**ARTIFICIAL INTELLIGENCE FOR FARMERING**

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***Abstract: The use of mobile devices has become common even in rural areas of the country. Agriculture is the backbone of the Indian economy and due to this sudden influx of the number of people having access to a mobile phone, mobile-enabled information services have improved information sharing in the knowledge-intensive agriculture sector. Farmers can use the mobile application to access a variety of information services that aid in farm management, control, and monitoring helping them to improve quality and productivity.***

***Farmers may use a mobile app to improve their crops and make more money. This research paper states different such modules that can impact farming activities in India as well as discuss future measures as well. To keep up with the world's population growth, demand for agricultural goods is consistently increasing. The relationship between land, population, and agricultural production is complicated. Agriculture's reliance on land and on individual labor is decreasing as it becomes more modernized. Farmers must adopt new technologies in the face of these challenges. E-Agriculture is one such concept that is contributing to the improvement of agricultural processes.***

***Keywords: Neural Network, ANN, CNN, NLP, Dialogue Flow, Deep Learning, Artificial Intelligence, Flutter, Android, Information Management, DBMS.***

# **Introduction**

Agriculture is the primary occupation of most of the Indian population. Agriculture provides a living to almost 60 to 70 percent of the Indian population. The most difficult task that most of the farmers face in India is information access and management due to the volume of data and the complication of processes. Data for farming, such as crop life cycle detail, seeds, crop selection, crop processes, weather, pesticides, fertilizer, and so on, are available from a variety of sources, including newspapers, printed media, audio and, mobile, TV, internet, visual aids, and so on. However, the structures and formats of data vary. As a result, it is extremely difficult for farmers to obtain precise information and to be aware of a wide range of information that has been disseminated from various sources. When transferring data from one format to another, several manual steps may be required. Therefore, it is necessary to build an application that takes into consideration all these problems faced by farmers regarding the crop and the farm. Artificial Intelligence has come a long way with the help of ANN, CNN an NLP now farmers can help themselves without a need of another person and rely on their smartphones which will be helped with the module discussed this paper.

The succession of crop growing production directly increases the Indian economy, and vice versa. It is necessary to provide the best technological solutions to farmers to modernize their lives. Many techniques and methods are being developed to help with agricultural routine activities. Mobile farming apps may be the best option for increasing agricultural production in the country. Due to a lack of knowledge, new agricultural technology inventions are not easily accessible to farmers. They are unaware of the source from which they can obtain valuable information. As a result, many farmers are unable to achieve their desired production rate. As a result, it is necessary to create a user-friendly system through which farmers can access critical information. Smart phone technology has created numerous new opportunities for farmers. In this research paper there are various modules regarding the Artificial Intelligence of farming.

In agriculture, yield prediction is critical. Any farmer wants to know how much he may expect in terms of yield. We look at a variety of connected parameters such as geography and so on. The nutrient value of the soil in the region, as well as the amount of rainfall within the region, can be assessed using third-party applications such as APIs for weather and temperature. All these characteristics will be examined, and several machine learning algorithms will be trained in order to create a model. The system includes a model that can accurately estimate crop yield and provide users with advice on which crops to sow to enhance yield and farmer revenue.

Speech-based conversational interfaces have the potential to provide several benefits to farmers. There are few literacy requirements, and it provides a natural and familiar modality that does not require the user to learn new technical concepts or interaction methods. Agriculture experts can easily edit or customize the conversational system's knowledge base.

Losses maybe huge and can cost the farmers up to 42% of the total production. The pathogens also produce toxins, and they can create problems for consumers health. Hence it becomes very important to avoid diseases in plants and here plant disease detection becomes a top priority. Plant diseases occur quite often. If not taken care of, it can have a harmful effect on plants. These diseases can affect product quality, quantity and the overall productivity. If such diseases can be detected automatically through some symptoms, then it considerably helps in managing the workload in large farms. This paper presents a technique for identification of various diseases and their classification.

