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Determination of the Best Accuracy Model for Predicting Average Years of Schooling using the Fletcher Reeves Algorithm

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ABSTRACT

The average length of schooling is an important and significant factor in looking at the quality of an individual human being, with increasing the quality of human resources it can increase access to decent work which also promises a stable economic income, and to some extent affects the economy in a country. Therefore, a prediction was made. This prediction method uses the Fletcher Reeves algorithm which is an artificial neural network algorithm method for data prediction. However, this paper does not discuss the results of the prediction, but discusses the ability of the Fletcher Reeves neural network algorithm to predict data. The research dataset used in this study is data on the average length of schooling in North Sumatra Province from 2015-2020, this dataset was taken from BPS North Sumatra. The data is then formed into 5 models, namely 2-10-1, 2-15-1, 2-20-1, 2-25-1, 2-30-1. -30-1 with an MSE value of 0.000430727. With these results the 2-30-1 architectural model gets the lowest score, so it can be concluded that the model can be used to predict the average length of schooling in North Sumatra Province.

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1. INTRODUCTION

The factor of average length of schooling also plays a role in determining and increasing access to the job market, with the growing level of education taken, the quality of the individual also grows, and also with schools also having a role in increasing the domestic economy.[1][2].

Therefore, there needs to be growth as well as improvement, and it is also necessary to predict (predict) the average length of schooling so that it will be in the future, so that it becomes a

joint evaluation in the following years. The algorithm used in this study uses Fletcher Reeves, because of its performance and has also been frequently used in forecasting or predicting data.[3]. However, this paper does not discuss the average length of schooling in the following year. However, this paper discusses the ability of the Fletcher Reeves algorithm to make predictions or forecasts based on the dataset of the average length of schooling obtained from BPS North Sumatra. Where it is known that the Fletcher Reeves algorithm is one of the optimization algorithms of conventional backpropagation. So this paper will test it based on the architectural model and the parameters that have been determined

In research A. Wanto et al (2017) conducted a research on CPI prediction based on the Health group using the Conjugate Gradient Fletcher Reeves[4]. Syaiful Anam et al (2021) used the Fletcher Reeves algorithm to solve problems in predicting COVID-19 sufferers in Malang City[5]. Ni Luh Wiwik Sri Rahayu Ginantra (2022) uses Fletcher Reeves in predicting or forecasting export value prices with the Standard International Trade Classification (SITC) group[3]

Based on previous research, Fletcher Reeves' performance was analyzed in solving problems in predicting the average length of schooling in North Sumatra Province. In addition, the dataset becomes a benchmark for proving and testing the performance of the Fletcher Reeves algorithm.

2. RESEARCH METHOD

2.1 Data Collection

The selection of data for research conducted using quantitative methods, namely data on the average length of schooling in North Sumatra in 2015-2020. Data obtained from the BPS North Sumatra website.

2.2 Stages Of Research

The flow of this research can be seen in Figure 1, which can be seen below carefully.

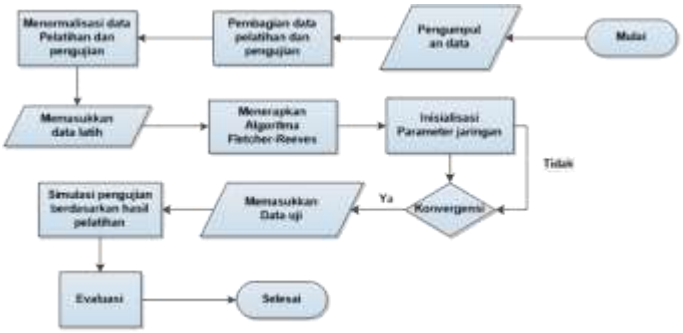

Figure 1. Research Diagram

3. RESULT AND DISCUSSION

3.1 Data Normalization Results

The data that has been divided in half is then normalized using the formula (1) which can be seen carefully.

