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Using Deep Learning to Classify Corn Diseases

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Abstract: *A corn crop typically refers to a large-scale cultivation of corn (also known as maize) for commercial purposes such as food production, animal feed, and industrial uses. Corn is one of the most widely grown crops in the world, and it is a major staple food for many cultures. Corn crops are grown in various regions of the world with different climates, soil types, and farming practices. In the United States, for example, the Midwest is known as the "Corn Belt" due to its extensive corn production. Corn crops can be grown using a variety of methods, including conventional tillage, no-till farming, and the use of genetically modified crops. Due to its importance, there is a need for discovering the corn diseases and treating them. The aim of this study is to propose a deep learning model for the classification of corn leaf diseases based on Convolutional Neural Network. A model for classifying maize diseases was developed using a dataset for classifying Corn diseases that contains 4 classes of disease. The dataset was collected from Keggel website. The proposed model was trained, validated, and tested. The F1-score (99.83%), Recall (99.83%), precision (99.83%), Accuracy (99.83%).*

Keyword: Corn, Deep Learning, Classification, RegNetY320

1. INTRODUCTION

Corn, also known as maize, is a grain crop that is native to the Americas. It is one of the most widely grown and widely consumed crops in the world, and it is a staple food in many countries. Corn is a highly versatile crop, and it is used for a variety of purposes, including human consumption, livestock feed, and biofuels. Corn is a cereal grain that is typically yellow, but it can also be white, red, or purple. It is a good source of vitamins, minerals, and carbohydrates, and it is relatively cheap and easy to grow [1].

Corn and maize are basic ingredients in many regions across the world. The ears can be roasted and eaten as a vegetable right from the cob, or the kernels can be extracted and used to make a range of meals, including cereals and flour. Maize is also a significant source of starch, which can be converted into oils and high-fructose corn syrup [2].

All of this makes maize and cornmeal very important ingredients, therefore it's understandable why one would want to keep them free of illnesses like Common Rust, Ray Leaf Spot, and Blight. These diseases are a major source of concern for maize and corn growers in Asia, Africa, and the Americas. Plant age, pathogen species, and environment all play a role in symptom expression.

The diseases are more common in humid, warm climates. As a result, early detection of these diseases is critical in order to mitigate the harm. Corn is usually grown in large quantities on farms, and it is harvested and processed in various ways depending on its intended use.

There are several diseases that can affect corn plants, including [3]:

- Corn smut: This is a fungal disease that causes large, black galls to form on the ears and stalks of the corn plant.
- Corn rust: This is a fungal disease that causes reddish-brown pustules to form on the leaves and stalks of the corn plant.
- Corn leaf blight: This is a fungal disease that causes brown or tan lesions to form on the leaves of the corn plant.
- Corn mosaic virus: This viral disease causes the leaves of the corn plant to become mottled or distorted, and it can reduce the yield of the crop.
- Corn stunt: This bacterial disease causes the plant to become stunted and the ears of corn to be small and deformed.

To prevent or control these diseases, farmers can use resistant varieties of corn, practice good hygiene and crop rotation, and use fungicides and insecticides as needed.

By looking at deep learning and convolutional neural networks (CNN), we find that this technique has proven its efficiency in many common diseases of many plants in the classification of diseases related to them[4]-[6], although a person can classify these diseases manually and with the naked eye, but let us take into account that not all humans can distinguish and classify diseases related to plants or fruits, as it takes a lot of time, effort, and sometimes cost, and given that a person usually always searches for comfort in time and effort, we will find that a person goes to technology, and from here came the many technologies that facilitate human life and make it better compared to normal traditional life, and therefore we will focus our focus on deep learning in general and on convolutional neural networks in particular that fall under the heading of deep learning in classifying things by teaching them in the right ways and with continuous and repeated training until they give final accurate results [15]-[20].

A model for classifying maize diseases was developed using a dataset for classifying Corn that contains 4 classes.

2. RELATED WORK

There are a number of previous studies that deals with corn diseases. Most studies used customized Convolutional Neural Network (CNN) as a model for the classification of Corn diseases. Each study uses different dataset with different number of classes in each dataset. Some of the studies used more than one method in the same study to classify the corn diseases [2], [7], [9], [10]. The number of classes in the datasets are the same in the studies [1], [12]-[14]. The metric used in the previous studies are accuracy, F1-score, Recall, and Precision. The F1-score accuracy in the previous studies ranged from 93.00% to 99.00%. Table 1 summarizes the previous studies in terms of number of images in that dataset, number of classes in the dataset, methods used, and best F1-score accuracy attained.

Table 1 summarizes the previous studies

Reference	# of images	# of classes	Approach used	Best F1-score accuracy
[1]	800	4	CNN	95.86%
[2]	500	9	GoogleNet	98.90%
[2]	500	9	Cifar10	98.80%
[3]	1796	15	CNN	96.70%
[7]	50,000	5	KNN	96.17%
[7]	50,000	5	CNN	93.01%
[8]	720	2	Iterative method	94.70%
[9]	3852	4	10 CNN models	98.60%
[10]	18,888	4	4 CNN models	99.00 %
[11]	4188	4	CNN	93.00%
[12]	3823	4	Customized CNN	98.78%
[13]	15,408	4	DenseNet121	98.56%
[14]	17,600	4	Customized AlexNet	93.28%

3. STUDY OBJECTIVE

The objectives of this study is to propose a CNN based model for the classification of Corn Diseases:

