Predictions of World Population Life Expectancy Using Cyclical Order Weight / Bias

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Abstract. Life expectancy is the average number of years of life that is still lived by someone who has reached a certain age. Life Expectancy is a tool to evaluate government performance in improving the welfare of the population in general and improving health status in particular. The purpose of this paper is to estimate the life expectancy of the world population so that the government has a benchmark in determining policies to further improve the health and health of the people in their respective countries. The estimation stated in this paper will use the Cyclical Order Weight Neural Network method. The data used in this paper is the number of world population expectations. Data sources come from the United Nations: "World Population Prospect: The 2010 Revision Population Database". The results of this study are expected to be a reference for the governments of each country to pay more attention to the level of health and welfare of its population so that the life expectancy of the population will be higher. This study uses 5 architectural models. Of these 5 models, the best architectural model is 3-5-10-1 with an accuracy of 97% and an MSE value of 0.0008358919.

1. Introduction

Life Expectancy is the average number of years of life lived by someone who has reached a certain age. The benefit of knowing life expectancy is to evaluate the performance of the government in improving the welfare of the population in general and improving health status in particular. Low life expectancy in an area/country must be followed by health development programs, and other social programs including environmental health, nutritional and calorie adequacy including poverty eradication programs [1]. Based on the data of life expectancy of 38 countries in the world in 1995-2015 which are counted every 5 years, sourced from the United Nations: "World Population Prospect: The 2010 Revision Population Database" and the Indonesian Central Statistics Agency (BPS), it is noted that the country having the highest life expectancy in 2010-2015 was Japan at 83.5 years. Followed by Hong Kong of 83.3 years. While the people of Indonesia itself is ranked 31 with a life expectancy of 70.1 years [2].

Because of the importance of Life Expectancy in Indonesia, it is necessary to estimate the Life Expectancy Rate in the following years, so that each country, especially the Indonesian government, has clear references and references to determine policies or make appropriate strategic steps so that the Expectation Rate Life in Indonesia should not be reduced in the future, even able to increase every year. One good method used to estimate is Cyclical Order weight. This method is one method of the Artificial Neural Network. Artificial Neural Networks are widely used for solving problems related to estimation, pattern recognition, data analysis, control, and grouping [3]–[7]. Simple neural networks were first introduced by McCulloch and Pitts in 1943. McCulloch and Pitts concluded that the...
combination of several simple neurons into a neural system would increase their computational ability. The weight in the network proposed by McCulloch and Pitts is set to perform simple logic functions. The activation function used is the threshold function \[8\].

Cyclical Order weight/bias method is an artificial neural network method that trains networks with burdensome learning rules and bias with additional updates after the data presented in the input. The data that is input is displayed in a sequence arranged in a circle \[9\]. With this method, data on World Population Life Expectations will be divided into 2 parts, namely data training (training) and data testing (testing), each of which has a different target. As with other ANN methods, this method also uses parameters with hidden layer (hidden layer) neurons to obtain the best network architecture model \[10\][11]. This best network architecture model will be used to estimate World Population Life Expectations in the coming years \[12\]. In general, this method works by updating the weight and bias values according to the data presented \[13\].

In previous Researches, studies have been conducted to review and analyze life expectancy in schizophrenics. Research and analysis have shown that mortality in people with Skizofrenia is higher than the general population with the lowest life expectancy in Asia and Africa \[14\]. Further research was conducted to see the projections of future life expectancy in 35 industrial countries using the Bayesian ensemble model. This study aims to bring together all available epidemiological data using a coherent measurement framework, standard estimation methods, and transparent data sources to enable comparisons of health losses over time and across causes, age-sex groups, and countries. GBD can be used to produce summary steps such as adjusted years of life disability (DALYs) and healthy life expectancy (HALE) that allow a comparative assessment of broad epidemiological patterns across countries and times \[1\]. Further research was conducted to predict the Consumer Price Index (CPI) using backpropagation ANN algorithm and Conjugate Gradient Fletcher-Reeves. This study produces predictions with 75% accuracy when using Backpropagation and 67% when using Conjugate Gradient Fletcher-Reeves \[15\]. Based on this background, the authors are interested in predicting World Population Life Expectations by using a different method using the Cyclical Order weight/bias method. The results of this study are expected to be able to contribute to the Indonesian government as a reference and reference in determining policies to increase community life expectancy.

2. Methodology

2.1. Data Used

The data used are life expectancy data in 38 countries in the world from 1995-2015 which are counted every 5 years, sourced from the United Nations: "World Population Prospect: The 2010 Revision Population Database" and the Indonesian Central Statistics Agency.

| No | Country’s          | Age/Years       |
|----|--------------------|-----------------|
|    |                    | 1995-2000 | 2000-2005 | 2005-2010 | 2010-2015 |
| 1  | United States      | 76.4     | 77.1     | 78.1     | 78.9      |
| 2  | Saudi Arabia       | 71.6     | 73.1     | 74.3     | 75.4      |
| 3  | Australia          | 78.9     | 80.4     | 81.7     | 82.4      |
| 4  | Bangladesh         | 64.1     | 66.4     | 68.4     | 70.5      |
| 5  | Netherlands        | 77.8     | 78.7     | 80.2     | 80.9      |
| 6  | Belgium            | 77.3     | 78.3     | 79.5     | 80.4      |
| 7  | Brazil             | 69.4     | 71.0     | 72.4     | 73.8      |
| 8  | China              | 70.9     | 73.4     | 74.4     | 75.2      |
| 9  | Denmark            | 76.0     | 77.3     | 78.6     | 79.3      |
| 10 | Russian Federation | 65.7     | 65.0     | 67.2     | 67.9      |
| 11 | The Philippines    | 66.4     | 67.1     | 67.8     | 68.6      |
2.2. Research Flowchart

