Machine Learning Methods to Classify Mushrooms for Edibility-A Review

Rakesh Kumar Y¹ | Dr. V. Chandrasekhar²

¹Dept. of Electronics and Communication Engineering, Research Scholar, Osmania University, Hyderabad, India.

²Dept. of Electronics and Communication Engineering Former principal & Professor, MVSR Engineering College, Hyderabad, India

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ABSTRACT

There are thousands of species of Mushrooms in the world; they are edible and non-edible being poisonous. It is difficult for non-expertise person to Identify poisonous and edible mushroom of all the species manually. So a computer aided system with software or algorithm is required to classify poisonous and nonpoisonous mushrooms. In this paper a literature review is presented on classification of poisonous and nonpoisonous mushrooms. Most of the research works to classify the type of mushroom have applied, machine learning techniques like Naïve Bayes, K-Neural Network, Support vector Machine(SVM), Artificial Neural Network(ANN), Decision Tree techniques. In this literature review, a summary and comparisons of all different techniques of mushroom classification in terms of its performance parameters, merits and demerits faced during the classification of mushrooms using machine learning techniques.

KEYWORDS: Data Mining Techniques, Mushroom Edibility Classification, Machine Learning Techniques, Image Processing Methods, UCI Machine Learning Repository.

I. INTRODUCTION

Varying degrees of protein and fiber are available in all kinds of edible mushrooms. Mushrooms contain vitamin B element called selenium, a powerful anti-oxidant which supports immune system. The research work on mushrooms is increasing day by day because of its health benefits and different medicinal properties. These commercially available mushrooms like button, milky, oyster etc., only are edible and it has become a great source of business for small farmers. Mushroom hunting, from the term we could say that collecting mushrooms in the wild for food is a well practice in most of the places. Therefore, the common safety advice to consume mushrooms is that only truly recognized mushrooms should be eaten. At this point we may not be able to identify

edible and non-edible mushrooms.

Developing a computer aided system by training the system with various machine learning algorithms depending on the accuracy helps many of them to classify mushrooms and protect them from consuming poisonous mushrooms. Unknowingly, if humans consume toxic mushrooms may lead to allergic reactions, vomiting and sometimes even death. Detecting poisonous mushrooms with naked eyes is always a trivial task for human. So classifying edible from poisonous mushrooms is a great need and demand to save lives of mushroom hunters.

This paper deals with comprehensive overview of recent research in classification of edible and non-edible mushrooms. The remaining part of the paper is organized as: Section II provides the literature review on edible mushroom

classification; comparative analysis on different classification methods is presented in section III; Finally, Section IV concludes the paper.

II. CLASSIFICATION OF EDIBILITY MUSHROOM

S.K. Verma, M Dutta [1] focused on evaluating the performance of different classification methods like Artificial Neural Networks (ANN), Adaptive Nuero Fuzzy inference system (ANFIS) and Naïve Bayes on mushroom data sets collected from UCI Machine Learning Repository. Data set considered consists of 8124 instances, 22 attributes and 2 possible classes of edible and non-edible. The parameters used to analyze the performance of ANN, ANFIS and Naïve bayes algorithm are incorrectly classified instances (ICCI), correctly classified instances (CCI), MAE, Kappa statistic. It is observed from the results that ANFIS is performing better than ANN and Naïve Bayes. It is also observed that Accuracy is increasing as training set is increased.

Nusrat Jahan Pink, S. M.Mohidaul Islam, Rafia Sharmin Alice, [2] used ensemble Techniques developed by combining different classifiers to classify the edible and poisonous mushrooms. Naïve Bayes and dissimilarity measure are used for bagging; Adaboost is used for boosting and decision Tree is used for random forests. Mushroom dataset was taken from UCI machine learning repository and dataset consists of edible and non-edible of 8124 instances and 22 attributes with 2 possible class levels. These 22 tributes are Odour, cap-surface, cap-shape, cap-color, bruises, gill-size, gill-shape, gill-attachment, stalk-root, stalk-shape, stalk-color-below-ring, stalk-color-above-ring, stalk-surface-above-ring, and stalk-surface-below-ring, habitat, population, ring-type, veil-color, veil-type, ring type, ring-number, spore-print-color. Five base models of each ensemble method using five feature sets are developed by selecting the most significant feature set. To test the performance, accuracy is considered for both randomly selected feature set and fixed feature set are considered for ensemble methods. The better performance is obtained by fixed feature set based models compared to randomly selected feature set based models. The accuracy is found to be high for random forest and dissimilarity measure –based bagging, but random forest is faster than the dissimilarity measure based bagging method.