- To identify diseases in corn plants as early as possible. Early detection can enable farmers to take timely and effective measures to control and prevent the spread of diseases, thereby reducing crop loss and ensuring higher yields.
- To accurately identify and differentiate between different types of diseases that affect corn plants. Accurate identification of diseases is essential for developing targeted interventions, such as the use of specific fungicides or other disease management strategies.
- To develop effective management strategies to prevent and control the spread of diseases. Classification of diseases can enable the development of targeted management strategies, such as crop rotation, use of resistant varieties, or the use of biocontrol agents.
- To enhance crop productivity by enabling farmers to detect and manage diseases effectively. With fewer crop losses due to diseases, farmers can increase their yield and overall crop productivity, leading to improved economic outcomes.
- To advance the use of technology in agriculture. The development of sophisticated models and algorithms for disease classification can enable the use of precision agriculture techniques, leading to more efficient and sustainable farming practices.

4. METHODOLOGY

4.1 Dataset

A balanced data set was used from Kaggel containing approximately 8000 images divided between training, test and validation data, in 4 classes and they are:
Rust, Gray_Leaf_Spot, Healthy, Leaf_Blight. Some samples of each category are shown in Figure 1.

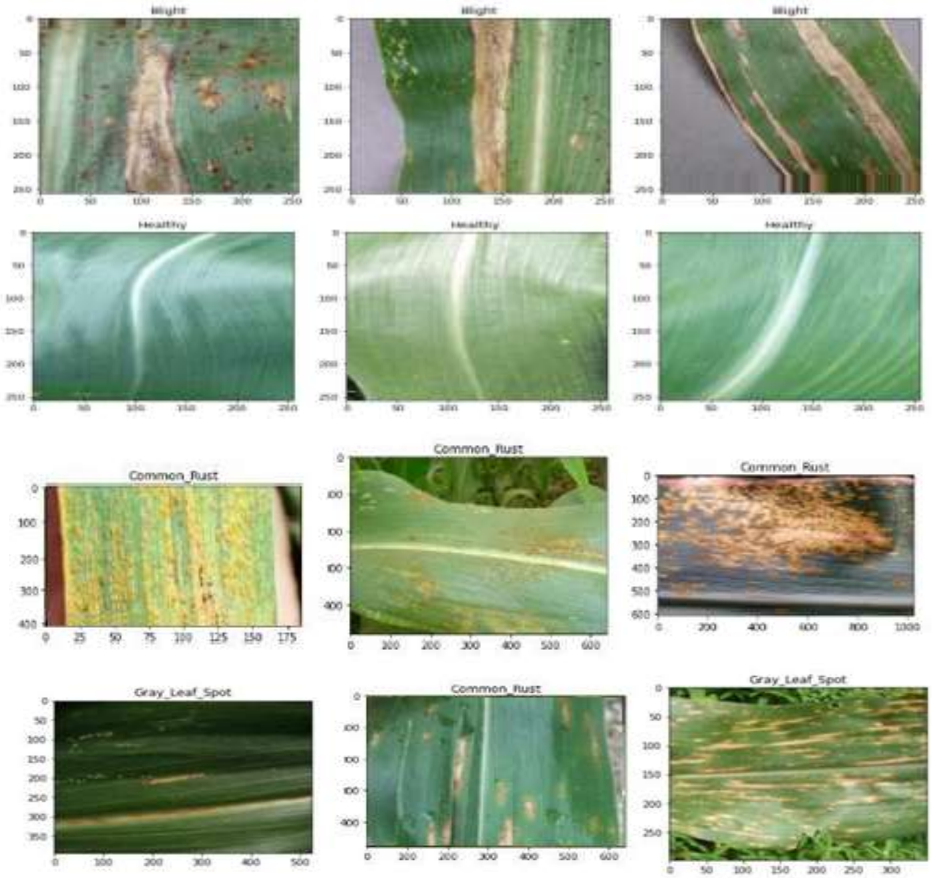

Figure 1: Samples from the dataset of Corn Diseases

4.2 Proposed Model

CNN is a type of neural network commonly used in deep learning and computer vision applications [15-20], including image and video recognition, object detection, and segmentation [21]-[25].

The CNN architecture is inspired by the biological organization of the visual cortex in animals, and it is designed to automatically learn and extract hierarchical features from input data such as images. A CNN typically consists of multiple layers, including convolutional layers, pooling layers, and fully connected layers [26]-[30].

Convolutional layers apply a set of filters to the input image, which convolve or slide over the image to extract features such as edges, corners, or textures. Pooling layers then reduce the spatial dimensionality of the output by downsampling the feature maps, while fully connected layers combine the extracted features and classify the input image into different categories [31]-[35].

CNNs have achieved state-of-the-art results in many computer vision tasks and have been widely used in many real-world applications, including facial recognition, object detection, and autonomous driving [36]-[40].

Our model takes the raw images as input, so we used an accurate model for each CNN-trained RegNetY320 model to extract the features, as a result the model will consist of (feature extraction) images of Corn leaves.

RegNetY320 **i**s a convolutional neural network architecture that was introduced in the 2020 research paper "Designing Network Design Spaces" by Radosavovic et al. The RegNetY320 model has 32.6 million parameters and achieves state-of-the-art performance on the ImageNet classification task, with a top-1 accuracy of 82.2% and a top-5 accuracy of 95.3% [41].

