

Appilcation of adaline artificial neural network for classroom determination in elementary school

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Abstract. Technology has been widely applied to the field of education in the form of system that is, help and solve various problems that exist in school. However, this technology is still rarely applied at elementary school level so that researchers will implement intelligent systems that can help in the determination of classes for new students. This determination is based on reading and writing tests. Classes are divided into regular and special, where students who score less than the minimum standard enter in a special class while students are able to enter the regular classroom. The intelligent system in this research will use instructional technique with Adaline method. Adaline is an artificial neural network that has a weight change algorithm and an activation function

1. Introduction

Technology has been widely applied in the field of education such as computer-based national exams, new student admissions systems, raport/value systems, etc. The information system is one of technology that continues to develop to facilitate, assist and solve various problems in school. Example of system development is to apply artificial intelligence into a system, so that system can be called as an intelligent system which can solve problems more quickly and precisely. Although intelligent systems have been applied to the field of education, but in reality not all levels of education have used it optimally. The level of education that has not used the intelligent system is at the elementary school level, the lack of intelligent system specifically developed for that level is one of the reasons, hence more development of intelligent systems are needed and in accordance with the needs of the existing level.

There are some elementary schools that apply classroom determination according to student ability, especially for new students. Determination of the classroom based on the score of reading tests and written test which calculated into a final score. After calculation of the final score done, then classroom determination will be made. Classes are divided into two, the regular and special classes, students who have the final score less than the minimum standard will enter into a special class, while students who have the final score above the minimum standard will be entered into the regular class. However, the calculation of the final score and the class determination is still done manually so as to enable the occurrence of human error, so it is needs an intelligent system that can determine the class in accordance with the input data in the form of reading test score and write test score so as to minimize the possibility of human error and help elementary school in determining class more quickly and precisely.



Intelligent system in this research using learning approach technique with Adaline method, learning approach means the system will automatically find the expected rules that can be generally applicable to data that has never been known before, but to find a rule is required data learn that the initial data used as a reference, in this study data learn are from reading test scores and write test scores. Adaline method is one of artificial neural network which has weight change algorithm and special activation function. Through this Adaline method will be generated a weight that is a rule or reference to determine the class in the next data.

2. Adaline

The Adaline (Adaptive Linear Neuron) discovered by Widrow & Hoff (1960) has a network architecture similar to perceptron with multiple inputs and biases that are connected directly to an output neuron. The difference with perceptron lies in the case of weighting modifications. The differences with perceptron lies in the case of weighting modifications. Weight modification with the delta rule (often also called Least Mean Square) [1]. During the training, the activation function used is the identity function. Delta rule learning method is used in training both Adaline and Madaline networks. The main purpose of the delta rule is to fix the weights that connect the input and output units so that the difference between the network input for the output unit (y_{in}) and the target value (t) becomes minimal.

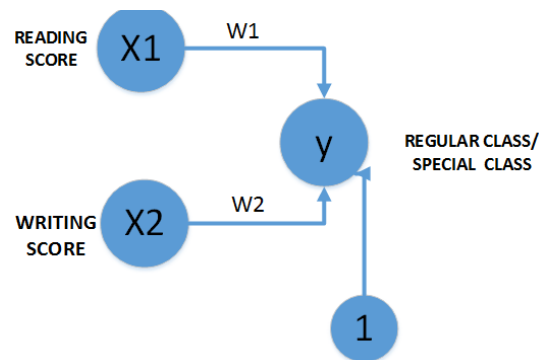


Figure 1. Adaline architecture network.

ADALINE (Adaptive Linear Neuron) is one of many artificial neural network methods that have only one output [2]. While input from ADALINE can be single or multiple input in accordance with the desired model. Adaline is a single unit (neuron) that receives input from several units. Some Adalines that receive signals from the same input output can be integrated into a single layer network as in a perceptron network [3]. Adaline has the following characteristics:

- The network consists of one or more input units and one output unit.
- Has a bias that behaves like a customizable weight located on the connection of a unit that always outputs a +1 signal so that the bias weight can be trained like any other weight with the same process in the training algorithm
- Some Adaline networks that receive signals from the same input unit in combination into a single layer network such as perceptron
- Some Adaline can also be combined so that the output from some Adaline becomes input to other Adaline, and will form a multilayer network called the Madaline (Many Adaptive Linear Neurons).

In the development of this intelligent system there are two input data in the form of test reading value (X_1) and write test value (X_2) which then produce one output data in the form of class determination (regular class or special class). The range in the input and output data is $[1, -1]$ because the Adaline method uses bipolar.

