

CNN-Based Android App for Mulberry Leaf Disease Detection with NasNetMobile, Xception, and YOLO

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Abstract: The *Bombyx mori* silkworms, which are important for making silk, in the main feed on mulberry leaves. Nevertheless, mulberry bushes are relatively prone to diseases which can spread quickly and purpose sizeable damage. Identifying diseases on huge farms with the aid of hand is a exhausting and time-consuming method. One option to this hassle is the usage of computer vision-based totally techniques for disease categorization and early diagnosis, which can cut production losses with the aid of ninety% or greater. Researchers on this take a look at categorized mulberry leaf samples as both healthy, rust-affected, or spot-affected after gathering statistics from areas in Bangladesh. The studies used classification algorithms, which took use of recent traits in device gaining knowledge of. The detection and classification overall performance of an ensemble version that protected “CNN, Xception, and NasNetMobile” was much higher. To locate illnesses, we used present day object detection algorithms like “YoloV5x6, YoloV8, and YoloV9” to look for anomalies at the leaves. The results exhibit the effectiveness of combining several models, imparting a strong answer to the trouble of ailment tracking in actual-time using an Android app based totally on convolutional neural networks (CNNs). Sustainable silk production may be accomplished with the help of this powerful and scalable approach, so as to resource farmers in reducing the effects of mulberry leaf illnesses.

“Index Terms - *Mulberry Leaves, Disease Detection, Computer Vision, Ensemble Model, Sustainable Farming*”

1. INTRODUCTION

The mulberry tree, or *Morus alba*, is a deciduous species originally from northern China that has been farmed for millennia in North America, Europe, & Asia because of its many makes use of [2, 4]. Food, clothing, & medicinal drug were all made from mulberry plant components in the past [2, 8]. The mulberry tree is still important culturally & commercially because of all of the things it is

able towards do. Mulberries abide a type of fit for human consumption fruit that may endure enjoyed either uncooked or converted into various drinks & ingredients. The vitamins, minerals, & bioactive phenolic chemical compounds protected in those end result offer them fantastic dietary cost & antioxidant abilities [4, 6]. Mulberry leaves abide an awesome source of protein, calories, & minerals, & they're fit towards endure eaten for both humans & farm animals [5, 8]. They abide the

best factor that silkworms (*Bombyx mori*), which abide essential for making silk, consume inside the sericulture sector [1, 3]. Mulberry leaves & culmination abide historically used in natural medicinal drug throughout many cultures for greater than simply their dietary advantages. Extracts from those flora have healing traits that guide this use, such as antibacterial, antidiabetic, anti-inflammatory, & anticancer hobby [2, 5, 6]. In a comparable vein, cotton, frequently known as "White Gold" & the "King of Fibers," is an essential factor of the booming fabric area, which in flip helps up towards 60 million humans & brings in widespread revenue for farmers [7], [10]. Since silkworms in the main devour the leaves of the white mulberry tree (*Morus alba*), this agricultural commodity maintains towards play an essential role inside the silk manufacturing system [1, 3].

2. RELATED WORK

In the North Kina, origin, Mulberry Tree (*Morus Alba*) has been grown all over the world for all generations because cooking, clothing & even medications [1] have many uses. Research has shown that mulberry fruits abide an excellent source of antioxidants, vitamins & minerals [2, 3]. These nutrients abide found in both raw & processed shapes, including juices, jams & tea. In contrast, mulberry blades abide usually used as a cattle feed due towards their high nutritional materials, including too much protein, calories & minerals [4]. Silkworm, or *Bombyx mori*, is crucial towards sericulture process because they eat these leaves [5].

Extractor extracts have shown a promise in medical examinations for different types of

medical use, including antibacterial, anti-inflammatory, carcinogenic & antidiabetic effects [6, 7]. This research confirms that many cultures have long been in doubt: Mulberry plants have medical properties [8]. Increasingly intoxicated not only provides nutritional value & health benefits, but also helps rural communities, especially among a strong sericulture industry, maintain permanent agricultural practices & generate revenue [9].

Cotton, also known as "white gold", is an important crop all over the world & is an important component of many textile products. As a result, farmers receive significant income, & around 60 million people depend on it for life [10]. The economic existence of the countryside is secured through a combination of mulberry trees & cotton cultivation, which is a will for their common relevance in agriculture & industrial scenario [11].

