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Implementation of Conjugate Gradient Bacpropagation Algorithm in Predicting the Percentage of Formal Labor in Sumatran Pulau

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ABSTRAK

Formal workers work for companies as trained workers or those whose job status is employees and employees. They get stronger legal protection and official employment contracts and are in organizations that are legal entities. This paper aims to prove and implement the conjugate gradient backpropagation algorithm that can predict data on trends in formal labour on the island of Sumatra's impact Covid-19. The research data is on the percentage of formal workers on the island of Sumatra in 2015-2021, whose source is the Central Statistics Agency (BPS). This study uses 5 architectural models, namely 5-10-1, 5-15-1, 5-20-1, 5-25-1, 5-25-1, 5-30-1, 5-35-1. Of the five architectural models that have been used, the best architecture is obtained, namely the 5-20-1 model with a perf result of 0.000000002, literacy 292 in 4 seconds.

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1. Introduction

In general, formal labour is often called white-collar workers referring to delicate jobs or workers who work in companies as skilled workers or those whose employment status is employees and employees such as office staff, teachers, managers, directors, analysts, lecturers, doctors and the like. They gain stronger legal protections and official employment contracts. They are within incorporated organizations, as stipulated in the Manpower Law and the Trade Union Law, plus various government regulations (PP) and ministers (Permen) on labour. Although the workforce on the island of Sumatra is still flooded with freelance specialists, the pattern of formal specialist labour continues to experience an expansion of information. Information from the Focal Measurement Agency shows that in 2015, the level of legal specialists was 42.25%. Then, at the time, it increased in 2019 to 44.28%. As a capital escalation area, a viable place is a relatively protected ally of the Indonesian economy. However, vigilance against the world pandemic on 11, 2020, due to the Coronavirus pandemic, impacted the world economy, including Indonesia. To reduce the spread of infection, guidelines for staying at home or being dynamic at home are empowered. However, these guidelines affect many organizations that face misfortune and, surprisingly, close their organizations, thereby affecting the representatives and workers of the organization. Based on information from the Ministry of Labor Provision (Kemnaker) dated April 13, 2020, a total of 1.2 million conventional formal workers were laid off, and 212.4 thousand people experienced layoffs. Formal labor around the island of Sumatra has not been evenly distributed, and the security of legal labor has not been able to be watched out for. (Dewi et al., 2020)

(Afriliansyah & Zulfahmi, 2020) (Indonesia, 2020; Juaningsih, 2020; Moh . Muslim : " Layoffs During the Covid-19 Pandemic " 358, 2020; Putri et al., 2021)

To overcome the problem of achieving equal distribution of formal workers on the island of Sumatra, this study was carried out to predict legal labour on the island of Sumatra to suggest data images in the future so that it can become a benchmark for government to create solutions in the stability of formal labour in Indonesia. The method used to make predictions is conjugate gradient backpropagation. This research method is one of the Artificial Neural Network methods often used to create a data prediction. Moreover, this method can predict data based on previous data to get predictive results after testing and training based on existing data.(Tinambunan et al., 2020)(Sinaga et al., 2019)(Siregar et al., 2019)(Andriani et al., 2018; Purba & Wanto, 2018; Siang, 2005)(Asih et al., 2018; National et al., 2018; Sari & Mangkurat, 2022; Plants et al., 2018).

2. Research Methods

2.1 Data Collection

The data collection strategy used in this study is a quantitative technique, namely the rediscovery of formal labour force level information by region through the website of the Central Statistics Agency (BPS). In this review, the workforce studied is legal labour on the island of Sumatra. Based on formal labour data on the island of Sumatra in 2015-2021 obtained from the Ministry of Manpower, the highest percentage of legal workers was compiled in the Riau Islands Region in 2015-2021. of 71.90%, until 2021, it is still held by the Riau Islands Region, and the minimum information for 2015-2021, the lowest or smallest data is owned by the Lampung region with the lowest level of 27.74%. For more details, here we present the table. (Afriliansyah & Zulfahmi, 2020) (Tinambunan et al., 2020).

