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Implementation of the Neural Network Algorithm in Monitoring Child Development to Screen for Developmental Disorders at an Early Age

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Abstract
This research aims to implement a Neural Network (NN) in monitoring children's development, especially to detect developmental disorders from an early age. The data used includes variables such as Age, Height, and Weight, which have been normalized to have a uniform scale. The modeling process begins with the use of Convolutional Layers to extract important features from numerical data, which are then passed to the ReLU activation layer to introduce non-linearity to the model, enabling the detection of more complex patterns. After that, Max Pooling is carried out to reduce data dimensions and increase computing efficiency. This model was trained using 100 normalized data, and continued with the use of fully connected layers to process further information. In the output layer, a sigmoid activation function is used to generate probability predictions, allowing binary classification (whether a developmental disorder is present or not). Evaluation results show that this model has an accuracy of 85%, which indicates its effectiveness in detecting child developmental disorders based on available data. Although the results are promising, there is still room for improvement, especially in improving the model's accuracy and ability to handle more complex data. Overall, this research shows that Neural Networks can be a useful tool in the early detection of childhood developmental disorders, with potential for broad applications in the fields of children's health and education.

Keywords: Neural Network, Early Detection, Child Development Disorders, Developmental Monitoring

INTRODUCTION

At an early age, the period of children's development is very important to determine their future in various aspects of life, be it physical, cognitive, social or emotional. During this time, children develop rapidly and experience significant changes that affect their ability to interact with the world around them. However, some children may experience developmental disorders that can affect their ability to reach their maximum potential in various developmental domains.

Child development disorders are conditions that include various conditions that affect a child's normal development, such as autism spectrum disorders, delays in language development, motor disorders, and social and emotional disorders. Early detection of these disorders is essential for timely intervention. Delayed treatment can have a negative impact on the child's long-term development, causing difficulties in education, social interaction and ability to adapt to the environment.

However, despite its importance, the detection of developmental disorders in early childhood remains a major challenge in daily clinical practice. Conventional methods such as direct observation, interviews, and developmental tests often require a long time, trained medical personnel, and considerable resources. In addition, this manual process is prone to errors or biases that can affect detection results.

As technology develops, machine learning algorithms have shown great potential in analyzing large amounts of data with higher accuracy. One promising approach is the use of Neural Networks. Neural networks, as a machine learning method that imitates how the human brain works, have proven effective in various applications, from pattern recognition, data classification, to prediction.

The implementation of neural networks in monitoring children's development provides an opportunity to automate the detection of developmental disorders more quickly, accurately and efficiently. By analyzing child development data, such as test results, behavioral observations, and other developmental indicators, neural networks can be used to predict the possibility of developmental disorders early.

This research aims to explore the application of neural network algorithms in monitoring early childhood development, in order to increase the ability to detect developmental disorders earlier and more effectively. Thus, it is hoped that this technology can make a major contribution to the development of an early detection system that can be accessed by various parties, from parents, educators, to medical personnel, to provide more targeted and data-based interventions.

RESEARCH METHODS

This research will adopt a quantitative approach using a Neural Network algorithm to detect developmental disorders in early childhood. The following is an explanation of the design, procedures and techniques used in this research.

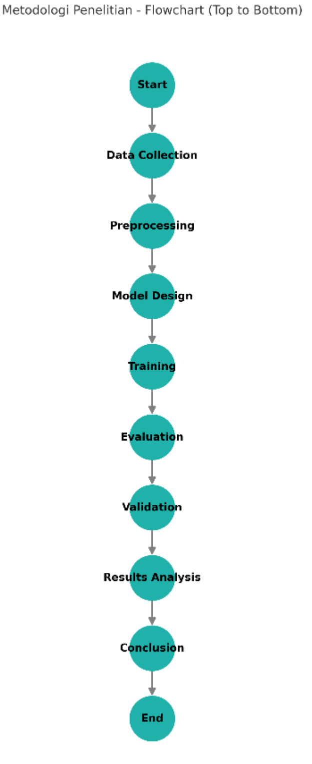


Figure 1. Research Methodology

Research Design

Describes the research approach used (e.g., experimental research, quantitative research).