The stages of this study are as follows:

![Research Flowchart](image)

**Figure 1.** Research Flowchart

Explanation in Figure 1 that training data and testing data are the first data that must be available and stored on the computer. Then training and testing data must first be normalized using the

| No | Country’s        | 1995-2000 | 2000-2005 | 2005-2010 | 2010-2015 |
|----|------------------|-----------|-----------|-----------|-----------|
| 12 | Finland          | 77.0      | 78.3      | 79.5      | 80.5      |
| 13 | Hong Kong SAR    | 79.4      | 81.3      | 82.4      | 83.3      |
| 14 | India            | 61.2      | 63.1      | 64.9      | 66.3      |
| 15 | Indonesia        | 66.0      | 67.8      | 69.1      | 70.1      |
| 16 | English          | 77.1      | 78.4      | 79.6      | 80.4      |
| 17 | Italy            | 78.7      | 80.2      | 81.5      | 82.3      |
| 18 | Japan            | 80.5      | 81.8      | 82.7      | 83.5      |
| 19 | German           | 77.2      | 78.6      | 79.8      | 80.7      |
| 20 | Cambodia         | 59.8      | 64.5      | 69.5      | 71.6      |
| 21 | Canada           | 78.5      | 79.7      | 80.5      | 81.4      |
| 22 | Kazakhstan       | 63.0      | 64.6      | 65.7      | 66.4      |
| 23 | South Korea      | 74.9      | 77.4      | 80.0      | 81.4      |
| 24 | Kuwait           | 72.9      | 73.4      | 73.8      | 74.2      |
| 25 | Malaysia         | 72.3      | 73.3      | 74.0      | 74.9      |
| 26 | Mexico           | 68.0      | 69.0      | 69.9      | 71.1      |
| 27 | Egypt            | 73.7      | 75.0      | 76.3      | 77.4      |
| 28 | Myanmar          | 61.3      | 62.8      | 64.2      | 65.1      |
| 29 | Nigeria          | 46.3      | 47.3      | 50.2      | 52.3      |
| 30 | Norway           | 78.2      | 79.2      | 80.6      | 81.4      |
| 31 | Pakistan         | 63.1      | 64.5      | 65.7      | 66.5      |
| 32 | France           | 78.3      | 79.5      | 80.9      | 81.7      |
| 33 | Singapore        | 77.7      | 79.2      | 81.2      | 82.2      |
| 34 | Sri Lanka        | 69.1      | 73.2      | 73.4      | 74.2      |
| 35 | Sweden           | 79.2      | 80.1      | 81.1      | 81.7      |
| 36 | Thailand         | 70.6      | 71.5      | 73.3      | 74.3      |
| 37 | Venezuela        | 72.1      | 72.8      | 73.7      | 74.5      |
| 38 | Vietnamese       | 73.0      | 74.4      | 75.1      | 75.9      |
equation (1) formula. Normalized data will then be processed using the parameter Cyclical order weight/bias method. The next stage of the network will train data based on predetermined parameters. After all, steps are taken last, the best test results will be obtained that will be used to predict.

2.3. Data Normalization

The formula used is:
\[
x' = \frac{0.8(x-a) + 0.1}{b-a}
\] ................................. (1)

where \( x' \) is the normalized data, \( x \) is the normalized data, \( a \) is the data with the smallest value, and \( b \) is the maximum data with the highest value.

Life Expectancy Data divided into two parts, the first data for 1995-2010 is used as training data, while data for 2005-2010 used as training targets. The second data from 2000-2015 is used as testing data, while data for 2010-2015 used as target data testing.

3. Results and Discussion

This research uses 5 architectural models, including: 3-5-1, 3-8-1, 3-10-1, 3-5-8-1 and 3-5-10-1. Training and test parameters using Minimum Error Target = 0.001 - 0.03, Epoch = 1000, and max_fail = 5. The method used is Cyclical order weight / bias (trainc). Of these 5 architectural models, the best architecture is 3-5-10-1 with 97% accuracy.

From Figure 2 it can be explained that Epoch 149 iterations with a duration of 27 seconds.

| Architecture | Epoch | Times | MSE       | Accuracy |
|--------------|-------|-------|-----------|----------|
| 3-5-1        | 703   | 01.58 | 0.0011031685 | 92%      |
| 3-8-1        | 279   | 00.42 | 0.0012539833 | 89%      |
Based on Table 4 it is explained that the best architectural model of the 5 architectural models used is 3-5-10-1 with an accuracy of 97% and MSE 0.0008358919. From Figure 4 it is also known that a 3% margin error is obtained from the maximum number of accuracy (100%) minus the resulting accuracy.

4. Conclusion

The conclusion that can draw from this study is that the 3-5-10-1 architectural model is the best architectural model of the 5 models used to estimate population life expectancy in 38 countries using the Cyclical order weight/bias method. The accuracy obtained reached 97% and the lowest MSE compared to other models, which amounted to 0.0008358919.

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