

# Neural Networks Simply Calculated With Numerical Examples

Neural networks have become increasingly popular in various fields, including artificial intelligence, machine learning, and data analysis. These powerful computational models are designed to mimic the workings of the human brain, enabling them to learn from data, recognize patterns, and make predictions. In this article, we will explore the basics of neural networks and provide numerical examples to help you understand their calculation process.

## Understanding Neural Networks

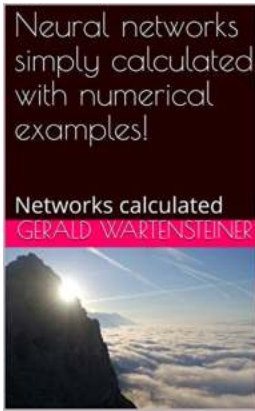
A neural network consists of interconnected artificial neurons, also known as nodes or units. These nodes are organized in layers, typically including an input layer, one or more hidden layers, and an output layer. Numeric values, called weights, connect these neurons. The weights represent the strength of the connections between neurons and determine the impact of each neuron's input on the final output.

The calculation process of a neural network involves two main stages: forward propagation and backward propagation. During forward propagation, the input data travels through the network layer by layer, with each neuron receiving and processing the incoming signal. The weighted sum of the inputs is then passed through an activation function, which introduces non-linearity into the network and helps the model learn complex relationships in the data.

### **Neural networks simply calculated with numerical examples!: Networks calculated**

by Óscar Ocaña Parrón ([Print Replica] Kindle Edition)

★★★★☆ 4.6 out of 5



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Once the output is generated, it is compared to the expected output, and a loss function is used to measure the error or discrepancy. The goal is to minimize this error and train the neural network to produce accurate predictions. This is where backward propagation, also known as backpropagation, comes into play. It involves adjusting the weights based on the calculated error, enabling the network to learn and improve its performance over time.

## Numerical Examples

Now, let's dive into some numerical examples to better understand how neural networks perform calculations. We will use a simple neural network with a single hidden layer for demonstration purposes.

### Example 1: XOR Gate

The XOR gate is a classic example that demonstrates the computational power of neural networks. It takes two binary inputs and produces a 1 if exactly one of the inputs is 1, otherwise it produces a 0.

In our neural network, we will have an input layer with two neurons to represent the binary inputs (0 or 1). The hidden layer will consist of two neurons, while the

output layer will have a single neuron representing the binary output (0 or 1).

To calculate the output, we need to assign random weights to the connections between neurons. Let's assume the following weights:

- Input Layer to Hidden Layer:  $w_1 = 0.4$ ,  $w_2 = 0.9$
- Hidden Layer to Output Layer:  $w_3 = 1.2$ ,  $w_4 = -1.0$

For simplicity, we will use the sigmoid activation function, which maps any real-valued number to a value between 0 and 1.

Suppose we have the inputs  $A = 1$  and  $B = 0$ . The calculation of the hidden layer neurons can be done as follows:

1. Neuron 1 in the hidden layer:  $(A * w_1) + (B * w_2) = (1 * 0.4) + (0 * 0.9) = 0.4$
2. Neuron 2 in the hidden layer:  $(A * w_3) + (B * w_4) = (1 * 1.2) + (0 * -1.0) = 1.2$

Next, we apply the activation function to each neuron in the hidden layer:

1. Activation of Neuron 1:  $1 / (1 + \exp(-0.4)) = 0.5987$
2. Activation of Neuron 2:  $1 / (1 + \exp(-1.2)) = 0.7685$

To calculate the output, we need to calculate the weighted sum of these hidden layer activations:

$$\text{Output} = (0.5987 * w_3) + (0.7685 * w_4) = (0.5987 * 1.2) + (0.7685 * -1.0) = 0.4184$$

Finally, we apply the activation function to the output neuron:

$$\text{Activation of Output Neuron: } 1 / (1 + \exp(-0.4184)) = 0.6030$$

The neural network predicts a value of approximately 0.6030 for the XOR gate with inputs  $A = 1$  and  $B = 0$ .

## **Example 2: Handwritten Digit Recognition**

Another fascinating application of neural networks is handwritten digit recognition. Let's say we have a dataset of handwritten digits ranging from 0 to 9 and we want to train a neural network to recognize them.

In this example, we will use a neural network with an input layer of 784 neurons (representing a 28x28 pixel image), a hidden layer with 200 neurons, and an output layer with 10 neurons (one for each digit).

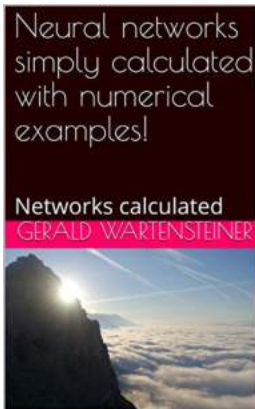
The weights will be initialized randomly, and the activation function used will be the rectified linear unit (ReLU), defined as the maximum between 0 and the weighted sum of inputs.