# **LITERATURE REVIEW**

The requirements and planning required for developing a software model for precision farming are discussed in the paper [1]. It delves deeply into the fundamentals of precision farming. The author begins with the fundamentals of precision farming and progresses to the development of a model to support it. This paper describes a model for applying Precision Agriculture (PA) principles to small, open farms at the individual farmer and crop levels to achieve some control over variability. The model's overarching goal is to provide direct advisory services to even the smallest farmer at the level of his or her smallest crop plot, using the most accessible technologies such as SMS and email. This model was created for the scenario in Kerala State, where the average holding size is significantly lower than in the rest of India. As a result, with some modifications, this model can be positioned elsewhere in India.

The paper [2] examines assortment algorithms and their performance in yield prediction in precision husbandry. These algorithms are implemented in a data set gathered over several years for yield prediction on the soya bean crop. In this paper, the yield prediction algorithms used are Support Vector Machine, Random Forest, Neural Network, REPTree, Bagging, and Bayes. The conclusion is that bagging is the best algorithm for yield prediction among the aforementioned algorithms because the error deviation in bagging is the smallest, with a mean absolute error of 18985.

The paper [3] discusses the importance of crop selection and the factors that influence crop selection, such as production rate, market price, and government policies. This paper proposes a Crop Selection Method (CSM), which solves the crop selection problem and increases the crop's net yield rate. It recommends a series of crops to be planted over the course of a season, considering factors such as weather, soil type, water density, and crop type. The accuracy of CSM is determined by the predicted value of influential parameters. As a result, a prediction method with improved accuracy and performance is required.

The purpose of this paper [4] is to solve the critical problem of selecting classifiers for ensemble learning. A method to select a best classifier set from a pool of classifiers has been proposed. The proposal seeks to improve accuracy and performance. Based on accuracy and classification performance, a method called SAD was proposed. The dependency between the most relevant and accurate classifiers is identified using Q statistics. The ensemble was formed by combining the classifiers that were not chosen. This metric is intended to improve the ensemble's performance and diversity. Several algorithms were identified, including the SA (Selection by Accuracy), SAD (Selection by Accuracy and Diversity), and NS (No selection) algorithms. Finally, it is deduced that SAD is more effective than others.

To classify the liver disease data set, the paper [5] proposes various classification methods. The importance of accuracy is emphasized in the paper because it is dependent on the dataset and the learning algorithm. To classify these diseases and compare their effectiveness and correction rate, classification algorithms such as Nave Bayes, ANN, ZeroR, and VFI were used. The models' performance was measured in terms of accuracy and computational time. All classifiers, except for naive bayes, were found to have improved predictive performance. Among the proposed algorithms, the multilayer perceptron has the highest accuracy.

The paper [6] attempts to address the issue of food insecurity in Egypt. It proposes a framework for forecasting production and imports for that particular year. To make the prediction, WEKA employs Artificial Neural Networks and Multi-layer Perceptron’s. We would be able to visualize the amount of production import, need, and availability at the end of the process. As a result, it would aid in determining whether additional food imports are required.

The soil datasets from paper [7] are analysed, and a classification is predicted. As a Classification rule, the crop yield is predicted based on the predicted soil category. Crop yield predictions are made using the Nave Bayes and KNN algorithms. The stated future work is to develop efficient models using various classification techniques such as support vector machine and principal component analysis.

The paper [8] in this paper tensorflow.js instead of python the general way it has been used for training of CNN objects without a tflite file. A direct middleware to the server which helps to understand the application-based object detection. Which trains the classes with the help of frontend of the html methods and send the to the middleware, where one-hot encoding is done for the classes and with help of the web user can have successful result of object-detection.

# **METHODOLOGY**

This section describes the specific constraints and implementations of the proposed modules.

**3.1 CROP RECOMMENDATION**

The module of crop prediction uses the ANN to predict the suitable crop according to the given conditions of a particular area. The module considers several parameters which are nitrogen, potassium, phosphorous and Ph level of the soil which are fetched from the app itself after the farmer sends the data. Other parameters are the temperature, humidity and rainfall of that area which are collected from the weather API used in the app. After some preprocessing and labelling of data, the whole of the data is passed to the ANN which gives us the desirable output.

