Deep Learning Techniques for Accuracy Optimization in Wireless Networks

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Summary
Nowadays, to improve performance and increase the accuracy of routing in wireless networks, deep learning has been widely concerned and implemented to predict the best routing paths through dynamic alternative path selection to governor the data traffic. However, it is still some challenging to improve the performance of routing using different techniques. In view of this challenge, this paper presents study and evaluation of deep learning techniques this shows how to utilize deep learning algorithms to enhance wireless network performance and accuracy in specific.
The paper discusses the deep learning algorithms such as artificial neural network, conventional neural network, recurrent neural network, deep belief network, deep Boltzmann machine, stacked auto encoder. Then select deep ANN as a suitable algorithm to implement. After that, compare it with ANN machine learning algorithm. And then evaluates the implementation
At last, dataset applied to verify the accuracy ratio and the effectiveness of our proposed model, we find that deep learning is better than machine learning, based on accuracy and loss since deep learning accuracy ratio was 94% while the accuracy ratio of the machine learning was 68%. Regarding the loss function, its 32% in deep learning, while its 38% for machine learning.

Key words:
Deep learning, Machine learning, an artificial neural network, Wireless network.

1. Introduction

In the early days of artificial intelligence (AI) ,AI classified as new field that can rapidly resolve problems that are rationally difficult for humans but relatively direct for computers, problems that can be expressed by a list of mathematical formal. AI has evolved considerably every day until it reached deep learning. [1]. Deep learning (DL) had becomes most effective due to its immense ability to simulate human neurons. The main advantages of DL are the extraction of the data high-level features, working with labels included or not, and it can be trained to achieve several goals. This can be useful in different fields such as smart business, image processing and speech recognition. In addition to this, the benefits of deep learning have attracted many researchers in different fields to solve many problems after attempts to solve in the machine learning Technique. [2]
Deep learning is a branch of machine learning that relies on artificial neural networks, as the neural network would imitate the human brain so it is also a kind of simulation of the human mind, For This reason has characterized by great efficiency [3].
In [4] the authors define the machine learning as a branch of artificial intelligence that relies on the process of transforming experience into experience or knowledge. The input to the learning is training data and experience representation so the output is some experience which usually takes the form of another computer program that can do some tasks.
Modern advances in machine learning have been applied to solve several problems in different fields such as wireless networks including: cellular networks, wireless local area network (WLAN), wireless sensor network (WSN). Wireless networking challenges include Routing, troubleshooting, estimating of data quality and preserving energy.
Routing is one of the prominent challenges in wireless networks due to low bandwidth, limited power supply, processing capacity and less memory capacity [2]. Routing is more critical in WSN, due to thousands of randomly distributed nodes, the lifetime of the sensor nodes that causing the potential for energy consumption of the sensor nodes. Deep learning techniques will be employed to develop routing algorithms and improve wireless network performance.
The proceeds of this paper are arranged as follows. In the second section, it discusses related work about deep learning and machine learning, which may be useful for wireless network performance. also, its focuses on deep learning techniques and its evaluation, Next, in section 3 the experiment and method are discussed, with analysis and discusses the final result. finally, the paper is concluded in Section 4.

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2. Literature Survey

After covering many papers regarding the new technologies in the art, we notice that Deep learning is one of the most effective topics in our time, due to its tremendous ability to store and analyze data while ensuring results that are more accurate

In [5] the authors introduce the Deep learning as a part of ML where some algorithms develop computational models. It mentions the importance of deep learning, which is increasing much prevalence and wide use in different computer science fields, for example, object acknowledgment, discourse acknowledgment, flag preparing, apply autonomy, AI gaming, etc. at last, the paper presented the applications of deep learning in network related areas such as Deep Learning in WSNs, which consistently bring focus to that area. WSN have gotten a kick out of many ML applications.

In [6] the authors discuss a deep learning for big data. It has been accomplished as a standout amongst the most presently amazing machine learning strategies; it has made extraordinary progress in numerous applications. The article utilizes supervised and unsupervised techniques to learn staggered portrayals and highlights in hierarchical architectures for the undertakings of classification and acknowledgment as an example. Ongoing improvement in sensor systems and correspondence advancements has empowered the gathering of large data. The Paper also discusses the deep learning applications that covers many platform implementations.

Paper [7] describes in details, the importance of using Machine learning in wireless network to improve situational perception and general network operations to utilize predictive and intelligent data analytics; as well as the usage of ML in physical layer to improve the performance of intelligent wireless network and to enhance the Rapid deployment of high-performance wireless services.

In [8] the Functional challenges when planning WSN are mentioned to be considered such as power and memory requirements of sensor nodes, topology changes, correspondence link failures, decentralized administration and routing. It is a main advantage to utilize reinforcement learning in WSN routing, as it does not require information about the global system structure to accomplish an acceptable routing solution. The paper also discusses the Non-Functional challenges, such as Quality of Administration, Data Uprightness and Fault Discovery and Miscellanea.