RegNetY320 is part of a family of models called RegNets, which are designed to have a highly efficient architecture that can be scaled to different model sizes while maintaining strong performance. The "Y" in RegNetY320 indicates that the model uses a "width" parameter of 8, which determines the number of channels in each layer. The "320" in the name indicates that the model has a depth of 320 layers [42].

The RegNetY320 architecture is based on a repeating "network block" that consists of a series of convolutional layers followed by a bottleneck layer, which reduces the number of channels before the next block. The blocks are connected in a hierarchical structure that gradually reduces the spatial resolution of the feature maps while increasing the number of channels. The resulting feature maps are fed into a global average pooling layer and a linear classifier to produce the final predictions [43].

4.3 Architecture of the proposed model

The RegNetY320 architecture is a deep convolutional neural network designed for image classification tasks. It is based on a repeating "network block" that is connected in a hierarchical structure to form the overall network. Here is a high-level overview of the architecture [44]:

1. Input: The input to the network is an image of size 224x224.
2. Stem: The stem is the initial part of the network that processes the input image. In RegNetY320, the stem consists of a single 3x3 convolutional layer with 32 channels, followed by batch normalization and a ReLU activation.
3. Network Blocks: The network blocks forms the bulk of the network and are repeated multiple times. Each network block consists of a series of convolutional layers followed by a bottleneck layer that reduces the number of channels before the next block. The number of channels in each block is determined by a "width" parameter that can be adjusted to scale the network to different sizes. In RegNetY320, the width parameter is set to 8, so each block has 256 channels. The network blocks are connected in a hierarchical structure, with each block reducing the spatial resolution of the feature maps while increasing the number of channels.
4. Head: The head is the final part of the network that produces the output predictions. In RegNetY320, the head consists of a global average pooling layer that averages the feature maps across spatial dimensions, followed by a linear classifier that produces the final predictions.

The RegNetY320 architecture has a total of 32.6 million parameters and is designed to be highly efficient and scalable to different sizes while maintaining strong performance on the ImageNet classification task.

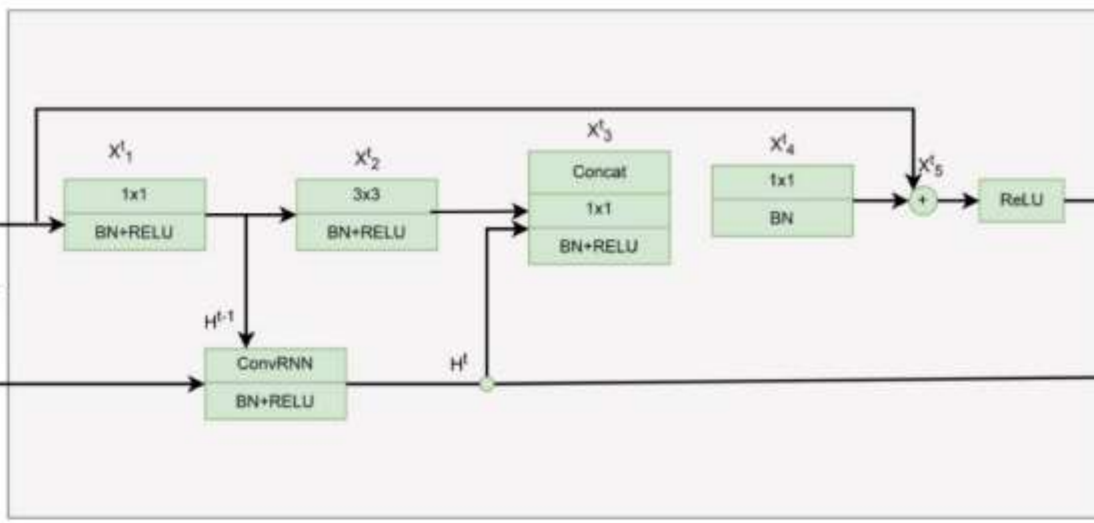

Figure 2: Proposed Model Architecture

4.4 Proposed System Evaluation

The metrics that we used to evaluate the proposed model is the ones we found in the previous literature [45]-[46]: F1-score, accuracy, Recall, Precision as in equations (1) to (4).

$$\text{Precision} = \frac{\text{TP}}{\text{TP + FP}} \quad (1)$$

$$\text{Recall} = \frac{\text{TP}}{\text{TP + FN}} \quad (2)$$

$$F1 - score = 2 * \frac{\text{Precision x Recall}}{\text{Precision + Recall}} \quad (3)$$

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$$\text{Accuracy} = \frac{\text{TN} + \text{TP}}{\text{TN+FP+ TP + FN}} \quad (4)$$

After preprocessing of the corn dataset, we have split the corn dataset into 3 sets (train, test, valid). We trained and validated the proposed model using the train and valid sets for 80 epochs with Adam function, learning rate (0.0001).

The training accuracy attained was 99.45%, Training Loss: 0.0204 the Validation Accuracy: 99.50, Validating Loss: 0.0185. The history of training and validation accuracy and loss of the last 20 epochs are shown Figure 3 and Figure 4.

