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Early Prediction and Analysis of Fetal Abnormalities using Machine Learning Models

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Abstract: The purpose of this literature review is to provide a thorough overview of current state-of-the-art approaches, problems, and future possibilities in the field of fetal anomaly classification utilising deep learning CNN Models. The findings from the examination of the 10 influential models will be used to build a robust and accurate machine learning-based system for fetal anomaly classification. This research has the potential to greatly contribute to improved fetal healthcare.

Keywords: Fetal, anomaly, classification, deep leanring, CNN, accuracy

1. INTRODUCTION

A machine learning algorithm is a mathematical or logical piece of code that facilitates the investigation, analysis, interpretation, and exploration of large, complex datasets by experts. Each algorithm is a set of rules for processing data in order to make predictions or assign data to categories based on what has been learned, established, and detected. This literature survey aims to provide a formal and comprehensive analysis of ten influential machine learning models that address the classification of fetal images. By critically examining the existing literature, this survey seeks to identify prevailing trends, highlight challenges, and outline potential directions for future research in this domain. The presented models encompass a diverse range of topics related to fetal abnormality classification, including deep learning architectures, feature extraction techniques, dataset characteristics, and evaluation metrics. Each paper was reviewed to assess its contribution to the field and extract key insights that can inform the development of an effective deep learning-based system for fetal abnormality classification.

2. LITERATURE REVIEW

The literature review begins with an explanation of the importance of foetal abnormality categorization in prenatal treatment. It emphasises the shortcomings of traditional approaches while emphasising the potential benefits of using machine learning techniques to improve classification accuracy and efficiency.

3. MACHINE LEARNING MODELS

The four major categories of machine learning algorithms are known as supervised, semi-supervised, unsupervised, and reinforcement learning, each of which is based on a different learning strategy[23-29]. It is usual practice to employ regression and classification algorithms when trying to predict results, identify trends in data, or spot outliers.

3.1 Supervised Learning To create predictions, supervised learning algorithms make use of labelled datasets. This learning strategy is useful when you know what kind of result you want.

3.2 UnSupervised Learning Unlabeled data is used by unsupervised learning systems. This method of learning labels unlabeled material by categorising it or expressing its type, form, or structure. When the nature of result is unknown, this strategy comes in helpful.

3.3 Semi-Supervised Learning: The above two are combined in Semi-supervised learning methods, which use both labelled and unlabeled data. The goal of these algorithms is to classify unlabeled data using knowledge acquired from labelled data.

3.4 Reinforcement Learning: Reinforcement learning algorithms employ the outcome or result as a benchmark to determine the next action step. In other words, these algorithms learn from prior outcomes, receive input after each step, and then decide whether to proceed with the next step or not. During the process, the system determines whether it made the correct, incorrect, or neutral option. Because they are designed to make decisions with minimum human intervention, automated systems can use reinforcement learning.

We examine the top ten machine learning algorithms that are commonly utilised to achieve real-world results.

1. Linear regression
2. Logistic Regression
3. Decision Trees
4. Support Vector Machines
5. Naïve Bayes
6. KNN
7. K-Means
8. Random Forest
9. Artificial Neural Networks
10. Recurrent Neural Networks

Linear regression

In linear regression, the independent variable (x) is correlated with the dependent variable (y) to get a predicted value for the latter. Let's break down the algorithm with an example in which you must arrange a few plastic boxes of varying sizes on distinct shelves based on their weights. The goal of linear regression is to identify the best fit line that reflects the relationship between variables y and x.