In [2] the paper mentions that Wireless sensor network (WSN) is a standout amongst the most promising technologies for some constant applications due to its size, savvy and effectively deployable nature. The activity of WSN is to screen a field of intrigue and assemble certain data and transmit them to the base station for post information investigation. A portion of the WSN applications comprises a great number of sensor nodes. In this way, overseeing such countless requires a scalable and efficient algorithm. In addition, because of the external causes or planned by the framework architects, the WSNs may change powerfully. Thusly it might influence network directing systems, limitation, delay, cross-layer structure, inclusion, QoS, link quality, fault detection, etc.

The paper mentions that Machine Learning (ML) is the procedure that automatically develops or learns from the study or experience, and deeds without being explicitly programmed. Ongoing developments in ML have been connected to unravel different issues in WSNs. Applying ML not just improves the execution of WSNs and furthermore constrains human involvement or re-program. Access large measure of information gathered by the sensors, and concentrate the valuable data from the information isn't so natural without ML.

It is clear that Routing is one of the essential difficulties in WSNs due to the restricted power supply, low transmission data transfer capacity, less memory limit, and handling limit. In WSNs, sensors sent haphazardly in the earth. Every sensor hub gathers the data from nature and broadcast to the base station for further handling. [2]

Also, Routing is affected by randomization of thousands of nodes [3] deep learning techniques help in solving this problem specifically in WSN.

Paper [9] discusses WSN, it is the most part utilized in low data transfer capacity and postpone tolerant, applications running from common and military to natural and human services observing. WSNs mostly comprised of at least one of base stations and maybe tens or thousands of sensor hubs distributed in a physical space. With a combination of data detecting, calculation, and wireless correspondence, the sensor hubs can detect physical data, rough process data. WSN hub is included low-control detecting gadgets, inserted processor, correspondence channel and power module. The implanted processor is commonly utilized for gathering and handling the flag information taken from the sensors [10]. The wireless correspondence channel gives a medium to exchange the data removed from the sensor hub to the outside world, which might be a PC network, and between hub correspondences [11].

Table 1: Evaluation of related work and ours

Reference	*Focus on*	*Scope*			
		Machine Learning		*Network*	
		Deep Learning	*Other Machine Learning*	*Wireless Network*	*Wireless sensor Network*
[2]	Machine learning algorithms for wireless sensor networks		√		√
[5]	State-of-the-art deep learning	√			
[6]	A survey on deep learning for big data	√			
[7]	Artificial neural networks-based machine learning for wireless networks:		√	√	
[8]	Machine learning in wireless sensor networks: Algorithms, strategies, and applications		√		√
[9]	Wireless multimedia sensor networks				√
Our work	Deep learning techniques for accuracy optimization in wireless Network	√	√	√	√

Table 2: Evaluation of Deep learning algorithms

DL Algorithms	*Type*	*Evolution*
ANN	Supervised	- best in determining data trend patterns - suited for prediction.
CNN	supervised / unsupervised	- Complicated - The torsion layer is slow, so it takes a long time
RNN	supervised	- Sequential, dependent on context or sequence - Difficult to remember reliable data if it is long-term
DBN	supervised / unsupervised	- Its data input is less. - slow so the routing is specified so it takes longer time
SAE	unsupervised	- Specific data - Loss of important data after decryption
DBM	unsupervised	- Sometimes slow in the work, take long time

3. Experiments

3.1 Experiment and method

Longitude and latitude data for the sender and latitude and longitude data for the receiver were collected, and path between the sender and receiver was found using the dijkstra algorithm implemented in Python. Dijkstra algorithm used to find the path between different nodes.
Python is a translated high-level programming language for universally useful programming. it has been used in the implementation of deep learning algorithm because Python uses a large number of free libraries for artificial intelligence
specifically, deep learning such as TensorFlow, sickie-learn and keras. Researchers do not need to recognize the language before using DL or AI with Python. Even a programmer with basic knowledge of any other language can easily use Python. [12]-[13]-[14].

3.2 Result, discussion and Analysis

ANN was implemented in Python, because it contains all libraries needed
First use keras that's used for library of ANN, TensorFlow so pip and install TensorFlow that includes keras
Some important libraries that are used to implement ANN algorithm are summarized in a Table 3. [15] - [17].

