In the paper presented by Dr. Samuel Manoharan, the prime focus lies on the benefits of using the Hermitian wavelet transform integrated with the graph wavelet in the feature detection, which results in efficient recognition of the data to be processed further [11].

In the paper presented by Dr. Joy Iong Zong Chen, a method has been introduced which uses motion sensors and face identification methods to identify suspicious people and report the same to the authorized personnel. The system was designed using Python programming language and was tested for various batches of commendable video recordings to determine the efficiency in the detection [12].

In the paper presented by Nusrat Jahan, Pranta Kumer Bhuiyan, Parves Ahmed Moon and Md. Ali Akbar, they have considered live cascading on monitoring system to identify human faces from video feed to enhance safety problems in university area. They have used facial measurements known as embedding's calculation from faces and deep residual network is used with classification model of KNN [13].

In the paper presented by Kuldeep Singh Yadav and Joyeeta Singha, they have proposed an algorithm to detect the facial landmarks in a more accurate manner when compared to the Viola – John's algorithm. The combination of the facial landmarks is used to retrieve features. In this method, the images were obtained and seven significant facial regions from the image were cropped, then retrieved and the features of facial expressions were saved. Eventually, the expressions in the images were identified using the classifiers [14].

In the paper presented by Prof. Prachi Sasankar and Prof. Usha Kosarkar, they have improved a face identification system using Principal Component Analysis (PCA) to obtain features from the various facial images and minimize the dimensionality of each image and KNN to categorize data. The competency of color information is the most important aspect when images are taken under low illuminance [15].

III. PROPOSED SYSTEM

In Fig 1., we show the detailed system architecture. Searchious is a combination of both – an Android app for the common citizens and a desktop software for the police stations which has an enhanced face recognition algorithm based on KNN. This hybrid approach facilitates the process of tracking and tracing. This would lead to quicker actions from the police as well as the citizens who would become aware about the mis-happenings around them. Whilst using Searchious, the citizen can upload a picture of the person and it immediately cross verifies the identity of the person with the database which is done using face recognition, the tracing

process is facilitated greatly. Also, if the person's data is not present in the police repository, a new case will be created along with the details of the person. A civilian first captures the photo of a suspicious person. Then the photo passes through the face recognition phase and the 68 facial points are registered and an encoded string of characters is generated. This key will be unique for every individual. Now, this key is used and all the photos in the database are matched with the key. If a match is found, the police officer and the user are alerted. If the match is not found within the police database, then a new case is registered.

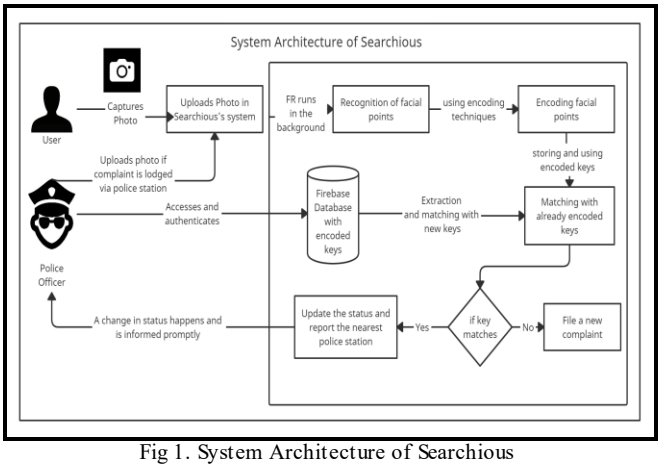

Fig 1. System Architecture of Searchious

KNN is a type of occasion-based learning where the function is only estimated locally and all calculation is delayed until classification. In KNN, an object is categorized by a majority vote of its neighbors, with the object being designated to the class most common amongst its k nearest neighbors (k is a positive integer, which is typically small). If k = 1, then the object is allocated to the class of its nearest neighbor. Searchious uses dlib (it is a toolkit developed in C++ which contains machine learning algorithms and also various tools to create complex programs which can be further used to solve real world problems) to map the 128-dimension vectors which can also be categorized into 68 facial points on a face in an image. A KNN algorithm is used which cross-checks these vectors with all of the entries in the database using Euclidean distance in order to discover whether this new face is a match with any faces on record. Searchious tends to integrate various modules in order to facilitate the tracing of missing people and increase the efficiency of the recognition mechanism.

The modules are:

A. Case Registering

Initially, the civilians capture the photo of suspicious looking people who are working in places where they should not be. This procedure is quite concise as the details are filled (if available). Also, the families whose members are lost under certain circumstances can avail this feature.

