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Accurate Detection and Classification of Melanoma Skin Cancer Using Decision Tree Algorithm over CNN

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Abstract: The study's primary purpose is to propose an automatic melanoma cancer detection system using the Decision Tree algorithm and convolutional neural network algorithm to detect melanoma cancer and compare their accuracy. Group 1 was the Decision Tree algorithm with a sample size of 10, and Group 2 was a convolutional neural network algorithm with a sample size of 10. They were iterated 20 times to predict the accuracy percentage of identifying melanoma cancer. Compared to convolutional neural network accuracy(75.58 %), the Decision Tree method has substantially higher accuracy (85.61%). The Decision Tree $p=0.018$ ($p<0.05$) Independent Sample T-test has a high statistical significance. Within the scope of this study, the Decision Tree method outperforms convolutional neural networks in melanoma skin cancer detection.

Keywords. Decision Tree algorithm, Convolutional Neural Network, Novel Melanoma Skin Cancer Detection, Melanoma Cancer, Non-Melanoma Cancer, Machine Learning, Accuracy.

1. Introduction

Melanoma is a skin cancer disease that develops a pigment by producing cells. Since the end of 2015, there has been a rise in Melanoma Cancer cases, resulting in 3.1 million active cases and 59,800 deaths [1]. This study can be used in many applications like abnormalities identification in the various portions of the skin and other similar kinds of problems such as different skin cancer detection, pneumonia detection, plant disease detection, and skin disease detection using sample images [2–4].

The ability to diagnose Melanoma using sample skin photos is restricted. As a result, photos of chest skin samples are used to diagnose Melanoma automatically. Because it is a cost-efficient and effective method for detecting skin cancer [7]. Melanoma skin cancer detection has been the subject of three studies published in ScienceDirect, 146 papers in Google Scholar, and 71 articles in IEEExplore. [8] proposed an automatic melanoma cancer detection system with different CNN architectures, and machine learning classifiers are used to detect melanoma [8, 9]. To

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classify the data, they utilized machine learning methods. As a result, the precision attained is minimal [10].

Using sample skin images for the detection of Melanoma is limited. So, chest skin sample images are used for automatic Melanoma detection. Since it is cost-effective and a promising approach for skin cancer detection [5]. To identify a melanoma,[6] suggested an autonomous melanoma cancer detection system using several CNN architectures and machine learning classifiers[7]. They used only machine learning algorithms to classify the input. So, the accuracy obtained is low [8]. The main aim of this study is to detect melanoma skin cancer by using the Decision Tree Algorithm and convolutional neural network (CNN) algorithm to compare their accuracy.

2. Materials and Methods

The suggested model was tested in the DBMS Lab, Department of Computer Science and Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Chennai. There were two groups identified: one was a Decision Tree Algorithm, and the other was a Convolutional Neural Network Algorithm. The sample size obtained for Group 1 was 28%, whereas the sample size obtained for Group 2 was 28%. The g power calculation calculates the needed samples for this problem[9]. The analyses' minimum power is 0.8, while the maximum allowed error is 0.5.

The data set was collected from kaggle.com. The data set incorporates 1850 images of Melanoma and non-Melanoma images. After the data preprocessing, the data set is updated to 1300 images, where 800 images are Melanoma, and 700 are non-Melanoma images. The images were of different dimensions, and they are resized to 244x244.

2.1. Decision Tree

Decision Trees are a kind of supervised machine learning in which data is separated regularly based on a parameter (you explain what the input is and what the related output is in the training data). The tree may be described using two entities: decision nodes and leaves.

2.2. Conventional Neural Network

A convolutional neural network is a deep learning model. CNN is an image classification technique. It takes an image as an input and processes it under certain classifications and categories. It took the image's height, width, and resolution as categories. CNN trains and tests each piece of information and sends it through several convolutional layers with filters. Figure 1 illustrates the architecture of the Convolution Neural Network.