3. Methodology

3.1. Data Flow Diagram (DFD)

3.1.1. DFD level 0. The data flow diagram (DFD) level 0 describes the general input and output data flow in the system. The process starts from the input data in the form of learning data that is the value of reading test and written test score. In this study used 20 data learned obtained from a primary school with a target or the results of class determination has been known, in other words 20 data is data from previous students. After doing the data input learn, the user can perform the calculation of weight calculation. Query calculation is a process whereby the Adaline method algorithm works to generate new weights that are used as a rule or reference to determine the classes in new student data. After the new weights have been successfully saved, the user can input the new student data and see the result of the class determination automatically based on the calculation of the test value and the written test score and the new weight generated in the previous stage.

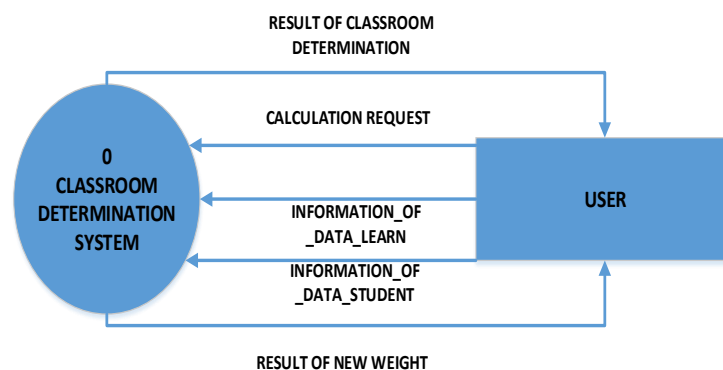


Figure 2. DFD Level 0.

3.1.2. DFD level 1. DFD level 1 describes more details of each input or output in each process that occurs. There are three processes in this system that enter the data learn, calculate the weight and classify the class. In the process of entering the data learn, the user enters the data of the test scores, the written test and the class results through a form, then the input data will be normalized by using the normalization formula to be in the range $[-1, 1]$ because the Adaline method uses bipolar. The result of normalizing the data is stored into the database.

After the data is stored in the database in the form of result of normalization of reading test value (X1) and write test value (X2), in calculating the weight of Adaline algorithm will run in sequence ie calculate net, $f(\text{net})$, weight change and new weight until data to 20. In the 20th data it will be checked condition to see whether the calculation stops on the epoch or epoch continues. If the calculation on an epoch has stopped, then the new weights generated in the data to learn to 20 will be stored in the database

After the new weights are stored in the database, the user can classify the class / class determination, but the user previously entered the data in the form of student name, the value of the reading test and the value of the written test as new data. In this process we calculate net and $f(\text{net})$ by using the weights stored in the database. The result of the class determination will be saved and can be viewed through the system.

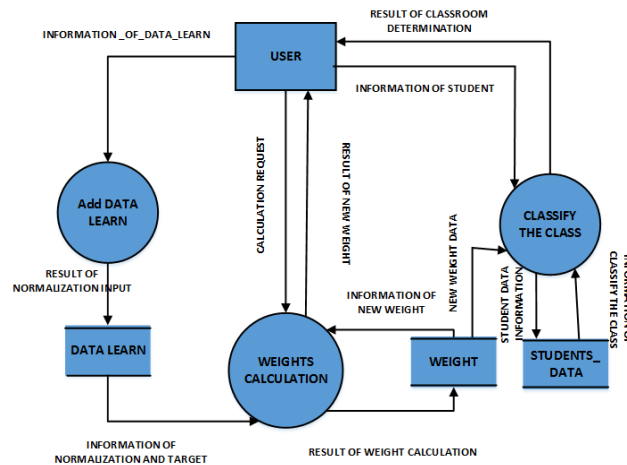


Figure 3. DFD Level 1.

3.1.3. Relation Table. The intelligent system in this study has three tables as in figure 4, the normalized input data will be stored into the data_learn table. The data_learn table has six fields ie code (primary key), read_x1 (read test value), write_x2 (write test value), x1 (result of normalization of read value), x2 (result of normalization of write value) and target (class category). The weights table has nine fields: kode_bobot (primary key), w1 (weight of read value), w2 (write value weight), b (bias), max_x1 (max value of read test), min_x1 (minimum value of read test), max_x2 (value maximum write test), min_x2 (minimum value of write test), and code (foreign key). The table data_siswa has ten fields namely nis (primary key), name, read (value of reading test), write (write test score), x1 (result of normalization of read value), x2 (result of normalization of write value), net, f (net) (result of activation function), class (result of regular / special class determination), kode_bobot (foreign key).

Based on the table relation in figure 4, the data_learn table is related to the weight table because through the weight calculation process which can be seen in the DFD in figure 10, the calculation is done by using learn data to generate new weight which is then stored in the weight table. The table data_siswa also interrelated with the weight table because to make the determination of the new student class required net calculations and f (net) using the new weight stored in the weight table.

