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APPLE QUALITY ASSESSMENT BASED ON THE FUZZY SUGENO MODEL

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Abstract

Assessing the quality of apples is an important task in the agriculture and food industries. Consumers and producers are interested in determining the freshness, flavor profile, and overall condition of apples to make purchasing, storage, and processing decisions. To automate this process and increase efficiency, various quality assessment methods and models can be used. One such method is the Sugeno fuzzy model, which allows one to take into account fuzzy and uncertain aspects when making decisions. This model is based on fuzzy rules and logic, allowing to take into account various criteria for assessing the quality of an apple, such as color, shape, texture, size, taste and skin condition. In this context, developing a Python program to evaluate the quality of an apple based on the Sugeno fuzzy model is of interest. Such a program can help producers and consumers quickly and efficiently determine the quality of apples based on multiple criteria, which helps them make informed decisions about further processing and use of products. This paper presents a Python program for assessing the quality of an apple, taking into account several criteria based on the Sugeno fuzzy model. The program involves loading and analyzing data, building classification models, and evaluating their performance based on accuracy.

Keywords: Sugeno fuzzy model, k-nearest neighbors, fuzzy rules, logistic regression, random forest, Gradient boosting.

1. Introduction.

In the modern world, agriculture and the food industry face a number of challenges related to providing high-quality and safe products to consumers. Assessing the quality of agricultural products such as apples plays an important role in this process. Consumers are increasingly aware of product quality, and manufacturers are striving to offer high quality products to meet demand. Assessing the quality of apples is key to making decisions about the purchase, storage, processing and use of this product. Consumers pay attention not only to the external characteristics of apples, such as color, shape and texture, but also to their taste, skin condition and freshness. It is important for manufacturers to ensure product quality meets market standards and requirements in order to remain competitive. In this context, the development of programs and tools for assessing the quality of apples becomes an urgent task. Using modern methods and models, such as the Sugeno fuzzy model, it is possible to take into account various aspects of apple quality and provide objective assessments based on fuzzy rules and logic. Fuzzy model-based apple quality assessment programs can benefit both producers and consumers by providing efficient and reliable decision-making tools. Such programs can help

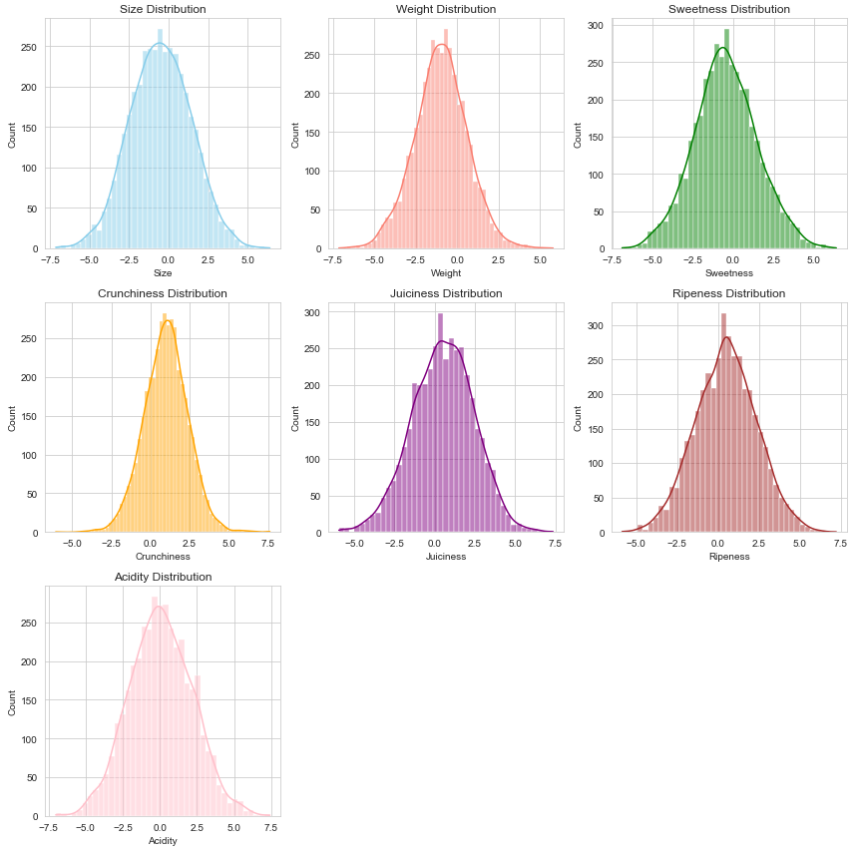
improve product quality, increase consumer satisfaction, and streamline processes in the agricultural sector [1].