Table 1. Test Data

County / City	2018 (X3)	2019 (X4)	2020 (Target)
sharpen	0.5378	0.5403	0.5775
Coal	0.4597	0.4820	0.4870
Binjai	0.8206	0.8231	0.8429
Dairi	0.6222	0.6457	0.6755
Deli Serdang	0.7177	0.7375	0.7388

County / City	2018 (X3)	2019 (X4)	2020 (Target)
Gunungsitoli	0.5304	0.5515	0.5552
Humbang Hasundutan	0.6383	0.6693	0.6705
Karo	0.6718	0.6805	0.7016
North Labuanbatu	0.5229	0.5242	0.5291
Labuhan Batu	0.6085	0.6321	0.6333
South Labuhanbatu	0.5676	0.5713	0.5726
Langkat	0.5440	0.5589	0.5602
Christmas Mandailing	0.4932	0.5242	0.5564
Medan	0.8975	0.8988	0.9000
Nias	0.1000	0.1260	0.1521
West Nias	0.2315	0.2488	0.2922
South Nias	0.1322	0.1732	0.2129
North Nias	0.2426	0.2625	0.3034
Old Field	0.5626	0.5651	0.6048
North Lawas	0.6110	0.6160	0.6495
Padangsidimpuan	0.8057	0.8144	0.8516
Mr. Bharat	0.5391	0.5701	0.6073
Pematangsiantar	0.8616	0.8702	0.8715
Samosir	0.6209	0.6222	0.6569
Serdang Bedagai	0.5428	0.5453	0.5465
Sibolga	0.7164	0.7499	0.7772
Simalungun	0.6259	0.6482	0.6780
Tanjung Balai	0.6333	0.6358	0.6581
South Tapanuli	0.5664	0.5998	0.6383
Middle Tapanuli	0.5155	0.5391	0.5564
North Tapanuli	0.6842	0.6916	0.7090
High cliff	0.7574	0.7623	0.7660
Toba Samosir	0.7698	0.7722	0.7921

3.2 Training And Testing

After the data is normalized, the next step is to determine the architectural model and train it with the Fletcher-Reeves algorithm with the help of the Matlab 2011b application. The model used is 2-10-1 (2 inputs, 10 hidden layer neurons, 1 output), 2-15-1 (2 inputs, 15 hidden layer neurons, 1 output), 2-20-1 (2 inputs, 20 hidden layer neurons, 1 output), 2-25-1 (2 inputs, 25 hidden layer neurons, 1 output), 2-30-1 (2 inputs, 30 hidden layer neurons, 1 output). While the parameters of the Fletcher-Reeves algorithm used can be seen in Figure 2 below.

3.2.1 Models 2-10-1

The results of the training using the 2-10-1 architecture can be seen in Figure 3. The results of the training using this model give an epoch result of 288 iterations. The training and testing table can be seen in table 4 and table 5.

Table 2. Training Results

County / City	X1	X2	Target	actual	Error	perfect
sharpen	0.5454	0.5466	0.5623	0.5591	0.0032	
Coal	0.4752	0.4764	0.4861	0.4945	-0.0084	
Binjai	0.7826	0.7826	0.8189	0.7995	0.0194	
Dairi	0.5902	0.5914	0.6156	0.6004	0.0152	
Deli Serdang	0.6858	0.7100	0.7124	0.7051	0.0073	
Gunungsitoli	0.5284	0.5309	0.5551	0.5520	0.0031	
Humbang Hasundutan	0.6156	0.6168	0.6398	0.6290	0.0108	0.000108649
Karo	0.6882	0.6894	0.6930	0.6937	-0.0007	
North Labuanbatu	0.5442	0.5466	0.5478	0.5598	-0.0120	
Labuhan Batu	0.5974	0.6011	0.6289	0.6124	0.0165	
South Labuhanbatu	0.5890	0.5902	0.5914	0.5990	-0.0076	
Langkat	0.4970	0.5284	0.5684	0.5553	0.0131	

County / City	X1	X2	Target	actual	Error	perfect
Christmas Mandailing	0.4619	0.4933	0.5067	0.5010	0.0057	
Medan	0.8697	0.8915	0.9000	0.9032	-0.0032	
Nias	0.1145	0.1339	0.1351	0.1420	-0.0069	
West Nias	0.2331	0.2368	0.2380	0.2362	0.0018	
South Nias	0.1000	0.1012	0.1375	0.1311	0.0064	
North Nias	0.2719	0.2731	0.2743	0.2756	-0.0013	
Old Field	0.5551	0.5563	0.5587	0.5655	-0.0068	
North Lawas	0.6168	0.6180	0.6192	0.6303	-0.0111	
Padangsidimpuan	0.8056	0.8068	0.8165	0.8303	-0.0138	
Mr. Bharat	0.5611	0.5623	0.5635	0.5703	-0.0068	
Pematangsiantar	0.8371	0.8395	0.8770	0.8695	0.0075	
Samosir	0.6083	0.6204	0.6216	0.6354	-0.0138	
Serdang Bedagai	0.5163	0.5478	0.5490	0.5713	-0.0223	
Sibolga	0.7306	0.7318	0.7330	0.7350	-0.0020	
Simalungun	0.6035	0.6107	0.6216	0.6241	-0.0025	
Tanjung Balai	0.6422	0.6434	0.6446	0.6550	-0.0104	
South Tapanuli	0.5393	0.5490	0.5877	0.5652	0.0225	
Middle Tapanuli	0.5091	0.5103	0.5405	0.5399	0.0006	
North Tapanuli	0.6652	0.6664	0.6834	0.6745	0.0089	
High cliff	0.7560	0.7572	0.7596	0.7651	-0.0055	
Toba Samosir	0.7584	0.7596	0.7608	0.7681	-0.0073	