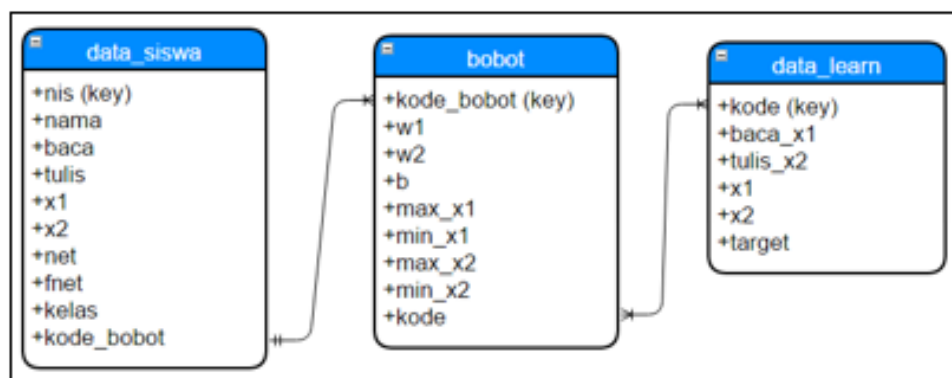


Figure 4. Relation table.

4. Discussion and result

Figure 5 showing user interface for input data learn as the initial data so system can generate a weight as a rule to determine classroom. In data learn panel user can input data first before calculate a weights. After some data learn stored in database system, user can perform new weight calculations by pressing the calculate weights button. Weighting calculation is doing by normalization data, net, f (net), weight changes, and new weight every epoch. After weighting calculation done, so new weight from w1(the weight of the read value), w2(the weight of the write value) and bias will be stored in database system and can be used as a class determination calculation on the actual data.

**PENERAPAN JARINGAN SYARAF TIRUAN ADALINE PADA
PENENTUAN KELAS SISWA DI SEKOLAH DASAR**

Penentuan Kelas
Masukkan Data Learn

Data Learn

Data Learn akan digunakan untuk menghitung bobot baru yang digunakan untuk penentuan kelas Isikan data learn terlebih dahulu agar sistem mempelajari pola penentuan kelas

Nilai Baca :

Nilai Tulis:

Masuk Kelas :

Kelas Reguler ▼

Tambah

Hitung Bobot

REKAP DATA BOBOT

KODE	W1	W2	BIAS
3	0.91216	0.677605	0.113719

Figure 5. User interface for calculation weight.

Besides being able to see new weights, users can see the data learn that has been previously entered and stored in the system database like figure 6. X1 is result of normalization from reading score, X2 is result of normalization from writing score and target is result of classroom determination on data learn. Normalization is done to change the value into the range $[-1, 1]$. Target is 1 if students enter the regular class, and target is -1 if students enter the special class.

REKAP DATA LEARN					
KODE	NILAI BACA	NILAI TULIS	X1	X2	TARGET
1	60	35	0.142857	-0.375	-1
2	60	65	0.142857	0.375	1
3	60	57	0.142857	0.175	1
4	60	78	0.142857	0.7	1
5	60	50	0.142857	0	1
6	67	22	0.342857	-0.7	-1
7	79	38	0.685714	-0.3	1
8	85	40	0.857143	-0.25	1
9	40	60	-0.428571	0.25	1
10	90	10	1	-1	1
11	70	80	0.428571	0.75	1
12	70	65	0.428571	0.375	1
13	60	70	0.142857	0.5	1
14	40	70	-0.428571	0.5	1
15	70	65	0.428571	0.375	1
16	70	70	0.428571	0.5	1
17	67	90	0.342857	1	1

Figure 6. Recap learn data that is stored in the database system.

The calculation for the classroom determination in elementary school which step by user can enter data input for new student to class determination. User can enter input data new student for class determination where input data are name, reading test score, and writing test score. If the calculation process is done, then the student data will be seen in the table of student data recap and its class determination. X1 and X2 is the result of normalization of the value of the test read and write test, net and f (net) is the result of the activation function by using the weights that have been obtained in the previous stage and stored in the database. The result of class determination can be seen from column f (net) and class classification, where if f (net) is 1 then the student will enter into regular class, if f(net) is value -1 then student will enter into special class

The calculation of data learn is done as a knowledge base or basic knowledge of the system so that the system can recognize class classification so that the resulting weight value is used to calculate or classify the class on the actual data. There are 20 data used as basic knowledge where 20 students have reading test scores, written test score, accumulation value and class classification.