Table 1 Percentage of formal labor in Suamatera Island in 2015 -2021

No	Provinsi	2015	2016	2017	2018	2019	2020	2021
1	Aceh	39.50	42.83	40.42	40.56	42.88	38.12	39.31
2	Sumatera Utara	39.86	40.02	42.00	43.43	45.00	40.38	40.67
3	Sumater Barat	35.59	38.20	35.61	36.06	37.87	33.72	35.23
4	Riau	51.36	46.37	47.30	45.05	47.78	44.03	45.43
5	Jambi	41.35	37.91	41.47	43.55	42.94	37.26	37.99
6	Sumatera Selatan	38.69	39.29	37.60	38.78	39.48	34.74	35.84
7	Bengkulu	31.19	34.08	33.61	31.16	34.88	30.77	31.84
8	Lampung	29.17	29.90	29.71	29.21	31.51	27.74	28.69
9	Kep. Bangka Belitung	45.87	44.43	51.62	49.57	53.18	47.07	49.07
10	Kep. Riau	71.90	66.20	68.51	68.22	70.43	64.59	64.80

2.2. Research Flow

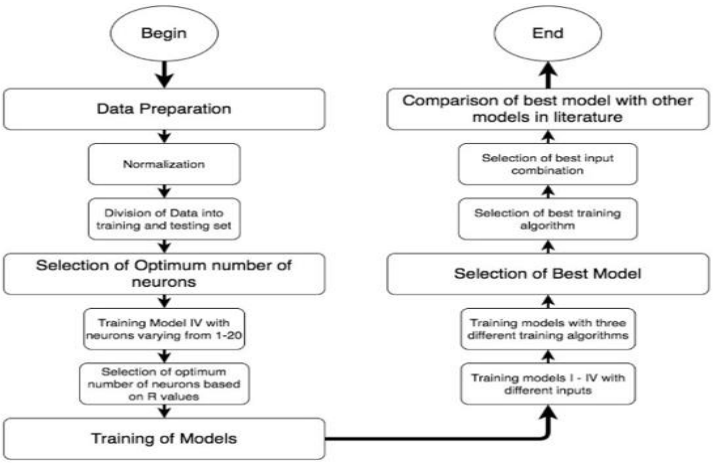

Figure 1. Research Framework

The Research Framework can be seen in figure 1; it is explained that the first step taken from the research stage is the collection of datasets contained in table 1 (Based on table 1). the next stage is to separate the research dataset into two parts: training data and testing data. Data for 2015-2019 with a target of 2020 will be used as training data, and data for 2016-2020 with a target of 2021 will be used as testing data. After being divided into two parts, the data will be normalized using the sigmoid function. So the next step is to normalize the training and testing data using the formula of equation 1. (National et al., 2018).

$$x' = \frac{0.8(x-a)}{b-a} + 0.1$$

The description of the above formula starts from X', which is the result of data that has been normalized from the original data; 0.8 and 0.1 are the default normalization formulas, x is the actual data to be normalized, b is the data with the highest value of all the original data and a is the data with the lowest or smallest value. The next stage is that the information is shared for data separation, namely input data and target data, and then the data is ready to be processed in the application of the conjugate gradient algorithm with the types of tansig and logsig network functions; after that immediately initialize the selected network parameters, namely Trainscg, then enter commands to see performance results or MSE (Mean Squared Error). If the training data has been completed in the process, it is continued by processing the test data, followed by the last stage, which is to evaluate to see the best architecture model where the assessment is assessed based on the results of the most minor performance or MSE.

3. Results and Discussion

3.1. Normalization Data Results

Table 2 results from the normalization of the training data used, namely in 2015-2020 in 2020 as a target. These data are taken based on table 1. This data is normalized using the sigmoid function as written in equation (1).

Table 2. Normalization of training data for 2015-2020

			N			
No	**2015**	**2016**	**2017**	**2018**	**2019**	**2020 (t)**
1	0,3130	0,3734	0,3297	0,3322	0,3743	0,2880
2	0,3196	0,3225	0,3583	0,3842	0,4127	0,3290
3	0,2422	0,2895	0,2426	0,2507	0,2835	0,2083
4	0,5279	o,4375	0,4543	0,4136	0,4630	0,3951
5	0,3466	0,2842	0,3487	0,3864	0,3754	0,2725
6	0,2984	0,3092	0,2786	0,3000	0,3127	0,2268
7	0,1625	0,2149	0,2063	0,1620	0,2293	0,1549
8	0,1259	0,1391	0,1357	0,1266	0,1683	0,1000
9	0,4284	0,4024	0,5326	0,4955	0,5609	0,4502
10	0,9000	0,7967	0,8386	0,8333	0,8734	0,7676

The following Table 3 is the result of the normalization of the test data used, which is 2016-2021, with 2021 as the target. These data are taken based on table 1. Likewise, this test data is normalized by the formula of equation (1).