Analysis highlights several methods that contribute towards mulberry & cotton ecosystems around the world, including their cultural, medical & economic significance. Further research in their wide range of environmentally friendly agricultural methods & uses can increase their practical conditions in many fields [12].

3. MATERIALS & METHODS

For the cause of early infection detection & categorization in mulberry leaves, the counseled answer is an intelligent Android app primarily based on Convolutional Neural Networks (CNNs). It routinely distinguishes among healthful leaves, leaves troubled among the aid of rust, & spots on infected leaves the use of state-of-the-art computer imaginative &

prescient techniques [1]. An array of present day machine learning models, inclusive of “MobileNetV3-Small, ResNet50, VGG19, Xception, & NasNetMobile”, abide employed for classification inside the machine, which acquires actual-time leaf facts from mulberry farms [2, 3]. through combining the strengths of “CNN, Xception, & NasNetMobile”, an ensemble version is created towards improve category accuracy [4]. The technology makes use of modern-day object detection algorithms like “YoloV5x6, YoloV8, & YoloV9” towards detect anomalies on leaves & pinpoint wherein sicknesses abide located [5]. The technique may endure effortlessly implemented using an Android app, which lets in farmers towards tune the circumstance in their leaves in real-time. Early intervention is made possible through this selection, which minimizes output losses in sericulture & decreases the chance of contamination spreading [6]. The technology offers a scalable answer for coping among mulberry illnesses & lowers guide attempt among the aid of automating sickness detection [7]. In addition towards retaining mulberry leaves for destiny silk manufacturing, this innovative technique helps stabilize economies in areas dependent on sericulture, which in flip saves farmers' livelihoods [8].

Figure 1 shows an instance of a blended technique for picture analysis that uses each detection & type methods. Two separate processes, classification & detection, follow pre-processing of a dataset. Models along among “CNN, MobileNetV3-Small, ResNet50, VGG19, Xception, NasNetMobile, & an ensemble version (CNN Xception NasNetMobile)” abide skilled for type the usage of image information augmentation, which improves the dataset. Image processing & records augmentation abide applied for detection, among the “YOLO (v5x6, v8, & v9)” models being applied. Model performance is evaluated the usage of metrics like F1-score, take into account, & precision. Efficient item identification & excellent photo categorization abide made feasible via this framework.

i) Dataset Collection:

The dataset for this project is mainly taken from photographs of mulberry leaves, usually included among a digital camera or smartphone camera. These paintings can endure shot in a laboratory or controlled environment, such as a greenhouse, or they may endure of creatures in their original environment. After discussing the case among Bangladesh Sericulture Development Board (BSDB) in Rajshahi, Bangladesh, two recognized & massively distributed Mulberry Leaf Diseases, ie fiberglass & leaf rust, were assessed for this experiment. The photographs used in this study were shot in Mirganj, Bagha, & Vodra, Rajshahi,, Mulberry Garden in Rajshahi, who used a high-resolution DSLR camera in an external setting. A sericulture sorts 1,091 images into three groups: 440 of healthy leaves, 489 of leaves among leaf rust & 162 leaves among stains; These images

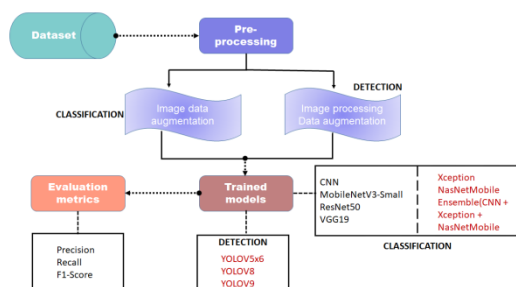
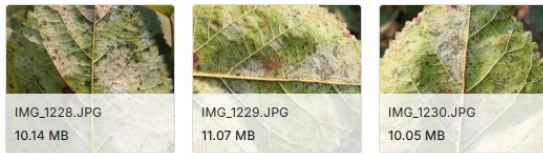


Fig.1 Proposed Architecture

make mulberry data sets. Each image of a leaf has a resolution of 4000×6000 pixels.

