Image Augmentation and Class Imbalance in Medical Imaging Machine Learning

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Background/Problem Being Solved
Deep learning neural network models are available for investigation of classification problems in medical imaging.¹ The deeper the network, the more powerful yet more data-hungry, risking failure to converge from vanishing gradients.² In medical imaging, numerous examples of pathology may be difficult to obtain, with rare diseases or uncommon presentations potentially limiting available training sets.³ A common practice is to use image augmentation techniques to increase the amount of training set data by mathematic transformations on the original images.⁴ These transformations include: horizontal and vertical flips, image rotation, z-axis projection, skewing, and scaling up and down. The deep learning investigator also needs to consider the effects of class imbalance in their training set.⁵ At the recent 2nd C-MIMI conference, based upon the varied presentations, there was no standardization or consensus on either class imbalance issues or image augmentation protocols. It is worthwhile to consider both for the reproducibility and accuracy of medical imaging research.

Interventions
Class imbalance in training datasets must be assessed and dealt with, minimizing bias. Image data set transformations can be performed by external, pre-training image processing or on-the-fly processing during the training process. A definition and review of class bias imbalance is performed. A discussion of available image processing algorithms with relevant parameters using common applications such as matplotlib, keras, and imagemagik is presented.⁶

Outcome
The reader will understand how to avoid injecting class imbalance errors into their training datasets, solutions thereof, and tools and commands for image data augmentation appropriate for medical imaging will be explained.

Conclusion
Training set design for machine learning algorithms to avoid unexpected results is necessary to avoid failure of applications when confronted with out-of-sample data. This includes dealing with class imbalance issues and utilizing data augmentation techniques appropriately by understanding what they do, and what the results of those transformations will be upon the training set.

Statement of Impact
As deep learning networks are created for medical image classification, image augmentation will almost certainly be used to deepen the training set and improve classifier robustness. Mindful training set creation with appropriate image augmentation techniques and attention to class imbalance issues is necessary for reproducibility of medical imaging machine learning.

Keywords
convolutional neural network, machine learning, medical imaging, deep learning, image augmentation

References:
5. Dalyac A, Tackling Class Imbalance with Deep Convolutional Neural Networks, online.