In the crop recommendation and fertilizer recommendation modules, the user can provide the soil data from their side and the module will predict which crop should the user grow. It helps the farmers to get informed decision about the farming strategy and helps then have an analytical approach towards farming. This Module which would allow the users to build a predictive model to recommend the most suitable crops to grow in a particular farm based on various parameters. The parameter are:

* N - ratio of Nitrogen content in soil
* P - ratio of Phosphorous content in soil
* K - ratio of Potassium content in soil
* temperature - temperature in degree Celsius
* humidity - relative humidity in %
* ph - ph value of the soil
* rainfall - rainfall in mm

The nutrients that are needed by crops in the largest quantities are N, P and K. For that reason, they're frequently considered as the most important nutrients of soil in farming.

The main functions of N and P are that they're ingredients of proteins and nucleic acids, which are important factors of factory towel. K is the only nutrient that isn't an element of organic factory composites but is substantially of significance in the regulation of processes in the factory, similar as osmosis and enzyme conditioning. K is generally playing an important part for the quality of gathered factory products. For the optimal growth of crops, enough nutrients should be available in the root zone of the crops. Those nutrients can be incompletely supplied by the soil and should be incompletely added with organic coprolites and diseases. Soils will contain different quantities of available nutrients, depending on the parent material, and differences in the operation history similar as antedating crops, operation of crop remainders and use of ordure and diseases in the history. Also differences in climatic conditions may alter the available nutrients. For that reason, it's of significance for growers to know the N P K content of their soil, so that they know how important N, P and K they should add with organic or mineral diseases, to optimize crop growth, product, and yield.

Nutrients are present in the soil in different forms, which differ in its vacuity for shops. For illustration, utmost nitrogen is present in the soil in organic form as part of organic matter, while it can be taken up only in mineral forms (ammonium and nitrate). The organic nitrogen should be mineralized into mineral forms before factory roots can take it up. Phosphorus in the soil is also present in organic matter, but frequently substantially in chemical forms, which differ in solubility and factory vacuity. Potassium is substantially present in the soil result and adsorbed to soil patches, similar as complexion and organic matter, from which it can desorb fluently by changes in equilibrium between the face of soil patches and the soil result.

The crop roots take up the available nutrients from the top subcaste of the soil. Despite differences in factory root systems, which vary from shallow to all crops take up their nutrients from the topsoil.

The mobility of nutrients in soils explosively differs N and K dissolve in water relatively well and are veritably mobile in soil, while P is rather immobile in soil. The consequence is that the force of N and K to plant roots is substantially sufficient, handed that the quantum in soil is high enough, while the P force to plant roots, especially in the first stages after sowing or planting, may be delicate.

The working of the module can be summarized the following steps: -

1.Input of data

2.Preprocessing and labelling of data

3.ANN algorithm

In first step dataset of crops grown in India in different conditions was acquired from Kaggle. It contained the information regarding the flora grown in almost all the states and UTs of India with respect to above given parameters, This dataset focuses on how changing some of the input parameters changes the flora of that given place.

In second step is regarding the cleaning, preprocessing and labelling of data before the training process. So, after acquiring the data necessary step is to remove the unnecessary rows or columns which don’t affect the output of the module or to simplify the complex parameters. Label encoder was used to convert the string type label into values which will govern the output of the module.

Table

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**Fig.1. Algorithm**

The third step is the use of ANN algorithm on the dataset. Artificial neural networks (ANNs) are biologically inspired computer programs designed to simulate the way in which the human brain processes information. ANNs gather their knowledge by detecting the patterns and relationships in data and learn (or are trained) through experience, not from programming. An ANN is formed from hundreds of single units, artificial neurons or processing elements (PE), connected with coefficients (weights), which constitute the neural structure and are organized in layers. The power of neural computations comes from connecting neurons in a network.

Each processing node has its own small sphere of knowledge, including what it has seen and any rules it was originally programmed with or developed for itself. The tiers are highly interconnected, which means each node in tier *n* will be connected to many nodes in tier *n-1* -- its inputs -- and in tier *n+1,* which provides input data for those nodes. There may be one or multiple nodes in the output layer, from which the answer it produces can be read.

