Conjugate Gradient Polak Ribiere In Improving Performance in Predicting Population Backpropagation

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Abstract. Perform predictive data in the form of time series required a correct method, one method is now often used is the propagation of this method is a method that is able to minimize the error value of the output of the predicted number of people, but still generate quite a lot of iteration that needs to be optimized by minimize iterations and use of time, then the use of conjugate gradient polak Ribiere are expected to minimize the use of time, the number of the epoch of the results of standard backpropagation.

1. Introducing

This time the prediction is very often done to determine the circumstances in the future, for example, a company wants to make predictions about earnings in the period of 10 years, a football coach to predict the strategies to be carried out by opponents that the team can do prevention at opponent's strategy. A good predictor that has a range of very slight difference with the data of fact, the less difference prediction data with the data facts, the better the accuracy of these predictions. This case discusses the prediction of the number of people with one method in which back propagation neural network. Backpropagation originally introduced by Rumelhart [1]. The algorithm will be improving the performance by using conjugate gradient. There are several types of Conjugate Gradient method, one of them is Polak Ribiere. In certain cases, Polak Ribiere to find a solution even though the starting point away from the point of minimum so as to converge more quickly than before. Thus in this research network training using the Conjugate Gradient Polak Ribiere on Backpropagation in the case study predicted the number of people in the province of North Sumatra. Conjugate Gradient Polak Ribiere on Backpropagation is one of the neural network methods that is widely used to predict. Moreover, there have been many studies using neural network methods [2]–[15].

Projected population is predicted the number of people based on a particular method by assuming births, deaths and migration. According to demographers, the prediction is generally used to predict the number of people for a period between census and after the census was held in a certain area, While the projection implies that the estimated number of people in the future who have not known the exact number, and the future value of an indication of the number of future residents if implemented in fertility, morality and certain immigration that may apply.

In previous studies, [16] conducted a study in predicting population density by using the binary sigmoid activation function and linear function. The forecast accuracy using a combination of these functions is 94%. The weakness of this study is that this study only uses binary sigmoid functions and linear functions without discussing the function of bipolar sigmoid at all. Therefore, by applying the method Conjugate Gradient Polak Ribiere expected to improve the accuracy of prediction of the number of people in North Sumatra province so that it can cope with a range difference prediction results with the original data is not too far away.
2. Research methods

This study uses data from the Central Bureau of Statistics of North Sumatra. The data used has a time span from 2011-2018 year, each data can be grouped based on the number of cities and districts in North Sumatra. Here is the data used;

| Years | Nias | Mandailing | South Tapanuli | Central Tapanuli | ... | Field | Binjai | Padangsidimpuan | Gunung Sitoli |
|-------|------|------------|----------------|------------------|-----|-------|-------|-----------------|--------------|
| 2011  | 132605 | 408731     | 266282         | 314142           | ... | 2117224 | 248456 | 193322          | 127382       |
| 2012  | 132860 | 410931     | 268095         | 318908           | ... | 2122804 | 250252 | 198809          | 128337       |
| 2013  | 133388 | 413475     | 268824         | 324006           | ... | 2123210 | 252263 | 204615          | 129403       |
| 2014  | 133388 | 413475     | 268824         | 324006           | ... | 2123210 | 252263 | 204615          | 129403       |
| 2015  | 136115 | 430894     | 275098         | 350017           | ... | 2210624 | 264687 | 209796          | 135995       |
| 2016  | 141403 | 435303     | 276889         | 356918           | ... | 2229408 | 267901 | 212917          | 137693       |
| 2017  | 142110 | 439505     | 278587         | 363705           | ... | 2247425 | 270926 | 216013          | 139281       |
| 2018  | 142840 | 443490     | 280283         | 370171           | ... | 2264145 | 273892 | 218892          | 140927       |

The initial step in solving problems is to first make the selection data from the Central Statistics Agency website North Sumatra, then the data will be prepared to do the processing using standard backpropagation method and conjugate gradient backpropagation polak Ribiere. The next step the data will be normalized the data using a sigmoid function which is an asymptotic function did not reach 0 or 1 then needs to be normalized. Once the data is normalized will be made to the training network using a combination of inputs 3-5-1, 4-4-1, 5-3-1, 6-2-1, 2-6-1 this is done to get maximum results in the training process. In the case raised the authors used a combination of input 3-5-1 because it scores fewer errors and has better accuracy results. Once the data is normalized already done training the network and get the testing data that has been normalized earlier into a standard back propagation method This method is used because the method is capable of formulating knowledge and experience and is also flexible enough to change the rules of forecasts, Then, after the data is processed using backpropagation standards and get the next result of the same data is used to perform processing by using backpropagation optimized using the conjugate gradient polak Ribiere to get results in training close to the target and then do the testing, the results of the testing will be conducted comparison of the results so that it can be deduced whether by adding a conjugate gradient method to optimize the results polak Ribiere of accuracy compared with the results of standard propagation.