Table 3. Normalization of Testing Data for 2016-2021

No	**2016**	**2017**	**2018**	**2019**	**2020**	**2021 (t)**
1	0,3828	0,3376	0,3402	0,3837	0,2945	0,3168
2	0,3301	0,3672	0,3940	0,4234	0,3369	0,3423
3	0,2960	0,2475	0,2559	0,2898	0,2121	0,2404
4	0,4491	0,4665	0,4244	0,4755	0,4053	0,4315
5	0,2906	0,3573	0,3963	0,3848	0,2784	0,2921
6	0,3164	0,2848	0,3069	0,3200	0,2312	0,2518
7	0,2188	0,2100	0,1641	0,2338	0,1568	0,1768
8	0,1405	0,1369	0,1275	0,1706	0,1000	0,1178
9	0,4128	0,5475	0,5091	0,5767	0,4622	0,4997
10	0,8207	0,8640	0,8586	0,9000	0,7906	0,7945

3.2. Training and Testing

After the normalization stage is completed, the next step is to process the architecture model and train it using the Conjugate Gradient algorithm with the help of the Matlab 2011b application. The architectural models used are 5-10-1, 5-15-1, 5-20-1, 5-25-1, 5-30-1. Then continue to initialize the parameters of the Conjugate Gradient algorithm used; you can see the following source code. (Mathematics et al., 2011).

```
net.trainParam.epochs = 1000;
net.trainParam.show = 25;
net.trainParam.showCommandLine = 0;
net.trainParam.showWindow = 1;
net.trainParam.goal = 0
net.trainParam.time = inf;
net.trainParam.min_grad = 1e-6;
net.trainParam.max_fail = 5;
net.trainParam.sigma = 5.0e-5;
net.trainParam.lambda = 5.0e-7;
```

a. Model 5-10-1.

The training results using the 5-10-1 architecture model can be seen from the source code run in the Matlab 2011b application. The results of training using this model resulted in an epoch of 329 iterations. The training and testing tables can be seen in table 4 and table 5.

Table 4 Training Data .

No	X1	X2	X3	X4	X5	Target (y1)	Epoch 329		
							actual	error	Perf
1	0,3130	0,3734	0,3297	0,3322	0,3743	0,2880	0,2880	0,0000	
2	0,3196	0,3225	0,3583	0,3842	0,4127	0,3290	0,3290	0,0000	
3	0,2422	0,2895	0,2426	0,2507	0,2835	0,2083	0,2081	0,0002	
4	0,5279	0,4375	0,4543	0,4136	0,4630	0,3951	0,3951	0,0000	
5	0,3466	0,2842	0,3487	0,3864	0,3754	0,2725	0,2724	0,0001	
6	0,2984	0,3092	0,2786	0,3000	0,3127	0,2268	0,2269	-0,0001	0,000000007
7	0,1625	0,2149	0,2063	0,1620	0,2293	0,1549	0,1549	0,0000	
8	0,1259	0,1391	0,1357	0,1266	0,1683	0,1000	0,1000	0,0000	
9	0,4284	0,4024	0,5326	0,4955	0,5609	0,4502	0,4502	0,0000	
10	0,9000	0,7967	0,8386	0,8333	0,8734	0,7676	0,7676	0,0000	

Tabel 5 Testing Data

No	X1	X2	X3	X4	X5	Target (y1)	Epoch		
							actual	Error	Perf
1	0,3828	0,3376	0,3402	0,3837	0,2945	0,3168	0,1246	0,1922	
2	0,3301	0,3672	0,3940	0,4234	0,3369	0,3423	0,0919	0,2504	
3	0,2960	0,2475	0,2559	0,2898	0,2121	0,2404	0,1251	0,1153	
4	0,4491	0,4665	0,4244	0,4755	0,4053	0,4315	0,1035	0,3280	
5	0,2906	0,3573	0,3963	0,3848	0,2784	0,2921	0,0970	0,1951	
6	0,3164	0,2848	0,3069	0,3200	0,2312	0,2518	0,1159	0,1359	0,083071534
7	0,2188	0,2100	0,1641	0,2338	0,1568	0,1768	0,0857	0,0911	
8	0,1405	0,1369	0,1275	0,1706	0,1000	0,1178	0,0545	0,0633	
9	0,4128	0,5475	0,5091	0,5767	0,4622	0,4997	0,1401	0,3596	
10	0,8207	0,8640	0,8586	0,9000	0,7906	0,7945	0,1526	0,6419	