ANN model consists of 7 layers in which 5 are hidden layers. Input layer is having the ReLu function as an activation function and the output layer has softmax fuction as the activation function and all the hidden layers are using ReLu function as activation function

ReLu is a non-linear activation function that is used in multi-layer neural networks or deep neural networks. This function can be represented as:



Where x=input value

According to equation 1, the output of ReLu is the maximum value between zero and the input value. An output is equal to zero when the input value is negative and the input value when the input is positive. Thus, we can rewrite equation 1 as follows:

A picture containing graphical user interface

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Where x=input value.

Traditionally some non prevalent non linear functions like sigmoid or hyperbolic tangents were used to get the the activation value of each neuron but nowadays ReLu function is used as it has higher computation saving since the derivate of ReLu is 1 for positive value .

The function is great for **classification** problems, especially if you’re dealing with multi-class classification problems, as it will report back the “confidence score” for each class. Since we’re dealing with probabilities here, the scores returned by the softmax function will add up to 1.

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It states that we need to apply a standard exponential function to each element of the output layer, and then normalize these values by dividing by the sum of all the exponentials. Doing so ensures the sum of all exponentiated values adds up to 1.

A picture containing text, clock

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**Fig.2. example of softmax activation function.**

So the output of the ANN layers is the probabilities of different crops for a particular area and then the crop with highest probability is selected which gives the most suitable crop.

**3.2 FERTILIZER PREDICTION**

This module uses the ANN algorithm to predict the suitable fertilizer to grow a particular crop according to the given conditions of an area. The working of this module is similar to crop prediction module only difference is regarding the input and output values

INPUT PARAMETERS: -

1. TEMPERATURE
2. HUMIDITY
3. MOISTURE
4. SOIL TYPE
5. CROP TYPE
6. NITROGEN
7. POTASSIUM
8. PHOSPHOROUS

Temperature, humidity and moisture of the area are collected from the weather API and all the other parameters are given by the farmers.   
The steps involved in the predictions of the fertilizer are: -

1.Collection of data

2. Preprocessing and labelling of data

3. ANN algorithm

In the first step dataset is collected from Kaggle regarding the fertilizers used for different crops in different conditions. It provides us the detail of the fertilizers to be used to grow a particular crop which will enhance the soil nutrients and help the farmers to get the desirable results.

The second step involves preprocessing and cleaning of data. Undesirable columns are removed from the dataset and labelling of data is done.

The third step is giving the dataset to ANN algorithm. Similar as previous module this module has 7 layers. All the layers are the Relu function as the activation except the output the layer which is using the softmax function and the output of the softmax function is the probabilities for different fertilizers to be used and between them the highest probability is selected which gives us the most suitable fertilizer.

**3.3 DISEASE DETETECTION**

This module is about disease detection of crops from images, developing smart phone application module that assists in identifying plant damage with the help artificial intelligence. Images taken by farmer are directly uploaded the app and automatically analyzed by algorithms which identify the disease with results back to the farmer within a few seconds. Critical information whether the plant or crop has been affected or diseased on the bases on the Images, the of the disease’s symptoms, triggers, agriculture chemicals as well as biological treatments or the solution for the disease are provided to the farmer.

Diagram

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**Fig.3. Implementation of proposed Model**

The main steps of proposed methodology to leaf disease recognition are shown:

1. Input of Data
2. Resizing of Image
3. Image Acquisition &Visualization
4. CNN Algorithm

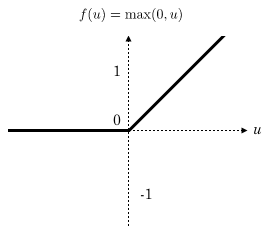
It is the process of acquiring images from a source Plant Village Dataset was taken from Kaggle. It is the first step in the proposed work because without image there is no processing. The obtained images are completely unprocessed. Data sets needed for the preparation, testing, and validation phases of the Convolutional Neural Network deep learning method are obtained. There are just a couple of images within the data sets of disease. The PlantVillage dataset obtained contains over 54,306 photographs of stable and diseased crop leaves, which have a spread of 38 class labels assigned to them.