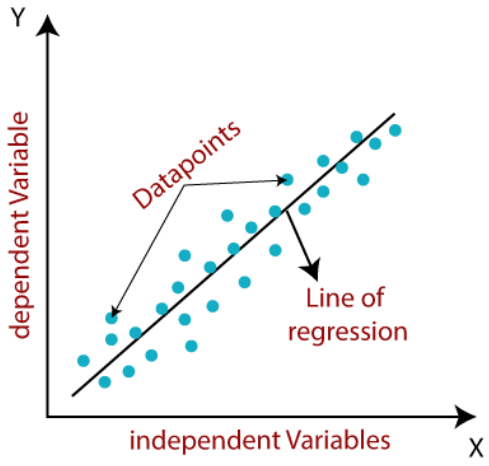

Figure 1 Linear Regression Model

Logistic Regression

The dependent variable in logistic regression is dichotomous, or can only take on two possible values. One dichotomous dependent variable is linked to several independent variables in this type of regression analysis. Predictive analytics like logistic regression use historical data to estimate future outcomes with the help of a logit function. Therefore, it is commonly known as logit regression.

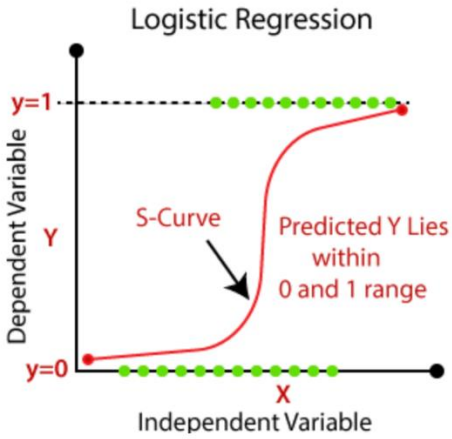

Figure 2 Logistic Regression Model

Decision Trees

Consider the decision tree below, which assists in making a weekend plan based on the weather forecast. A decision tree is a graphical representation of a decision set's expected outcomes. It helps organisations make educated decisions by weighing the pros and cons of many scenarios and weighing the odds of various events happening. Theoretically, a decision tree algorithm's mathematical architecture can foretell which choice is best, and in practise, it can be helpful when generating ideas for a choice. The tree has a central node representing the choice to be made, with offshoots representing possible courses of action. Each inference has the potential to produce offspring nodes, expanding the network's reach. The algorithm yields a tree-like structure that can be applied to problems of categorization.

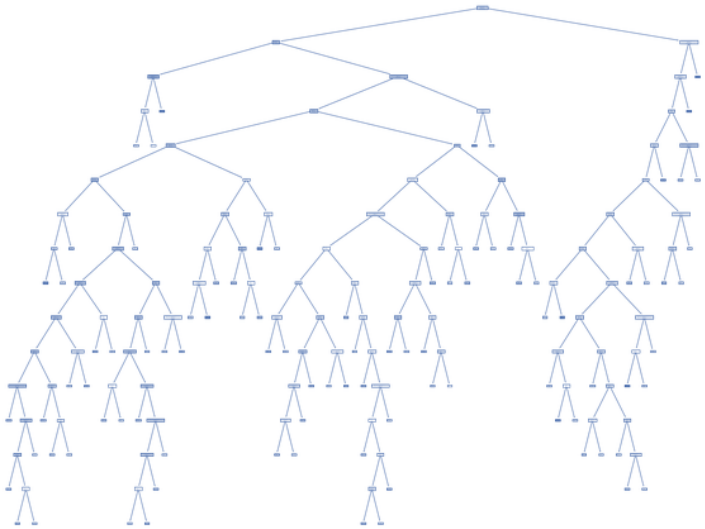

Figure 3 Decision Tree

Support Vector Machines

Support vector machine methods are used to perform classification and regression problems. This category of machine learning techniques is known as supervised learning, and it works by placing each data point in an n-dimensional space, where n is the total number of features. With a coordinate value associated with each feature value, plotting the features is simplified. For further classification, the hyper-plane separating the two sets of support vectors or classes must be determined. When data points are well separated, it's much easier to classify them.