Table 3. Test Result

County / City	X3	X4	Target	actual	Error	perfect
sharpen	0.5378	0.5403	0.5775	0.5565	0.0210	
Coal	0.4597	0.4820	0.4870	0.4866	0.0004	
Binjai	0.8206	0.8231	0.8429	0.8498	-0.0069	
Dairi	0.6222	0.6457	0.6755	0.6601	0.0154	
Deli Serdang	0.7177	0.7375	0.7388	0.7292	0.0096	
Gunungsitoli	0.5304	0.5515	0.5552	0.5714	-0.0162	
Humbang Hasundutan	0.6383	0.6693	0.6705	0.6778	-0.0073	
Karo	0.6718	0.6805	0.7016	0.6857	0.0159	
North Labuanbatu	0.5229	0.5242	0.5291	0.5482	-0.0191	
Labuhan Batu	0.6085	0.6321	0.6333	0.6485	-0.0152	
South Labuhanbatu	0.5676	0.5713	0.5726	0.5797	-0.0071	
Langkat	0.5440	0.5589	0.5602	0.5742	-0.0140	
Christmas Mandailing	0.4932	0.5242	0.5564	0.5510	0.0054	
Medan	0.8975	0.8988	0.9000	0.9190	-0.0190	
Nias	0.1000	0.1260	0.1521	0.1422	0.0099	
West Nias	0.2315	0.2488	0.2922	0.2490	0.0432	
South Nias	0.1322	0.1732	0.2129	0.1577	0.0552	0.000473532
North Nias	0.2426	0.2625	0.3034	0.2656	0.0378	
Old Field	0.5626	0.5651	0.6048	0.5734	0.0314	
North Lawas	0.6110	0.6160	0.6495	0.6292	0.0203	
Padangsidimpuan	0.8057	0.8144	0.8516	0.8312	0.0204	
Mr. Bharat	0.5391	0.5701	0.6073	0.5882	0.0191	
Pematangsiantar	0.8616	0.8702	0.8715	0.8950	-0.0235	
Samosir	0.6209	0.6222	0.6569	0.6347	0.0222	
Serdang Bedagai	0.5428	0.5453	0.5465	0.5591	-0.0126	
Sibolga	0.7164	0.7499	0.7772	0.7319	0.0453	
Simalungun	0.6259	0.6482	0.6780	0.6620	0.0160	
Tanjung Balai	0.6333	0.6358	0.6581	0.6483	0.0098	
South Tapanuli	0.5664	0.5998	0.6383	0.6175	0.0208	
Middle Tapanuli	0.5155	0.5391	0.5564	0.5640	-0.0076	
North Tapanuli	0.6842	0.6916	0.7090	0.6946	0.0144	
High cliff	0.7574	0.7623	0.7660	0.7678	-0.0018	
Toba Samosir	0.7698	0.7722	0.7921	0.7831	0.0090	

3.2.2 MODELS 2-15-1

The results of the training using the 2-15-1 architecture can be seen in Figure 4. The results of the training using this model give 250 iterations of epochs. The training and testing table can be seen in table 6 and also table 7.

