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Classification of Pistachio Images Using VGG16 and VGG19 Deep Learning Models

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Abstract

The value of the economy provided by pistachios to the countries where they are grown is increasing day by day. From this point of view, the importance of correct classification of pistachios is known. The more accurately the harvested pistachios are classified, the better the monetary return value. In this study, two different classes of pistachios were classified using VGG16 and VGG19 deep learning architectures. There are 2148 pieces of Kirmizi and Siirt Pistachio in the dataset. Experimental studies were carried out with 5-fold crossvalidation. As a result of the experimental studies, the Accuracy value of 0.802117 and the F1-measure value of 0.830593 were obtained from the average of 5 folds from the VGG16 deep learning model. Likewise, the Accuracy value of 0.779404 and the F-measure value as 0.779404 were obtained from the average of 5 folds from the VGG19 deep learning model.

Keywords: "Pistachio, deep learning, VGG16, VGG19."

1. Introduction

In order to increase the market value of pistachios, there is a need for automatic sorting and classification. Therefore, new techniques and technologies should be used to increase the yield of the product with high economic value [1]. Different studies have been carried out in the literature on pistachios. There is more interest in Kirmizi and Siirt pistachio varieties because of their higher economic value [2]. Pistachio is grown in many countries today, and the countries where it is grown form a very common trade network. In addition, it is stated that pistachios affect health positively [3,4]. Casasent et al. reported that they achieved 88% success in determining the quality of the performed classification of pistachios products [5]. Abbaszadeh et al. in their study, a classification accuracy of 80.3% was obtained by using deep neural networks to classify pistachios [6]. Rahimzadeh and Attar reported that they achieved average classification success of 85.28%, 85.19% and 83.32%, respectively, by using CNN-based ResNet50, ResNet152 and VGG16 models to identify different peanut species [7]. Likewise, different artificial intelligence techniques have been used for different fruit classification in the literature. art. Tarek Habib et al. Studies have been carried out on the automatic detection of diseases in jack fruit. They used 9 different classification algorithms and 7 performance metrics during classification. As a result of the tests performed on a total of 480 images, they achieved the best result of 89.59% [8]. Eduardo Assunçao et al. used 313 images and MobileNet-V2 network to detect diseases on peach in their study. As a result, the F1 score was 0.96 [9]. Juan et al. In this study, the usability of deep learning in characterizing cherries was investigated. In this study, the authors performed cherry detection and classification of detected cherries with Faster R-CNN and 85% accuracy was achieved [10]. Vasumathi et al. presented their approach to classify pomegranate fruits by combining two different deep learning methods in their study. There are 6519 pomegranate pictures in the dataset used in this study. The pomegranate pictures were divided into normal and abnormal, reaching an accuracy of 98.17% [11].

The aim of this study is to classify images of pistachios using deep learning models VGG16 and VGG19.

2. Material and Methods

In this study, deep learning models VGG16 and VGG19 were used for the classification of pistachios. In experimental studies, 5-fold crossvalidation was performed.

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The VGG16 architecture consists of 13 convolutions and 3 fully connected layers used to achieve better results in the ImageNet 2014 competition [12]. There are 41 layers in total, with MaxPooling, FullyConnectedLayer, ReLULayer, DropOutLayer and SoftmaxLayer layers. The image to be included in the input layer is 224x224x3. The last layer is the classification layer [13]. The architecture of the VGG16 deep learning model is shown in the Figure 1. [14].