Table 3: Important libraries to implement ANN

Library	***Description***
NumPy	It is more important for scientific computing
Matplotlib	It is easy to represent graph, plots and histograms
Panda	It is easy to use data analysis

After that do set-up imports for libraries

```
# Importing the Keras libraries and packages
import keras
from keras.models import Sequential
from keras.layers import Dense
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
```

Then load the data

```
# Importing the datasetYou can activate this behavior
dataset = pd.read_csv('dataDL.csv',header=0,encoding = 'unicode_escape')
X = dataset.iloc[:, 0:12].values
y = dataset.iloc[:, -1].values
```

Later the dataset is cleaned and preprocessed.
Firstly, create neural network, the neural network has three layers: an input layer, a hidden layer, and an output layer, ANN has been classified as machine learning.
Now, create neural network with single hidden layer like figure1 in [5].

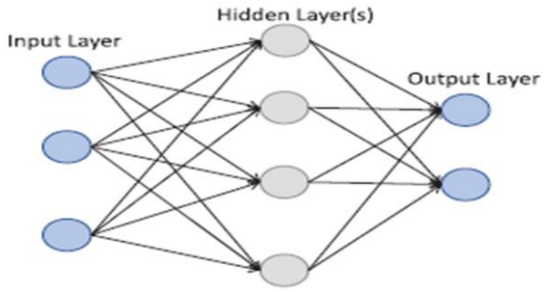

Fig. 1 Neural network with single hidden layer

We use sequential model to create neural network because:

1- sequential model allows to create one layer after the other.
2- sequential used for single input layer and output layer.

```
# Initialising the ANN
classifier = Sequential()
```

In all of neural network layers uses Dense, it is regular layer that connect layers with each other by take pervious layer as input layer.
the output layer uses Sigmoid in activation function because its useful when binary classification has output layer with the result is either 0 or 1. [15].

```
# Adding the output layer
classifier.add(Dense(units = 1, kernel_initializer = 'uniform', activation
```

Second step is compiling Artificial Neural Network for binary classification problem by use loss and metrics

```
# Compiling the ANN
classifier.compile(optimizer = 'adam', loss = 'binary_crossentropy', metric
```

Then fitting the ANN to the Training set

```
# Fitting the ANN to the Training set
h1=classifier.fit(X_train, y_train, batch_size = 10, epochs = 80)
```

Then the result is shown in figure 2 and 3

```
Epoch 80/80
0s 631us/step - loss: 0.3847 - accuracy: 0.6842 - [==============================] 19/19
```

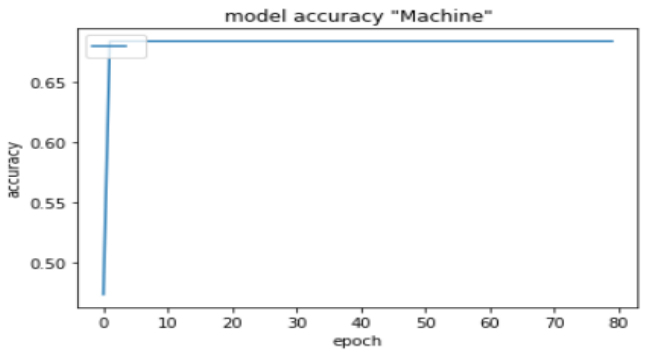

Fig. 2 Model accuracy of machine learning

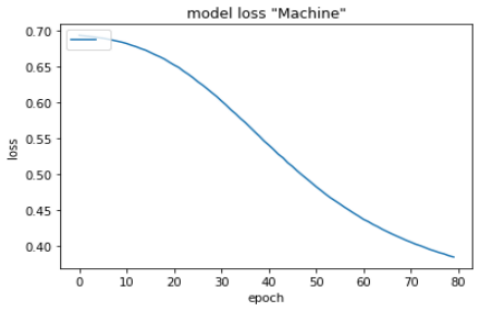

Fig. 3 Model loss of machine learning

Based on the results, the accuracy rate of machine learning was 68% and the loss was 38%
This result depending on model performance, which is a good separation to consider, is to use the loss and metric to evaluate and diagnose how well the model is learning [19].
Loss: Used to evaluate and diagnose model optimization only.
Metric: Used to evaluate and choose models in the context of the project such as accuracy.
accuracy is a metric that can be applied to classification tasks only. It describes just what percentage of your test data are classified correctly [18]. Then, create deep Artificial Neural Network like figure 4 in [5]
by add more hidden layer

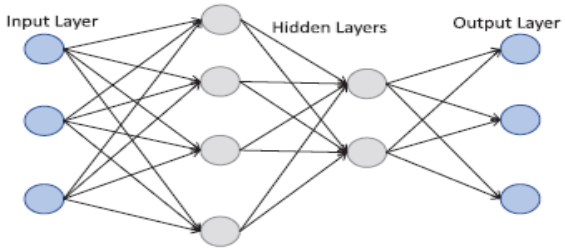

Fig. 4 Neural network with more hidden layer

also create deep neural network by using sequential model and add more hidden layer.
In hidden layer use ReLU in activation function because its simple mathematical operation and it initialize random weights, and it converge very quickly.
The result after add more hidden layer and represented in figure 5 and 6:

```
# Adding the hidden layer
classifier.add(Dense(units = 6, kernel_initializer = 'uniform', activation
```

```
Epoch 80/80
0s 1ms/step - loss: 0.3251 - accuracy: 0.9474 - [==============================] 19/19
```