Table 4. Training Results

County / City	X1	X2	Target	actual	Error	perfect
sharpen	0.5454	0.5466	0.5623	0.5655	-0.0032	
Coal	0.4752	0.4764	0.4861	0.4841	0.0020	
Binjai	0.7826	0.7826	0.8189	0.7984	0.0205	
Dairi	0.5902	0.5914	0.6156	0.6038	0.0118	
Deli Serdang	0.6858	0.7100	0.7124	0.7143	-0.0019	
Gunungsitoli	0.5284	0.5309	0.5551	0.5527	0.0024	
Humbang Hasundutan	0.6156	0.6168	0.6398	0.6285	0.0113	
Karo	0.6882	0.6894	0.6930	0.6939	-0.0009	
North Labuanbatu	0.5442	0.5466	0.5478	0.5649	-0.0171	
Labuhan Batu	0.5974	0.6011	0.6289	0.6109	0.0180	
South Labuhanbatu	0.5890	0.5902	0.5914	0.6027	-0.0113	
Langkat	0.4970	0.5284	0.5684	0.5496	0.0188	
Christmas Mandailing	0.4619	0.4933	0.5067	0.5161	-0.0094	
Medan	0.8697	0.8915	0.9000	0.9026	-0.0026	
Nias	0.1145	0.1339	0.1351	0.0000	0.1351	
West Nias	0.2331	0.2368	0.2380	0.0000	0.2380	
South Nias	0.1000	0.1012	0.1375	0.0000	0.1375	0.005234831
North Nias	0.2719	0.2731	0.2743	0.0001	0.2742	
Old Field	0.5551	0.5563	0.5587	0.5732	-0.0145	
North Lawas	0.6168	0.6180	0.6192	0.6297	-0.0105	
Padangsidimpuan	0.8056	0.8068	0.8165	0.8328	-0.0163	
Mr. Bharat	0.5611	0.5623	0.5635	0.5780	-0.0145	
Pematangsiantar	0.8371	0.8395	0.8770	0.8677	0.0093	
Samosir	0.6083	0.6204	0.6216	0.6227	-0.0011	
Serdang Bedagai	0.5163	0.5478	0.5490	0.5602	-0.0112	
Sibolga	0.7306	0.7318	0.7330	0.7337	-0.0007	
Simalungun	0.6035	0.6107	0.6216	0.6172	0.0044	
Tanjung Balai	0.6422	0.6434	0.6446	0.6541	-0.0095	
South Tapanuli	0.5393	0.5490	0.5877	0.5638	0.0239	
Middle Tapanuli	0.5091	0.5103	0.5405	0.5346	0.0059	
North Tapanuli	0.6652	0.6664	0.6834	0.6746	0.0088	
High cliff	0.7560	0.7572	0.7596	0.7645	-0.0049	
Toba Samosir	0.7584	0.7596	0.7608	0.7678	-0.0070	

Table 5. Test Result

County / City	X3	X4	Target	actual	Error	perfect
sharpen	0.5378	0.5403	0.5775	0.5600	0.0175	
Coal	0.4597	0.4820	0.4870	0.4950	-0.0080	
Binjai	0.8206	0.8231	0.8429	0.8531	-0.0102	
Dairi	0.6222	0.6457	0.6755	0.6397	0.0358	
Deli Serdang	0.7177	0.7375	0.7388	0.7509	-0.0121	
Gunungsitoli	0.5304	0.5515	0.5552	0.5625	-0.0073	
Humbang Hasundutan	0.6383	0.6693	0.6705	0.6613	0.0092	
Karo	0.6718	0.6805	0.7016	0.6846	0.0170	0.007777372
North Labuanbatu	0.5229	0.5242	0.5291	0.5475	-0.0184	
Labuhan Batu	0.6085	0.6321	0.6333	0.6252	0.0081	
South Labuhanbatu	0.5676	0.5713	0.5726	0.5839	-0.0113	
Langkat	0.5440	0.5589	0.5602	0.5688	-0.0086	
Christmas Mandailing	0.4932	0.5242	0.5564	0.5468	0.0096	
Medan	0.8975	0.8988	0.9000	0.8929	0.0071	
Nias	0.1000	0.1260	0.1521	0.0000	0.1521	
West Nias	0.2315	0.2488	0.2922	0.0000	0.2922	

County / City	X3	X4	Target	actual	Error	perfect
South Nias	0.1322	0.1732	0.2129	0.0000	0.2129	
North Nias	0.2426	0.2625	0.3034	0.0001	0.3033	
Old Field	0.5626	0.5651	0.6048	0.5795	0.0253	
North Lawas	0.6110	0.6160	0.6495	0.6244	0.0251	
Padangsidimpuan	0.8057	0.8144	0.8516	0.8515	0.0001	
Mr. Bharat	0.5391	0.5701	0.6073	0.5716	0.0357	
Pematangsiantar	0.8616	0.8702	0.8715	0.8898	-0.0183	
Samosir	0.6209	0.6222	0.6569	0.6338	0.0231	
Serdang Bedagai	0.5428	0.5453	0.5465	0.5639	-0.0174	
Sibolga	0.7164	0.7499	0.7772	0.7764	0.0008	
Simalungun	0.6259	0.6482	0.6780	0.6434	0.0346	
Tanjung Balai	0.6333	0.6358	0.6581	0.6460	0.0121	
South Tapanuli	0.5664	0.5998	0.6383	0.5897	0.0486	
Middle Tapanuli	0.5155	0.5391	0.5564	0.5551	0.0013	
North Tapanuli	0.6842	0.6916	0.7090	0.6954	0.0136	
High cliff	0.7574	0.7623	0.7660	0.7754	-0.0094	
Toba Samosir	0.7698	0.7722	0.7921	0.7867	0.0054	