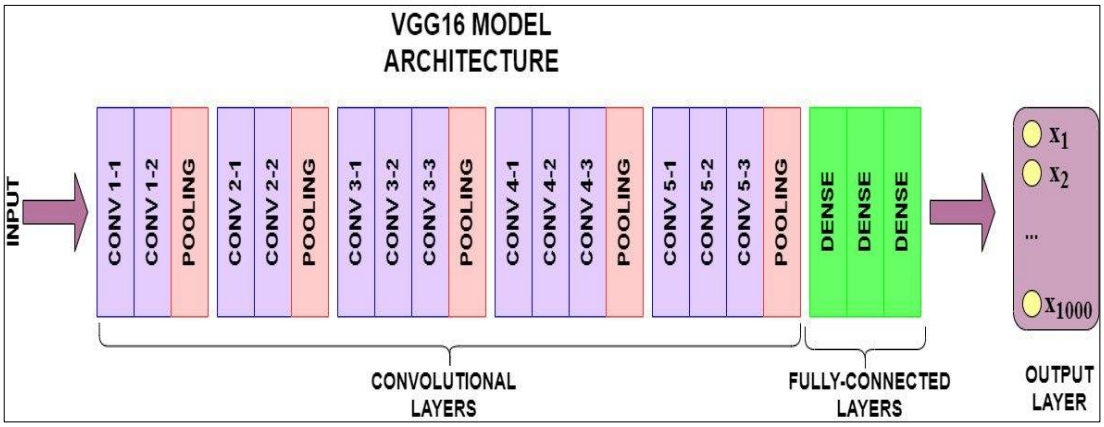


Figure 1. Structure of the VGG16 architecture

VGG19, the name of VGG19 comes from the group called "Visual Geometry Group" at Oxford University. The expression 19 indicates the number of layers. VGG19 includes 16 convolution, 3 fully connected layers, 5 MaxPools and 1 SoftMax layer [15]. The architectural structure of the VGG19 deep learning model is shown in Figure 2. [16].

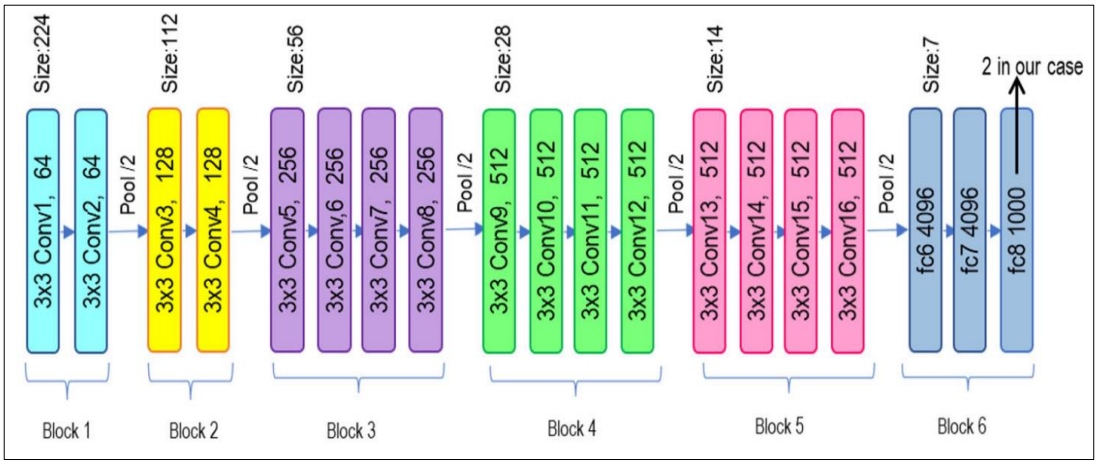
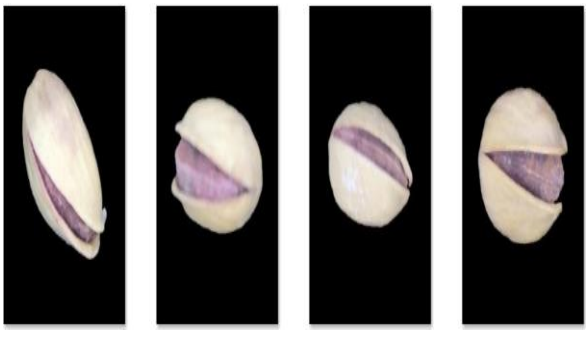


Figure 2. Structure of the VGG19 architecture

Example images of pistachio cultivars used in the database are shown in Table 1. [17, 18].

