International Journal of Academic Information Systems Research (IJAISR)
ISSN: 2643-9026
Vol. 8 Issue 4 April - 2024, Pages: 37-43

The Fast Food Image Classification using Deep Learning

Jehad El-Tantawi, Samy S. Abu-Naser

Department of Information Technology,
Faculty of Engineering and Information Technology
Al-Azhar University - Gaza, Palestine

Abstract: *Fast food refers to quick, convenient, and ready-to-eat meals that are usually sold at chain restaurants or take-out establishments. Fast food is often criticized for its unhealthy ingredients, such as high levels of salt, sugar, and unhealthy fats, and its contribution to the growing obesity epidemic. Despite this, fast food remains popular due to its affordability, convenience, and widespread availability. Many fast food chains have attempted to respond to these criticisms by offering healthier options, such as salads and grilled chicken sandwiches, and by using more natural and locally sourced ingredients. The aim in this paper to propose a deep learning model for the classification of fast food dishes. The proposed model, Xception, was trained on natural images and was fine-tuned to make up the fast food meals. The researchers collected the Fast Food V2 dataset from Kaggle depository, the dataset, contained 20,000 images. The dataset has ten labels of food images comprised of Baked Potato, Burger, Crispy Chicken, Donut, Fries, Hot Dog, Pizza, Sandwich, Taco, and Taquito. The dataset was split into three sets: training, validation and testing. The accuracy, F1-score, recall, precision on the separate test set showed that classification of fast food was accuracy (95.13%), Precision (95.34%), Recall (95.13%), and F1-Score (95.14%).*

Keywords DCNN, Classification, Fast Food, Deep Learning

1. INTRODUCTION

The rapid increase in food obesity has led to a higher risk of various obesity-related diseases such as type-2 diabetes, cancer, heart disease, and, due to excessive calorie intake [1]. To combat this, there is a need for an efficient dietary assessment system that can classify fast food images, in an effort to reduce the risk of food obesity [2]-[3].

Recent research has proposed using supervised machine-learning systems to address the limitations of traditional food recognition and classification methods [4]-[10]. Machine-learning techniques such as Support Vector Machine (SVM), K-Nearest Neighbors (K-NN), Artificial Neural Network (ANN), and Classification and Regression Trees (CART) have been employed in the classifications [11][[20]. However, the performance of these conventional machine-learning techniques is not optimal due to the need for manual feature engineering to train the model and make accurate predictions from the datasets. The latest trend in this field is the use of Convolutional Neural Network (CNN) techniques, which are based on deep learning, to handle the complex relationships between the image class and datasets [21]-[23]. This makes CNNs particularly suitable for food classification based on images.

CNN learning has significant advantages in terms of image classification and recognition, especially in food classification. The CNN model consists of multiple layers at different levels of abstraction to learn the features of datasets and has been successful in applications such as character recognition [24], face recognition [25], food identification [26], cooking method recognition [27], herbal medicine image recognition [28] food ingredient detection, and fake-food image recognition [29]. Thus, it is expected that CNN will be effective in food classification. However, this still requires investigation and validation, as CNN can be sensitive to factors such as the number of datasets, filter size, regularization, number of feature maps, and activation function. Current food classification algorithms also have limitations, including low accuracy, high processing time, and large weight matrices of the neural network. The best model is one that balances accuracy with processing time and reduces the weight matrices of the neural network. Recent studies of CNN-based food image classification have employed various techniques and algorithms to improve accuracy during the learning and testing phases. The classification accuracy based on CNN was 3.40% higher than SVM-based classification [30].

However, the current classification accuracy results remain low, which may be attributed to factors such as the number of datasets, filter size, regularization, number of feature maps, and activation function. There is still much room for improvement in this field.

2. LITERATURE REVIEW

The objective of this section is to survey existing studies, identify gaps, and provide a comprehensive overview of different tools, methodologies and techniques used in the related field of study. It also offers a critical evaluation of prior research and perspectives on various studies. The literature review focusing on classification of fast food dishes.