Yasemin Rukiye Erhan, Humar Kahramanli Ornek [3] to classify edible and non edible mushrooms an image processing technique thresholding segmentation method is used to separate object

and background. Then dilation and erosion is used to highlight or magnify the objects in binary images. Then classification techniques K-NN and Naïve Bayes were used to classify the segmented image. Data set of 25 mushroom types were grown naturally and collected from selcuk university campus, out of 25 mushroom types 8 were edible and 17 were non-edible. Experiment was carried out in Microsoft visual studio 2012 software. After analyzing results it was found that Accuracy of Naïve Bayes algorithm is 96% and 80 % is achieved by K-NN. Naïve Bayes performs better than K-NN algorithm for small amount of data sets.

Eyad Sameh Alkronz et.al [4] developed a model by using Artificial Neural Network (ANN) to detect edibility of mushrooms fed as input to the model. A multi layer ANN model is developed with one input layer, three hidden layers and one output layer was used to train and test the mushroom data set. The mushrooms represented data set was collected from UCI machine learning repository and dataset consists of edible and non-edible of 8124 samples (training samples are 5724 and test samples are 2400) and 22 attributes with 2 possible class levels. The network structure is developed by Just NN software and trained for 161501 epochs. After trial and error process, finally states that the best results were obtained by considering 22 attributes as 22 input neurons, 3 hidden layers with (2x1x3) neurons and 1 neuron as output layer. Result and analysis state that average accuracy was 99.25% in detecting edible and poisonous mushrooms.

Johaira U.Lidasan, Martina P.Tagacay [5] developed a mobile based application to recognize the mushroom using image processing techniques and Neural Network. This method includes image resizing, image segmentation, Feature Extraction, Normalization, Reorganization, classification. Grab Cut algorithm is used to segment mushroom from background, and then mushroom features are extracted. To recognize the mushroom a probabilistic Neural Network is developed, where in the input layer of each neuron is a normalized extracted feature of mushroom image. Then pattern layer is considered which performs dot product between input and weight, divided by a certain bias, so around 665 neurons form 133 training images and 5 features from each image. Finally summation layer is followed by output layer. Resultant accuracy is stated to be 92%

R F Rahmat et.al [6] to classify the poisonous and nonpoisonous mushrooms in a given input images are taken from UCI Machine Learning Repository. Then adopted various image processing stages,

they are preprocessing with gray scaling image, segmentation with canny edge detection and thresholding, then feature extraction process using zoning method and finally K nearest Neighbor is used to identify the poisonous mushrooms. A total of 40 mushrooms images were considered with 8 different types.

Ismail, Shuhadia, Amy Rosshaida Zainal, and Aida Mustapha [7] considered Mushroom features like shape, color and surface of the cap, stalk and gill, population and habitat and odour. Principal component analysis (PCA) is used as feature selection by sorting and ranking the attributes. Decision Tree (DT) is a classification algorithm in which each node represents a test of its attributes or features. Waikato Environment for Knowledge Analysis (WEKA) is used for classification experiment. Finally, to test the developed method classification accuracy, coefficient metric and processing times taken are used as evaluation metrics.

Agung Wibowo, Y/uri Rahayu, Andi Riuanto, Taufik Hidayatulloh [8] Applied Algorithms Decision Tree (C4.5), Naïve Bayes, support vector machine (SVM) to identify edible mushroom and their performances are compared. Experiments are carried out in Waikato Environment for Knowledge Analysis (WEKA) environment. Mushroom data of lepiota and agaricus are used to conduct experiment. To evaluate the performance of different algorithms, metrics used are correctly classified instances, incorrectly classified instances, kappa statistic, Mean Absolute Error (MEA), Root Mean Squared Error (RMSE), Relative Absolute Error (RAE), Root Relative Squared Error (RRSE). It is stated that results of the experiment of SVM and C4.5 algorithm has the same accuracy level, but C4.5 algorithm has high speed performance compared to SVM.

Lavanya B, G.R. Preethi [9] Applied different decision tree classification algorithms ID3, CART and Hoeffding Tree to classify the edible from

poisonous mushrooms. To compare the performance of the different decision tree algorithms, metrics considered are Tree structure, handling missing data, Method of handling attributes selection, time required for the tree construction, error rate, scalability. Compared to ID3 and CART algorithms, Hoeffding Tree algorithm stated as best performer in terms of accuracy and error rate of mushroom dataset.

III. COMPARATIVE ANALYSIS ON DIFFERENT MUSHROOM CLASSIFICATION METHODS

After survey conducted on the different available and published papers, this section, presents summary and observation on different classification algorithms developed by the researchers. Authors S.K. Verma, M Dutta (2018), Nusrat Jahan Pinky et.al (2019), Eyad Sameh Alkronz et.al (2019), Ismail et.al (2018), Agung Wibowo (2018), Lavanya B, G.R. Preethi (2017) used mushrooms representing data sets from UCI Machine Learning Repository to classify the edible and poisonous mushrooms using their respective developed data mining algorithms. Above reference papers classify artificially generated mushroom data sets and fixed data sets is considered, so proposed results may or may not work for all practical data sets.