The scaling of images is mentioned as image resizing. Scaling is useful in a variety of image recognition and machine learning applications. It aids in the reduction of the number of pixels in an image, which has many benefits, for example. It will reduce the time it takes to train a neural network since the more pixels in an image there are, the more input nodes there are, which increases the complexity. It also aids in image zooming. To meet the size requirements, we often need to resize the file, either shrinking it or scaling it up. Resized the images to 256 × 256 pixels and we perform both the model optimization and predictions on these downscaled images. Dataset was split into Training Dataset and Testing Dataset.

A step in the dimensionality reduction process that separates and reduces a vast array of raw data into smaller units is feature extraction. As a result, processing is going to be tons easier. The fact that these huge data sets have a vast number of variables is the most notable aspect. A significant amount of computing power is needed to process these variables. Feature selection assists in the retrieval of the ideal feature from vast data sets by sorting and merging variables into features, thus reducing data volume. When it comes to When you have a huge data set and need to reduce the number of resources without missing any significant or related information, the feature extraction technique comes in handy. Feature extraction aids within the reduction of duplicate data during a data package. Finally, reducing the data allows the computer to create the model with less effort and improve the learning speed.

A CNN, or convolutional neural network, may be a deep learning neural network designed to process ordered arrays of knowledge, like portrayals. Lines, gradients, circles, and even eyes and faces are alright picked up by CNN within the input image. It is because of this property that convolutional neural networks are so efficient in computer vision. CNN doesn't require any pre-processing and may run directly on an underdone image. CNN is made up of several convolutional layers layered on top of each other, each capable of understanding more complex patterns. A CNN, or convolutional neural network, may be a deep learning neural network designed to process organised arrays of knowledge like portrayals. A convolutional neural network is a multi-layered feed forward neural network that is built by stacking several invisible layers on top of each other in a specific order. CNN can learn hierarchical features because of the sequential nature. Convolutional layers are usually accompanied by grouping layers and opaque layers in CNN, and activation layers are typically followed by convolutional layers.

The first step in building the algorithm of CNN consisted of a convolutional layer with the help of Keras Conv2D is a 2D Convolution Layer, this layer creates a convolution kernel that is wind with layers input which helps produce a tensor of outputs. Convolutional layers are the layers where filters are applied to the original image, or to other feature maps in a deep CNN. A convolution is the simple application of a filter to an input that results in an activation. The result is highly specific features that can be detected anywhere on input images. The activation function used in this layer is relu layer. Rectified Linear Activation Function or RELU layer removes all negative values from the filtered image and replace it with zeros and the positive values are kept as it is. RELU is used to avoid the values from summing up to zero. It is the most used activation function in neural network models as it reduces the computational complexity, easier to train and achieves better performance.

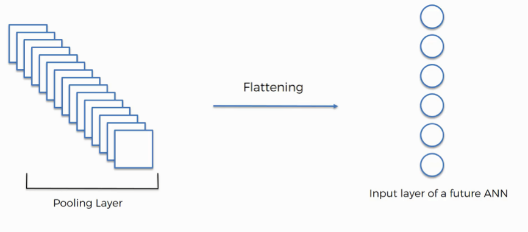


**Fig.4. Graph of Relu**

The second step consists of adding the pooling layer Pooling layers are used to reduce the dimensions of the feature maps. Thus, it reduces the number of parameters to find out, and therefore the amount of computation performed within the network. The pooling layer summarizes the features present in a region of the feature map generated by a convolution layer. Pooling layer operates on each feature map independently. The three sorts of pooling operations are:

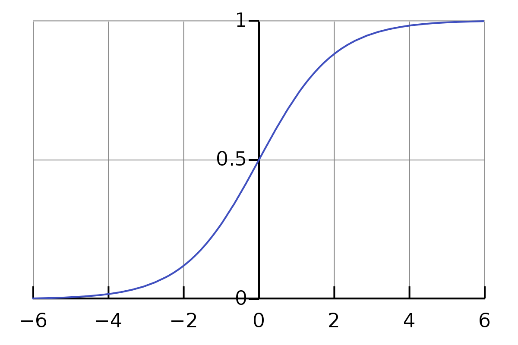
1. Max pooling: The maximum pixel value of the batch is selected.
2. Min pooling: The minimum pixel value of the batch is selected.
3. Average pooling: The average value of all the pixels in the batch is selected.