3.2.3 MODEL 2-20-1

The results of the training using the 2-20-1 architecture can be seen in Figure 5. The results of the training using this model give an epoch result of 1000 iterations. The training and testing tables can be seen in table 8 and table 9.

Table 6. Training Results

County / City	X1	X2	Target	actual	Error	perfect
sharpen	0.5454	0.5466	0.5623	0.5582	0.0041	
Coal	0.4752	0.4764	0.4861	0.4872	-0.0011	
Binjai	0.7826	0.7826	0.8189	0.8000	0.0189	
Dairi	0.5902	0.5914	0.6156	0.6054	0.0102	
Deli Serdang	0.6858	0.7100	0.7124	0.7114	0.0010	
Gunungsitoli	0.5284	0.5309	0.5551	0.5520	0.0031	
Humbang Hasundutan	0.6156	0.6168	0.6398	0.6294	0.0104	
Karo	0.6882	0.6894	0.6930	0.6952	-0.0022	
North Labuanbatu	0.5442	0.5466	0.5478	0.5588	-0.0110	
Labuhan Batu	0.5974	0.6011	0.6289	0.6148	0.0141	
South Labuhanbatu	0.5890	0.5902	0.5914	0.6040	-0.0126	
Langkat	0.4970	0.5284	0.5684	0.5651	0.0033	
Christmas Mandailing	0.4619	0.4933	0.5067	0.5061	0.0006	
Medan	0.8697	0.8915	0.9000	0.8998	0.0002	
Nias	0.1145	0.1339	0.1351	0.1362	-0.0011	
West Nias	0.2331	0.2368	0.2380	0.2385	-0.0005	
South Nias	0.1000	0.1012	0.1375	0.1372	0.0003	0.00000081244
North Nias	0.2719	0.2731	0.2743	0.2737	0.0006	
Old Field	0.5551	0.5563	0.5587	0.5659	-0.0072	
North Lawas	0.6168	0.6180	0.6192	0.6304	-0.0112	
Padangsidimpuan	0.8056	0.8068	0.8165	0.8343	-0.0178	
Mr. Bharat	0.5611	0.5623	0.5635	0.5717	-0.0082	
Pematangsiantar	0.8371	0.8395	0.8770	0.8709	0.0061	
Samosir	0.6083	0.6204	0.6216	0.6273	-0.0057	
Serdang Bedagai	0.5163	0.5478	0.5490	0.5599	-0.0109	
Sibolga	0.7306	0.7318	0.7330	0.7344	-0.0014	
Simalungun	0.6035	0.6107	0.6216	0.6221	-0.0005	
Tanjung Balai	0.6422	0.6434	0.6446	0.6511	-0.0065	
South Tapanuli	0.5393	0.5490	0.5877	0.5624	0.0253	
Middle Tapanuli	0.5091	0.5103	0.5405	0.5434	-0.0029	
North Tapanuli	0.6652	0.6664	0.6834	0.6734	0.0100	
High cliff	0.7560	0.7572	0.7596	0.7632	-0.0036	
Toba Samosir	0.7584	0.7596	0.7608	0.7664	-0.0056	