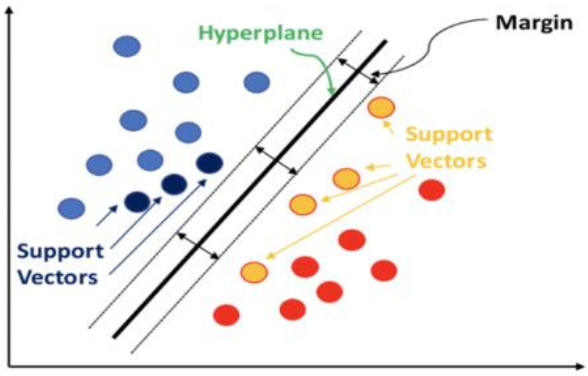

Figure 4 Support Vector Machines

Naïve Bayes

To classify data, Naive Bayes uses the Bayesian probability model and is a probabilistic machine learning technique. The fundamental assumption of the method is that the features being evaluated are uncorrelated, meaning that a change in the value of one feature does not affect the value of any other features being evaluated.

$$P(A|B) = \frac{P(B|A)\,P(A)}{P(B)}$$

using Bayesian probability terminology, the above equation can be written as

$$\text{Posterior} = \frac{\text{prior x likelihood}}{\text{evidence}}$$

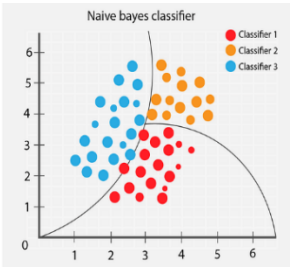

Figure 5 Naïve Bayes

KNN

K-Nearest Neighbours (KNN) is a method for resolving classification and regression issues. New use cases (or data points) are categorised and added to the existing use case collection. This categorization takes into account how well the most recent use cases match the ones already in existence. With KNN, the number of nearby points used to classify and separate the known n groups is determined by the parameter K. This is a supervised machine learning technique. There is no need for the algorithm to go through a dedicated learning phase because it learns as it goes along. The majority of the neighbourhood will decide how you're categorised.

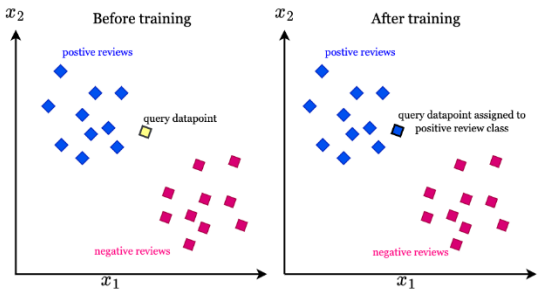

Figure 6 KNN

K-Means

K-Means is a distance-based, unsupervised machine learning algorithm commonly used for clustering. This approach partitions data sets into K clusters, where data points within a cluster share similar characteristics but those of two clusters differ significantly.

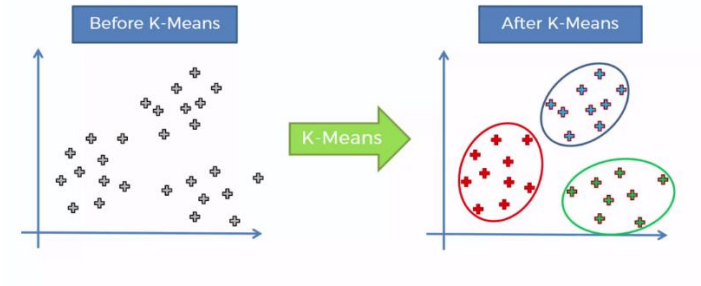

Figure 7 K-Means

Random Forest

Multiple decision trees are used in random forest approaches to tackle classification and regression problems. During training, this supervised machine learning method generates multiple decision trees from a pool of data points representing the training set. These techniques aid in missing data estimation and have a tendency to preserve precision even when a sizable portion of the original data is missing.