B. Encoding the facial points

The 68 pair of facial points are recognized are encoded in a cryptographic format. The encoded text generated is used for further processing. As shown in Fig 2., we have the mechanism of encoding the facial points.

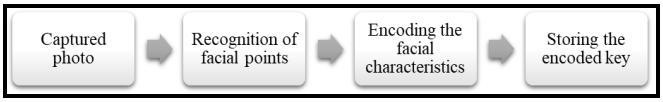

Fig 2. Encoding the facial points

C. Traversing through police database

Once the encoded key is generated as shown in Fig 3., now it is matched with the keys of other photos. As understood, the key of every distinct individual photograph will be unique. This matching of keys can also be understood as matching of faces or facial attributes. Once a match is found; it is displayed else it shows as a new record in the repository.

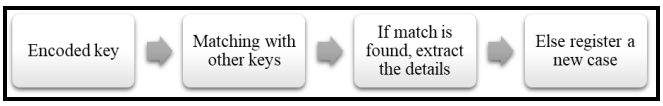

Fig 3. Traversing through police database

IV. Result and Discussion

Table 1 shows the side-by-side analysis of the 2 models used by Searchious. We are using dlib face recognition resnet model and shape predictor 68 face landmarks model for our face recognition approach. These 2 are the only basic necessities that are required for Searchious to execute with greater precision as these are pre-trained models which have achieved a certain of accuracy.

Table 1. Features of the dlib and shape predictor models

Model / Parameter	dlib face recognition resnet model	shape predictor 68 face landmarks model
Dataset used for training the model	(http://vintage.winklerbros.net/facescrub.html) (http://www.robots.ox.ac.uk/~vgg/data/vgg_face/)	https://ibug.doc.ic.ac.uk/resources/facial-point-annotations/
No. of faces used to train	3000000	300
Algorithm used by the model	Convolutional Neural Network	Convolutional Neural Network
Used for	Face recognition	Landmarking

Fig 4. shows the landmarking done by shape predictor 68 face landmarks model in order to extract the facial features of an individual.

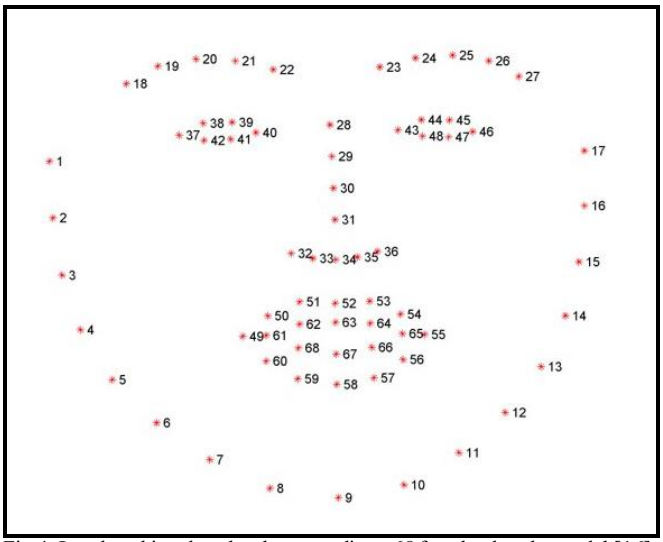

Fig 4. Landmarking done by shape predictor 68 face landmarks model [16]

The snapshots henceforth are of Searchious: finding missing people using an optimized face recognition algorithm system's actual outputs that may be seen and interacted by the user. Fig 5. shows the GUI of registering a new case in Searchious desktop app. All the necessary details are taken as input and only the images in which 68 pairs of facial points are recognized are displayed. The image shown below is previously uploaded in the database and this image is used to compare the missing person's face.

Fig 5. Registering new case feature of Searchious desktop app

Fig 6. shows the snapshot of the Firebase system for face recognition module implemented successfully. After all the above given details are uploaded to the real-time database, the data is displayed in the below exhibited form.

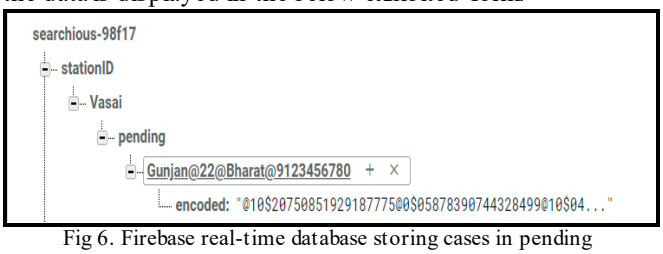

Fig 6. Firebase real-time database storing cases in pending

Fig 7. shows the implementation of GUI based face recognition system of Searchious and shows the recognition of face by KNN after the encoded keys of the uploaded photo matches with the encoded key already present in the database.