Table 7. Test Result

County / City	X3	X4	Target	actual	Error	perfect
sharpen	0.5378	0.5403	0.5775	0.5554	0.0221	
Coal	0.4597	0.4820	0.4870	0.4806	0.0064	
Binjai	0.8206	0.8231	0.8429	0.8537	-0.0108	
Dairi	0.6222	0.6457	0.6755	0.6407	0.0348	
Deli Serdang	0.7177	0.7375	0.7388	0.7372	0.0016	
Gunungsitoli	0.5304	0.5515	0.5552	0.5626	-0.0074	
Humbang Hasundutan	0.6383	0.6693	0.6705	0.6612	0.0093	
Karo	0.6718	0.6805	0.7016	0.6870	0.0146	
North Labuanbatu	0.5229	0.5242	0.5291	0.5487	-0.0196	
Labuhan Batu	0.6085	0.6321	0.6333	0.6267	0.0066	
South Labuhanbatu	0.5676	0.5713	0.5726	0.5810	-0.0084	
Langkat	0.5440	0.5589	0.5602	0.5668	-0.0066	
Christmas Mandailing	0.4932	0.5242	0.5564	0.5644	-0.0080	
Medan	0.8975	0.8988	0.9000	0.9162	-0.0162	
Nias	0.1000	0.1260	0.1521	0.1283	0.0238	
West Nias	0.2315	0.2488	0.2922	0.1946	0.0976	
South Nias	0.1322	0.1732	0.2129	0.1183	0.0946	0.001388119
North Nias	0.2426	0.2625	0.3034	0.1912	0.1122	
Old Field	0.5626	0.5651	0.6048	0.5745	0.0303	
North Lawas	0.6110	0.6160	0.6495	0.6276	0.0219	
Padangsidimpuan	0.8057	0.8144	0.8516	0.8383	0.0133	
Mr. Bharat	0.5391	0.5701	0.6073	0.5599	0.0474	
Pematangsiantar	0.8616	0.8702	0.8715	0.8925	-0.0210	
Samosir	0.6209	0.6222	0.6569	0.6336	0.0233	
Serdang Bedagai	0.5428	0.5453	0.5465	0.5581	-0.0116	
Sibolga	0.7164	0.7499	0.7772	0.7441	0.0331	
Simalungun	0.6259	0.6482	0.6780	0.6448	0.0332	
Tanjung Balai	0.6333	0.6358	0.6581	0.6442	0.0139	
South Tapanuli	0.5664	0.5998	0.6383	0.5792	0.0591	
Middle Tapanuli	0.5155	0.5391	0.5564	0.5635	-0.0071	
North Tapanuli	0.6842	0.6916	0.7090	0.6975	0.0115	
High cliff	0.7574	0.7623	0.7660	0.7681	-0.0021	
Toba Samosir	0.7698	0.7722	0.7921	0.7830	0.0091	

3.2.4 MODEL 2-25-1

The results of the training using the 2-25-1 architecture can be seen in Figure 6. The results of the training using this model give epoch results of 12 iterations. The training and testing table can be seen in table 10 and also in table 11.

Table 8. Test result

County / City	X3	X4	Target	actual	Error	perfect
sharpen	0.5378	0.5403	0.5775	0.5757	0.0018	
Coal	0.4597	0.4820	0.4870	0.5715	-0.0845	
Binjai	0.8206	0.8231	0.8429	1.0000	-0.1571	
Dairi	0.6222	0.6457	0.6755	0.6004	0.0751	
Deli Serdang	0.7177	0.7375	0.7388	0.9599	-0.2211	
Gunungsitoli	0.5304	0.5515	0.5552	0.5814	-0.0262	
Humbang Hasundutan	0.6383	0.6693	0.6705	0.6210	0.0495	
Karo	0.6718	0.6805	0.7016	0.6688	0.0328	0.016645082
North Labuanbatu	0.5229	0.5242	0.5291	0.5746	-0.0455	
Labuhan Batu	0.6085	0.6321	0.6333	0.5942	0.0391	
South Labuhanbatu	0.5676	0.5713	0.5726	0.5778	-0.0052	
Langkat	0.5440	0.5589	0.5602	0.5804	-0.0202	
Christmas Mandailing	0.4932	0.5242	0.5564	0.5800	-0.0236	
Medan	0.8975	0.8988	0.9000	1.0000	-0.1000	
Nias	0.1000	0.1260	0.1521	0.0000	0.1521	
West Nias	0.2315	0.2488	0.2922	0.0000	0.2922	

County / City	X3	X4	Target	actual	Error	perfect
South Nias	0.1322	0.1732	0.2129	0.0000	0.2129	
North Nias	0.2426	0.2625	0.3034	0.0000	0.3034	
Old Field	0.5626	0.5651	0.6048	0.5770	0.0278	
North Lawas	0.6110	0.6160	0.6495	0.5846	0.0649	
Padangsidimpuan	0.8057	0.8144	0.8516	1.0000	-0.1484	
Mr. Bharat	0.5391	0.5701	0.6073	0.5860	0.0213	
Pematangsiantar	0.8616	0.8702	0.8715	1.0000	-0.1285	
Samosir	0.6209	0.6222	0.6569	0.5859	0.0710	
Serdang Bedagai	0.5428	0.5453	0.5465	0.5759	-0.0294	
Sibolga	0.7164	0.7499	0.7772	0.9711	-0.1939	
Simalungun	0.6259	0.6482	0.6780	0.6019	0.0761	
Tanjung Balai	0.6333	0.6358	0.6581	0.5931	0.0650	
South Tapanuli	0.5664	0.5998	0.6383	0.5903	0.0480	
Middle Tapanuli	0.5155	0.5391	0.5564	0.5808	-0.0244	
North Tapanuli	0.6842	0.6916	0.7090	0.7230	-0.0140	
High cliff	0.7574	0.7623	0.7660	0.9994	-0.2334	
Toba Samosir	0.7698	0.7722	0.7921	0.9999	-0.2078	