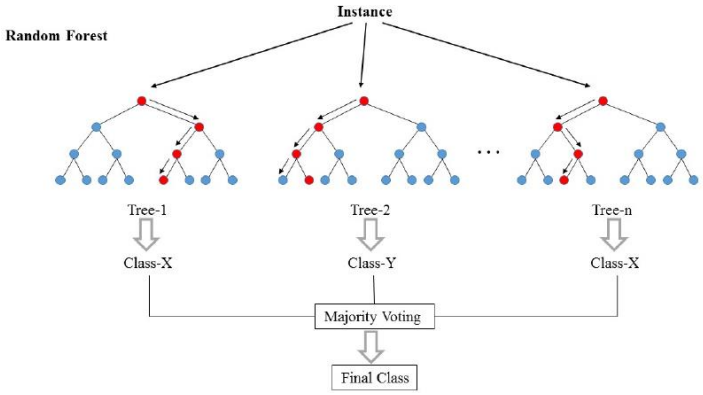

Figure 8 Random Forest

Artificial Neural Networks

Artificial neural networks (ANNs) are a type of machine learning algorithm that may solve difficult problems by simulating the activity and connectivity of real neurons. ANN relies on a computer model with three or more stacked layers to analyse incoming information. The first layer, called the input layer, is made up of neurons that provide information into the network at higher layers. The hidden layer is the second one. The components of this layer perform a series of changes on the data collected from earlier layers in order to improve or update that data. Additionally called neuronal layers. The problem's final output data is transmitted via the third layer, known as the output layer.

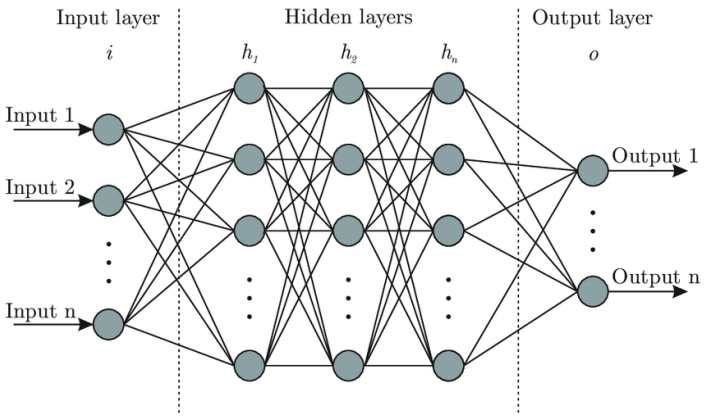

Figure 9 ANN

Recurrent Neural Networks

One variety of ANN, recurrent neural networks, is able to do studies on time series data. The output of the preceding step is used as an input in the current step. The hidden state helps with this because it stores data about a sequence. As a memory, it keeps track of the results of earlier computations. Using RNN memory reduces the neural network's overall complexity.

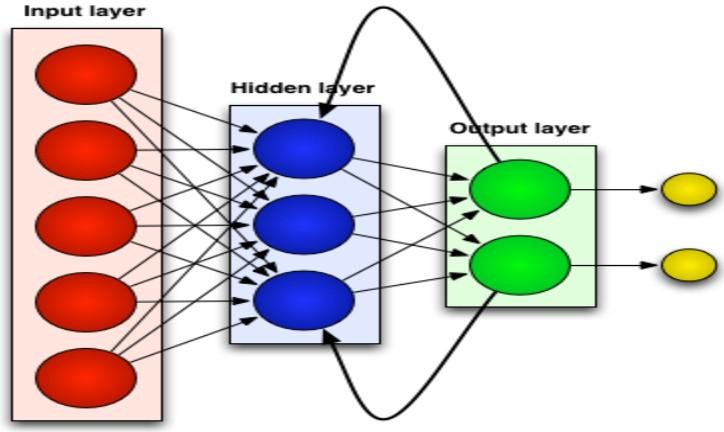

Figure 10. RNN

4. CONCLUSION

The goal of this literature review is to offer readers with a comprehensive summary of the present state-of-the-art methods, challenges, and potential applications of deep learning CNN models in the field of foetal abnormality classification. The results of this analysis of the 5 most important CNN Models will be used to develop a deep learning-based system that is both reliable and accurate for identifying foetal anomalies prediction. The advancement of prenatal care stands to benefit tremendously from the findings of this research work.