Table 1. Views of pistachio varieties

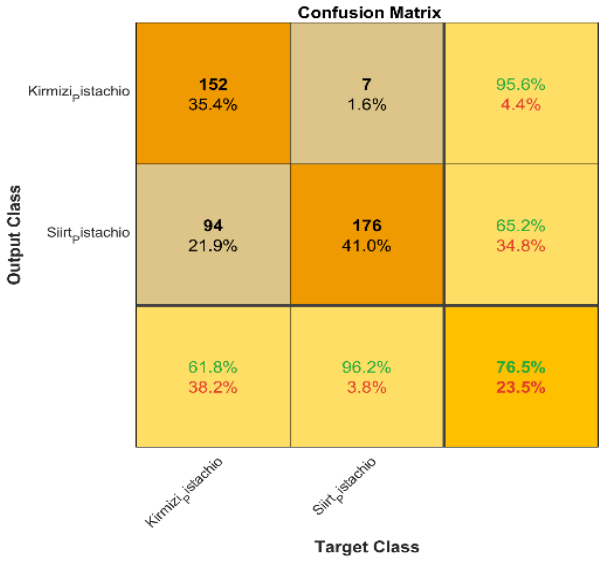
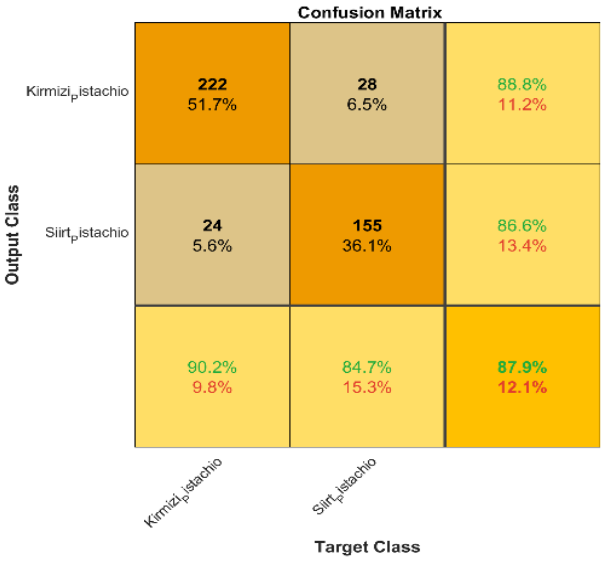
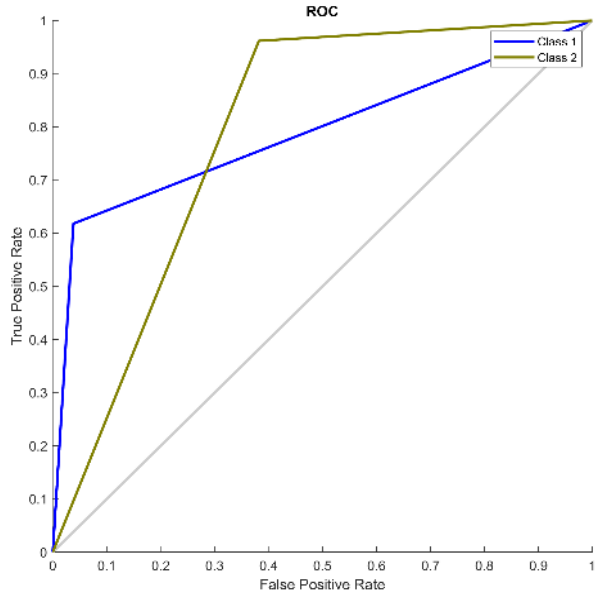
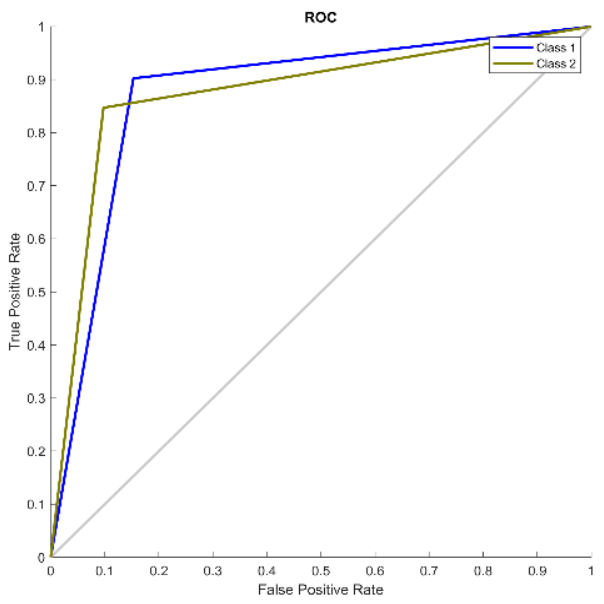
Kirmizi	Siirt
	

When we look at Table 1, it is seen that the shells of Siirt pistachios are more open.