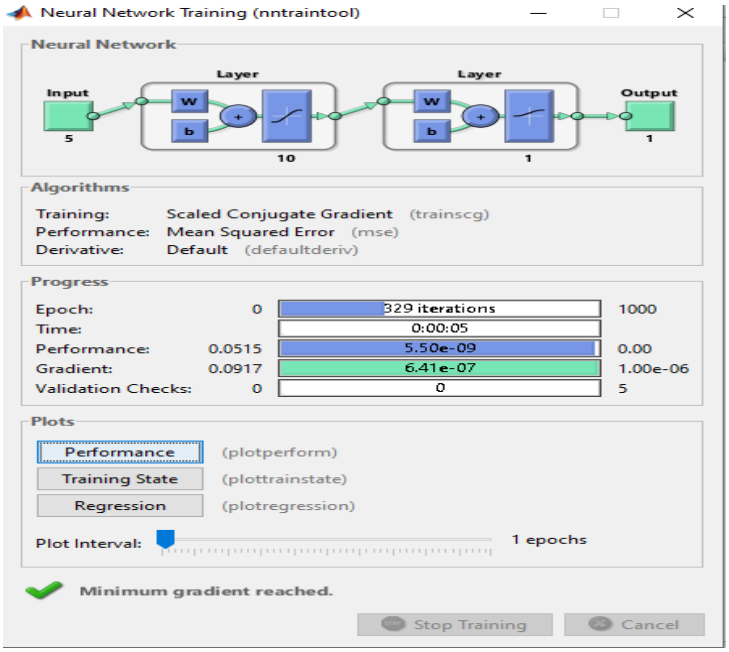

Figure 2. Layer 10 training with matlab 2011b.

b. Model 5-15-1.

The results of the training and testing process on the 5-15-1 architecture model can produce an epoch of 888 iterations with a time of 7 seconds. It is contained in table 6 and table 7 below.

Table 6 Training Data.

No	X1	X2	X3	X4	X5	Target (y1)	epoch 888		
							actual	Error	Perf
1	0,3130	0,3734	0,3297	0,3322	0,3743	0,2880	0,2881	-0,0001	
2	0,3196	0,3225	0,3583	0,3842	0,4127	0,3290	0,3289	0,0001	
3	0,2422	0,2895	0,2426	0,2507	0,2835	0,2083	0,2085	-0,0002	
4	0,5279	0,4375	0,4543	0,4136	0,4630	0,3951	0,3951	0,0000	
5	0,3466	0,2842	0,3487	0,3864	0,3754	0,2725	0,2726	-0,0001	0,000000017
6	0,2984	0,3092	0,2786	0,3000	0,3127	0,2268	0,2265	0,0003	
7	0,1625	0,2149	0,2063	0,1620	0,2293	0,1549	0,1548	0,0001	
8	0,1259	0,1391	0,1357	0,1266	0,1683	0,1000	0,1001	-0,0001	
9	0,4284	0,4024	0,5326	0,4955	0,5609	0,4502	0,4502	0,0000	
10	0,9000	0,7967	0,8386	0,8333	0,8734	0,7676	0,7676	0,0000	

Tabel 7 Training Data.

No	X1	X2	X3	X4	X5	target (y2)	Epoch		
							actual	error	Perf
1	0,3828	0,3376	0,3402	0,3837	0,2945	0,3168	0,1880	0,1288	
2	0,3301	0,3672	0,3940	0,4234	0,3369	0,3423	0,2667	0,0756	
3	0,2960	0,2475	0,2559	0,2898	0,2121	0,2404	0,1494	0,0910	
4	0,4491	0,4665	0,4244	0,4755	0,4053	0,4315	0,3008	0,1307	
5	0,2906	0,3573	0,3963	0,3848	0,2784	0,2921	0,2389	0,0532	0,007743012
6	0,3164	0,2848	0,3069	0,3200	0,2312	0,2518	0,1656	0,0862	
7	0,2188	0,2100	0,1641	0,2338	0,1568	0,1768	0,1242	0,0526	
8	0,1405	0,1369	0,1275	0,1706	0,1000	0,1178	0,0901	0,0277	
9	0,4128	0,5475	0,5091	0,5767	0,4622	0,4997	0,3760	0,1237	
10	0,8207	0,8640	0,8586	0,9000	0,7906	0,7945	0,7688	0,0257	