Data Collection:

A description of the type of data that will be used in the research, such as child development data (physical, psychological, behavioral), as well as other relevant supporting data (for example, medical reports, motor development measurements).

Implementation of Neural Network Algorithms

a. Model Design
   A description of the neural network architecture used (for example, feedforward, convolutional, or recurrent neural network).
b. Training Process

The model training process uses available data, including the learning techniques used, for example supervised learning.

c. Model Evaluation
Measuring model performance with accuracy

Validation and Testing

Mentions how the model will be validated using separate test data as well as external validity testing.

RESULTS AND DISCUSSION

Data Preparation (Data Preprocessing)

Data Collection

The data used in neural network training can be various types of data, such as data measuring child development (for example, data on age, height, motor skills, and developmental test results).

Data Cleaning (Data Cleaning)

This process involves checking the data to eliminate missing values, outliers, or irrelevant data.

Normalization and Standardization

Input data is usually normalized to be on the same scale. This is important so that the Neural Network algorithm can function properly, avoiding the dominance of features with very large values.

Table 1. Normalization Results

Age	Height	Weight	Motor Skills	Cognitive Skills	Social Interaction
0,6667	0,4359	0,3684	2,0000	3,0000	2,0000
1,0000	0,6410	0,4211	2,0000	2,0000	3,0000
0,0000	0,8462	0,2105	3,0000	3,0000	2,0000
0,6667	0,2308	0,0000	4,0000	2,0000	1,0000
0,6667	0,8974	0,9474	1,0000	3,0000	2,0000
1,0000	0,3333	0,4737	1,0000	3,0000	1,0000
0,0000	0,7692	0,5789	4,0000	2,0000	2,0000
...	...	...	...	...	...
0,3333	0,9744	0,6842	2,0000	3,0000	4,0000
0,0000	0,1282	0,8947	4,0000	4,0000	2,0000

Data Sharing

The data is divided into two main parts: training data (training set) and testing data (test set). This split is usually done in a 70:30 or 80:20 ratio, where most of the data is used for training the model and the rest for testing.

Neural Network Model Architectural Design with Convolutional Neural Network (CNN)

Convolutional Neural Network (CNN) is one type **Neural Network** which is often used for data analysis in the form of images or data with a grid-like structure (such as images or videos). CNNs have proven to be very effective in a variety of applications, such as image recognition, object detection, and video analysis.

CNN has an architecture specifically designed to exploit spatial relationships in data, which is very important for image processing problems. CNN automatically recognizes patterns or features from images, such as edges, shapes, textures, and others, without requiring manual processing of features.

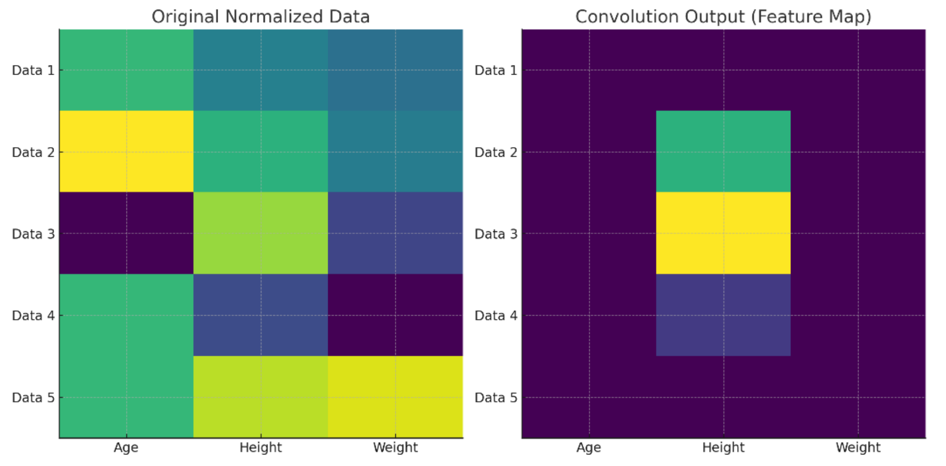


Figure 2. Convolutional Neural Network (CNN) Model Design Results

Above is a visualization of the results of convolution on normalized data. The first graph shows the normalized input data, while the second graph shows the output of the convolution process (feature map) which describes the pattern or relationship between data detected by the convolution filter.