3. Experimental Results and Discussions

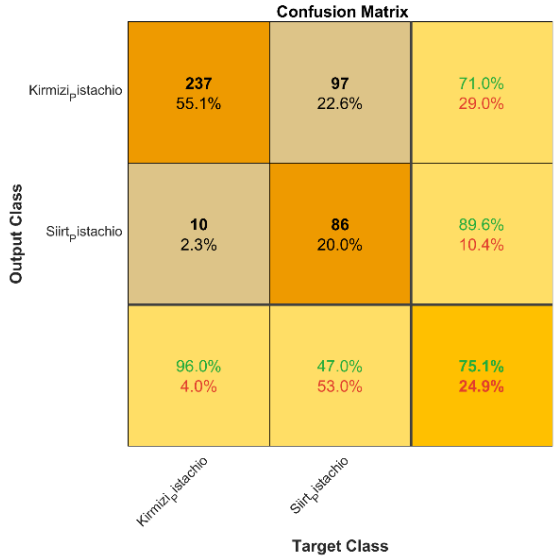
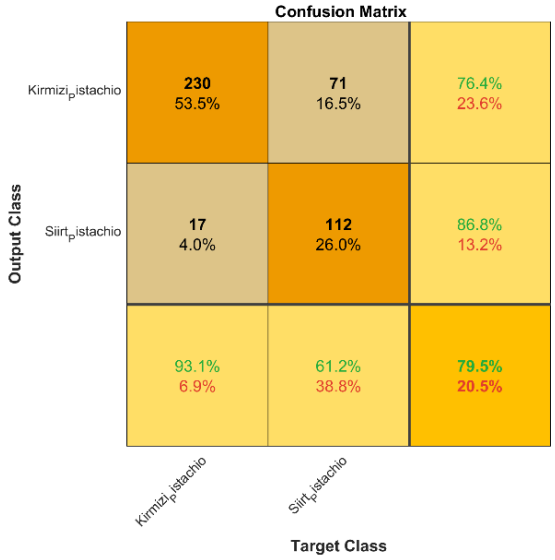
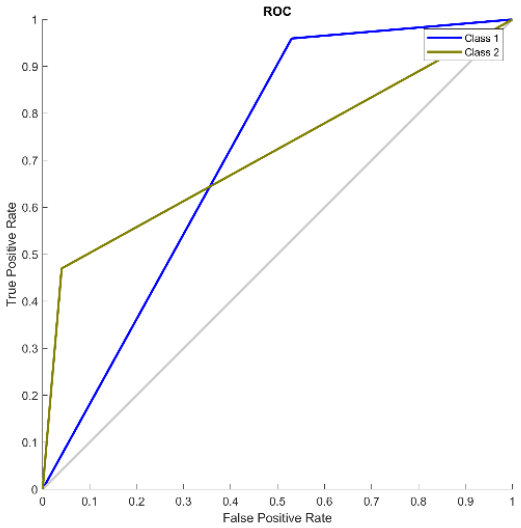
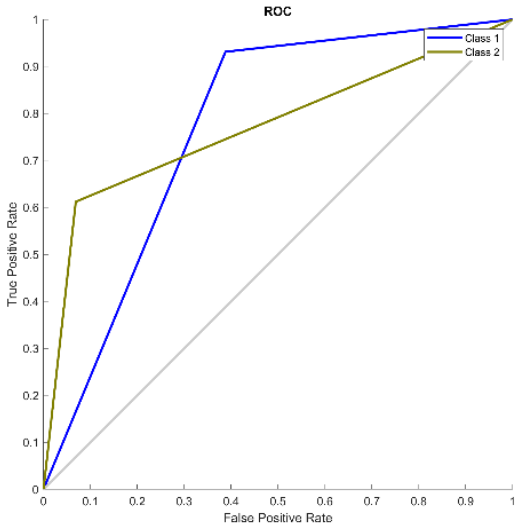
In this study, experimental studies on the database were tested statistically. CM results obtained from Fold 1 using VGG16 and VGG19 deep learning architecture are shown in Table 2.

Table 2. VGG16 and VGG19 1. Fold CM results

VGG16	VGG19
	
	

When we look at Table 2 for Fold 1, we see that VGG19 gives better results with a rate of 87.9%. %. CM results obtained from Fold 2 using VGG16 and VGG19 deep learning architecture are shown in Table 3.

Table 3. VGG16 and VGG19 2. Fold CM results

VGG16	VGG19
	
	

When we look at Table 3 for Fold 2, we see that VGG19 gives better results with a rate of 79.5%. CM results obtained from Fold 3 using VGG16 and VGG19 deep learning architecture are shown in Table 4.