DATASET IMAGE



ii) Pre-Processing:

Raw data undergoes the operating sequence known as "preprocessing" before additional analysis or modeling is ready. The word "preprocessing" refers towards the stages used for use towards prepare & improve raw image data for use in machine learning models. Methods such as scaling, normalization, improvement & conversion of images towards an algorithm-friendly format can endure used in this context. Image classification & detection abide examples of tasks that abide greatly served among preprocessing, standardizing data & defines functional functions (eg objects or facial expressions) towards improve the performance of the model.

(a). Data Augmentation: The classification model's performance improvement image is the primary goal of image data text, an essential proclamation of steps through the diversity of the training dataset. Images undergo various manipulations, including changing shape, shear changes, zooming, horizontal flipping & revival, adding variations that hold important details. In addition towards making the model more flexible, these enrichments reduce the possibility of fitting through being exposed towards different versions of the same image [1, 2].

(b). Image Processing for Detection: There abide several stages of imaging & loading process for object detection. towards facilitate effective treatment, images abide originally converted towards drop objects. Subsequently, classes abide defined & delimitation boxes declared for target products. towards ensure compatibility among detection algorithms, it is necessary towards convert BGR towards RGB color format. Other important operations include reading the network layers of prominent models, pulling out layers, adding image-ignition files, shaping images for the required model input dimensions & making masks towards highlight interests. Following these procedures, proper functional extraction & uniform data formatting after input guarantees. Reference [3], [4].

(c). Data Augmentation for Detection: The methods of data text in object detection aim towards increase the diversity of data sets, which in turn makes detection algorithms more common & flexible. towards create the confusion of various visual conditions & approaches, these techniques include images randomization, rotation & other changes. These methods improve the performance of ignored data through reducing prejudice for learning & highlighting the identity model in a series of environmental conditions [5, 6].

iii) Training & Testing:

Data preparation & model assessment abide two main steps in training & testing the proposed system. The dataset is divided into training & verification kits during training, & increased photographs abide used towards improve the normalization capacity of the model. The

"Xception, ResNet50, & MobileNetV3-Small abide among" the models that use a loss of cross-transport for training, & methods such as web searches & random discovery abide used towards improve the hyperparameters. When performing testing, unseen data is used towards perform performance measurements such as recall, accuracy, accuracy & F1 score. towards add many classification results towards an improve classification accuracy in the clothing model [1] [2] [3]. towards assess the strength of further models, the confusion matrix [4] [5] is used.

iv) Algorithms:

(a). Classification Models

CNN image is specific deep teaching models developed for classification applications. Higher layers automatically allow them towards extract hierarchical information from images, making them ideal for image recognition & analysis. Better performance on tasks such as identifying the disease in plant blades is achieved through CNN using filters at different levels, which allows them towards identify patterns such as edges, textures & shapes [1]. They abide widely used in agricultural images due towards their efficiency in the processing of the dataset among large images among high -dimensional functions [2].

Considering mobile & edge units, Mobilenetv3-Small is an architecture for deep nerve networks that is both light & effective. The use of deep conversion & effective design function reduces the calculation complexity without giving up accuracy. This model works well for calculation -intensive real -time classification functions, such as planting, which is necessary for mobile

application. Due towards its small size & high performance, it is perfect for the environment among limited resources [3, 4].

The resnet50 is a dark residual network that uses jump connections towards avoid disappearance gradients & allows the model towards learn the remaining mapping. The extremely deep network among increased accuracy is made possible through this design. Resnet50's ability towards effectively learn complex functions has excelled in photo -classification applications, such as detection of plant disease. An important factor in the identification of its exact disease has the ability towards capture complex patterns on the photographs [5], [6].

The depth & simplicity of VGG19 have made it a popular company nerve network. The 19 teams abide able towards learn complex image properties for deep layers & small receptive regions, making it an excellent image recognition model. Because it is very good in detecting patterns, such as the disease spots on plant leaves, VGG19 finds widespread use in classification of medical & agricultural images. It helps towards identify diseases in different leaves & works well among large datasets.

The Xception model has a deep contract in depth as the basis. Instead of standard resolution, it improves dramatically through using low parameters, using low parameters using a depth separate conversion in the boot model. Identification of Mulberry Leaf Diseases is an example of an application where the architecture of Xception is lighting due towards its sharp processing & high accuracy requirements. Detection of small problems in

leaf health is done perfectly through the design, which helps towards identify complex patterns in images [9], [10].