In [31], they assessed the accuracy of the classification component in their dietary assessment algorithm using various visual descriptors and classifiers, including a Support Vector Machine (SVM) classifier, which achieved an accuracy of 78.90%. They compared the performance of the SVM to that of the K-Nearest Neighbor (K-NN) classifier and found that SVM was a better option. Image segmentation was taken into account during the implementation of this model. However, the classification accuracy was low and SVM and

K-NN are not deep learning techniques. Thus, the algorithm appears to not support the proposed system for food classification and calorie prediction using deep learning.

In [32], they studied the accuracy of food and drink image dataset classification and detection using the NutriNet Deep Convolutional Neural Network (DCN) architecture system, resulting in 86.72% classification accuracy and 94.47% image detection accuracy. However, the DCN system was only designed for binary classification with two classes: food and drink, so it may not fully support the proposed food classification system.

In [33], they assessed the accuracy of Chinese character classification in a character recognition task using a Deep Convolutional Neural Network (DCN) system with three convolutional layers, two max-pooling layers, and a fully-connected layer, resulting in a classification accuracy of 82%. Further improvement could be made by incorporating image segmentation. The use of convolutional layers, max-pooling layers, and a fully-connected layer in the DCN model supports the proposed system.

In [34], they evaluated the accuracy of image classification for various food image datasets using two pertained Convolutional Neural Network (CNN) algorithms, ResNet-152 and GoogleNet, along with Artificial Neural Network, Support Vector Machine with RBF kernel (SVM-RBF), and Random Forest classifiers. The results showed an accuracy of 98.8%, which was an improvement over existing solutions using a combination of these classifiers. Despite this high accuracy, the use of SVM-RBF and Random Forest classifiers, which are not deep learning techniques, suggests that there may be limited potential for further improvement in the proposed food classification.

In [35], they studied the accuracy of image classification by combining a mixed-scale dilated convolutions network with a dense network, resulting in a class accuracy of 63.9% and a global accuracy of 87.0% with 200 layers. Although the global accuracy was high, the class accuracy was not substantial enough to achieve accurate calorie prediction. Hence, this combination of dilated convolutions network and deep network algorithm does not support the proposed food classification system.

In [36], they evaluated the classification accuracy for an automated food recognition system using a Deep Convolutional Neural Network (DCN). This resulted in a classification accuracy of 82.29% with precision of 66.37%, recall 65.84%, and an F1 score of 66.17%. Although this is an improvement over the existing food classification techniques using DCN, the low precision, recall, and F1 score values could lead to misclassification of food images and failure in calorie prediction. Despite this, the use of DCN in the solution is valuable to the proposed food classification system.

In [37], they evaluated the accuracy of food image recognition algorithms using Convolutional Neural Networks (CNNs) with image segmentation and image cropping. The study resulted in a top-1 accuracy of 77% and top-5 accuracy of 94.0%. Additionally, they examined the energy consumption for image analysis and image transferring, with values of 0.51 joules and 0.5 J, respectively. This was an improvement over previous CNN solutions. Hence, this algorithm can provide support to the proposed food classification system.

In [38], they examined the accuracy of the algorithm for recognizing multi-item food images. They achieved this by utilizing Convolutional Neural Network feature extraction, region mining, and classifier training, resulting in a recognition accuracy of 94.11% and a recall rate of 90.98% and precision rate of 93.05%. Although this is an improvement from the previous Convolutional Neural Network solution with a classification accuracy of 94.11%, the use of region collection, region mining, and pre-training in this system suggests that it provides support to the proposed food classification and calorie prediction system.

From the previous studies, we can see that the employed datasets are somewhat different from the one we are using, the CNN and Machine learning models used are not the same as the one we are proposing Xception model; furthermore, the accuracy achieved in the previous studies in terms of deep learning models came between [78.90% - 94.11%]. Thus there is a room for improvement in terms of Accuracy.