When we look at Table 4 for Fold 3, we see that VGG16 gives better results with a rate of 85.1%. CM results obtained from Fold 4 using VGG16 and VGG19 deep learning architecture are shown in Table 5.

When we look at Table 5 for Fold 4, we see that VGG16 gives better results with a rate of 85.6%. CM results obtained from Fold 5 using VGG16 and VGG19 deep learning architecture are shown in Table 6.

When we look at Table 6 for Fold 5, we see that VGG19 gives better results with a rate of 83.9%. CM results obtained from the average of 5 folds using VGG16 deep learning architecture Table 7. was also shown.

When we examine Table 7., it is seen that the average accuracy value for 5 folds was obtained as 0.802117 for both pistachio cultivars. It is seen that the highest F-measure value was obtained from the Kirmizi pistachio variety as 0.830593.

Table 4. VGG16 and VGG19 3. Fold CM results

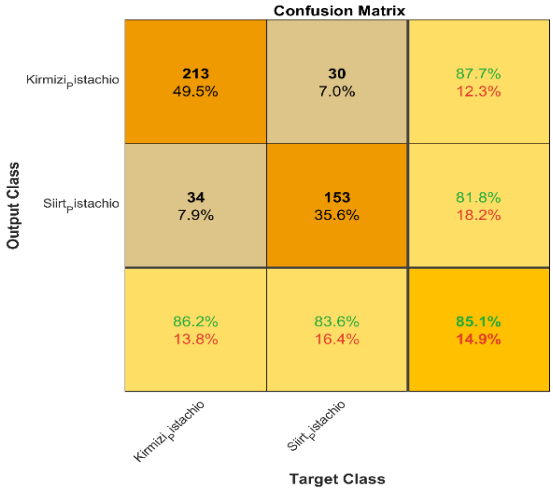
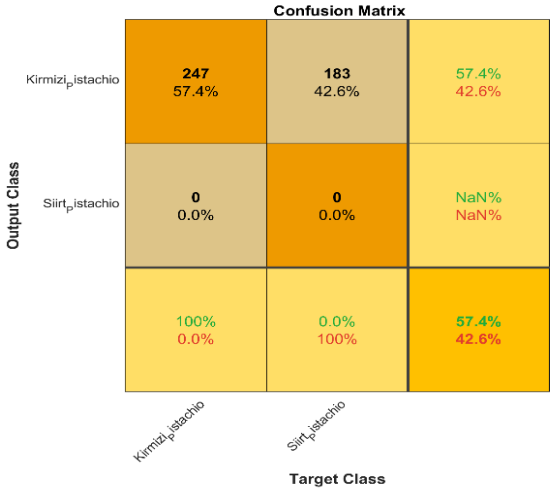
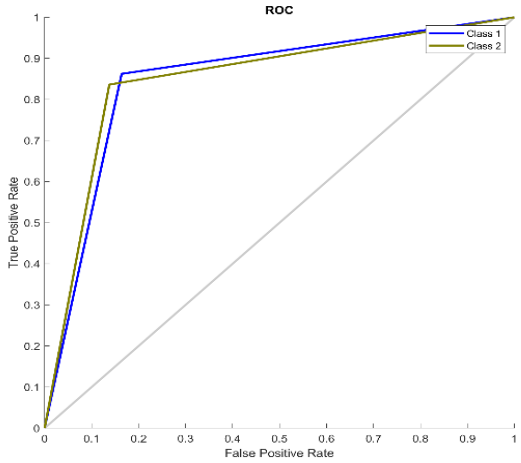
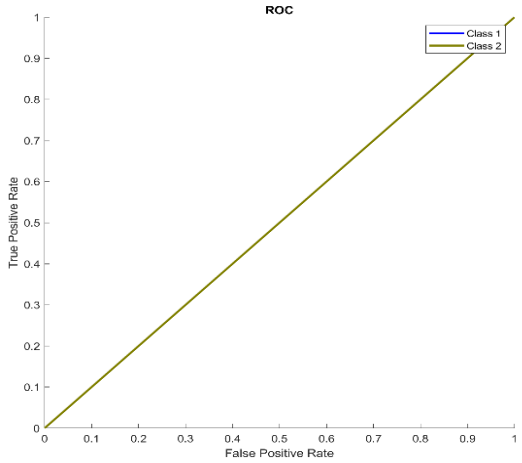
VGG16	VGG19
	
