

Tracking Future Trends of Under Five Mortality in Australia Using the Multilayer Perceptron Neural Network

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Abstract - This study uses annual time series data on under five mortality rate (U5MR) for Australia from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. The forecast evaluation criteria of the applied model indicate that the ANN (12, 12, 1) model is stable in forecasting U5MR. The neural network model projections revealed that U5MR will hover around 4 deaths per 1000 live births over the out of sample period. Therefore, we encourage the Australian government to continue supporting research and development, and MNCH programs in order to keep under five mortality under control.

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Sustainable development goals are a set of 17 objectives designed to tackle all the pertinent global issues affecting different population groups across the globe (UN, 2016; UN, 2015). The ambitious 169 targets are achievable but there is need for all UN member states to pool resources and demonstrate a unified response to the various challenges existing among different communities (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018). The emergence of highly infectious diseases such as COVID-19 calls for all countries to invest in research for vaccine and drug development. Modern day challenges require new strategies that are reconfigured to meet the task at hand. Under five mortality remains an important public health challenge particularly for developing countries (Ouedraogo *et al.* 2020; World Bank, 2020; Kayode *et al.* 2017; Liu *et al.* 2016; Sankar *et al.* 2016; PMCH, 2015; Tran *et al.* 2012; Oestergaard *et al.* 2011). Addressing factors that contribute to under five mortality in developing and developed countries should be a global health priority. Several interventions have been found to reduce under five mortality such as immunizations, integrated management of childhood illnesses, Vitamin A supplementation and exclusive breastfeeding (Yaya *et al.* 2018). The aim of this paper is to forecast future trends of under-five mortality rate for Australia using a machine learning algorithm. The findings of this study are expected to guide child health policies, planning and allocation of resources to child health program activities so as to keep under five mortality under control in the country.

II. LITERATURE REVIEW

Rasmussen *et al.* (2021) examined the recent figures and explored if potential differences could be explained by the well-known educational and income inequalities in stillbirth and infant death using a novel approach. The findings of the study showed that stillbirth and infant mortality varied considerably according to country of origin, with only immigrants from China, Norway, and Poland having an overall lower risk than Danish women. Women of Pakistani, Turkish, and Somali origin had a particularly high risk of both outcomes. Zeitlin *et al.* (2020) analyzed the patterns of stillbirth and neonatal mortality rates in Europe between 2004 and 2010. Data about live births, stillbirths and neonatal deaths by gestational age (GA) were collected using a common protocol by the Euro-Peristat project in 2004 and 2010. The study concluded that stillbirths and neonatal deaths declined at all gestational ages in countries with both high and low levels of mortality in 2004. Simeoni *et al.* (2019) analyzed the infant (IMR) and neonatal (NMR) mortality rates of Italian and foreign children and evaluated if there is a disparity among geographical macro-areas. Data from 2006 to 2015 were collected by the Italian Statistics Bureau (ISTAT) and extracted from two different national databases, which considered i) underlying cause of death and ii) birth registry. The main analyses were made comparing Italian versus foreigners as a single category as well as by country origin and contrasting Northern residents versus Southern ones. Comparisons between groups were done using relative risks. The study findings indicated that Inequalities in neonatal and infant mortality are evident between Italians and immigrants and among geographical macro-areas. A study in Portugal was carried out by Bandeira *et al.* (2016) to describe achievements in the maternal and child health program. The study highlighted that the joint venture of pediatricians and obstetricians with adequate top-down government commissions for maternal and child health for the decision making by health administrators and a well-defined schedule of preventive and managerial measures in the community and in hospitals, registry of special diseases and training of medical personnel are the most likely explanations for this success.

III. METHODOLOGY

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modelling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in architecture inspired by the way biological nervous systems of the brain appear like. Since no explicit guidelines exist for the determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting annual under five mortality rate for Australia.

Data Issues

This study is based on annual under five mortality rate in Australia for the period 1960 – 2020. The out-of-sample forecast covers the period 2021 – 2030. All the data employed in this research paper was gathered from the World Bank online database.

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	R
Observations	49 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.018167
MSE	0.099865
MAE	0.258406