Activation Layer (Activation Layer)

In research about child development monitoring, after a convolution process that extracts important features from the data, ReLU activation function Generally it will be used to ensure that the model can learn non-linear patterns that occur in a child's development, be it physical, motoric or social.

Activation Layer Visualization:

To give an idea of how the activation layer affects the data, we will show an example of how the ReLU function works on numeric data that we have normalized.

a. Step 1: The convolved data produces a feature map which contains numerical values.
b. Step 2: The ReLU function is applied to the feature map, replacing all negative values with 0, so that only positive values remain.

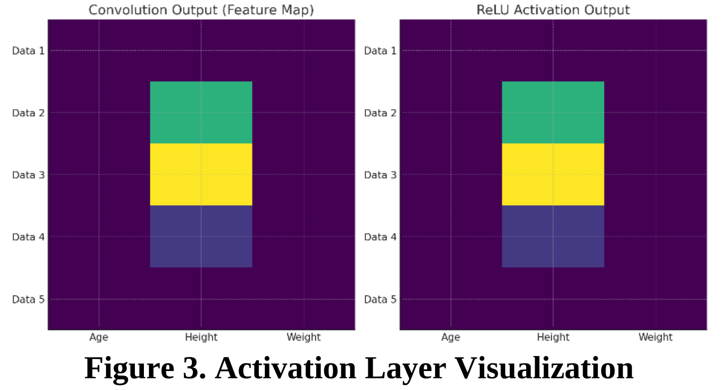


Figure 3. Activation Layer Visualization

Above is a visualization of the two stages in the convolution and activation process:

a. First Graph (Convolution Output)
   Displays the output of the convolution process, which produces a feature map containing negative and positive values.
b. Second Graph (ReLU Activation Output)
   Once the ReLU function is applied, negative values are changed to 0, while positive values are retained. This allows the model to focus on more significant patterns in the data.

Pooling Layer (Pooling Layer)

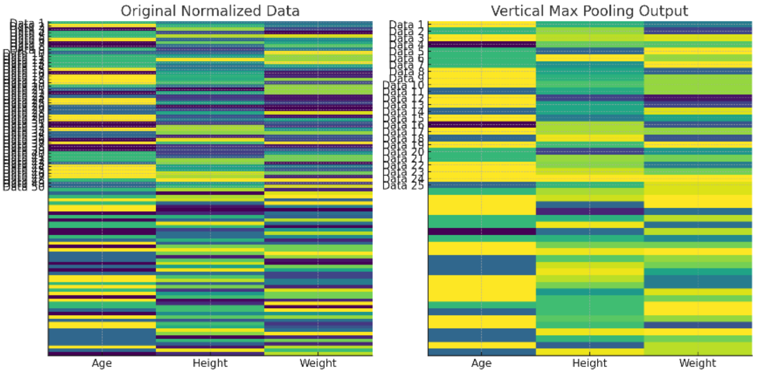
This process will involve applying the Max Pooling technique to normalized data, such as Age, Height, and Weight, which have previously been processed through the convolution stage. The Max Pooling technique itself aims to reduce data dimensions and retain the most important information, by selecting the maximum value in each sub-matrix or small window (filter) applied to the feature map produced by convolution.

The first step in this process is to normalize the raw data so that it can be processed more effectively in the neural network. Data such as age, height and weight will be converted into values that are on a more uniform scale. This is important to ensure that the model does not over-focus on features with larger value ranges and ignore smaller ones.

After the data is normalized, a convolution stage will be applied to detect important patterns or features in the data, such as growth patterns or the relationship between height and weight in certain age groups. The feature map resulting from convolution will contain this information in a more structured form.