	

Table 5. VGG16 and VGG19 4. Fold CM results

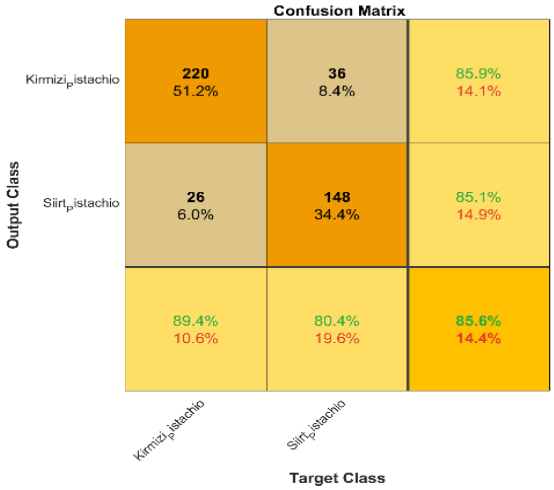
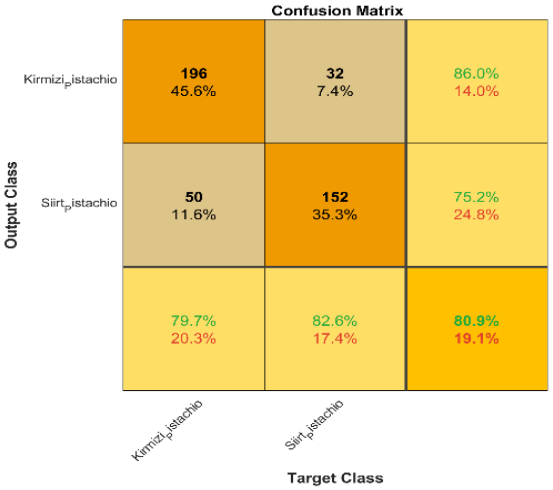
VGG16	VGG19
	

Table 5. VGG16 and VGG19 4. Fold CM results (continue)

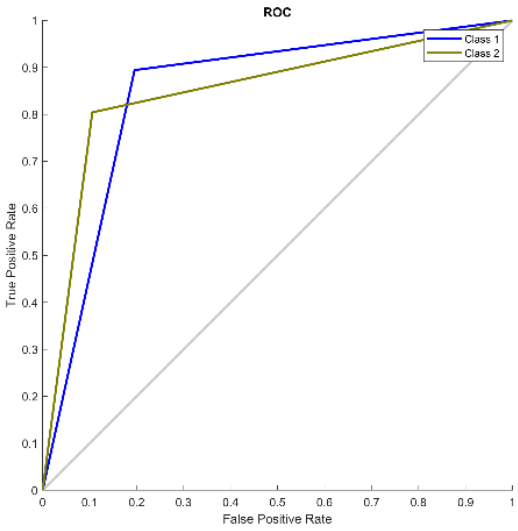
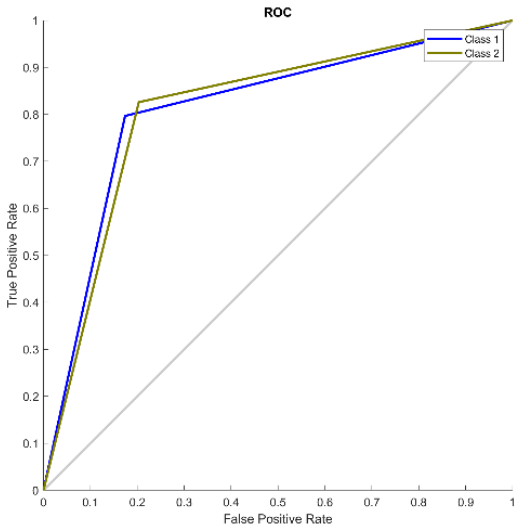
	