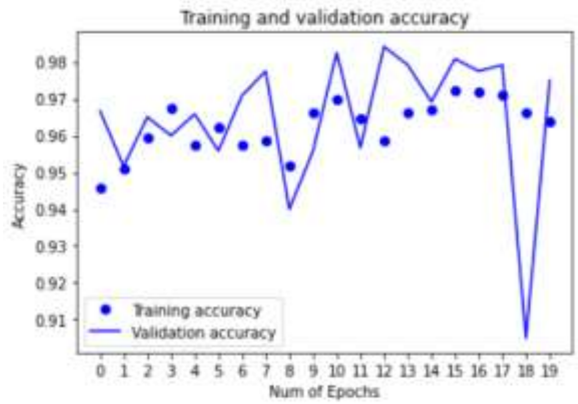

Figure 3: Training and validation accuracy of the model

Figure 4: Training and validation loss of the model

After we have finished the training and validation of the proposed model, we tested it with kept aside test data set. The output of testing was an accuracy of (99.83%) and the testing loss (0.0080).

We further used the ROC curve for each class, classification report, and the confusion matrix to assess the proposed model. The ROC curve for each class came out to be 1.0000 as can be seen in Figure 5. The output of the classification report gave the precision (99.83%), Recall (99.86%), F-score (99.83%), and accuracy (99.83%) as in Figure 6. The confusion matrix is shown in Figure 7, where the accuracy (99.83%).

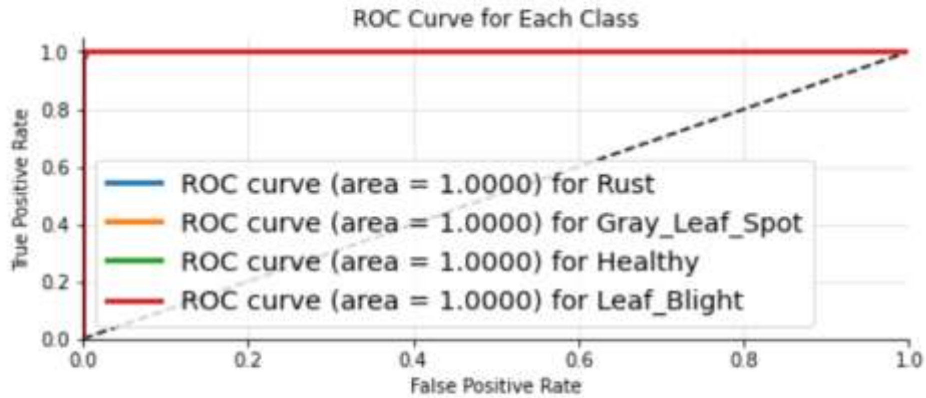

Figure 5: ROC curve for each class

	precision	recall	f1-score	support
Rust	0.9967	1.0000	0.9984	305
Gray_Leaf_Spot	1.0000	0.9965	0.9982	286
Healthy	1.0000	1.0000	1.0000	278
Leaf_Blight	0.9965	0.9965	0.9965	287
accuracy			0.9983	1156
macro avg	0.9983	0.9983	0.9983	1156
weighted avg	0.9983	0.9983	0.9983	1156

Figure 6: The classification report of the proposed model

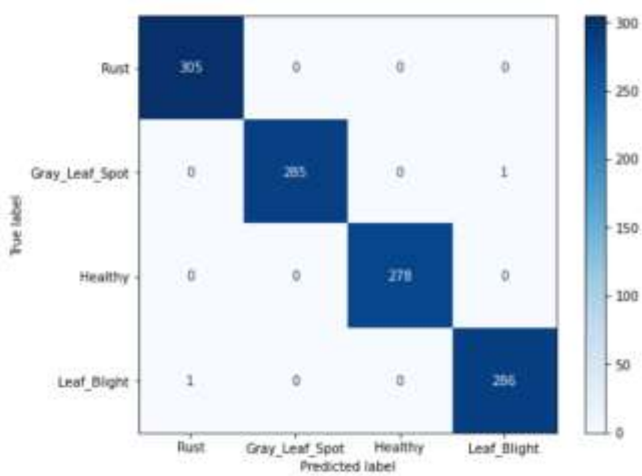

Figure 7: Confusion matrix of the proposed model

5. Results and discussion

After completing the evaluation of the proposed model the results came out promising, where the precision (99.83%), Recall (99.86%), F-score (99.83%), and accuracy (99.83%). That means the proposed model leaned the dataset and can deal with any new image that belongs to the same categories.

Furthermore, we compared our proposed model results with the studies found in the literature reviews and in Table 2. Our proposed model results gave much better F1-score when compared with the previous studies results.

Reference	# of images	# of classes	Approach used	Best F1-score accuracy

1	800	4	CNN	95.86%
2	500	9	GoogleNet	98.90%
2	500	9	Cifar10	98.80%
3	1796	15	CNN	96.70%
4	50,000	5	KNN	96.17%
4	50,000	5	CNN	93.01%
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6	3852	4	10 CNN models	98.60%
7	18,888	4	4 CNN models	99.00 %
8	-	4	CNN	93.00%
9	3823	4	Customized CNN	98.78%
10	15,408	4	DenseNet121	98.56%
11	17,600	4	Customized AlexNet	93.28%
Current Study	**8000**	**4**	**Customized RegNetY320**	**99.83%**

CONCLUSION

Corn disease classification is an important task in agriculture and crop management. With the help of modern technology such as deep learning and image recognition, it is possible to accurately classify different diseases that affect corn plants.

Through the use of advanced algorithms and large datasets of images, researchers and agricultural experts have been able to develop models that can detect and classify corn diseases such as Gray Leaf Spot, Rust, and Northern Corn Leaf Blight.

The classification of corn diseases is essential in identifying potential outbreaks and implementing effective measures to prevent and manage them. Early detection of diseases can lead to timely intervention and the prevention of significant crop loss, thereby increasing yield and overall crop productivity.