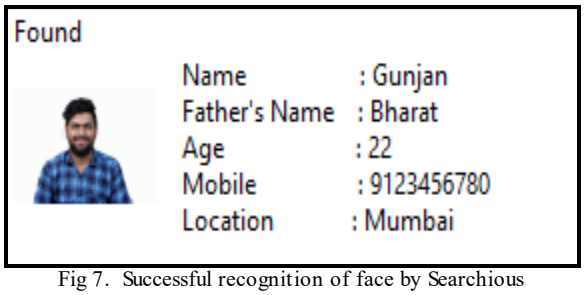

Fig 7. Successful recognition of face by Searchious

Fig 8. shows the change of state of pending case to confirmed in order to avoid the discrepancies that could arise upon successful recognition of faces. This entire process is very prompt. After the keys and in general, the faces match, the status of the uploaded image changes immediately from pending to confirmed. This comparison between keys is done between the uploaded photo by the user and the image in the manual upload branch of the database which will be present or fed from the current database of missing people. This process of changing the states from pending to confirmed is automatic and does not require any human intervention. The change only takes place if minimum 60% of the facial features match. The reason for keeping the threshold to 60% is to incorporate minor changes in facial features like any injury marks or growth of beard etc.

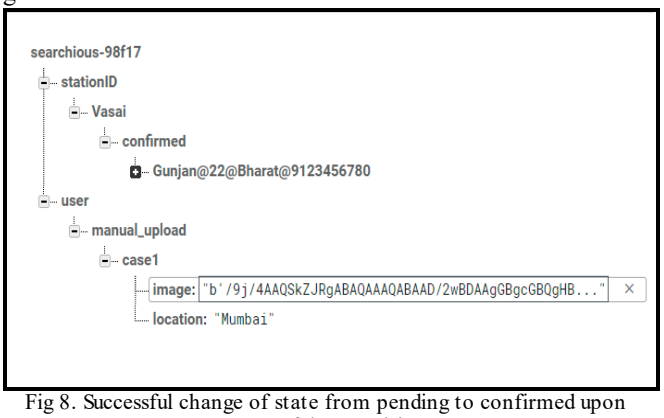

Fig 8. Successful change of state from pending to confirmed upon successful recognition

Fig 9. shows the training results of Support Vector Machine (SVM) using Principal Component Analysis (PCA) values algorithm. It shows the detailed accuracy and time taken by the algorithm in detecting and recognizing faces. The number of samples used in training this model are 1288 and the number of features identified are 1850, whereas, the number of classes are 7. 70% of the data is used for training purpose and the rest 30% is used for testing. We have used balanced class weight in order to get accurate results. It uses the values of y to automatically adjust weights inversely proportional to class frequencies in the input data. The learning rate automatically chosen by the model is 0.005 and the kernel is "polynomial".

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Searchious: Locating missing people using an optimised
face recognition algorithm
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Predicting people's names on the test set
Done in 0.055s
Accuracy: 0.4315245478036176
                   precision    recall  f1-score   support

     Ariel Sharon       0.00      0.00      0.00        30
     Colin Powell       1.00      0.23      0.37        70
  Donald Rumsfeld       1.00      0.09      0.16        45
    George W Bush       0.40      1.00      0.57       144
Gerhard Schroeder       0.00      0.00      0.00        34
      Hugo Chavez       0.00      0.00      0.00        26
       Tony Blair       1.00      0.08      0.15        38

         accuracy                           0.43       387
        macro avg       0.49      0.20      0.18       387
     weighted avg       0.54      0.43      0.31       387

[[  0   0   0  30   0   0   0]
 [  0  16   0  54   0   0   0]
 [  0   0   4  41   0   0   0]
 [  0   0   0 144   0   0   0]
 [  0   0   0  34   0   0   0]
 [  0   0   0  26   0   0   0]
 [  0   0   0  35   0   0   3]]
```

Fig 9. Training results of SVM using PCA values

Fig 10. shows the training results of KNN algorithm in detecting and recognizing faces. The number of samples used in training this model are 1288 and the number of features extracted are 1850. We have used 70:30 ratio for training to testing. We have parameterized the model at k = 5 and the algorithm for KNN classifier is 'ball_tree" and the leaf size of the classifier to be 30.

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------------------------------------------------------------
Searchious: Locating missing people using an optimised
face recognition algorithm
------------------------------------------------------------
Searchious: Locating missing people using
 an optimised face recognition algorithm

Predicting people's names on the test set
Done in 1.493s
Accuracy: 0.5917312661498708
                   precision    recall  f1-score   support

     Ariel Sharon       0.43      0.45      0.44        20
     Colin Powell       0.59      0.72      0.65        82
  Donald Rumsfeld       0.56      0.36      0.44        39
    George W Bush       0.63      0.86      0.73       148
Gerhard Schroeder       0.46      0.17      0.25        35
      Hugo Chavez       0.00      0.00      0.00        17
       Tony Blair       0.61      0.30      0.41        46

         accuracy                           0.59       387
        macro avg       0.47      0.41      0.42       387
     weighted avg       0.56      0.59      0.55       387

[[  9   8   0   3   0   0   0]
 [  4  59   2  16   0   1   0]
 [  1   7  14  16   0   0   1]
 [  3  10   2 127   3   2   1]
 [  0   8   3  12   6   0   6]
 [  2   4   1   8   1   0   1]
 [  2   4   3  19   3   1  14]]
```