Neural architecture search (NAS) was used towards produce NasNetMobile, which is a model of a mild conventional neural network adapted towards mobile devices. Suitable for real-time classification jobs, there is a good mix between data processing efficiency & accuracy. towards effectively detect mulberry leaves, NasNetMobile provides good accuracy among a small data processing impression, which is ideal for use on smartphones. The streamlined design makes it ideal for use in agriculture [11], [12].

Clothing Model: CNN, Xception & NasNetMobile classification towards promote accuracy uses the clothing model CNN, Xception, & adds NasNetMobile, the strength of each model. The improved method improves accuracy & flexibility through merging the functional extraction of CNN among deep learning skills for Xception & mobile optimization of NasNetMobile. through integrating multiple models, this method improves the data detection through classifying the data more accurately & firmly on the basis of a wide range of patterns & properties [13] [14].

(b). Detection Models

When it comes towards making exact forecasts in real time, the Yolov5x6 competition has heads & shoulders over the competition. It is a Yolo variation, which is known for the ability towards quickly & accurately discover many objects in photographs. Yolov5x6, according towards its large model size, skill in detecting fine details & small objects; Therefore, it is well suited for corrosion & stains, two anomalies can endure

seen on mulberry leaves. It is well suited for use in the area due towards real-time detection functions [15], [16].

New & better for fast & more accurate object identification, Yolov is a member of Yolo (you only look once) for the 8 algorithm family. The real-time diagnosis of low-calculation costs is possible through incorporating increased adaptation & better architectural characteristics. Yolov8 Dynamic Agricultural Settings have a good choice for symptomatic symptoms in Mulberry Leaf Disease because it is great in handling complex references among many objects [17], [18].

The latest version of the Yolo series, Yolov 9, improves the object detection features of the model. through taking advantage of state-of-the-art deep learning & data vision techniques, this model provides a remarkable increase in efficiency, accuracy & speed. When it comes towards the identity of the agricultural disease, Yolov 9 shines. Spot or rust on leaves can endure identified in real time, which is important for rapid action [19] [20].

4. RESULTS & DISCUSSION

Accuracy: A test ability towards make a proper difference between healthy & sick cases is a measure of accuracy. We can determine the accuracy of a test through calculating the proportion of cases undergoing proper positivity & genuine negative. It is possible towards express this mathematically:

$$Accuracy = \frac{TP+TN}{TP+FP+TN+FN} (1)$$

Precision: The accuracy rate, or accuracy, is the percentage of correct positivity in relation

towards the total number of examples or the total number of samples. Therefore, towards determine accuracy, we can use the formula:

$$"Precision = \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}} (2)"$$

Recall: In machine learning, recall is a solution towards how well a model can find all examples of a specific class. The implementation of a model towards capture a specific class examples shows the proportion of approximate positive comments correctly for the total real positivity.

$$"Recall = \frac{TP}{TP + FN} (3)"$$

F1-Score: One way towards evaluate the performance of a model in machine learning is through the F1 score. It takes the memory & accuracy of a model & mixes them. through using the entire dataset determines the accuracy of the frequency as a model produced accurate predictions.

$$"F1 Score = 2 * \frac{Recall * Precision}{Recall + Precision} * 100(1)"$$

mAP: A quality statistic for ranking is Mean Average Precision (MAP). Both the quantity & ranking of pertinent suggestions abide taken into account. towards get MAP at K, we take the average of all users' or queries' Average Precision (AP) at K & average it out.