As technology advances, it is expected that more sophisticated models will be developed, allowing for more accurate and efficient classification of corn diseases. This will further aid in the development of targeted solutions for crop protection, ultimately benefiting the agricultural industry and food security.

References

1. Abu Ghali, M. J., et al. (2018). "An Intelligent Tutoring System for Teaching English Grammar." International Journal of Academic Engineering Research (IJAER) 2(2): 1-6.
2. Abu Nada, A. M., et al. (2020). "Age and Gender Prediction and Validation Through Single User Images Using CNN." International Journal of Academic Engineering Research (IJAER) 4(8): 21-24.
3. Abu Nada, A. M., et al. (2020). "Arabic Text Summarization Using AraBERT Model Using Extractive Text Summarization Approach." International Journal of Academic Information Systems Research (IJAISR) 4(8): 6-9.
4. Abu Naser, S. (2008). "An Agent Based Intelligent Tutoring System For Parameter Passing In Java Programming." Journal of Theoretical & Applied Information Technology 4(7).
5. Abu Naser, S. S. (2001). "A comparative study between animated intelligent tutoring systems AITS and video-based intelligent tutoring systems VITS." Al-Aqsa Univ. J 5(1): 72-96.
6. Abu Naser, S. S. (2008). "Developing visualization tool for teaching AI searching algorithms." Information Technology Journal, Scialert 7(2): 350-355.
7. Abu Naser, S. S. (2012). "A Qualitative Study of LP-ITS: Linear Programming Intelligent Tutoring System." International Journal of Computer Science & Information Technology 4(1): 209.
8. Abu Naser, S. S. and M. J. Al Shobaki (2016). "Enhancing the use of Decision Support Systems for Re-engineering of Operations and Business-Applied Study on the Palestinian Universities." Journal of Multidisciplinary Engineering Science Studies (JMESS) 2(5): 505-512.
9. Abu Naser, S. S. and M. J. Al Shobaki (2016). The Impact of Management Requirements and Operations of Computerized Management Information Systems to Improve Performance (Practical Study on the employees of the company of Gaza Electricity Distribution). First Scientific Conference for Community Development.
10. Abu Naser, S. S. and M. J. Al Shobaki (2017). "Organizational Excellence and the Extent of Its Clarity in the Palestinian Universities from the Perspective of Academic Staff." International Journal of Information Technology and Electrical Engineering 6(2): 47-59.
11. Abu Naser, S. S. and M. J. Al Shobaki (2017). "The Impact of Senior Management Support in the Success of the e-DMS." International Journal of Engineering and Information Systems (IJEAIS) 1(4): 47-63.
12. Abu Naser, S. S. and M. Shobaki (2016). "Requirements of using Decision Support Systems as an Entry Point for Operations of Re-engineering in the Universities (Applied study on the Palestinian universities in Gaza Strip)." World Wide Journal of Multidisciplinary Research and Development 2(4): 32-40.
13. Abu Naser, S. S., et al. (2016). "KM Factor Affecting High Performance in Intermediate Colleges and its Impact on High Performance-Comparative Study." Computational Research Progress in Applied Science & Engineering 2(4): 158-167.
14. Abu Naser, S. S., et al. (2017). "Impact of Communication and Information on the Internal Control Environment in Palestinian Universities." International Journal of Hybrid Information Technology 10(11): 41-60.
15. Abu Naser, S. S., et al. (2017). "The Reality of Electronic Human Resources Management in Palestinian Universities from the Perspective of the Staff in IT Centers." International Journal of Engineering and Information Systems (IJEAIS) 1(2): 74-96.
16. Abu Naser, S. S., et al. (2017). "Trends of Palestinian Higher Educational Institutions in Gaza Strip as Learning Organizations." International Journal of Digital Publication Technology 1(1): 1-42.
17. Abu Naser, S., et al. (2011). "Human Computer Interaction Design of the LP-ITS: Linear Programming Intelligent Tutoring Systems." International Journal of Artificial Intelligence & Applications (IJAIA) 2(3): 60-70.
18. AbuEloun, N. N. and S. S. Abu Naser (2017). "Mathematics intelligent tutoring system." International Journal of Advanced Scientific Research 2(1): 11-16.
19. Abu-Naser, S. S. (2008). "JEE-Tutor: An Intelligent Tutoring System for Java Expression Evaluation." Information Technology Journal 7(3): 528-532.
20. Abu-Naser, S. S. (2015). "Sl5 Object: Simpler Level 5 Object Expert System Language." International Journal of Soft Computing, Mathematics and Control (IJSCMC) 4(4): 25-37.
21. Abu-Naser, S. S. and I. A. El Haddad (2016). "An Expert System for Genital Problems in Infants." WWJMRD 2(5): 20-26.
22. Abu-Naser, S. S. and I. S. Zaqout (2016). "Knowledge-based systems that determine the appropriate students major: In the faculty of engineering and information technology." World Wide Journal of Multidisciplinary Research and Development 2(10): 26-34.
23. Abu-Naser, S. S. and M. A. Al-Nakhal (2016). "A Ruled Based System for Ear Problem Diagnosis and Treatment." World Wide Journal of Multidisciplinary Research and Development 2(4): 25-31.