Google CoLab and Jupyter notebook using Python programming language was used to test the Decision Tree algorithm (IDE) and Convolutional Neural Network (CNN) algorithm. The system setup included an Intel Core i5 CPU and 8GB RAM. The machine had a 64-bit operating system, X64-based CPU, and a 917-GB hard drive. The working system Windows 10 is included in the software configuration

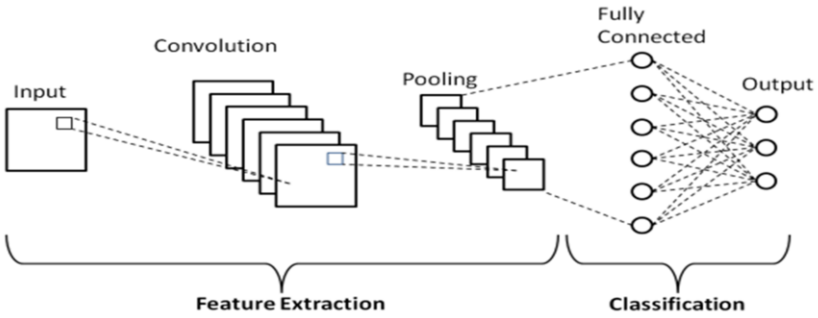

Figure1. Convolution Neural Network Architecture

The proposed model first performs the data preprocessing on the melanoma images and prepares the data. After that, use Decision Tree for feature extraction. Later split the data and applied it to image recognition algorithms, Decision Tree algorithms, and Convolutional Neural Network algorithms by devoting 70 percent of data for training and 30 percent for testing next performing evaluation metrics to understand the performance of the novel melanoma skin cancer detection models.

IBM SPSS version 21 was used for the analysis. It's a type of statistical software that's used to analyze data. For both proposed and current algorithms, ten iterations with a maximum of 10-20 samples were performed, and the projected accuracy for each iteration was recorded for accuracy analysis. Date, location, and disease name are independent variables in this study because they are inputs and remain constant even when other parameters are changed. In contrast, image pixels, color, and size are dependent variables because they depend on the inputs and vary with each change in the information. The study effort is analyzed utilizing the Independent T-Test, which compares the Decision Tree and Convolutional Neural Networks algorithms for detecting melanoma malignancy.

3. Results

Sample test data to show the melanoma without skin cancer images and with skin cancer were given in Figure2 and Figure3, respectively. Accuracy, loss and validation loss, and validation accuracy comparison of the testing data wereprovided in Figure 2. Results of novel melanoma skin cancer detection show the prediction of the melanoma in Figure 3.

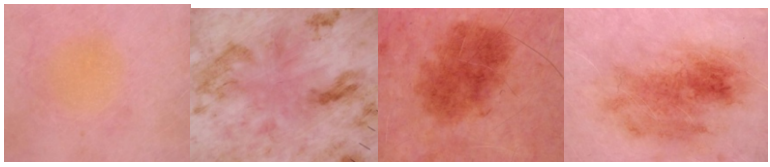

Figure2. Sample Images without Melanoma Skin cancer

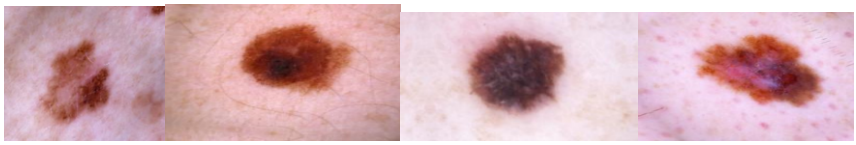

Figure 3. Sample Images with Melanoma Skin cancer

The results reveal that the Conventional Neural Network method outperformed the decision tree approach in terms of importance. Finally, the suggested classifier was found to be 85.61 percent accurate. As shown in **Table 1**.

Table 1. Accuracy and precision % of Decision Tree algorithm and CNN algorithm for 10 iterations.

ITERATIONS	ACCURACY(%)		PRECISION(%)	
	Decision Tree	Conventional Neural Network	Decision Tree	Conventional Neural Network
1	85.9	73.58	84.56	70.12
2	84.89	72.15	83.06	69.25
3	83.54	73.89	82.94	69.92
4	83.96	72.46	81.78	70.25
5	80.12	73.65	84.76	70.15
6	80.05	73.05	83.49	69.63
7	80.26	72.54	84.25	68.97
8	81.43	71.97	83.49	69.26
9	84.26	72.56	81.58	69.56
10	82.49	71.23	83.25	69.82

The model can accurately predict the detection of new melanoma skin cancers. Calculated accuracy and precision percentage of the decision tree algorithm and CNN were given in the **Table 2**.