Authors Yasemin Rukiye Erhan, Humar Kahramanli Ornek (2019), Johaira U.Lidasan, Martina P.Tagacay (2018), R F Rahmat et.al (2018) used their own collected mushroom images from different sources to classify the edible and poisonous mushrooms using image processing techniques and different machine learning classifiers. Above references used cropped images of mushroom with small back ground and limited images, so it may serve the few consumers in some situations only. Summarized information is given in Table I.

Table 1. Summary on different mushrooms edibility classification methods

Reference	Dataset type and size	Technique used	Extracted features	Observations on results
(S.K. Verma, M Dutta, 2018) [1]	Artificial mushroom data set of Agaricus and Lepiota family from UCI Machine Learning Repository [10]	Artificial Neural Networks(ANN) and Adaptive Nuero Fuzzy inference system (ANFIS), Naïve Bayes	Incorrectly classified instances(ICCI), correctly classified instances(CCI), MAE, Kappa statistic	ANFIS Performance is better than ANN, Naïve Bayes. For ANN algorithm CCI is 96.82%, MAE is .033, Kappa Statistic is .9316

				For ANFIS algorithm CCI is 99.75%, MAE is .0018, Kappa Statistic is .9956, For Naïve Bayes algorithm CCI is 96.817%, MAE is .0333, Kappa Statistic is .9316.
(Nusrat Jahan Pinky, 2019) [2]	Dataset consists of 8124 instances and 22 attributes with 2 possible class levels collected from UCI machine learning repository.	Naive Bayes and dissimilarity measure, Adboost, Decision Tree.	Accuracy	Fixed feature set based models perform better than randomly selected set based models
(Yasemin Rukiye Erhan, et.al, 2019) [3]	Naturally grown 25 species of mushrooms at seluck university campus	Image processing-threshold segmentation, KNN and Naïve Bayes	Accuracy	96% of accuracy is achieved by Naïve Bayes and 80% accuracy by KNN.
(Eyad Sameh Alkronz et.al 2019) [4]	Dataset collected from UCI machine learning repository [10]	Multi-Layer ANN model	Accuracy	99.25% of accuracy is achieved.
(Johaira U. Lidasan, et.al 2018) [5]	133 mushroom images	Grab cut for image segmentation and Probabilistic Neural Network for classification	Accuracy	92% of Accuracy rate is achieved.
(R F Rahmat et.al 2018) [6]	40 mushroom images with 8 types amanita muscaria, floccularia fusca, galerina marginata, cortinarius rubripes, agaricus bisporus, amanita phalloides, volvariella speciosagyromitra esculenta. Mushroomserver.org	Canny edge and thresholding for segmentation, zoning method for feature extraction, KNN to identify the poisonous mushrooms	Accuracy	Average accuracy is 90%
(Ismail et.al 2018) [7]	Dataset collected from UCI machine learning repository [10]	Principal Component Analysis (PCA) for feature selection, Decision Tree for classification	Accuracy, Coefficient Metric and evaluation time, Incorrectly classified instances, correctly classified instances, Kappa statistic, MAE, RMSE, RAE, RRSE.	Claims 100% accuracy
(Agung Wibowo et.al 2018) [8]	Lepiota and Agaricus mushroom data set	Decision Tree(C4.5), Naïve Bayes, Support Vector Machine	Incorrectly classified instances, correctly classified instances, Kappa statistic, MAE, RMSE, RAE, RRSE	Accuracy levels are same for SVM and C4.5, C4.5 is faster than SVM

(Lavanya B, & G.R. Preethi, 2017) [9]	Dataset collected from UCI machine learning repository [10]	Decision Tree algorithms CART and Hoeffding Tree	Accuracy, error rate, Tree structure, Handling missing data, Method of handling attributes selection, time required for the tree construction error rate, Scalability	Accuracy and error rate with Hoeffding Tree algorithm is best compared with ID3 and CART
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IV. CONCLUSION

In this paper different methodical and logical reviews on classification of edible and poisonous mushroom by researchers were compared. Most of these literature papers worked using data set collected from UCI machine learning repository and used Data mining methods to classify mushroom edibility. A very few of the author took their own mushroom images, but of limited in quantity and very few used image processing methods with different machine learning classifiers. This review can be a valuable contribution to develop novel methods to classify the mushrooms edibility using computer aided methods like image processing techniques.

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