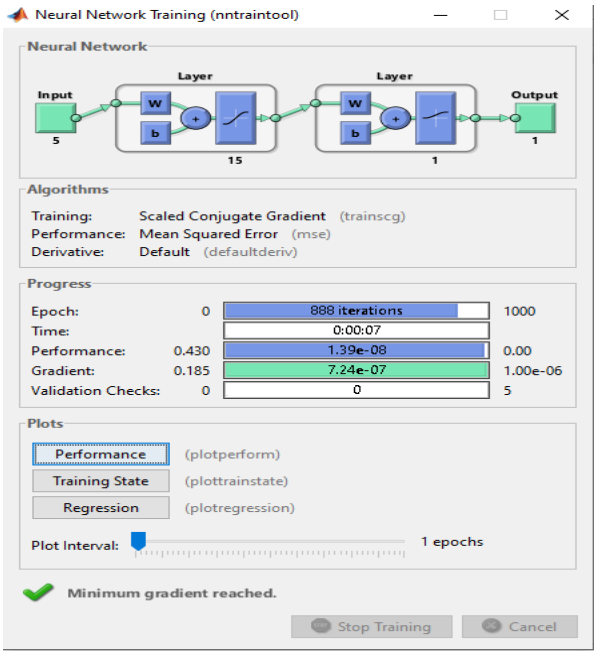

Figure 3. Training Layer 15 with matlab 2011b.

c. Model 5-20-1.

In the results of the 5-20-1 epoch architecture model, the result was 292 iterations in 4 seconds. can be seen in table 8 and table 9.

Table 8 Training Outcomes Data .

No.

No	X1	X2	X3	X4	X5	Target (y1)	epoch 292		
							actual	Erorr	Perf
1	0,3130	0,3734	0,3297	0,3322	0,3743	0,2880	0,2880	0,0000	
2	0,3196	0,3225	0,3583	0,3842	0,4127	0,3290	0,3291	-0,0001	
3	0,2422	0,2895	0,2426	0,2507	0,2835	0,2083	0,2083	0,0000	
4	0,5279	0,4375	0,4543	0,4136	0,4630	0,3951	0,3951	0,0000	
5	0,3466	0,2842	0,3487	0,3864	0,3754	0,2725	0,2725	0,0000	0,000000002
6	0,2984	0,3092	0,2786	0,3000	0,3127	0,2268	0,2268	0,0000	
7	0,1625	0,2149	0,2063	0,1620	0,2293	0,1549	0,1549	0,0000	
8	0,1259	0,1391	0,1357	0,1266	0,1683	0,1000	0,1000	0,0000	
9	0,4284	0,4024	0,5326	0,4955	0,5609	0,4502	0,4502	0,0000	
10	0,9000	0,7967	0,8386	0,8333	0,8734	0,7676	0,7676	0,0000	

Table 9 test result data.

No	X1	X2	X3	X4	X5	Target (y2)	Epoch		
							actual	Error	Perf
1	0,3828	0,3376	0,3402	0,3837	0,2945	0,3168	0,1556	0,1612	
2	0,3301	0,3672	0,3940	0,4234	0,3369	0,3423	0,1849	0,1574	
3	0,2960	0,2475	0,2559	0,2898	0,2121	0,2404	0,1227	0,1177	
4	0,4491	0,4665	0,4244	0,4755	0,4053	0,4315	0,2469	0,1846	
5	0,2906	0,3573	0,3963	0,3848	0,2784	0,2921	0,1445	0,1476	0,025936749
6	0,3164	0,2848	0,3069	0,3200	0,2312	0,2518	0,1259	0,1259	
7	0,2188	0,2100	0,1641	0,2338	0,1568	0,1768	0,0946	0,0822	
8	0,1405	0,1369	0,1275	0,1706	0,1000	0,1178	0,0757	0,0421	
9	0,4128	0,5475	0,5091	0,5767	0,4622	0,4997	0,2030	0,2967	
10	0,8207	0,8640	0,8586	0,9000	0,7906	0,7945	0,6318	0,1627	

3.3 Evaluation

After training and data testing of the 5-10-1 to 5-30-1 architecture model using the help of the Matlab 2011b Application and Microsoft Excel, the best training architecture model was obtained at 5-20-1 with the lowest performance / MSE test value of 0.0000000002 within 4 seconds.

