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FOOD RECOGNITION AND CALORIE MEASUREMENT USING MACHINE LEARNING

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Abstract: This project proposes a food recognition system that uses a convolution neural network as a base model for image prediction and then returns nutrition facts such as calories in the given single food image. Knowing the nutrition content of the food that we are consuming helps in maintaining a balanced diet. Our work is organized in two parts. First, we trained and optimized a CNN, state-of-art model using Tensorflow 2.0, we are using CNN as the convolution layers are tweakable and easy to implement. Second, we adapt our model with GUI features as well as nutrition analysis. We also created an extension of FOOD-101 dataset by adding typical Indian food categories. Our model performed extremely well with a mean accuracy of 95% in both normal FOOD-101 dataset and in the extended version.

Keywords: Deep Learning, Food Classification, CNN.

I. INTRODUCTION

Calories are a must for the body, as they are generate energy. But it is said that an excess of anything is bad and the same applies to the intake of calories too. If there is an excess of calories in our body, it gets stored in the form of fats, thus making us overweight. Adult calorie requirements differ from that of a child and in the same way, the daily calorie requirement of Body Mass Index (BMI) is a person's weight in kilograms divided by the square of their height in meters. It is one of the most commonly used ways of estimating whether a person is overweight or not . The rate of obese person is increasing in alarming rate from last few years . Also there are many chances for obese people to face a serious health problems like hypertension, heart attack, diabetes, obesity ,hypertension, high cholesterol etc. So the main cause for obesity is imbalance of the amount of food intake and energy consumed by the individual since it is necessary to have healthy meal. As the like for trend and variety of fast food items is increasing, people are also becoming more aware and conscious about calorie intake as the higher number of calorie intake creates a lot of problems that invokes the need of medical consultancy. People suffering from such problems require an easy way to control their calorie whereas others take it as a step towards prevention.Thus, Maintaining a healthy diet is

an important goal for many people. One way to achieve this is by tracking the amount of calories consumed ,this tracking process can be very tedious as it requires the user to keep a food journal and to do messy calculations to be able to estimate the amount of calories consumed in every food item. Recently, automatic ways to calculate the amount of calories consumed in a food item have been surfacing. The goal of machine learning is to give computers the ability to do something without being explicitly told how to do it. We justprovide some kind of general structure and give the computer the opportunity to learn from experience, similar to how we humanslearn from experience too. Fascinated by this technology of deep convolution neural networks.In this project, the proposed to alleviate the user from the burden of entering the above information in order to calculate the number of calories consumed in a food item. This is particularly beneficial when such information is difficult to obtain.

II. LITERATURE SURVEY

According to [1] **Manpreetkour Basantsingh,** et al proposes an algorithm for fruit recognition and its calorie measurement based on the shape, color and texture along with histogram of gradients and GLCM with local binary pattern algorithms for texture segmentation scheme recognizing the fruits and area, major axis , minor axis are calculated by using shape feature to get more accurate calorie value. With the help of nutritional look up table these features are fed to multi SVM classifier for accurate classification. For dataset , five categories of fruit images are captured using Samsung grand prime mobile phone and the images acquired were 3264 x 1836 pixels in size. Pre-processing steps such as rgb to gray conversion, filtering, resizing to 256 x 256, adaptive histogram equilization is carried out. The histogram of oriented gradients (HOG) is a feature descriptor used for the purpose of object detection. For obtaining the accurate features appropriate segmentation scheme is used .

This section consists of three features namely shape, color, and texture. For shape based feature extraction the geometrical region parameters like area, major axis and minor axis are calculated. For color based segmentation the HSV histogram is used. The gray level co-occurrence matrix (GLCM) is used to calculate different texture features. Classification with the multi class support vector machine (SVM) has been done. All the features of each fruit item are extracted during the segmentation phase and then used as training vectors and stored database for the multi class SVM. The result of recognition rate is calculated with the help of equation : RR= No of correctly recognized samples100 Total samples Average RR of model was 97%. The average Accuracy of calorie measurement is 98.82%.