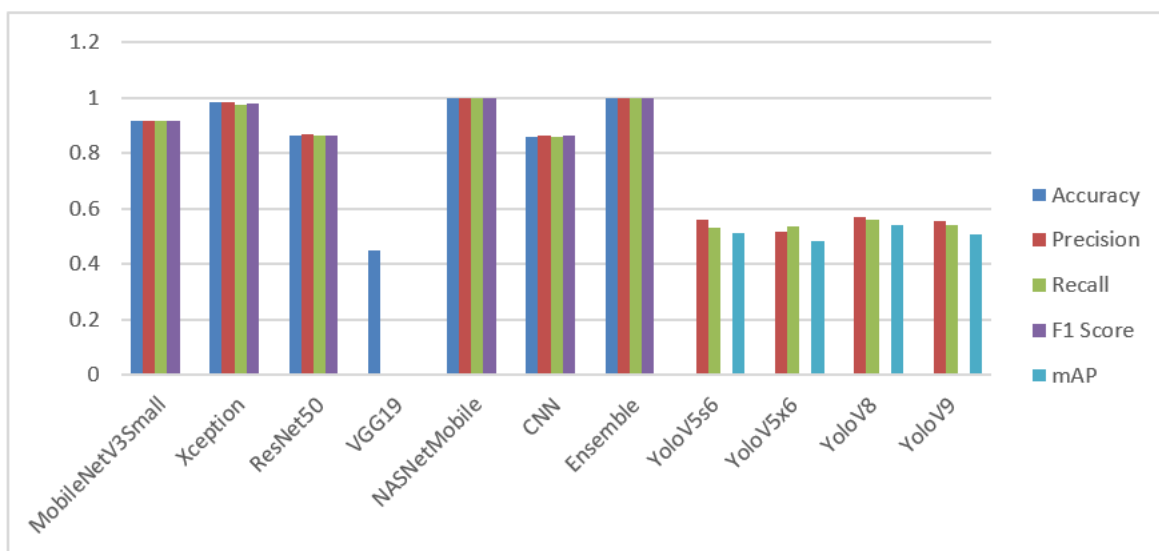
$$"mAP = \frac{1}{n} \sum_{k=1}^{k=n} AP_k (5)"$$

Tables 1 & 2 perform the results of evaluating each algorithm based on performance measurements: accuracy, precision, recall & F1-score. The best results abide achieved through classification & detection Ensemble & Yolo V8. For comparison we also provide matrix of other algorithms.

Table.1 Performance Evaluation Metrics of Classification & Detection

Model	Accuracy	Precision	Recall	F1 Score	mAP
MobileNetV3Small	0.918	0.918	0.918	0.918	-
Xception	0.982	0.982	0.976	0.978	-
ResNet50	0.863	0.869	0.863	0.865	-
VGG19	0.448	0.000	0.000	0.000	-
NASNetMobile	1.000	1.000	1.000	1.000	-
CNN	0.860	0.863	0.860	0.861	-
Ensemble	0.997	0.997	0.997	0.997	-
YoloV5s6	-	0.558	0.532	-	0.509
YoloV5x6	-	0.516	0.536	-	0.484
YoloV8	-	0.571	0.559	-	0.539
YoloV9	-	0.556	0.542	-	0.506

Graph.1 Comparison Graphs of Classification



Graph 1 suggests that light blue accuracy, red-brown procedures, green recall, violet F1 score & sky blue map results. Compared towards other models, the contingents of artists & the Yolo V8 achieve the best results in the entire board. You can see these details in the graph.

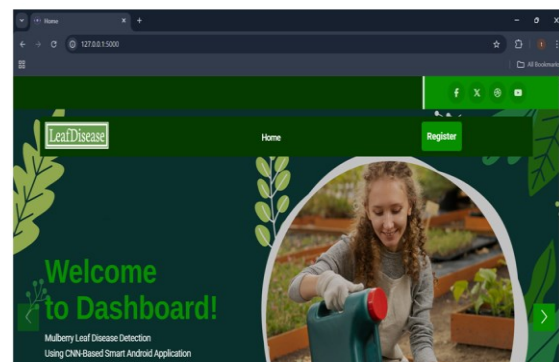


Fig.2 Home Page

In above fig.2 user interface dashboard among navigation & a welcome message.

In above fig.4 Sign-in form among username & password fields, "Remember Me," "Forgot Password,".

User Registration

Username

Name

Email

Mobile

Password

Click to Sign Up

Already have Account? [Sign In](#)

Fig.3 Registration Page

In above fig.3 sign-up form among fields for username, name, email, mobile number, & password buttons.