3.2.5 MODEL 2-3-1

The results of the training using the 2-3-1 architecture can be seen in Figure 7. The results of the training using this model give 364 iterations of epoch results. The training and testing table can be seen in table 12 and also table 13.

Table 9. Training Results

County / City	X1	X2	Target	actual	Error	perfect
sharpen	0.5454	0.5466	0.5623	0.5584	0.0039	
Coal	0.4752	0.4764	0.4861	0.4865	-0.0004	
Binjai	0.7826	0.7826	0.8189	0.7998	0.0191	
Dairi	0.5902	0.5914	0.6156	0.6068	0.0088	
Deli Serdang	0.6858	0.7100	0.7124	0.7106	0.0018	
Gunungsitoli	0.5284	0.5309	0.5551	0.5532	0.0019	
Humbang Hasundutan	0.6156	0.6168	0.6398	0.6315	0.0083	
Karo	0.6882	0.6894	0.6930	0.6957	-0.0027	
North Labuanbatu	0.5442	0.5466	0.5478	0.5586	-0.0108	
Labuhan Batu	0.5974	0.6011	0.6289	0.6158	0.0131	
South Labuhanbatu	0.5890	0.5902	0.5914	0.6052	-0.0138	
Langkat	0.4970	0.5284	0.5684	0.5599	0.0085	
Christmas Mandailing	0.4619	0.4933	0.5067	0.5068	-0.0001	
Medan	0.8697	0.8915	0.9000	0.9011	-0.0011	
Nias	0.1145	0.1339	0.1351	0.1352	-0.0001	
West Nias	0.2331	0.2368	0.2380	0.2376	0.0004	
South Nias	0.1000	0.1012	0.1375	0.1375	0.0000	0.0000093228
North Nias	0.2719	0.2731	0.2743	0.2745	-0.0002	
Old Field	0.5551	0.5563	0.5587	0.5639	-0.0052	
North Lawas	0.6168	0.6180	0.6192	0.6323	-0.0131	
Padangsidimpuan	0.8056	0.8068	0.8165	0.8373	-0.0208	
Mr. Bharat	0.5611	0.5623	0.5635	0.5688	-0.0053	
Pematangsiantar	0.8371	0.8395	0.8770	0.8672	0.0098	
Samosir	0.6083	0.6204	0.6216	0.6233	-0.0017	
Serdang Bedagai	0.5163	0.5478	0.5490	0.5672	-0.0182	
Sibolga	0.7306	0.7318	0.7330	0.7341	-0.0011	
Simalungun	0.6035	0.6107	0.6216	0.6211	0.0005	
Tanjung Balai	0.6422	0.6434	0.6446	0.6513	-0.0067	
South Tapanuli	0.5393	0.5490	0.5877	0.5608	0.0269	
Middle Tapanuli	0.5091	0.5103	0.5405	0.5431	-0.0026	
North Tapanuli	0.6652	0.6664	0.6834	0.6740	0.0094	
High cliff	0.7560	0.7572	0.7596	0.7624	-0.0028	
Toba Samosir	0.7584	0.7596	0.7608	0.7654	-0.0046	