3. METHODOLOGY

3.1 Dataset

The fast food V2 dataset was collected from Kaggle website. The dataset consists of 20,000 images of 10 different fast food classes. The 10 classes are Baked Potato, Burger, Crispy Chicken, Donut, Fries, Hot Dog, Pizza, Sandwich, Taco, and Taquito.

The dataset was resized, cropped, and normalized. The fast food V2 already split into Train, Valid, and Test sets. The Train set has 15000 images where each class has 1500 images. The Valid set consists of 3500 images where each class has 350 images. The Test set has 1500 images where some classes has 100 images and the other classes has 200 images.

Figure 1 presents some samples of the fast food V2 dataset.

Fig. 1. Samples from the fast food V2 dataset

3.2 Proposed model

The proposed model Xceprion was fine-tuning for the classification of the fast food dataset (Figure 2). Xception is a deep convolutional neural network architecture for image classification tasks. It was introduced in 2016 by François Chollet and is built on top of the concept of "depthwise separable convolutions". Unlike traditional convolutional layers, depthwise separable convolutions split the convolution operation into two separate steps: a depthwise convolution that operates on each channel of the input, and a pointwise convolution that combines the results. This design allows for a more efficient use of computational resources and reduces the number of parameters in the model, making it faster to train and less prone to overfitting.

Xception also utilizes "residual connections" which bypasses some of the intermediate layers and adds their inputs directly to the outputs, allowing the network to learn residual representations. Xception has been applied to a variety of computer vision tasks and has achieved state-of-the-art performance on several benchmark datasets for image classification, such as ImageNet.

The architecture of Xception can be summarized as follows (Figure 2):

- Initial Convolution layer: This layer applies a traditional convolution operation to the input image to produce a feature map.
- Depthwise Separable Convolutions: A series of depthwise separable convolution blocks are applied to the feature map, with each block consisting of a depthwise convolution layer followed by a pointwise convolution layer. The depthwise convolution layer operates on each channel of the input, while the pointwise convolution layer combines the results.
- Residual Connections: Some of the intermediate layers are bypassed, and their inputs are added directly to the outputs, allowing the network to learn residual representations.
- Max Pooling: The feature maps are down-sampled by applying max pooling layers.

- Fully Connected Layers: A series of fully connected layers are used for classification, mapping the feature
- maps to the output class scores.