Table 6. VGG16 and VGG19 5. Fold CM results

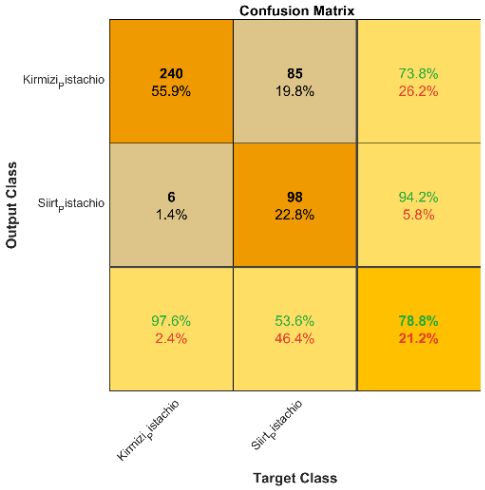
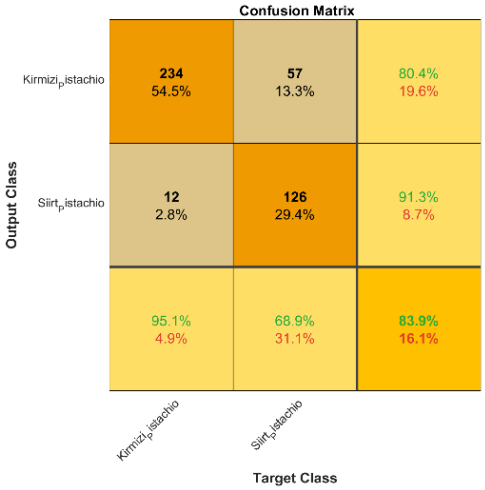
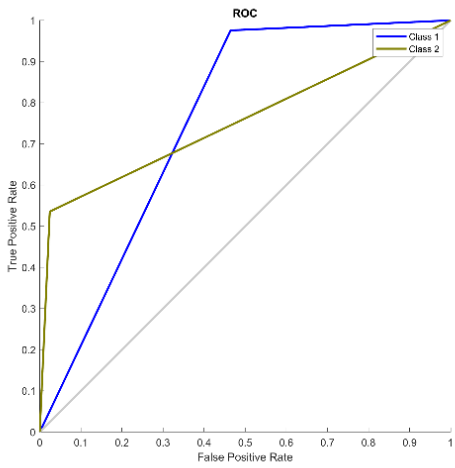
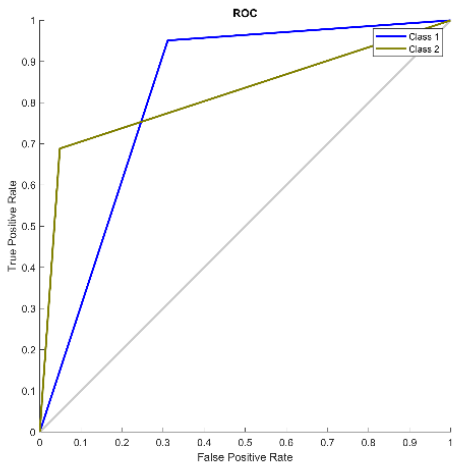
VGG16	VGG19
	
	

Table 7. VGG16 5 Fold AVG CM results

	Kirmizi	Siirt
precision	0.827987	0.83175
sensitivity	0.861933	0.721525
specificity	0.721525	0.861933
accuracy	0.802117	0.802117
F-measure	0.830593	0.74606

Table 8. VGG19 5 Fold AVG CM results

	Kirmizi	Siirt
precision	0.778062	0.849914
sensitivity	0.916316	0.594726
specificity	0.594726	0.916316
accuracy	0.779404	0.779404
F-measure	0.832556	0.786728

CM results obtained from the average of 5 folds using VGG19 deep learning architecture are shown in Table 8.

When we examine the Table 8., it is seen that the average accuracy value for 5 folds is obtained as 0.779404 for both pistachio varieties. It is seen that the highest F-measure value was obtained from the Kirmizi pistachio variety as 0.832556.

4. Conclusions and Future Works

Pistachio is a product with a specific market in different countries. Together with this market network, it appears as a food with a significant economic return. For this reason, the correct classification of pistachios will further increase the contribution to the economy. In this study, two pistachio types, called Kirmizi and Siirt, were classified using VGG16- and VGG19 deep learning models. While the sensitivity value was obtained as 0.861933 for the Kirmizi pistachio variety with the VGG16 model, it was obtained as 0.916316 for the VGG19 model. Similarly, with the VGG16 model, the specificity value was obtained as 0.861933 for the Siirt pistachio variety, while it was obtained as 0.916316 for the VGG19 model. Experimental studies can be carried out with different models in future studies. In addition, some preprocessing can be performed on images.

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