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Equity in Deep Learning Medical Applications: Leveraging the Gerchberg-Saxton Algorithm

Deep learning (DL) has become important in healthcare for its role in early diagnosis, treatment identification, and patient outcome predictions. However, due to varied medical practices and inconsistent data collection, DL may worsen biases and distort estimates. For instance, sampling bias challenges the effectiveness and applicability of statistical models. Selection bias, even with DL, can lead to unreliable or inaccurate results, particularly for underrepresented groups. Addressing bias is crucial to prevent unintended harm from the broader use of DL in healthcare. A recent paper in the Journal of Healthcare Informatics Research explores a new method for reducing bias using frequency domain transformation via the Gerchberg-Saxton (GS) technique and its impact on racial and ethnic biases.

Tackling bias in machine learning: a focus on healthcare equity

In machine learning, bias refers to systematic inaccuracies disadvantaging certain groups, while fairness is impartiality regardless of characteristics. Bias can manifest as data-to-algorithm bias, algorithm-to-user bias, or user-to-data bias. This study focuses on mitigating data-to-algorithm bias, particularly sampling bias, which skews training data representation. In healthcare, skewed data poses risks, leading to representation and population bias. Addressing bias is crucial to ensure safe and ethical machine learning applications, especially in medicine where bias can cause severe consequences like misdiagnosis. The study proposes a method using the Gerchberg-Saxton algorithm to mitigate racial bias in DL classification by equalizing frequency domain magnitudes, resulting in more consistent and equitable model performance across different racial categories. This approach shows promise in improving healthcare equity by enhancing model performance for underrepresented populations.

Innovative bias mitigation techniques in deep learning: the Gerchberg-Saxton algorithm

Existing tools were utilised innovatively to mitigate bias across diverse racial and ethnic groups in a deep learning model. By focusing on highly correlated features and employing advanced frequency domain operations, we tackled bias using the Gerchberg-Saxton algorithm on the MIMIC-III database known for selection biases. The GS algorithm, a model-agnostic technique, transforms data rather than altering the model directly, making it crucial for addressing dataset-level biases. However, challenges arise with processing voluminous datasets, requiring batch processing and careful curation to ensure equitable representation. While the transformed data may be structurally different, it doesn't hinder AI model efficacy, and the original dataset remains accessible for interpretation. The GS algorithm aims to distribute information evenly across all racial and ethnic categories, resulting in improved prediction accuracy and fairness across demographic groups.

This study showcases a method for mitigating bias in biomedical data using advanced frequency domain operations through the Gerchberg-Saxton algorithm. By applying this algorithm to the MIMIC-III dataset, reserachers demonstrated how information distribution affects the accuracy of mortality rate predictions, leading to more consistent and fair predictions across different racial and ethnic groups. Through SHAP calculations and Shannon entropy analysis, authors confirmed that the GS algorithm promotes a more uniform feature contribution, indicating a fairer training process. While further research is needed to explore the GS algorithm's potential in different contexts and modalities within medical applications, these findings suggest significant implications for advancing bias mitigation efforts in this field.

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