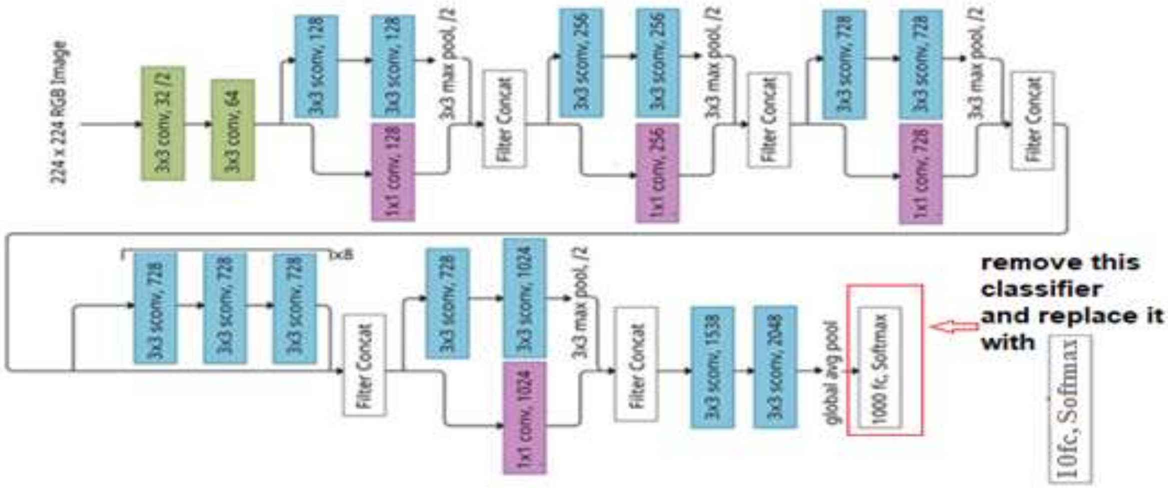

Fig. 2. Fine-tuned Xception Architecture

3.3 Training and validating the proposed model

After we have finished pre-processing of the images we kept training and validating the proposed model once using augmentation for 20 epochs and another 20 epochs without augmentation until we reached the highest accuracy possible. Figure 3 show the history of training and validation for a 20 epochs while Figure 4 shows the history of the training and validation Loss for a 20 epochs.

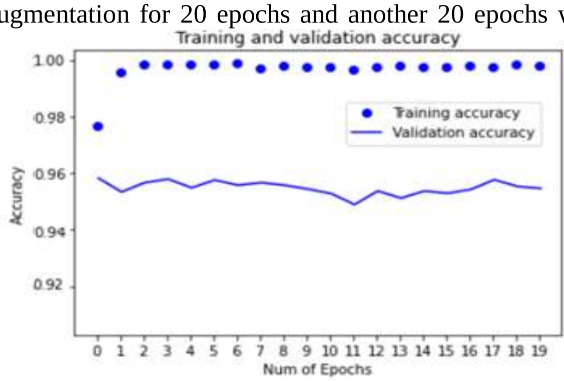

Figure 3. History of training and validation accuracy for a 20 epochs

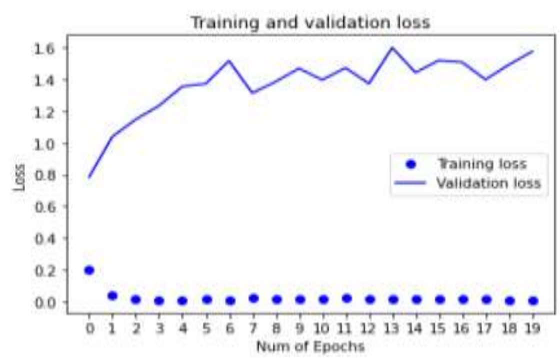

Figure 4. History of training and validation Loss for a 20 epochs

3.4 Evaluating the proposed model

There are several evaluation metrics commonly used to assess the performance of the Xception model for fast food V2 dataset. We have used the following metrics:

- Accuracy: Proportion of correct predictions among all instances as in equation 1.
- Precision: Proportion of correct positive predictions among all positive predictions made as in equation 2.
- Recall: Proportion of positive instances that were correctly classified among all positive instances as in equation 3.
- F1-Score: Harmonic mean of precision and recall as in equation 4.
- Confusion Matrix: A matrix that summarizes the performance of a classifier by counting the number of true positive, false positive, false negative, and true negative predictions.
- ROC Curve: A plot of the true positive rate against the false positive rate. It is used to visualize the

International Journal of Academic Information Systems Research (IJAISR)
ISSN: 2643-9026
Vol. 8 Issue 4 April - 2024, Pages: 37-43

performance of a classifier and choose a threshold for class predictions.

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

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

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

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

Where: FP = False Positive; FN = False Negative; TP = True Positive; TN = True Negative

Figure 5 outline the classification report of the Xception model which include the Precision, Recall, F1-Score, supporting number of images for each class in the fast food V2 dataset. Furthermore, it include the overall accuracy, Macro Average, and weighted Average.

From Figure 5, the proposed model achieved accuracy (95.13%), Precision (95.34%), Recall (95.13%), and F1-Score (95.14%).

ROC Curve for the proposed Xception model is greater than 0.99 for each class in the fast food V2 dataset as can be seen in Figure 6.