The step 3 contains Flattening is converting the info into a 1-dimensional array for inputting it to subsequent layer. We flatten the output of the convolutional layers to make one long feature vector. And it's connected to the ultimate classification model, which is named a totally connected layer.



**Fig.5. Flattening**

The output layer during a CNN as mentioned previously may be a fully connected layer, where the input from the opposite layers is flattened and sent so because the transform the output into the number of classes as desired by the network. The activation function used is sigmoid Function acts as an activation function in machine learning which is employed to feature non-linearity during a machine Functions which are used in machine learning and deep learning. Learning model, in simple words it decides which value to pass as output and what not to pass.



**Fig.6. Graph of sigmoid**

**3.4 CONVERSATION BOT**

Application is a flutter-based application, which supports both android as well as iOS operating system. Our application has five modules that is crop prediction, fertilizer prediction, E-market (Buy and Sell), Plant Disease Detection, and Chat Bot. These all modules are User friendly and very easy to use and interact. Along with this our app is secure and provides authentication to farmers by taking details like mob no., Aadhar no. into consideration. For database purpose, we have used Firebase Realtime DB which is No-sql database and very easy to integrate in flutter application. We have 3 separate collections of database they are User, order\_details, item\_details. For database storage we have used firebase storage for storing user’s profile image and item image.

In chat bot module we have given Service of Google assistant for farmers to better understand the production activities.

For a human to answer a certain question, he/she must know information about it. In an analogous way Chatbot will need information/data about what we are going to ask. For this, we provide Dataset. As we are going to ask farming related queries, we collected Kissan Call Centre Dataset (Farmers Call Center).

The dataset has queries asked by farmers and what were the answers given by Agricultural experts. Dataset was taken from github.com (https://github.com/AgriChatbot/ScrapeBot). The first column consists of quries, and the second column is the solution to query.

Graphical user interface, text, application, email

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**Fig.7. Training Dataset**

This dataset was stored on dialogueflow, a cloud platform, which is used to build dataset.

On dialogueflow console, we created new agent and enabled beta features and api, and create a new secret key in credentials. We will use this newly created key in json format later.

In Knowledge beta in dialogueflow console, we create our own database using our KCC database. Firstly, we convert our excel dataset to csv format, using inbuild feature of google sheet. This csv file must be uploaded as knowledge base in dialogueflow. To let dilogeflow that our second column stands as solution, in responses of Knowledge base we write “$Knowledge.Answer[1]”, as [1] refers to second column.

Graphical user interface, application

Description automatically generated

**Fig.8. Test Response**

After doing this we can see that every query is mapped to a solution. When a query is asked to our chatbot, dilougeflow will automatically answer it according to corresponding solution. Here our backend for chatbot is ready.

Graphical user interface, text, application, email

Description automatically generated

**Fig.9. Query and solution in Dialogue Flow**

# **CONCLUSION**

Mobile apps have emerged and gained enormous importance in the rapidly expanding digital ecosystem. Mobile apps are being introduced to aid the farming community in the advancement of the agriculture sector. India is a country that is heavily reliant on agriculture. A variety of new agricultural technologies are being developed. The Indian government also provides additional resources to farmers to increase productivity. Due to inequitable management, all critical farming information and plans do not reach farmers in a timely manner. Most farmers are unaware of the applications of new agricultural technologies. To bridge the gap between farmers and new technology, as well as government aids to improve agricultural growth, researchers will devise a novel solution. This mobile app will define the necessary procedure and model to raise farmers' awareness of new and diverse agricultural knowledge while also assisting them in their efforts to improve agriculture in our nation.

Successfully made an application with different modules. All features of the model in the application with friendly and very interactive mobile UI. Use of Neural Network in classification of Crop recommendation and Fertilizer recommendation which gave accuracy of 98% and 97% and the tflite was integrated with flutter. Disease Detention with image gave an accuracy of 96.7%.

# **FUTURE SCOPE**

Farming is a field which has improved over the years in terms of technology and sustained the development. Future work will focus on improving performance, continued progress on device compatibility.In future we can extend or expand the functionality of the model. May use smart watering integrated to the application which will consist of adding IOT application. Adding regional languages according to the area of the user will be an additional feature for the conversation BOT section.

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