24. Abu-Naser, S. S. and M. H. Al-Bayed (2016). "Detecting Health Problems Related to Addiction of Video Game Playing Using an Expert System." World Wide Journal of Multidisciplinary Research and Development 2(9): 7-12.
25. Abu-Naser, S. S. and M. J. Al Shobaki (2016). "Computerized Management Information Systems Resources and their Relationship to the Development of Performance in the Electricity Distribution Company in Gaza." EUROPEAN ACADEMIC RESEARCH 6(8): 6969-7002.
26. Abu-Naser, S. S. and M. M. Hilles (2016). "An expert system for shoulder problems using CLIPS." World Wide Journal of Multidisciplinary Research and Development 2(5): 1-8.
27. Abu-Naser, S. S., et al. (2011). "An intelligent tutoring system for learning java objects." International Journal of Artificial Intelligence & Applications (IJAIA) 2(2): 86-77.
28. Abu-Naser, S. S., et al. (2016). "Promoting Knowledge Management Components in the Palestinian Higher Education Institutions-A Comparative Study." International Letters of Social and Humanistic Sciences 73: 42-53.
29. Abu-Nasser, B. S. and S. S. Abu Naser (2018). "Rule-Based System for Watermelon Diseases and Treatment." International Journal of Academic Information Systems Research (IJAISR) 2(7): 1-7.
30. Abunasser, B. S., et al. (2022). "Breast Cancer Detection and Classification using Deep Learning Xception Algorithm." International Journal of Advanced Computer Science and Applications 13(7).
31. Abu-Saqer, M. M. and S. S. Abu-Naser (2019). "Knowledge Based System for Uveitis Disease Diagnosis." International Journal of Academic Information Systems Research (IJAISR) 3(5): 18-25.
32. Afana, M., et al. (2018). "Artificial Neural Network for Forecasting Car Mileage per Gallon in the City." International Journal of Advanced Science and Technology 124: 51-59.
33. Ahmad, H. R., et al. (2018). "Information Technology Role in Determining Communication Style Prevalent Among Al-Azhar University Administrative Staff." International Journal of Information Technology and Electrical Engineering ` 7(4): 21-43.
34. Ahmed, A. A., et al. (2018). "The Impact of Information Technology Used on the Nature of Administrators Work at Al-Azhar University in Gaza." International Journal of Academic Information Systems Research (IJAISR) 2(6): 1-20.
35. Akkila, A. N. and S. S. Abu Naser (2017). "Teaching the right letter pronunciation in reciting the holy Quran using intelligent tutoring system." International Journal of Advanced Research and Development 2(1): 64-68.
36. Akkila, A. N., et al. (2019). "Survey of Intelligent Tutoring Systems up to the end of 2017." International Journal of Academic Information Systems Research (IJAISR) 3(4): 36-49.
37. Al Barsh, Y. I., et al. (2020). "MPG Prediction Using Artificial Neural Network." International Journal of Academic Information Systems Research (IJAISR) 4(11): 7-16.
38. Al Hila, A. A., et al. (2017). "Organizational Excellence in Palestinian Universities of Gaza Strip." International Journal of Information Technology and Electrical Engineering 6(4): 20-30.
39. Al Shobaki, M. J. and S. S. Abu Naser (2016). "Performance development and its relationship to demographic variables among users of computerized management information systems in Gaza electricity Distribution Company." International Journal of Humanities and Social Science Research 2(10): 21-30.
40. Al Shobaki, M. J. and S. S. Abu Naser (2016). "The reality of modern methods applied in process of performance assessments of employees in the municipalities in Gaza Strip." International Journal of Advanced Scientific Research 1(7): 14-23.
41. Al Shobaki, M. J. and S. S. Abu-Naser (2016). "The Dimensions Of Organizational Excellence In The Palestinian Higher Education Institutions From The Perspective Of The Students." GLOBAL JOURNAL OF MULTIDISCIPLINARY STUDIES 5(11): 66-100.
42. Al Shobaki, M. J. and S. S. Abu-Naser (2017). "The Requirements of Computerized Management Information Systems and Their Role in Improving the Quality of Administrative Decisions in the Palestinian Ministry of Education and Higher Education." International Journal of Academic Pedagogical Research (IJAPR) 6(6): 7-35.
43. Al Shobaki, M. J., et al. (2017). "Strategic and Operational Planning As Approach for Crises Management Field Study on UNRWA." International Journal of Information Technology and Electrical Engineering 5(6): 43-47.
44. Al Shobaki, M. J., et al. (2018). "The Role of Measuring and Evaluating Performance in Achieving Control Objectives-Case Study of" Islamic University"." International Journal of Engineering and Information Systems (IJEAIS) 2(1): 106-118.
45. Al Shobaki, M. M., et al. (2017). "The Efficiency of Information Technology and its Role of e-HRM in the Palestinian Universities." International Journal of Engineering and Information Systems (IJEAIS) 1(6): 36-55.
46. Al Shobaki, M., et al. (2018). "Performance Reality of Administrative Staff in Palestinian Universities." International Journal of Academic Information Systems Research (IJAISR) 2(4): 1-17.
47. Alajrami, E., et al. (2019). "Blood Donation Prediction using Artificial Neural Network." International Journal of Academic Engineering Research (IJAER) 3(10): 1-7.