Residual Analysis for the Applied Model

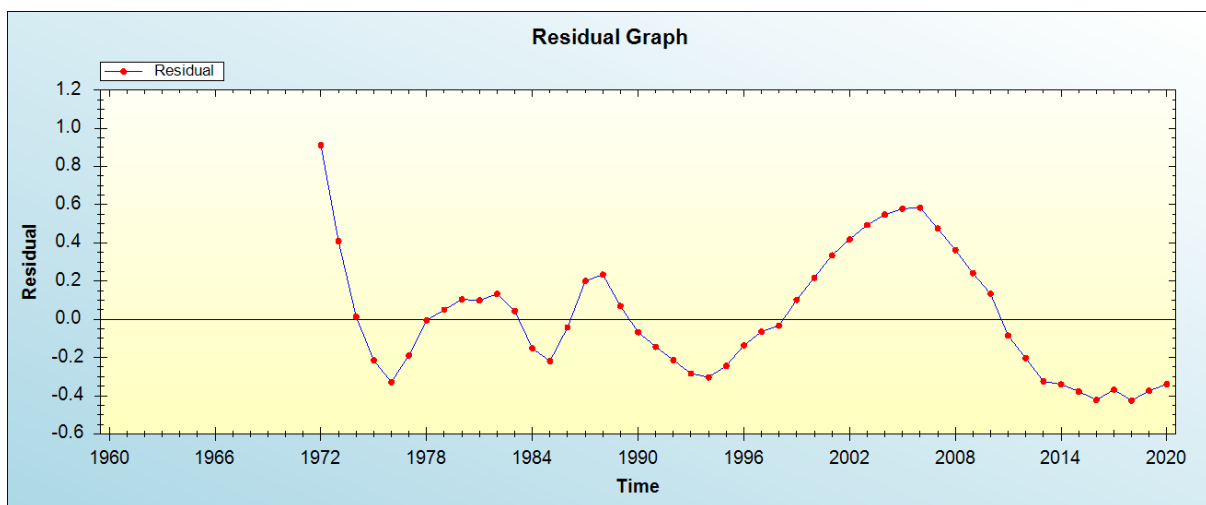


Figure 1: Residual analysis

In-sample Forecast for R

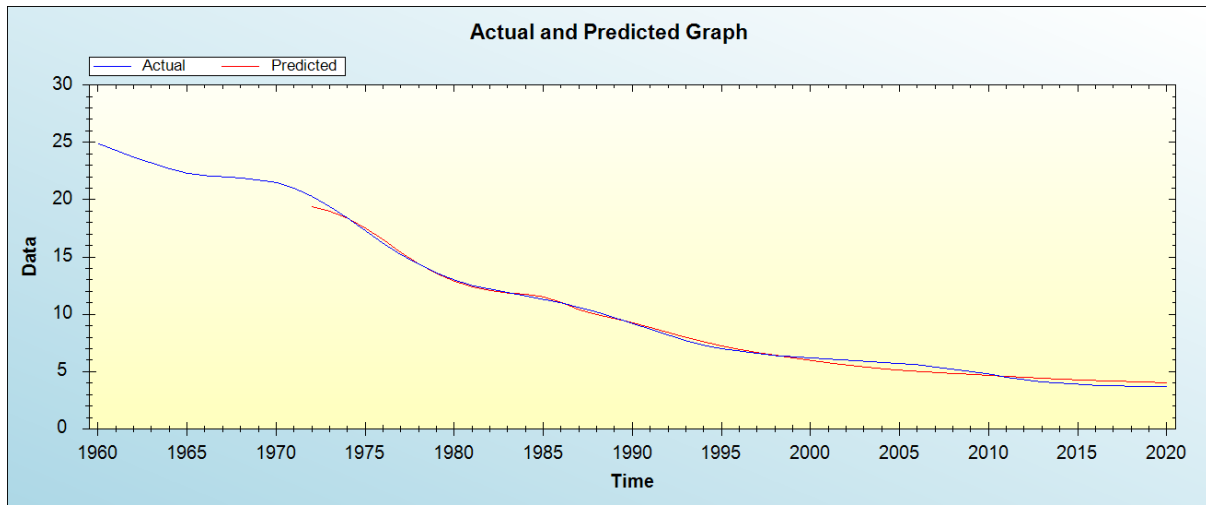


Figure 2: In-sample forecast for the R series

Out-of-Sample Forecast for R: Actual and Forecasted Graph

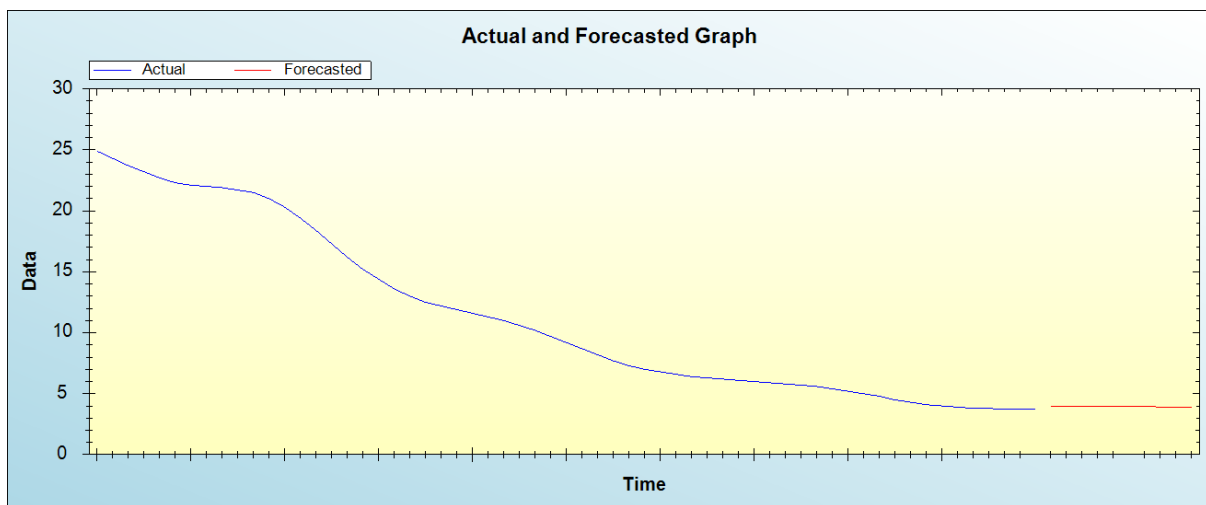


Figure 3: Out-of-sample forecast for R: actual and forecasted graph

Out-of-Sample Forecast for R: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	3.9938
2022	3.9815
2023	3.9633
2024	3.9705
2025	3.9547
2026	3.9361
2027	3.9369
2028	3.9223
2029	3.9242
2030	3.9208

The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that annual U5MR will hover around 4.0 deaths per 1000 live births over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Sustainable development goals (SDGs) will remain part of national plans and budgets in order to address all the various challenges being experienced across the globe. In this study, the ANN model projections highlighted that U5MR will hover around 4 deaths per 1000 live births over the out of sample period. Therefore in line with Agenda 2030, the government must continue to support research and development in order to improve patient care and inform public health policies. The government must continue providing financial resources to the maternal and child health (MNCH) program to keep under five mortality under control.

REFERENCES

- [1] UNICEF. (2019). Levels and trends in child mortality: report 2019. Estimates developed by the UN Inter-agency Group for child mortality estimation. New York: UNICEF.
- [2] United Nations. (2015). transforming our world: The 2030 agenda for sustainable development, A/RES/70/1. New York: UN General Assembly.
- [3] UN (2020) sustainable development goals. <https://www.un.org/sustainabledevelopment/development-agenda>
- [4] UNICEF (2018). Every Child alive. New York: UNICEF
- [5] World Health Organization (WHO) (2019). SDG 3: Ensure healthy lives and promote wellbeing for all at all ages.