Table 2. Predicted accuracy to detect Melanoma skin cancer

Algorithm	Accuracy	F1 score	Recall	Precision
Decision Tree	85.61%	82.4%	85%	79.4%
Conventional Neural Network	75.58%	72.56%	75.4%	70.5%

Table 3 illustrates the mean, standard deviation, and standard error mean of the decision tree algorithm-based novel melanoma skin cancer detection and convolutional neural network algorithm-based novel melanoma skin cancer detection. Std.Deviation 0.3966 with a sample size of N=10 and an accuracy mean of 75.58 percent for the convolutional neural network, Std. With a standard deviation of 0.73919 for a sample size of N=10, the statistical significance of the decision tree approach is vital.

Table 3. Independent sample T-test result

		F	Sig.	t	df	Sig. (2-tailed)	Mean diff.	Std. Error diff.	Lower	Upper
Accuracy	Equal Variance assumed	.623	.018	15.49	18	.000	9.357	.60371	8.088	10.625
	Equal Variance not assumed			15.49	17.02	.000	9.357	.60371	8.083	10.630

The independent Sample T-Test between convolutional neural network-based novel melanoma skin cancer detection and decision tree algorithm-based melanoma skin cancer detection was tabulated in Table 3, which shows a significant difference between the two groups since $p<0.018$ gave the comparison of Accuracy between the decision tree as 85.61% and CNN as 75.58% for ten iterations were given. Figure 4 illustrates the Bar graph of the mean accuracy of a convolutional neural network algorithm based on novel melanoma skin cancer detection and a decision tree algorithm based on novel melanoma skin cancer detection.

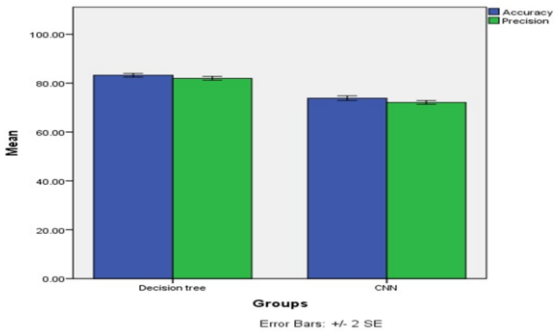

Figure 4. Comparison of CNN algorithm and decision tree algorithm in terms of mean accuracy and precision.

4. Discussion

The particle swarm optimization approach looks more accurate than the convolutional neural network. [10] et al. used convolutional neural network classifiers to identify melanoma skin cancer and achieved a 60 percent accuracy rate. [11] described how they employed an ensemble deep learning model to identify melanoma skin cancer.

Computational cost, picture quality, and dataset size influence melanoma skin cancer diagnosis. The model's capacity to recognize images relies entirely on the picture and its properties; smaller datasets with fewer class labels perform better in terms of convergence. [12] took 200 melanoma samples and 300 non-melanoma samples. The accuracy of this study was 65 percent to decision tree algorithms, and CNN classifiers [13] [12] gathered this dataset's melanoma data from various sources. The characteristics of the produced picture data may change from image to image [14] [15], resulting in various image quality. As a result, the radiographic pictures gathered should be identical, and preserving uniformity is critical for efficient analysis and consistency.

The accuracy measurement on more extensive data sets cannot produce a better result due to restrictions such as threshold, precision, and recall. Furthermore, convolutional neural networks tend to have a more significant mean error than the random forest approach. It would be preferable if we could lower the mean error somewhat. However, by employing optimization algorithm approaches, the task may improve accuracy and mean error. Feature selection methods can be utilized before classification to increase the classification accuracy of classifiers. As a result, feature selection methods are used to minimize computation time and increase classifier classification accuracy.

5. Conclusion

Based on the obtained results, the Decision Tree provides 85.61% accuracy compared to the Conventional Neural Network, which results in 75.58% accuracy. In this work, the Decision Tree proved with better accuracy than the Conventional Neural Network.

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