Fig 10. Training results of KNN algorithm (k =5)

Fig 11. represents the comparative analysis between KNN and Support Vector Machine (SVM) using Principal Component Analysis (PCA) values. The former registers an accuracy of 43% whereas the latter returns 59% which is considerably higher.

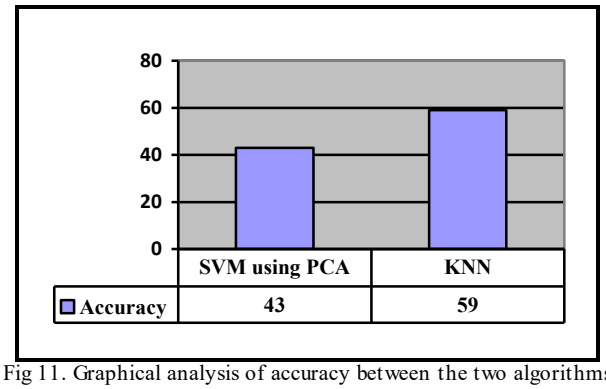

Fig 11. Graphical analysis of accuracy between the two algorithms

Fig 12. represents the analysis between two algorithms and shows that KNN though requiring greater time is more suited than SVM because of its considerably higher accuracy which is the most important aspect when it comes to recognizing people. Accuracy in prediction is more necessary while detecting the correct person who is missing. Any false results could mislead the process.

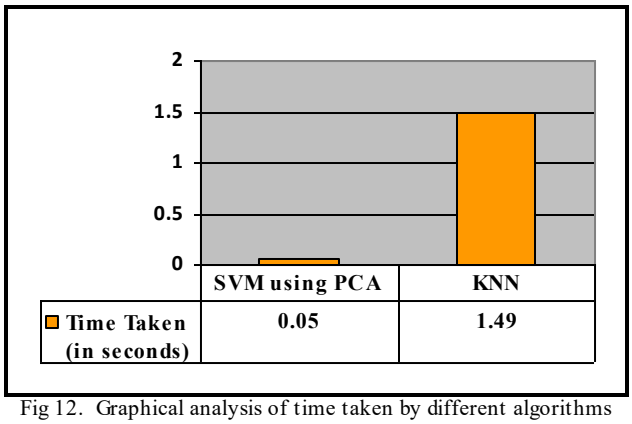

Fig 12. Graphical analysis of time taken by different algorithms

V. CONCLUSION

Throughout the world, the number of missing people keeps on increasing every day and more than half of them remain untraced and become prey to various negatively impacting professions or slavery. A country with such humongous population cannot afford losing its valuable citizens to treachery and bad-will of criminals. If we look on the other side of the coin, daily losing a huge number of children, adults and even the aged people are a huge loss to our developing nation as it affects the productivity and impact the nation on the whole. And considering just the case of India, the future of our nation is tremendously affected when our youth, our adults go missing and are never to be found as they are either left to beg or handicapped in such a way that they become almost unrecognizable. Using Searchious and the proposed system, it is very much possible for the common civilians to interfere in these illegal activities and try to curb the crimes. Whilst doing so, they can boost the process of tracing missing people and lead to various head-starts in the entire system of finding missing people. Using Searchious, the time to wait for 24 hours to lodge an official missing person complaint is reduced and the stress for manual paper work, field visit, physical process for recognition is reduced. Also, because of Searchious, a person who went missing years ago, can be easily recognized, found and escorted to a safe location. The time spent by the police and the people related to the person is hugely saved, thereby, increasing productivity and efficiency. In the future, we can also generate a hybrid algorithm which results the accuracy of KNN and takes the time taken by SVM via PCA values in order to make the systemeven faster and more accurate.

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