- [6] Yaya S, Bishwajit G, Okonofua F, Uthman OA (2018). Under five mortality patterns and associated maternal risk factors in sub-Saharan Africa: A multi-country analysis. PLoS ONE 13(10): e0205977. <https://doi.org/10.1371/journal.pone.0205977>
- [7] Liu L, Oza S, Hogan D et al., Global, regional, and national causes of under-5 mortality in 2000–15: an updated systematic analysis with implications for the Sustainable Development Goals. Lancet 2016; 388: 3027–35 [https://doi.org/10.1016/S0140-6736\(16\)31593-8](https://doi.org/10.1016/S0140-6736(16)31593-8) PMID: 27839855
- [8] World Bank (2020). Child Mortality Rate. <https://data.worldbank.org/indicator/SH.DYN.MORT>.
- [9] Ouedraogo P., Zagre N., Mahoukèdè Zohoncon T., Ouattara AK., Bissyande V., Ouedraogo/Yugbare S (2020). Risk Factors for Neonatal Mortality at St Camille Hospital in Ouagadougou, Burkina Faso. Int J Pediatr, 8, 2: 10817-825.
- [10] Kayode GA., Grobbee D. E., and Amoakoh-Coleman M (2017). Variation in neonatal mortality and its relation to country characteristics in Sub-Saharan Africa: an ecological study. BMJ Glob Health 2017, 2:e000209.
- [11] M. J. Sankar., C. K. Natarajan., R. R. Das., R. Agarwal., A. Chandrasekaran., and V. K. Paul (2016), “When do newborns die? A systematic review of timing of overall and causespecific neonatal deaths in developing countries,” Journal of Perinatology, vol. 36, no. S1, pp. S1–S11.
- [12] H. T. Tran, L. W. Doyle, K. J. Lee, and S. M. Graham, “A systematic review of the burden of neonatal mortality and morbidity in the ASEAN region,” WHO South-East Asia Journal of Public Health, vol. 1, no. 3, pp. 239–248, 2012.
- [13] M. Z. Oestergaard., M. Inoue., S. Yoshida (2011). “Neonatal mortality levels for 193 countries in 2009 with trends since 1990: a systematic analysis of progress, projections, and priorities,” PLoS Medicine, vol. 8, no. 8, article e1001080.
- [14] The partnership for maternal and child health: newborn death and illness, 2015, http://www.who.int/pmnch/media/press_materials/fs/fs_newborndeadth_illness/en/
- [15] United Nation. Transforming our world: The 2030 agenda for sustainable development 2016.

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