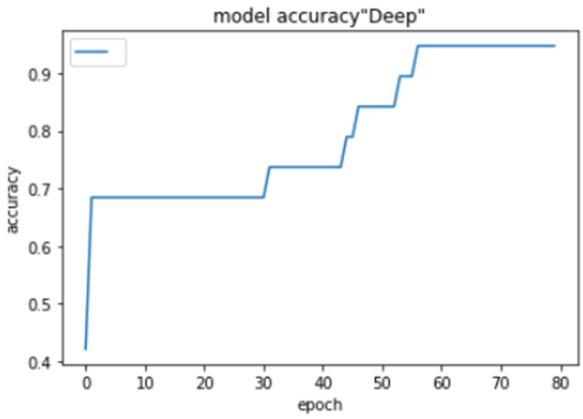

Fig. 5 Accuracy model of deep learning

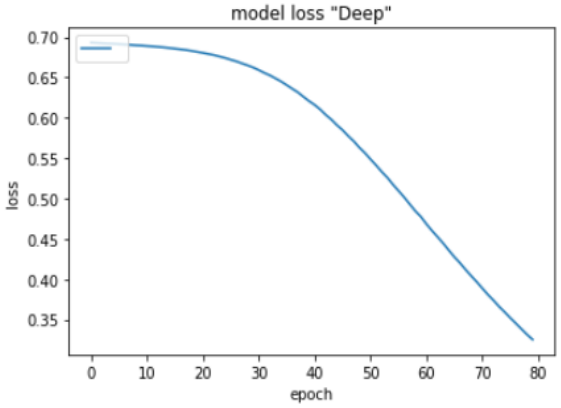

Fig. 6 Loss model of deep learning

Based on the results, the accuracy rate of deep learning was 94%, so deep learning has higher accuracy than machine learning; also, the loss was 32% that is less than loss of machine learning summarizes the result in Table 4.

Table 4: The Final Result

Technique	Epoch	Accuracy rate	Loss rate
Machine learning	80	68%	38%
Deep learning	80	94%	32%

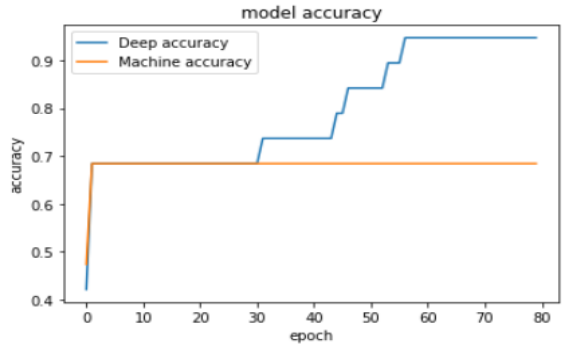

Fig. 7 Accuracy between deep learning and machine learning

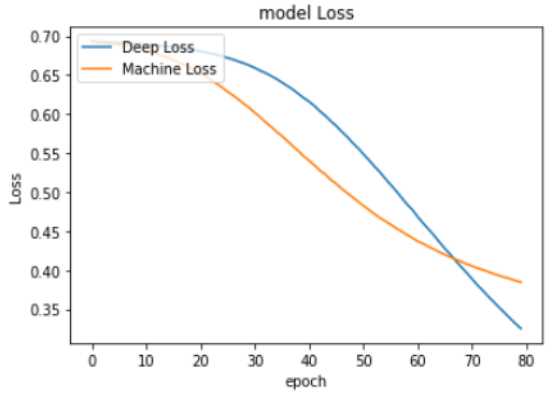

Fig. 8 Loss between deep learning and machine learning

4. Conclusion

We can conclude that, the aim of this work is to implement the artificial intelligent techniques to solve routing problem in wireless network. The best route or path selected by using machine learning algorithms specifically Artificial Neural Network (ANN) and deep learning algorithms (DANN) this done to a data set using Python tools.

The experiments result illustrates that deep learning algorithm DANN is better and more accurate than machine learning algorithm. According to the number of hidden layers, machine learning has only one hidden layer. However, in deep learning it has more than one hidden layer. Consequently, the wireless network performance is thus improved by getting a better result in less training time.

The accuracy ratio was 94% when implementing DANN while it was 68% for ANN, correspondingly the loss function in deep learning DANN was 32% while it was 38% in ANN, so we conclude that DANN is more accurate and better than ANN.

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