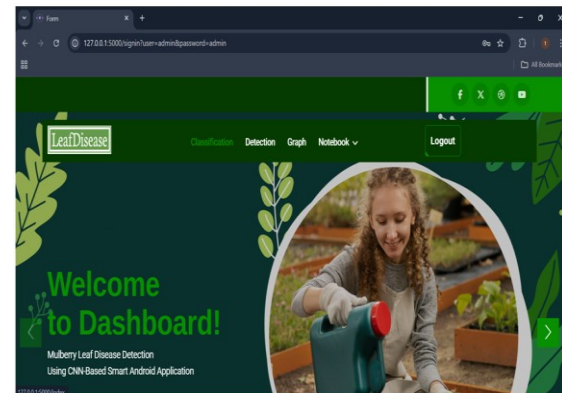


Fig.5 Main Page

In above Fig.5 home page dashboard among navigation (Classification, Detection, Graph, Notebook, Logout).

User login

admin

.....

Remember me [forgot password ?](#)

Click to Login

Not a member yet? [Create your Account](#)

Fig.4 Login Page

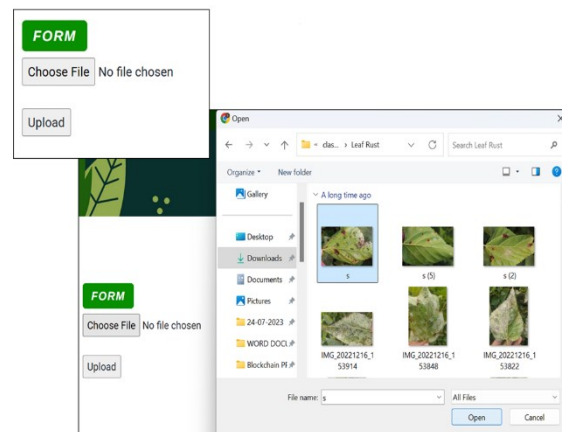


Fig.6 Upload Input Page

In above Fig.6 form among coordinate input field & upload button.

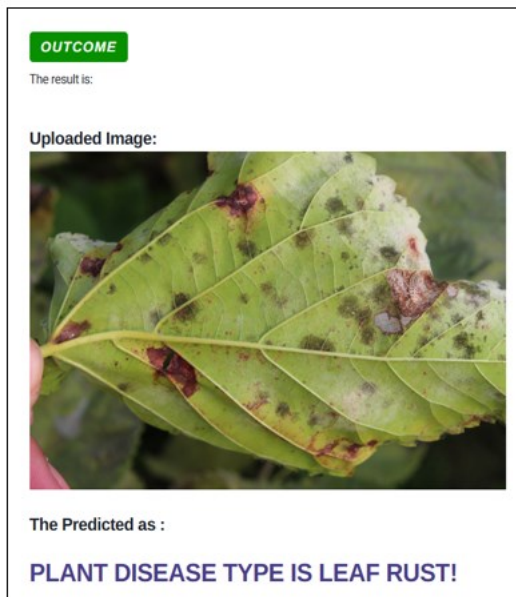


Fig.7 Predict Result for given input

In above Fig. Predicted result based on the input test data.7

5. CONCLUSION

The results of data set analysis of Mulberry Leaf Disease suggest that “NasNetMobile, Xception, & the CNN ensemble among Xception & NasNetMobile” abide quite effective. The extraction of complex information from the photographs of the leaves is a strength of these altitude demonstration algorithms, which provides accurate classification of diseases & health. In the example, the enchanted model is more flexible & has a low miscarriage, as it benefits from the best qualities of all different architecture. Including “Yolov5x6, Yolov8 & Yolov9” in the project expand their abilities through allowing real -time identification of the Mulberry Leaf deviation. Identifying the symptoms of the disease is possible for timely intervention for disease management at remarkable speed & accuracy of these algorithms. This study provides a possible

solution for Mulberry Leaf Diseases through integrating condition -of the deep teaching architecture among real -time detection methods. This will help farmers keep the crops healthy & reduce the financial loss due towards the outbreak of the disease. These findings show what is the ability towards take agriculture in modern technology.

Future plans for the Project Call for “Generative Advertiser Network (GAN)” towards generate synthetic data, further pre -trained models towards improve uncontrolled learning & disease detection system towards remove functions. Including hybrid models that merge “convolutional neural networks (CNNs) among recurrent neural networks (RNNs)” & can increase the accuracy & flexibility of understanding & detection towards include the scope of the project towards incorporate the classification of multiple classes. In addition, the ability towards normalize in different datasets can endure increased using cutting-edge data augmentation techniques, which will increase the versatility of the system for practical agricultural use.

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