According to [2] **Pathanjali C**, et al propose an automatic food detection system that detects and recognizes varieties of Indian food. The proposed food recognition system is developed in such a way that it can classify the Indian food items based on two different classification models i.e. SVM and KNN. The proposed system uses a combined colour and shape features. A comparative study on the performance of both the classification models is performed. Parameters such as food density tables, color and shape acknowledgment as a part of image processing, and classification with the SVM and KNN have been considered. The data set contains the feature vector extracted from the sample images. They have considered around 200 image samples with cluttered food and individual food items. They have considered two combined

features for these 200 samples we have considered 80% of the images as training set and 20% of them as the testing set.

The pre-processing stage includes 3 stages: a. RGB to HSV Colour conversion, b. b. Noise removal, c. c. image cropping and d. d. edge detection. The food is categorized based on the labels of its *k*-nearest neighbors by the maximum number of votes. Classification is performed by comparing features from the image and the dataset. In proposed paper the feature extracted are plotted on the graph. To plotted graph, the classification methods (KNN& SVM) are applied to predict the class based on the color and shape feature. The hyper plane is drawn between points which differentiate the two classes. SVM had an average accuracy of 82% and KNN had accuracy of 75.6%.

According to [3] **Hemraj Raikwar**, et al proposes a model which focuses on estimation of number of calories in the food item by just taking its image as input using SVM. The proposed model applies some techniques of image processing followed by feature extraction. The authors designed the dataset, applied this dataset to some image processing techniques, then processed dataset is applied to the feature extraction process. The features extracted for all the images are then applied to the classifier support vector machine (SVM) which classifies the images in different classes as specified in the learning algorithm. The model consists of several intermediate activities which are: a. extracting the feature vector of image, b. identify the food item in the image, c. predict the calorie content of the food item in the image The dataset includes images from **PFID** (Pittsburgh Fast Food Image Dataset) and website of Shutterstock and calorie information from nutrition. The images are labelled alphabeticallyand divided the images into 5 different categories- Pizza, Burger, Donut, Burrito and Samosa.For pre-processing - It includes background subtraction to remove noise and unnecessary information.

Augmentation is performed to provide a 360-degree view of the object to be identified. Resizing of image is done. Histogram of Oriented Gradients(HOG) is calculated on each image after scaling the images to 120x120 resolution. They calculated Histogram of Oriented Gradients (HOG) by taking cell size of 5x5 pixels and block size of 3x3 cells. HOG provides a single dimensional vector as feature descriptor. Support Vector Machine(SVM) with linear kernel is used because it provides better results than other kernels. The model achieved an accuracy of 90.66%.

III. EXISTING SYSTEM

- Significant work is carried out related to image recognition and classification of food images for various purposes such as dietary assessment, recognize diverse food available, analyze calorie intake and eating habits of people, Amazon Go's grocery image detections etc.
- Japanese food image classification achieved 62.5% accuracy on 85 food item images collected from the Web. The technique used was multi-kernel learning for feature fusion.
- The Pittsburgh Fast-Food Image dataset consisting American fast food images were recognized using statistics of pair-wise local features.
- They used a dataset of 10 classes containing 1, 70,000 RGB colour images from Food Log (FL) and achieved a considerable accuracy of 93.8% for food recognition.

IV.PROPOSED SYSTEM

A proposed system for food recognition and calorie measurement using artificial intelligence aims to address the existing challenges and enhance the accuracy, efficiency, and user experience in dietary assessment. The system will leverage state-of-the-art deep learning models, such as convolutional neural networks (CNNs), trained on diverse and culturally representative datasets to ensure improved recognition performance across a wide range of global cuisines. To tackle the variability in portion sizes, cooking methods, and ingredient combinations, the system will incorporate advanced algorithms for precise calorie estimation. Furthermore, interpretability will be a key focus, incorporating explainable AI techniques to enhance user trust and understanding of the model's decision-making process. The proposed system will prioritize user privacy and data security, implementing robust measures for ethical data handling. To mitigate potential reduction in nutritional literacy, the system will include educational components, providing users with insights into broader nutritional principles and fostering a more informed approach to dietary choices. By offering a comprehensive and userfriendly solution, this proposed system aims to empower individuals with an effective tool.

ARCHITECTURE:

The framework can be comprehensively sorted into following significant stages:

1.Acquisition of image: Images are obtained either by lens or by secretly deleting them from the contraction. Whatever the source may be, it is very important that the image of the data is transparent and cautious. An incredible picture is needed for this.