References

1. Illanes and M. Haritopoulos, “Fetal heart rate feature extraction from cardiotocographic recordings through autoregressive model’s power spectral- and pole-based analysis,” Proc. Annu. Int. Conf. IEEE Eng. Med. Biol. Soc EMBS, vol. 2015-Novem, pp. 5842–5845, 2015.
2. A. Pinas and E. Chandraharan, “Continuous cardiotocography during labour: Analysis, classification and management,” Best Pract. Res. Clin. Obstet Gynaecol., vol. 30, pp. 33–47, 2016.
3. C. Rotariu, H. Costin, A. Păsărică, and agoş Nemescu “Classification of parameters extracted from cardiotocographic signals for early detection of metabolic acidemia in newborns,” Adv. Electr. Comput. Eng., vol. 15, no. 3, pp. 161–166, 2015.
4. Chinnaiyan, R., Kondaveeti Sai, and P. Bharath. "Deep Learning based CNN Model for Classification and Detection of Individuals Wearing Face Mask." *arXiv preprint arXiv:2311.10408* (2023).
5. Chinnaiyan, R., Prasad, G., Sabarmathi, G., Swarnamugi, Balachandar, S., Divya, R. (2023). Deep Learning-Based Optimised CNN Model for Early Detection and Classification of Potato Leaf Disease. In: Bhateja, V., Yang, XS., Ferreira, M.C., Sengar, S.S., Travieso-Gonzalez, C.M. (eds) Evolution in Computational Intelligence. FICTA 2023. Smart Innovation, Systems and Technologies, vol 370. Springer, Singapore. https://doi.org/10.1007/978-981-99-6702-5_47
6. D. Ayres-De-Campos, C. Y. Spong, and E. Chandraharan, “FIGO consensus guidelines on intrapartum fetal monitoring: Cardiotocography,” Int. J. Gynecol. Obstet., vol. 131, no. 1, pp. 13–24, 2015.
7. Das, S. *et al.* (2023). Crowd Monitoring System Using Facial Recognition. In: Bhateja, V., Carroll, F., Tavares, J.M.R.S., Sengar, S.S., Peer, P. (eds) Intelligent Data Engineering and Analytics. FICTA 2023. Smart Innovation, Systems and Technologies, vol 371. Springer, Singapore. https://doi.org/10.1007/978-981-99-6706-3_50