Table 10. Comparison of Model Overall Results

Algorithm	Architecture	Training Function	Epoch	MSE Training	MSE Testing
Conjugate Gradient	5-10-1	Trainscg	329	0,000000007	0,007743012
	5-20-1	Trainscg	888	0,000000017	0,007743012
	5-15-1	Trainscg	292	0,000000002	0,25936749
	5-25-1	Trainscg	369	0,000000005	0,004868148
	5-30-1	Trainscg	437	0,000000002	0,018630109

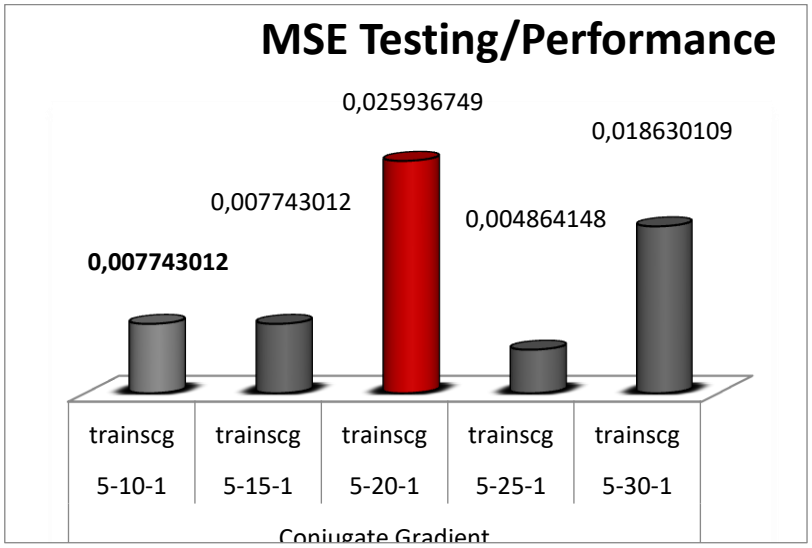

Figure 4. Comparison Chart on Erformance Test Results

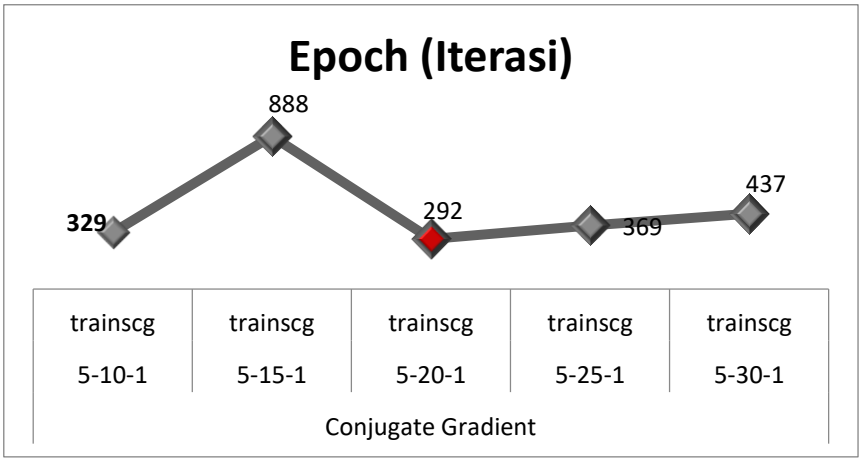

Image 5. Training Epoch comparison chart

4. Conclusion

Based on the results and discussion of the training and testing data, conclusions can be drawn: Conjugate Gradient algorithm with the best architectural training model, namely 5-20-1 with an epoch of 292 Literacy in 4 seconds, can be used and utilized to predict the percentage of formal labor in sumatra island, because the training time for achieving convergence is not too long and the resulting performance is quite good compared to the other four architectural models. The results of the training and testing of the five architects that have been described above, produced various kinds of Performance or MSE results and varied epochs on the Backpropagation algorithm.

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