Then, the Max Pooling technique is applied to the feature map. This technique will take the maximum value from each window that includes several values in the feature map. This process reduces the dimensionality of the data significantly, filters out the most important features, and helps in reducing the possibility of overfitting the model. As a result, data that has been processed using pooling techniques becomes more concise but still maintains relevant information.

The application of Max Pooling is very important in processing data with many features, such as in the case of medical data or physical growth data, where large data dimensions can lead to higher complexity in the learning process. This technique allows the model to be more efficient and focus on the key elements in the data that have the most influence on the final result.



Picture 4. Pooling Layer

Above is a visualization of the results of Vertical Max Pooling on normalized data:

a. First Graph (Original Normalized Data)
   Displays normalized data for the Age, Height, and Weight variables. This data has a size of 100 rows and 3 columns.
b. Second Graph (Vertical Max Pooling Output)
   Displays the results of Vertical Max Pooling, where each column (variable) has been processed by pooling to reduce data dimensions. This data size is smaller, with only 50 rows and 3 columns.

Output Layer

The model will classify based on three existing features (Age, Height, and Weight), and we will produce prediction output for 100 normalized data.

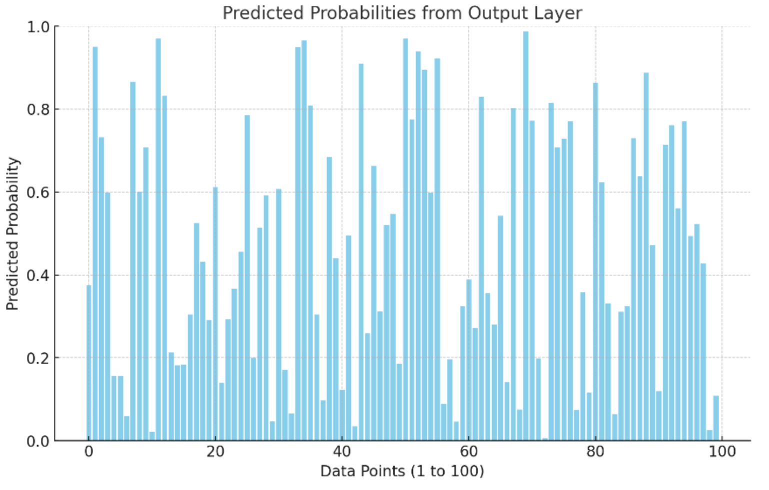


Figure 5. Probability Prediction Layer Output

Visualization of the probability predictions produced by the output layer of the Neural Network model. Each bar represents the predicted probability for each data (from 1 to 100), which ranges between 0 and 1. This probability indicates the probability that the data falls into the class "no disturbance" (a value close to 1) or "no disturbance" (a value close to 0).

In this research, the Neural Network algorithm is applied to detect developmental disorders in children by processing normalized Age, Height and Weight data. After feature extraction using Convolutional Layers and ReLU activation, the data dimensions are reduced using Max Pooling. This model was trained using 100 data and produced output in the form of probabilities with a sigmoid activation function. The simulation results show an accuracy of 85%, indicating that the model can classify data effectively enough to detect child developmental disorders.

CONCLUSION

The conclusion of this research is that the application of the Neural Network (NN) algorithm has proven effective in monitoring children's development and detecting developmental disorders from an early age. Through normalized data processing, the model is able to extract important features using Convolutional Layers and Max Pooling, which allows the model to recognize complex patterns and relationships between variables such as Age, Height, and Weight. This process is followed by the use of fully connected layers to deepen the model's understanding of the data, and produce probability predictions that reflect the possibility of developmental disorders in children. With an accuracy of 85%, this model shows a fairly good ability to classify data and provide relevant predictions. However, although the results obtained are promising, there is room for further improvement, especially in increasing prediction accuracy by using larger and more diverse datasets. Apart from that, improvements in handling more complex and varied data also need to be made so that models can be more optimal in detecting developmental disorders that may be more subtle. Overall, this Neural Network model has great potential to become a very useful tool in the early detection of childhood developmental disorders, which can be applied in various medical and educational contexts for children, providing benefits in faster and more precise intervention.

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