Figure 7 show the confusion matrix that summarizes the performance of the Xception model by counting the number of true positive, false positive, false negative, and true negative predictions.

	precision	recall	f1-score	support
Baked Potato	0.9406	0.9500	0.9453	100
Burger	0.9894	0.9350	0.9614	200
Crispy Chicken	0.9074	0.9800	0.9423	100
Donut	0.9848	0.9700	0.9773	200
Fries	0.9510	0.9700	0.9604	100
Hot Dog	0.9637	0.9300	0.9466	200
Pizza	0.9652	0.9700	0.9676	200
Sandwich	0.9561	0.9800	0.9679	200
Taco	0.8291	0.9700	0.8940	100
Taquito	0.9540	0.8300	0.8877	100
accuracy			0.9513	1500
macro avg	0.9441	0.9485	0.9451	1500
weighted avg	0.9534	0.9513	0.9514	1500

Fig. 5. Classification report of the Xception proposed model

International Journal of Academic Information Systems Research (IJAISR)
ISSN: 2643-9026
Vol. 8 Issue 4 April - 2024, Pages: 37-43

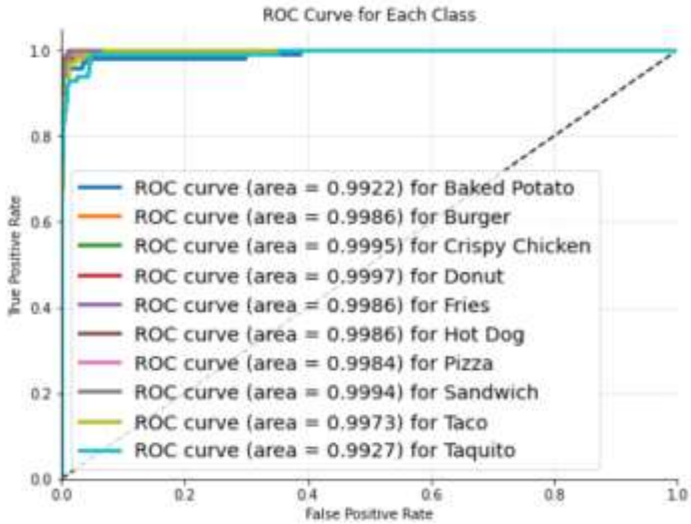

Fig. 6. The ROC Curve of each class in Fast Food V2 Dataset

95	0	2	0	0	1	1	0	0	1
0	187	0	1	0	3	0	7	2	0
0	0	98	0	2	0	0	0	0	0
1	0	1	194	0	2	2	0	0	0
1	0	1	0	97	0	0	0	0	1
0	1	1	2	0	186	3	1	4	2
1	1	1	0	1	0	194	1	1	0
1	0	0	0	0	0	1	196	2	0
1	0	2	0	0	0	0	0	97	0
1	0	2	0	2	1	0	0	11	83

Fig. 7. Confusion Matrix

4. RESULTS AND DISCUSSION

To compare the performance of the previous studies with the current study, the dataset should be the same in both previous studies and current study; furthermore, the CNN model should be the same. Even though the previous studies used somewhat different datasets and different CNN models and Machine learning, the current study achieved much better accuracies that the previous studies. The proposed model in current study achieved accuracy (95.13%), Precision (95.34%), Recall (95.13%), and F1-Score (95.14%).

5. CONCLUSION

Fast food is often criticized for its unhealthy ingredients, such as high levels of salt, sugar, and unhealthy fats, and its contribution to the growing obesity epidemic. Despite this, fast food remains popular due to its affordability, convenience, and widespread availability. The aim of the current study was to propose a CNN deep learning model to classify Fast Food V2 dataset. The CNN deep learning pre-trained Xception was fine-tuned for the classification task. The proposed model was trained, validated and tested using the Fast Food V2. The results showed that the proposed Xception model achieved an accuracy (95.13%), Precision (95.34%), Recall (95.13%), and F1-Score (95.14%). This proved that CNN models with modification and pre-processing of the images can classify Fast Food V2 images accurately.

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.