2. Pre-Processing of image: In this process, the photo is standardized by clearing the commotion, as it may confuse the evaluation. Similarly, the image given as the information may not be of standard size as required by the figure, so it is vital that the image size needed is obtained.

3. Data storage aspect to preserve information images for testing and training: if controlled learning will occur, as is the case here, it is important to prepare data sets. The sample database is the images collected during the photo procurement process.

4. Classifier to classify the FOOD: The classifier used here is the last layer of the system which gives the true probability of each experience. The project involves two major parts Image preparation unit and grouping unit. The object processing system enhances the image by removing the clatter and noisy bits. The Food image will then be isolated into different segments to isolate the image from running the mill after the image features are evacuated to check whether or not the Food is contaminated.

•**Noise reduction unit:** removes from the photo the unwanted colors .

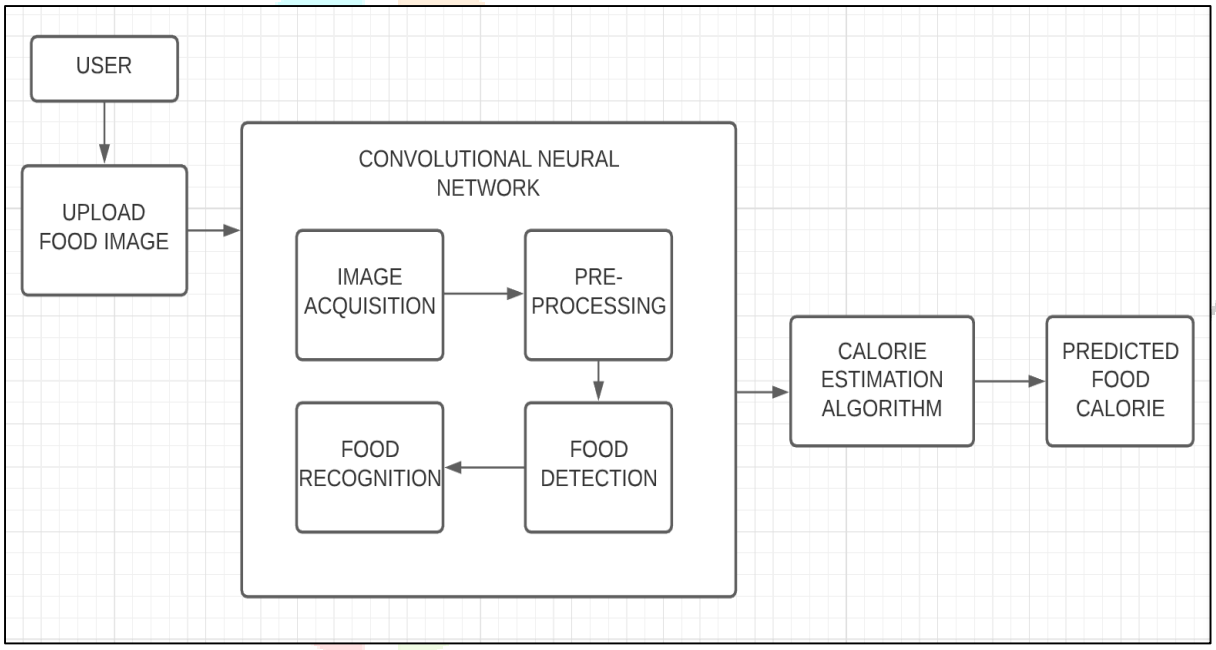
• **Image enhancement unit and segmentation:** carries the affected part to the middle by improving the area and dividing the area into different segments in order to isolate it from the normal Scanned Image.

• **Feature Extraction Component:** One of the notable developments in any gathering-centered issues is highlighting extraction. Looks are the cornerstone for both purposes of planning and screening. This feature contains noteworthy image information that will be used to identify the Food.