Table 10. Test result

County / City	X3	X4	Target	actual	Error	perfect
sharpen	0.5378	0.5403	0.5775	0.5563	0.0212	
Coal	0.4597	0.4820	0.4870	0.4826	0.0044	
Binjai	0.8206	0.8231	0.8429	0.8556	-0.0127	
Dairi	0.6222	0.6457	0.6755	0.6306	0.0449	
Deli Serdang	0.7177	0.7375	0.7388	0.7422	-0.0034	
Gunungsitoli	0.5304	0.5515	0.5552	0.5645	-0.0093	
Humbang Hasundutan	0.6383	0.6693	0.6705	0.6500	0.0205	
Karo	0.6718	0.6805	0.7016	0.6841	0.0175	
North Labuanbatu	0.5229	0.5242	0.5291	0.5505	-0.0214	
Labuhan Batu	0.6085	0.6321	0.6333	0.6205	0.0128	
South Labuhanbatu	0.5676	0.5713	0.5726	0.5770	-0.0044	
Langkat	0.5440	0.5589	0.5602	0.5655	-0.0053	
Christmas Mandailing	0.4932	0.5242	0.5564	0.5571	-0.0007	
Medan	0.8975	0.8988	0.9000	0.8880	0.0120	
Nias	0.1000	0.1260	0.1521	0.1380	0.0141	
West Nias	0.2315	0.2488	0.2922	0.2803	0.0119	
South Nias	0.1322	0.1732	0.2129	0.1812	0.0317	0.000430727
North Nias	0.2426	0.2625	0.3034	0.2978	0.0056	
Old Field	0.5626	0.5651	0.6048	0.5710	0.0338	
North Lawas	0.6110	0.6160	0.6495	0.6272	0.0223	
Padangsidimpuan	0.8057	0.8144	0.8516	0.8482	0.0034	
Mr. Bharat	0.5391	0.5701	0.6073	0.5727	0.0346	
Pematangsiantar	0.8616	0.8702	0.8715	0.8847	-0.0132	
Samosir	0.6209	0.6222	0.6569	0.6350	0.0219	
Serdang Bedagai	0.5428	0.5453	0.5465	0.5581	-0.0116	
Sibolga	0.7164	0.7499	0.7772	0.7589	0.0183	
Simalungun	0.6259	0.6482	0.6780	0.6342	0.0438	
Tanjung Balai	0.6333	0.6358	0.6581	0.6435	0.0146	
South Tapanuli	0.5664	0.5998	0.6383	0.5918	0.0465	
Middle Tapanuli	0.5155	0.5391	0.5564	0.5621	-0.0057	
North Tapanuli	0.6842	0.6916	0.7090	0.6960	0.0130	
High cliff	0.7574	0.7623	0.7660	0.7693	-0.0033	
Toba Samosir	0.7698	0.7722	0.7921	0.7832	0.0089	

3.3 Evaluation

After training and testing the data on architectural models 2-10-1, 2-15-1, 2-20-1, 2-25-1, and 2-30-1 with the help of Matlab and Microsoft Excel, it was found The best architectural model is 2-30-1 with the lowest MSE testing/Performance value of 0.000430727. The data results for all models can be seen in table 14.

Table 11. Overall Model Results

Algorithm	Architectural Model	Training Function	Epoch (Iteration)	MSE Training	MSE Testing/Performance
Fletcher-Reeves	2-10-1	traincgf	288	0.000108649	0.000473532
	2-15-1	traincgf	250	0.005234831	0.007777372
	2-20-1	traincgf	1000	0.0000081244	0.001388119
	2-25-1	traincgf	12	0.014303564	0.016645082
	2-3-1	traincgf	364	0.0000093228	0.000430727

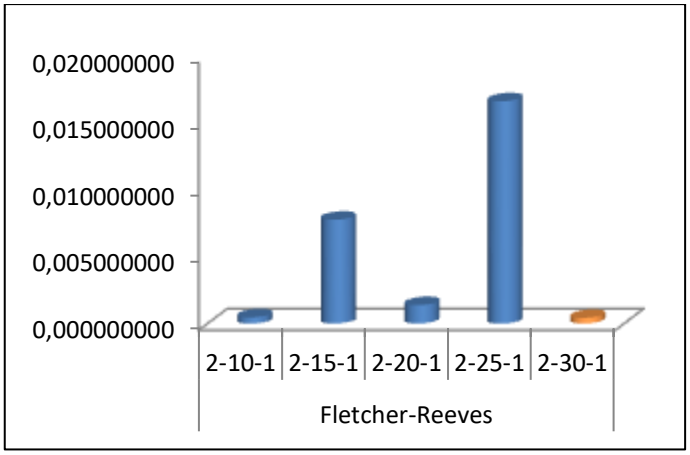

Figure 2. Overall Graph of MSE Testing / Performance

3. CONCLUSION

On the basis of the whole and discussion, it can be concluded that the Fletcher-Reeves Algorithm with the 2-30-1 architectural model can be used and utilized to predict the average length of schooling in North Sumatra by year, because the convergence training time is not too long and also the performance is low. produced quite well compared to the other four architectural models. Overall, it can be concluded that the Fletcher-Reeves algorithm (traincgf) is able to provide a good level of optimization, namely producing a (low) Performance/MSE test value, relatively fast time to reach convergence and iteration.

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