From the data in Table 1 it is known that students who have an accumulative value greater than or equal to 50 enter into the regular class, while less than 50 will enter into a special class, this will become the target of the calculation, which is the regular class is the target 1 and class special target -1, used range [1, -1] because the Adaline method using bipolar.

The search values of x1 and x2 are used to convert the values into the range [1, -1], then in the next step net, f (net), (t-y) calculations, new weight and weight changes. For the first initialization then use value 0 for w1, w2 and bias. For this calculation used value $\alpha = 0.3$ and tolerance limit is 0.15.

Table 1. Data learn classroom determination in elementary school.

Student	Reading Score	Writing Score	Total Score	Classroom
1	60	35	47,5	special
2	60	65	62,5	reguler
3	60	57	58,5	reguler
4	60	78	69	reguler
5	60	50	55	reguler
6	67	22	44,5	special
7	79	38	58,5	reguler
8	85	40	62,5	reguler
9	40	60	50	reguler
10	90	10	50	reguler
11	70	80	75	reguler
12	70	65	67,5	reguler
13	60	70	65	reguler
14	40	70	55	reguler
15	70	65	67,5	reguler
16	70	70	70	reguler
17	67	90	78,5	reguler
18	20	20	20	spesial
19	55	65	60	reguler
20	40	48	44	special

Regular and specific class determination data in Table 3 is the same as the Elementary School class data in epoch 2 so that the calculations of x_1 , x_2 and target have the same values in table 4. Maximum $[\Delta w] = 0.150804 > \text{tolerance}$, tolerance limit used is 0.15 so proceed to epoch 2 and the calculation continues. To initialize the new weights in epoch 2 then we use new weights that have been calculated in epoch 1. The maximum $[\Delta w] = 0.137481513 > \text{tolerance}$, the tolerance used is 0.15, since the condition is false, the calculation stops until epoch 2. After obtaining new weights, the calculation of trials for similarity and see the accuracy of data is done by calculating the net using the new weight obtained in epoch 2 then compare the results $f(\text{net})$ from the net try with the target. The comparison results can be seen in table 2 where the orange blocked columns show the error of the calculation, since $f(\text{net})$ calculated using the new weights does not match the desired target.

Table 2. Trials calculation for 20 data.

X1	X2	Target	net coba	f(net)
0.142857	-0.375	-1	-0.01036	-1
0.142857	0.375	1	0.498145	1
0.142857	0.175	1	0.362544	1
0.142857	0.7	1	0.718495	1
0.142857	0	1	0.243894	1
0.342857	-0.7	-1	-0.04829	-1
0.685714	-0.3	1	0.535639	1
0.857143	-0.25	1	0.725901	1
-0.42857	0.25	1	-0.10781	-1
1	-1	1	0.347701	1
0.428571	0.75	1	1.012998	1
0.428571	0.375	1	0.758747	1
0.142857	0.5	1	0.582895	1

Table 2. Cont.

-0.42857	0.5	1	0.061689	1
0.428571	0.375	1	0.758747	1
0.428571	0.5	1	0.843498	1
0.342857	1	1	1.104318	1
-1	-0.75	-1	-1.30702	-1
0	0.375	1	0.367843	1
-0.42857	-0.05	-1	-0.31121	-1

5. Conclusion

From the results and the discussion can be concluded that, Adaline method can be used in the classroom in elementary school by entering the value of read and write so that the output of classification of special class and regular, so that can facilitate the school in determining the class more quickly and precisely. In this intelligent system, the calculation begins by determining the weights using the data learn, where the first calculation is to determine the value of x_1 and x_2 as the result of normalizing the input data to convert the value into range $[1, -1]$, then the value will be the basis for searching change of weight, new weight and final weight. In the calculations of Epoch 1, and 2 have different weight results using the same x_1 and x_2 values. The epoch calculation will stop when the maximum value $[\Delta w] > \text{tolerance limit}$, at 20 data learn the weight calculation stops at epoch 2, resulting in weight and bias which can be used to calculate the $f(\text{net})$ of new data. Based on the result of comparison between the target and the new $f(\text{net})$ calculated using the new weight and bias, on 20 data learn there is one data that is not match / unsuitable, so can be said the accuracy of this system is 95%.

References

- [1] Handayani A N 2009 Perbandingan Model PERCEPTRON dan ADALINE pada Fungsi Logika AND fan OR menggunakan Artificial Neural Network *Seminar Nasional Electrical, Informatics and Its Education*
- [2] Jong Jek Siang 2009 *Jaringan Syaraf Tiruan & Pemrograman Menggunakan MATLAB* (Yogyakarta, Indonesia: ANDI)
- [3] Kusumoputro B 2009 Metode Pembelajaran *Computational Intelligence* 1-20