

A Deep Learning Approach to Small Area Estimation

Anthony W. Mamani¹, Daniel A. Gutierrez-Pachas²

Departamento de Computación, Universidad Católica San Pablo, Arequipa, Perú.

Making accurate estimates across geographic areas is a crucial challenge with significant potential for application. However, data scarcity makes it difficult to generate reliable estimates. Small Area Estimation (SAE) has emerged as an effective statistical solution to tackle these challenges by leveraging auxiliary information and data from related areas to improve estimation accuracy, even with small sample sizes [4]. This approach leverages “borrowed strength” from external data, allowing for the production of more representative and applicable results [5].

Although SAE has traditionally been dominated by conventional statistical methods, known for their transparency and ease of interpretation, artificial intelligence (AI) models have gained prominence due to their ability to handle complex data. However, the low interpretability of many AI models, combined with their high complexity, has limited their adoption in this field. In this context, TabNet [1], a deep learning architecture for tabular data, is recognized for its ability to strike a balance between accuracy and interpretability, offering a promising alternative to traditional methods and other AI techniques.

We aim to develop a model that combines ease of use with high interpretability while ensuring accurate and reliable estimates. Unlike other models that require more complex data types, such as images or text, TabNet is optimized for tabular datasets, minimizing the need for extensive preprocessing and facilitating its implementation in real-world applications [1]. One of the key advantages of TabNet is its attention mechanism, which enables the model to autonomously identify and prioritize the most relevant features during training. This improves prediction accuracy and improves interpretability, which is crucial for estimating health conditions such as anemia, where understanding underlying factors is essential for effective interventions. Additionally, this approach reduces the risk of overfitting and enhances the model’s ability to generalize to new data, thereby increasing the reliability of its estimates.

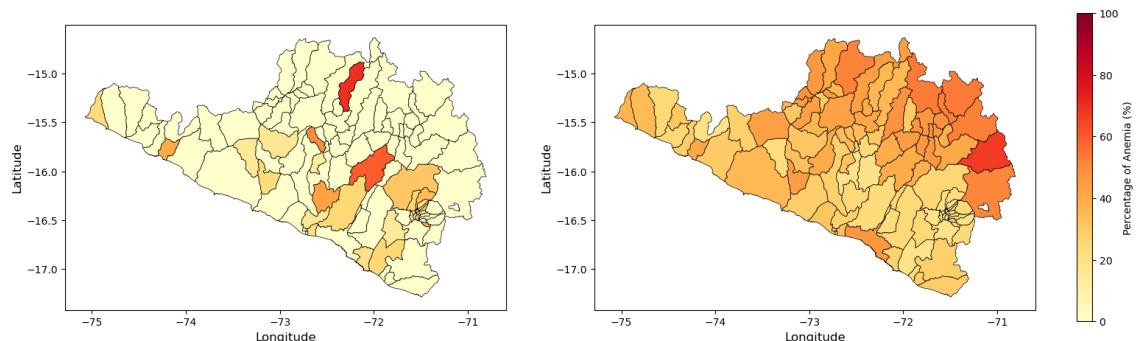


Figura 1: Percentage of anemia in Arequipa’s districts. The left image represents actual data. The right image represents the estimate using TabNet. Source: Own elaboration.

¹anthony.mamani@ucsp.edu.pe

²dgutierrezp@ucsp.edu.pe

We apply TabNet to the case study proposed in [3]. The evaluation will be conducted in two stages (see Figure 1). First, we compare the results obtained using TabNet and employ standard evaluation metrics. These metrics will help assess the accuracy of TabNet's estimates. Also, the prediction will be classified based on percentage values, following the approach used in [2], and evaluated for accuracy and confusion matrix analysis to assess the model's classification performance. The second stage of the evaluation focuses on evaluating the reliability of TabNet's estimates. This reliability analysis will examine the spatial correlation between the forecast and other relevant variables. The impact of each feature used in the estimation will be analyzed to determine its influence on the final results.

Finally, our proposal aims to significantly impact public policy by enhancing the accuracy and reliability of estimates, which is crucial for optimizing resource allocation and budget planning in public health. Improved precision will enable more effective strategic planning, ensuring better-targeted interventions for vulnerable communities. This study addresses the perception of artificial intelligence models, often called “black boxes” due to their lack of interpretability. By employing TabNet, a model that combines robustness with interpretability, we seek to demonstrate that AI can deliver accurate results and clear and understandable explanations of its decisions. This will facilitate its adoption as a reliable tool in complex studies, promoting the use of more transparent and accessible AI models in public health and beyond.

Referências

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