48. Alamawi, W. W., et al. (2016). "Rule Based System for Diagnosing Wireless Connection Problems Using SL5 Object." International Journal of Information Technology and Electrical Engineering 5(6): 26-33.
49. Alawar, M. W. and S. S. Abu Naser (2017). "CSS-Tutor: An intelligent tutoring system for CSS and HTML." International Journal of Academic Research and Development 2(1): 94-98.
50. Al-Bastami, B. G. and S. S. Abu Naser (2017). "Design and Development of an Intelligent Tutoring System for C# Language." EUROPEAN ACADEMIC RESEARCH 6(10): 8795.
51. Albatish, I. M. and S. S. Abu-Naser (2019). Modeling and controlling smart traffic light system using a rule based system. 2019 International Conference on Promising Electronic Technologies (ICPET), IEEE.
52. Aldahdooh, R. and S. S. Abu Naser (2017). "Development and Evaluation of the Oracle Intelligent Tutoring System (OITS)." EUROPEAN ACADEMIC RESEARCH 6(10): 8711-8721.
53. Al-Daour, A. F., et al. (2020). "Banana Classification Using Deep Learning." International Journal of Academic Information Systems Research (IJAISR) 3(12): 6-11.
54. Al-Habil, W. I., et al. (2017). "The Impact of the Quality of Banking Services on Improving the Marketing Performance of Banks in Gaza Governorates from the Point of View of Their Employees." International Journal of Engineering and Information Systems (IJEAIS) 1(7): 197-217.
55. Al-Hanjori, M. M., et al. (2017). "Learning computer networks using intelligent tutoring system." International Journal of Advanced Research and Development(2): 1.
56. Al-Hila, A. A., et al. (2017). "The Impact of Applying the Dimensions of IT Governance in Improving e-training-Case Study of the Ministry of Telecommunications and Information Technology in Gaza Governorates." International Journal of Engineering and Information Systems (IJEAIS) 1(7): 194-219.
57. Al-Kahlout, M. M., et al. (2020). "Neural Network Approach to Predict Forest Fires using Meteorological Data." International Journal of Academic Engineering Research (IJAER) 4(9): 68-72.
58. Al-Masri, A., et al. (2011). "A prototype decision support system for optimizing the effectiveness of elearning in educational institutions." International Journal of Data Mining & Knowledge Management Process (IJDKP) 1: 1-13.
59. Almasri, A., et al. (2019). "Intelligent Tutoring Systems Survey for the Period 2000-2018." International Journal of Academic Engineering Research (IJAER) 3(5): 21-37.
60. Almurshidi, S. H. and S. S. Abu-Naser (2018). Expert System For Diagnosing Breast Cancer, Al-Azhar University, Gaza, Palestine.
61. Al-Nakhal, M. A. and S. S. Abu Naser (2017). "Adaptive Intelligent Tutoring System for learning Computer Theory." EUROPEAN ACADEMIC RESEARCH 6(10): 8770-8782.
62. Al-Qumboz, M. N. A. and S. S. Abu-Naser (2019). "Spinach Expert System: Diseases and Symptoms." International Journal of Academic Information Systems Research (IJAISR) 3(3): 16-22.
63. Alshawwa, I. A., et al. (2019). "An Expert System for Coconut Diseases Diagnosis." International Journal of Academic Engineering Research (IJAER) 3(4): 8-13.
64. Alshawwa, I. A., et al. (2019). "An Expert System for Depression Diagnosis." International Journal of Academic Health and Medical Research (IJAHMR) 3(4): 20-27.
65. Al-Shawwa, M. and S. S. Abu-Naser (2019). "Knowledge Based System for Apple Problems Using CLIPS." International Journal of Academic Engineering Research (IJAER) 3(3): 1-11.
66. Al-Shawwa, M. and S. S. Abu-Naser (2019). "Predicting Birth Weight Using Artificial Neural Network." International Journal of Academic Health and Medical Research (IJAHMR) 3(1): 9-14.
67. AlZamily, J. Y. and S. S. Abu-Naser (2018). "A Cognitive System for Diagnosing Musa Acuminata Disorders." International Journal of Academic Information Systems Research (IJAISR) 2(8): 1-8.
68. Anderson, J., et al. (2005). "Adaptation of Problem Presentation and Feedback in an Intelligent Mathematics Tutor." Information Technology Journal 5(5): 167-207.
69. Ashqar, B. A. M. and S. S. Abu-Naser (2019). "Identifying Images of Invasive Hydrangea Using Pre-Trained Deep Convolutional Neural Networks." International Journal of Academic Engineering Research (IJAER) 3(3): 28-36.
70. Bakr, M. A. H. A., et al. (2020). "Breast Cancer Prediction using JNN." International Journal of Academic Information Systems Research (IJAISR) 4(10): 1-8.
71. Barhoom, A. M., et al. (2019). "Predicting Titanic Survivors using Artificial Neural Network." International Journal of Academic Engineering Research (IJAER) 3(9): 8-12.
72. Dheir, I. M., et al. (2019). "Knowledge Based System for Diabetes Diagnosis Using SL5 Object." International Journal of Academic Pedagogical Research (IJAPR) 3(4): 1-10.
73. El Kahlout, M. I. and S. S. Abu-Naser (2019). "An Expert System for Citrus Diseases Diagnosis." International Journal of Academic Engineering Research (IJAER) 3(4): 1-7.
74. El Talla, S. A., et al. (2018). "The Nature of the Organizational Structure in the Palestinian Governmental Universities-Al-Aqsa University as A Model." International Journal of Academic Multidisciplinary Research (IJAMR) 2(5): 15-31.
75. El-Mashharawi, H. Q. and S. S. Abu-Naser (2019). "An Expert System for Sesame Diseases Diagnosis Using CLIPS." International Journal of Academic Engineering Research (IJAER) 3(4): 22-29.