![Figure 1. Block Diagram of Standard Backpropagation Methods](image-url)
3. Results and Discussion

3.1. Standard Backpropagation Network
By using the standard back propagation method is carried out training of the data that has been normalized. Based on the data obtained epoch were 71 and working time 8 seconds performance results of the training of BP Standard are as follows:

Figure 3. Training Performance Prediction Population Using Backpropagation Standard

From the results of the training showed that finding the best training patterns in the epoch that is large enough that 71 epoch and his best training performance MSE value is 0.0097133.
Figure 4. Comparison Chart View with Results Output Target Population Prediction Using Backpropagation Standard

From the results above shows that the output data of the neural network copies are still too far from the target so it needs to be maximized.

3.2. Network Conjugate Gradient Polak Ribiere

After training using standard backpropagation then done using conjugate gradient Backporgagation polak Ribiere with the data is normalized and the selection of training data and the data on the same target the MSE value obtained by 0.000054846 convergence in the epoch to 4. Here is a figure of the results of MSE:

Figure 5. Backpropagation Training Performance Display CGPR in Predicting Population

From the picture above we can say that by using conjugate gradient obtained polak Ribiere 4 epoch and the time required in the process is only 1 second.

Figure 6. Graph View CGPR Backpropagation Training in Predicting Population
Based on the chart above shows that the output data of the neural network is almost close to the target or it could be said to have a range that is not too far from the targeted data.

3.3. Testing

| Target Data | Backpropagation Standard | Backpropagation CGPR |
|-------------|--------------------------|-----------------------|
| 142 840     | 54 456                   | 159 850               |
| 443 490     | 638 993                  | 424 178               |
| 280 283     | 219 546                  | 282 032               |
| 370 171     | 434 043                  | 365 694               |
| 299 881     | 265173                   | 299 627               |
| 182 673     | 13836                    | 192 457               |
| 486 480     | 748 004                  | 466 623               |
| 724 379     | 1319830                  | 712 493               |
| 863 693     | 1540520                  | 871 622               |
| 283 203     | 227 003                  | 284 133               |
| 409 675     | 540 044                  | 398 739               |
| 2155625     | 1647215                  | 2111081               |
| 1035411     | 1705567                  | 1048274               |
| 317 207     | 306 064                  | 315 687               |
| 188 480     | 24560                    | 199 074               |
| 48 119      | 222 524                  | 52200                 |
| 125 816     | 91 062                   | 135 589               |
| 614 618     | 1093532                  | 586 406               |
| 412 992     | 554 952                  | 397 810               |
| 267 771     | 187 035                  | 276 141               |
| 275 515     | 203 005                  | 283 790               |
| 332 922     | 339 282                  | 333 952               |
| 360 926     | 416 519                  | 352 757               |
| 137 002     | 70 876                   | 147 754               |
| 81 663      | 173 402                  | 81 866                |
| 87 317      | 157 315                  | 94 837                |
| 173 302     | 4942                     | 184 695               |
| 253 500     | 158 710                  | 258 967               |
| 162 581     | 24 626                   | 174 240               |
| 2264145     | 1608996                  | 2136018               |
| 273 892     | 203 247                  | 278 524               |
| 218 892     | 84 525                   | 229 321               |
| 140 927     | 64 278                   | 152 256               |
| MSE         | 0.0097133                | 0.000054846           |

4. Conclusion
After testing the results of research that discussed the problems of the conclusions obtained are as follows;
   a. Backpropagation and conjugate gradient method polak Ribiere can be used to perform the prediction process.
   b. Standard backpropagation method has poor accuracy in predicting the data changes.
   c. The combination of the conjugate gradient backpropagation method polak Ribiere and using sigmoid activation function and Biner can improve performance in this case the time series data prediction accuracy significantly nearing the target data to the MSE value of 0.000054846.

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