Suppose we have an image of the digit 7 as our input. The forward propagation process involves passing the input values through the network and calculating the activations of each neuron. The same process as described in Example 1 applies, but with larger dimensions and more complex calculations.

Once the output is obtained, the backward propagation algorithm adjusts the weights based on the calculated error, minimizing it and fine-tuning the network's ability to recognize digits accurately.

Neural networks are powerful computational models that can learn complex relationships from data. They are used in various applications, ranging from pattern recognition to predictive analytics, and have proven to be highly effective in many fields. In this article, we explored the basics of neural networks and provided numerical examples to help you understand their calculation process.

By simulating the calculations involved in simple problems like the XOR gate and complex tasks like handwritten digit recognition, we highlighted the capabilities and potential of neural networks. So, dive into this fascinating field, experiment with different network architectures, and unleash the power of neural networks in your own projects!



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Neural networks simply calculated with numerical examples!

The author gave himself to this complex subject with interest and curiosity.

Unfortunately, NUMBER EXAMPLES are in the specialist literature hard to find.

This book is intended to close this gap.

Simple Numerical examples are calculated step by step. Thereby the procedure becomes "self-explanatory".

Actually, "anyone" who understands simple calculations can also understand how a neural network works.

Neural networks simply calculated with numerical examples

That is the title of this book.

\*\*\*BECAUSE\*\*\*

“Gray, dear friend, is all theory and green the golden tree of life”

(Johann von Wolfgang von Goethe)

With this in mind, I would like to invite the valued reader with me a journey into the "realm of neural networks" to start.

Questions after questions:

What can a neural network do?

What does a neural network calculate?

How is that calculated?

How can you program a neural network?

A very simple "perceptron" and a small neuronal Back propagation network are presented.

The "error correction in reverse gear" is the author in Detail carried out step by step.

Every arithmetic step becomes understandable through the "NUMBER EXAMPLES".

Furthermore, the forecasting method according to Holt is also briefly presented, which fits well with the topic "forecasting and previewing data series".

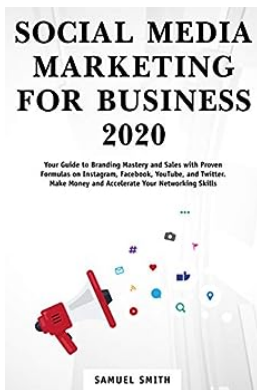
This book is also an "artistic" work in the broadest sense Senses and thus completely incomplete.

The author did “EVERYTHING” and the examples programmed in a simple classic programming language.

The author also does not want to make any money with this book, this book was written “exclusively” for the fun and enjoyment of the topic.

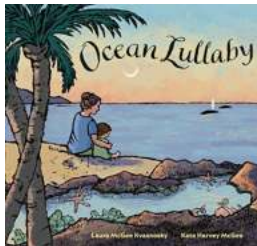
Ing. Gerald Wartensteiner

The author from Austria apologizes for any translation errors caused by the translation program and hope these mistakes are funny



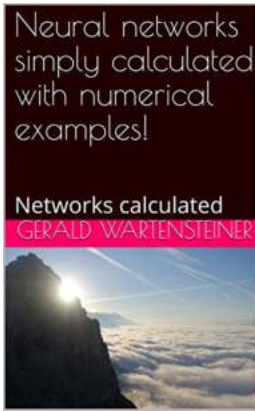
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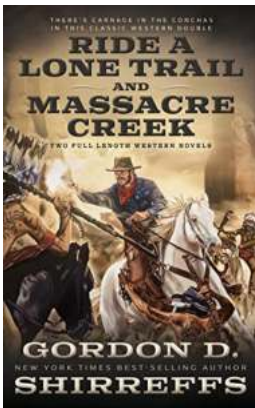
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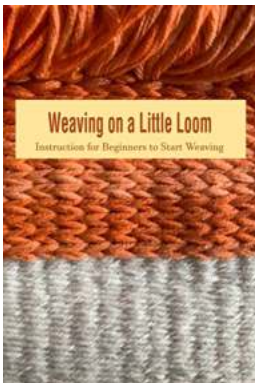
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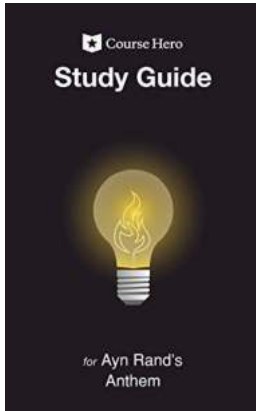
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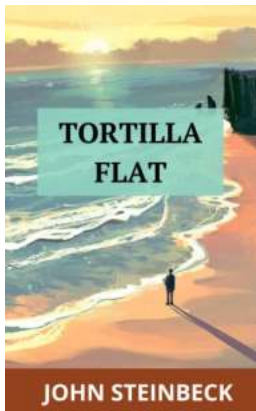
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