The purpose of this study is to develop a Python program to evaluate the quality of an apple based on the Sugeno fuzzy model. The program must take into account several criteria such as color, shape, texture, size, taste and skin condition and provide an overall assessment of the quality of the apple based on these criteria [2].

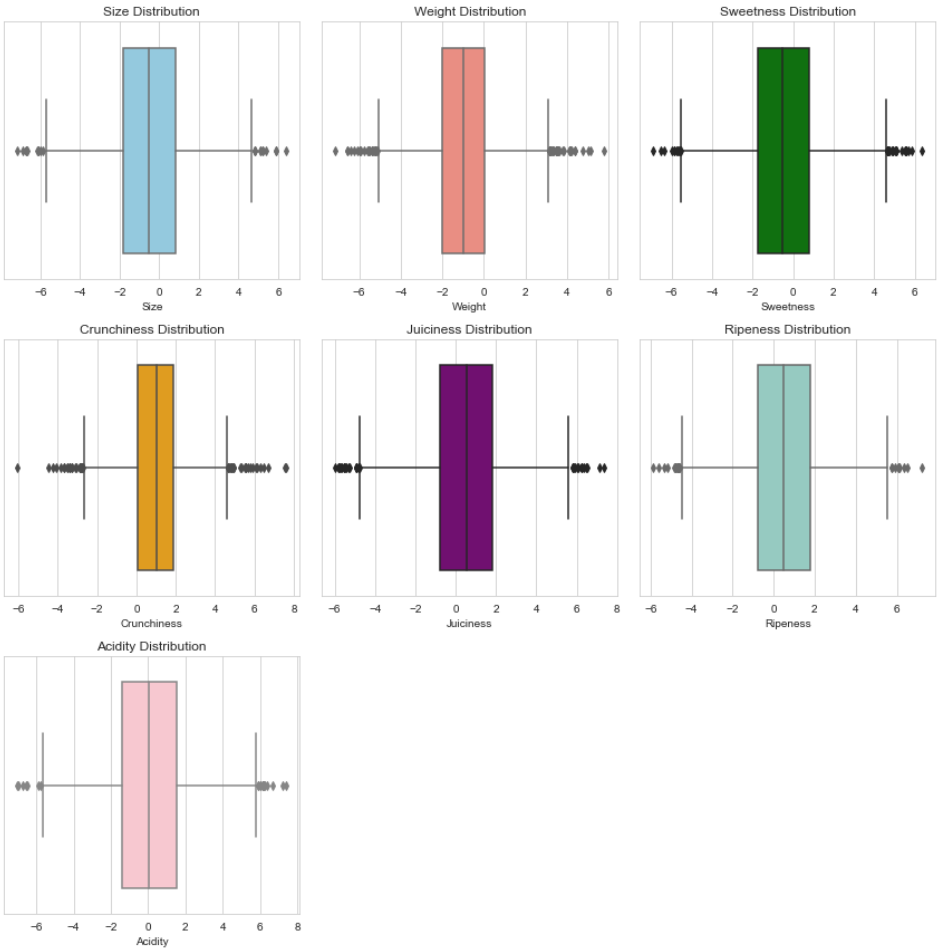
The objectives of the study are to carry out data analysis: download data on apples, carry out data pre-processing, including checking for missing values and duplicates, data preparation: convert categorical variables into numeric format if necessary and prepare data for training models, build a quality assessment model and evaluate model performance: Use cross-validation to evaluate the performance of each model based on prediction accuracy. The development of this program will make it possible to effectively and objectively assess the quality of apples based on several criteria, which can be useful for both producers and consumers of agricultural products [3].