76. El-Mashharawi, H. Q., et al. (2019). "An Expert System for Arthritis Diseases Diagnosis Using SL5 Object." International Journal of Academic Health and Medical Research (IJAHMR) 3(4): 28-35.
77. Elnajjar, A. E. A. and S. S. Abu Naser (2017). "DES-Tutor: An Intelligent Tutoring System for Teaching DES Information Security Algorithm." International Journal of Advanced Research and Development 2(1): 69-73.
78. Elsharif, A. A., et al. (2020). "Potato Classification Using Deep Learning." International Journal of Academic Pedagogical Research (IJAPR) 3(12): 1-8.
79. Elzamly, A., et al. (2015). "Predicting Software Analysis Process Risks Using Linear Stepwise Discriminant Analysis: Statistical Methods." Int. J. Adv. Inf. Sci. Technol 38(38): 108-115.
80. FarajAllah, A. M., et al. (2018). "The Impact of the Leadership Standard in International Quality Models on Improving University Performance through the Intermediate Role of the Strategy Standard." International Journal of Engineering and Information Systems (IJEAIS) 2(9): 21-32.
81. Hamed, M. A. and S. S. Abu Naser (2017). "An intelligent tutoring system for teaching the 7 characteristics for living things." International Journal of Advanced Research and Development 2(1): 31-45.
82. Harz, H. H., et al. (2020). "Artificial Neural Network for Predicting Diabetes Using JNN." International Journal of Academic Engineering Research (IJAER) 4(10): 14-22.
83. Jamala, M. N. and S. S. Abu-Naser (2018). "Predicting MPG for Automobile Using Artificial Neural Network Analysis." International Journal of Academic Information Systems Research (IJAISR) 2(10): 5-21.
84. Kashkash, K., et al. (2005). "Expert system methodologies and applications-a decade review from 1995 to 2004." Journal of Artificial Intelligence 1(2): 9-26.
85. Khalil, A. J., et al. (2019). "Apple Trees Knowledge Based System." International Journal of Academic Engineering Research (IJAER) 3(9): 1-7.
86. Madi, S. A., et al. (2018). "The dominant pattern of leadership and Its Relation to the Extent of Participation of Administrative Staff in Decision-Making in Palestinian Universities." International Journal of Academic Management Science Research (IJAMSR) 2(7): 20-43.
87. Mahdi, A. O., et al. (2016). "An intelligent tutoring system for teaching advanced topics in information security." World Wide Journal of Multidisciplinary Research and Development 2(12): 1-9.
88. Marouf, A. and S. S. Abu-Naser (2018). "Predicting Antibiotic Susceptibility Using Artificial Neural Network." International Journal of Academic Pedagogical Research (IJAPR) 2(10): 1-5.
89. Mettleq, A. S. A., et al. (2019). "Expert System for the Diagnosis of Seventh Nerve Inflammation (Bell's palsy) Disease." International Journal of Academic Information Systems Research (IJAISR) 3(4): 27-35.
90. Nasser, I. M. and S. S. Abu-Naser (2019). "Artificial Neural Network for Predicting Animals Category." International Journal of Academic and Applied Research (IJAAR) 3(2): 18-24.
91. Nasser, I. M. and S. S. Abu-Naser (2019). "Predicting Tumor Category Using Artificial Neural Networks." International Journal of Academic Health and Medical Research (IJAHMR) 3(2): 1-7.
92. Qwaider, S. R., et al. (2020). "Artificial Neural Network Prediction of the Academic Warning of Students in the Faculty of Engineering and Information Technology in Al-Azhar University-Gaza." International Journal of Academic Information Systems Research (IJAISR) 4(8): 16-22.
93. Salama, A. A., et al. (2017). "The Relationship between Performance Standards and Achieving the Objectives of Supervision at the Islamic University in Gaza." International Journal of Engineering and Information Systems (IJEAIS) 1(10): 89-101.
94. Salama, A. A., et al. (2018). "The Role of Administrative Procedures and Regulations in Enhancing the Performance of The Educational Institutions-The Islamic University in Gaza is A Model." International Journal of Academic Multidisciplinary Research (IJAMR) 2(2): 14-27.
95. Salman, F. M. and S. S. Abu-Naser (2020). "Expert System for COVID-19 Diagnosis." International Journal of Academic Information Systems Research (IJAISR) 4(3): 1-13.
96. Shamia, M. J., et al. (2018). "Using the Asian Knowledge Model "APO" as a Determinant for Performance Excellence in Universities-Empirical Study at Al-Azhar University-Gaza." International Journal of Information Technology and Electrical Engineering 7(1): 1-19.
97. Sultan, Y. S. A., et al. (2018). "Effect of the Dominant Pattern of Leadership on the Nature of the Work of Administrative Staff at Al-Aqsa University." International Journal of Academic Information Systems Research (IJAISR) 2(7): 8-29.
98. Sultan, Y. S. A., et al. (2018). "The Style of Leadership and Its Role in Determining the Pattern of Administrative Communication in Universities-Islamic University of Gaza as a Model." International Journal of Academic Management Science Research (IJAMSR) 2(6): 26-42.
99. Zaqout, I., et al. (2018). "Information Technology used and it's Impact on the Participation of Administrative Staff in Decision-Making in Palestinian Universities." International Journal of Academic Multidisciplinary Research (IJAMR) 2(8): 7-26.