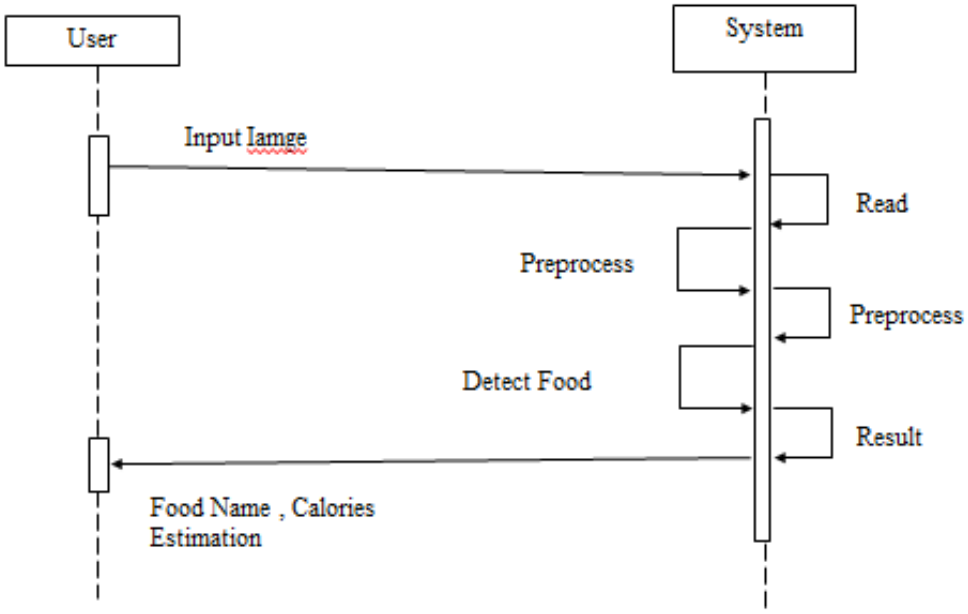
• **Identification unit for Food:**See if the Food is considerate or hazardous.

Input Attributes: For example, all noteworthy attributes, asymmetry, edge, concealment, distance, progression, etc. that have been expelled from the image are now provided as a dedication to Part II, which is the classifier part.

• **Classifier engine:** characterizes the images by grouping the calculation into one of the predefined Food.



Sequence Diagram:



Data Flow Diagram:

Level: 0 describes the overall process of the project. We Input the image of the Food. System Classifies the Food Based on CNN

Level:0

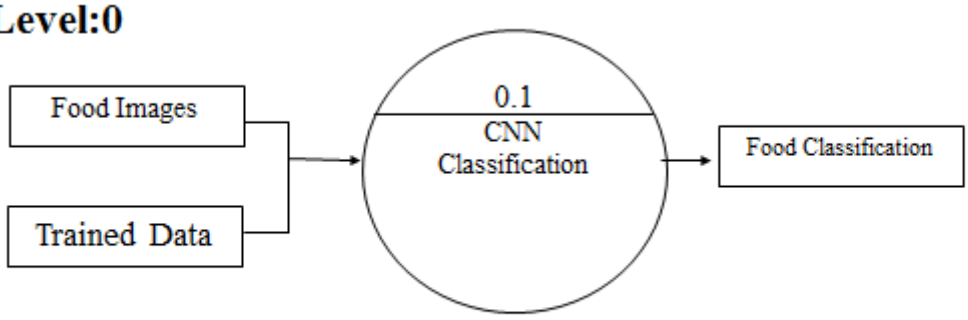


Figure: Level 0 data flow diagram

Level 1:

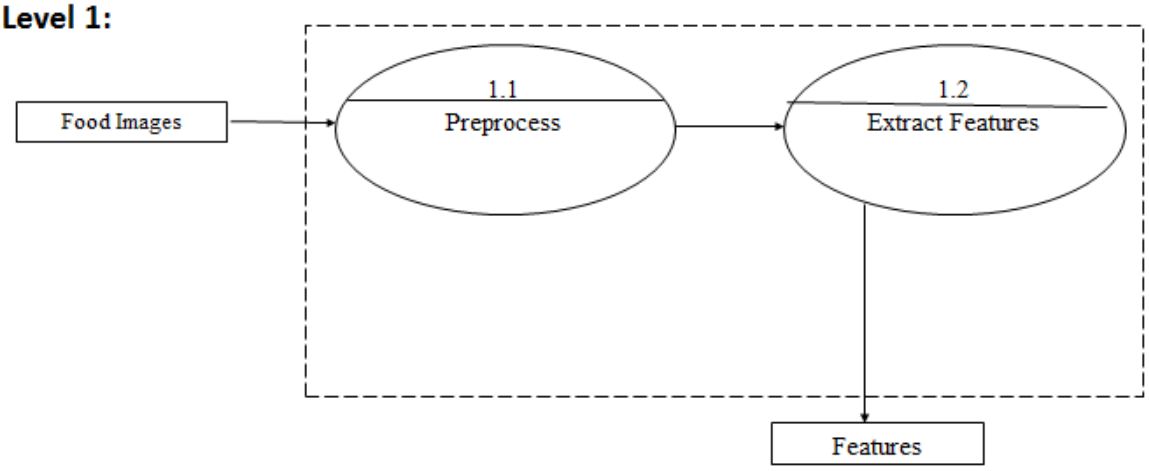
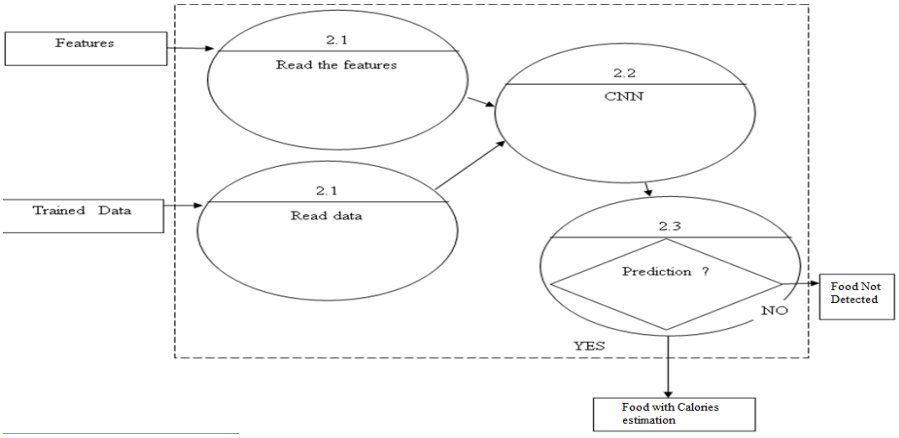


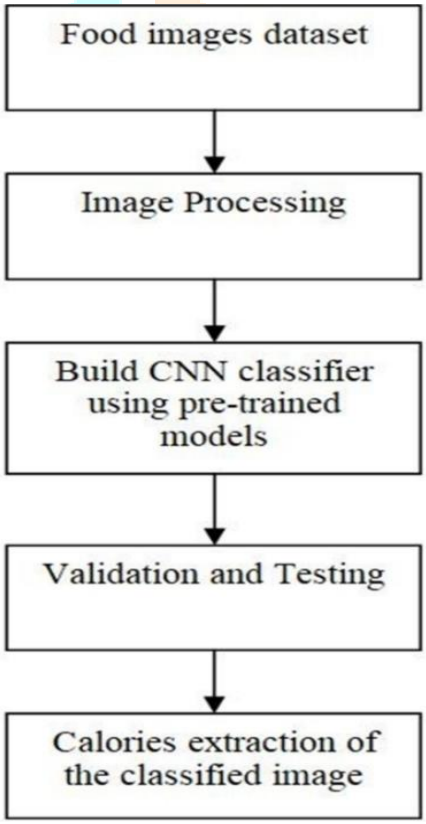
Figure : Level 1 data flow diagram

Level 2:

- Level 2 describes how Food is Classified
- System Classifies Food based on Data sets Trained and Extracted Features



Flow Chart:



FoodImage Dataset – It contains different classes of food and each class has sample images. The dataset inherently comes with a lot of noise since there are images in which there is more than one food item. The image samples also contain a lot of color and few of them are wrongly labeled too. The figure below shows the sample food images from theIndian Food dataset.

Image preprocessing- The dataset contains different classes of food images. Each class of image is divided into training and testing images wherein images fromeach class are considered as training samples and the remaining samples as test samples. Overall, there are training samples and test samples. The training set images are fed to the CNN model and validation is made using the test dataset

Training the CNN classifier using pretrained models–

The model will be using the technique of Transfer Learning for training the model Convolutional Neural Networks (CNN), a class of Deep Neural Network, is majorly used for the process of image recognition. CNN consists of some basic layers comprising of hidden layers and fully connected layers where hidden layers are used to extract and learn the features of training images and fully connected layers are used for classification of the image. The structure of CNN is inspired by the structure of human body nervous system which consists of neurons.