8. H. Ocak, “A medical decision support system based on support vector machines and the genetic algorithm for the evaluation of fetal well-being,” J. Med. Syst., vol. 37, no. 2, 2013.
9. H. Tang, T. Wang, M. Li, and X. Yang, “The Design and Implementation of Cardiotocography Signals Classification Algorithm Based on Neural Network,” Comput. Math. Methods Med., vol. 2018, 2018.
10. Jadhav, Sarvesh, et al. "Evaluation of Consumer Behavior Regarding Food Delivery Applications in India." *arXiv preprint arXiv:2401.14409* (2023).
11. K. A. Allen and D. H. Brandon, “Hypoxic Ischemic Encephalopathy: Pathophysiology and Experimental Treatments,” Newborn Infant Nurs. Rev., vol. 11, no. 3, pp 125–133, 2011.
12. K. Agrawal and H. Mohan, “Cardiotocography Analysis for Fetal State Classification Using Machine Learning Algorithms,” 2019 Int. Conf. Comput. Commun. Informatics, ICCCI 2019, no. October, pp. 1–6, 2019.
13. M. Arif, “Classification of cardiotocograms using random forest classifier and selection of important features from ardiotocogram signal,” Biomater. Biomech. Bioeng., vol. 2, no. 3, pp. 173–183, 2015.
14. M. de Sa, J. Bernardes, and A. de Campos, “Cardiotocography Data Set,” UCI - Machine Learning Repository, 2010.
15. M. E. B. Menai, F. J. Mohder, and F. Al-mutairi, “Influence of Feature Selection on Naïve Bayes Classifier for Recognizing Patterns in Cardiotocograms,” J. Med. Bioeng., vol. 2, no. 1, pp. 66–70, 2013.
16. N. Chamidah and I. Wasito, “Fetal state classification from cardiotocography based on feature extraction using hybrid K-Means and support vector machine,” ICACSIS 2015 - 2015 Int. Conf. Adv. Comput. Sci. Inf. Syst. Proc., pp. 37–41, 2016
17. N. J. Ali Kadhim and J. Kadhim Abed, “Enhancing the Prediction Accuracy for Cardiotocography (CTG) using Firefly Algorithm and Naive Bayesian Classifier,” IOP Conf. Ser. Mater. Sci. Eng., vol. 745, p. 012101, 2020.
18. P. U. Okorie, “The Significant of Biomedical Engineering to Medical Field in Nigeria The Significant of Biomedical Engineering to Medical Field in,” Am. J. Biomed. Sci. Eng. vol. 2, no. 1, 2015.
19. R. Jyothi, S. Hiwale, and P. V. Bhat, “Classification of labour contractions using KNN classifier,” 2016 Int. Conf.Syst. Med. Biol. ICSMB 2016, no. January, pp. 110–115, 2017.
20. S. A. A. Shah, W. Aziz, M. Arif, and M. S. A. Nadeem, “Decision Trees Based Classification of Cardiotocograms Using Bagging Approach,” Proc. - 2015 13th Int. Conf. Front. Inf. Technol. FIT 2015, pp. 12–17, 2016.
21. S. Velappan, D. Murugan, J. Rani, and K. Rajalakshmi, “Comparative Analysis of Classification Techniques using Cardiotocography Dataset,” IJRIT Int. J. Res. Inf. Technol., vol. 1, no. 12, pp. 274–280, 2013.
22. Z. CÖMERT and A. KOCAMAZ, “A Study of Artificial Neural Network Training Algorithms for Classification of Cardiotocography Signals,” Bitlis Eren Univ. J. Sci. Technol., vol. 7, no. 2, pp. 93–103, 2017.
23. Chinnaiyan, R., Kondaveeti Sai, and P. Bharath. "Deep Learning based CNN Model for Classification and Detection of Individuals Wearing Face Mask." *arXiv preprint arXiv:2311.10408* (2023).
24. Sungheetha, Akey. "Optimized Deep Learning Models for AUV Seabed Image Analysis." *arXiv preprint arXiv:2311.10399* (2023).
25. Sungheetha, Akey. "Emotion Based Prediction in the Context of Optimized Trajectory Planning for Immersive Learning." *arXiv preprint arXiv:2312.11576* (2023).
26. Sungheetha, Akey. "Revolutionizing Underwater Exploration of Autonomous Underwater Vehicles (AUVs) and Seabed Image Processing Techniques." *arXiv preprint arXiv:2402.00004* (2023).
27. Jadhav, Sarvesh, et al. "Evaluation of Consumer Behavior Regarding Food Delivery Applications in India." *arXiv preprint arXiv:2401.14409* (2023).
28. Das, S. *et al.* (2023). Crowd Monitoring System Using Facial Recognition. In: Bhateja, V., Carroll, F., Tavares, J.M.R.S., Sengar, S.S., Peer, P. (eds) Intelligent Data Engineering and Analytics. FICTA 2023.

Smart Innovation, Systems and Technologies, vol 371. Springer, Singapore. https://doi.org/10.1007/978-981-99-6706-3_50

29. Chinnaiyan, R., Prasad, G., Sabarmathi, G., Swarnamugi, Balachandar, S., Divya, R. (2023). Deep Learning-Based Optimised CNN Model for Early Detection and Classification of Potato Leaf Disease. In: Bhateja, V., Yang, XS., Ferreira, M.C., Sengar, S.S., Travieso-Gonzalez, C.M. (eds) Evolution in Computational Intelligence. FICTA 2023. Smart Innovation, Systems and Technologies, vol 370. Springer, Singapore. https://doi.org/10.1007/978-981-99-6702-5_47