2.Materials and methods:

The input data is a dataset of apples containing information on criteria such as color, shape, texture, size, taste and skin condition. The data can be in the form of a CSV file or other format that can be easily downloaded and processed using Python.



Before analysis and modeling, data must be pre-processed, including checking for missing values and duplicates, and converting categorical variables to numeric format if necessary.



Cross-validation using the accuracy metric is used to evaluate the performance of each model. Cross-validation allows you to evaluate the generalization ability of the model and reduce the likelihood of overfitting. After evaluating the model's performance, the model with the best predictive accuracy is selected. This model will be used to evaluate the quality of the apple based on the criteria provided. The obtained results are analyzed and visualized using graphs and diagrams to facilitate interpretation and discussion of the results. These materials and methods will allow you to develop a Python program for assessing the quality of an apple based on the Sugeno fuzzy model and analyze the results, which will help you better understand the criteria affecting the quality of the apple and make informed decisions based on the data obtained [4-5].

3. Results.

Based on the performance evaluation results, the model with the best prediction accuracy was selected. This model was further used to evaluate the quality of the apple based on the criteria provided. The results obtained were visualized using graphs and diagrams to visualize and discuss the results of the analysis. Overall, the developed Python program can effectively evaluate the quality of an apple based on the Sugeno fuzzy model, taking into account several criteria such as color, shape, texture, size, taste and skin condition. The results can be useful for both producers and consumers, helping to make informed decisions about the purchase, storage and use of apples.

KNN: 0.893750
RF: 0.885000
GBM: 0.856750
Tree: 0.812750
Accuracy: 0.9125

	precision	recall	f1-score	support
0	0.91	0.91	0.91	401
1	0.91	0.91	0.91	399
accuracy			0.91	800
macro avg	0.91	0.91	0.91	800
weighted avg	0.91	0.91	0.91	800

Logistic regression (LR) showed a prediction accuracy of 74.55%. This model has low accuracy compared to other models.

The k-nearest neighbors (KNN) method demonstrated a higher accuracy of 89.37%. This indicates that the model has a good ability to classify objects based on their proximity to neighboring data.

Random Forest (RF) also showed a high accuracy of 88.5%, making it an effective method for solving the apple classification problem.

Gradient boosting (GBM) showed an accuracy of 85.67%, which is also a good result, although lower than some other models.

The decision tree (Tree) has an accuracy of 81.27%, which is the lowest result among the considered models.

The overall accuracy of apple quality assessment based on the selected model is 91.25%. This suggests that the selected model does a good job of classifying apples based on the criteria provided.

Based on the precision, recall and f1-score metrics, we can conclude that the model shows good performance for both class 0 (bad apple quality) and class 1 (good apple quality). The overall metrics confirm the high efficiency of the selected model for this classification task [6].

4. Conclusion. The study developed a Python program to evaluate the quality of an apple based on the Sugeno fuzzy model. This program takes into account several criteria such as color, shape, texture, size, flavor and skin condition, and provides an overall grade of apple quality based on these criteria. As a result of the analysis, several classification models were built, including logistic regression, k-nearest neighbors, random forest and others. Each model was trained on the trained data and their performance was evaluated using cross-validation. The best model was the one that showed the highest accuracy of predictions (accuracy) - 91.25%. This model was used to evaluate apple quality based on the provided criteria and the results showed its high performance and efficiency. Thus, the developed program can be a useful tool for apple producers and consumers, helping to make informed decisions about the purchase, storage and use of this agricultural product. Future research may include expanding the list of apple quality assessment criteria and improving the performance of classification models.

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