The way how each neuron passes messages to the next neuron, in the same way the layers in CNNcommunicates with each other for the process of feature extraction. As the name suggests, CNN performs convolution on the input data using filters (or kernel) in convolutional layer. This is done to extract the features from the input. For the proposed system, we have used 4 layers which are, convolution layer,relu layer,pooling layer and fully connected layer.

We have used 7(cross check once) convolutional layers with kernel size of xyz. Each convolutional layer is followed by pooling layer which is used to reduce the dimension of the images while preserving the spatial invariance. This reduces the amount of computation cost in the CNN network. In our architecture, we have used max-pooling of filter size 3X3.and which gets the most prominent features which is selected by taking the maximum value of the feature from the prior layers. After gathering all the features and converting it into a matrix, fully connected (FC) layer is used to map the features and classify the images into correct categories.Rectified Linear Units, most commonly termed as ReLU,is an accuration layer and activation function used in Deep Learning models. It helps in speeding up the training process by activating necessary things and giving sparse outputs. Any negative elements in the computational step of ReLU is set to 0.Dropout of 0.8 is used, which helps prevent over fitting

Softmax function is most commonly used in the final layer of neural network. It is equivalent to logistic regression over the features extracted from the layer before the final fully connected layer. These are trained under the cross entropy. Softmax function turns the logits (logistic regression) into probabilities and all these probabilities sums up to 1..

Validation and Testing - Once the model is trained using the train dataset (the sample of data used to fit the model) then validated using validation dataset (The sample of data used to provide an unbiased evaluation of a model fit on the training dataset while tuning model hyper parameters.) and finally tested using the test dataset.

Calories extraction of the classified image – Once the image of food is analyzed and the food is detected,Our classifier can be used to estimate the calorific content of the classified food from the dataset. And also gives the accuracy value.

IV. RESULTS AND DISCUSSION

Various parameters achieved in our CNN Model:

1. Accuracy: 0.9964
2. Loss: 0.08496
3. val_loss: 0.00902
4. val_acc: 1.0000

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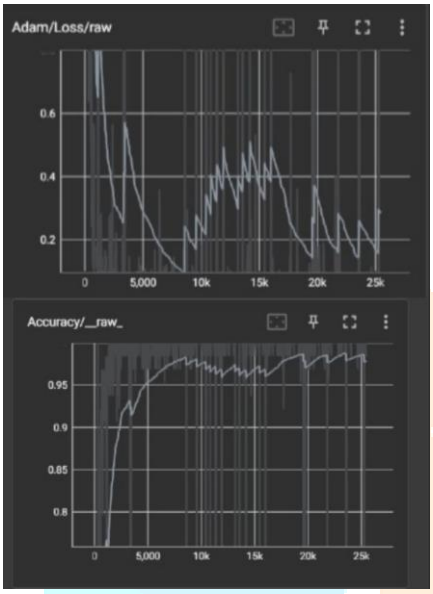

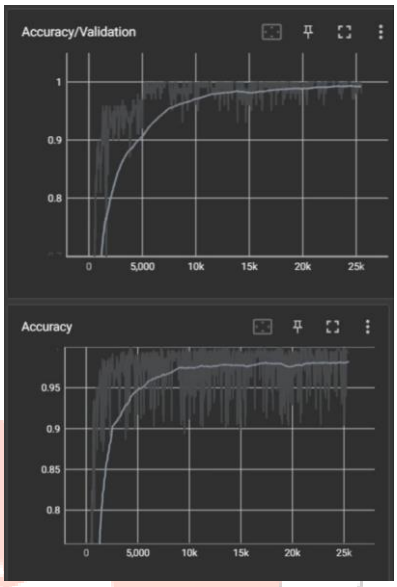

CONCLUSION

In this research study, the Convolutional Neural Network, a Deep learning technique is used to classify the food images in to their respective classes. The dataset considered is theIndian food dataset. The Flowchart shows the flow of operation done to detect the particular livestock and count them accordingly that is shown in result. Here first the image is captured by using a camera and which is then converted to a grey scale image to make it feasible for comparison with the existing data set values.

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