Elastic deformation invariance in medical imaging

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In the field of medical imaging, acquiring training data is in general costly. It is therefore important to use available data in an efficient way when training a model. Existing methods often apply data augmentation, such as image transformation, to increase the amount of data. More recent literature is focussed on semi-supervised learning techniques to increase model accuracy by increasing the data efficiency. In this project, we have applied a siamese neural network [1] to learn elastic deformation invariance on medical data, with the goal of thereby increasing the prediction accuracy for image classification with limited data availability.

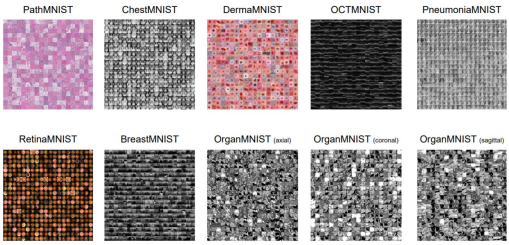

Figure 1: The MedMNIST dataset collection

MedMNIST is a collection of ten medical imaging datasets. Following the approach by the MNIST dataset, the images in this dataset have been standardized and preprocessed to 28x28 pixel images with the goal of making a lightweight standardized classification dataset. These ten datasets are of different modalities, ranging from organ classification (OrganMNIST) to disease classification in chest x-ray images (ChestMNIST).

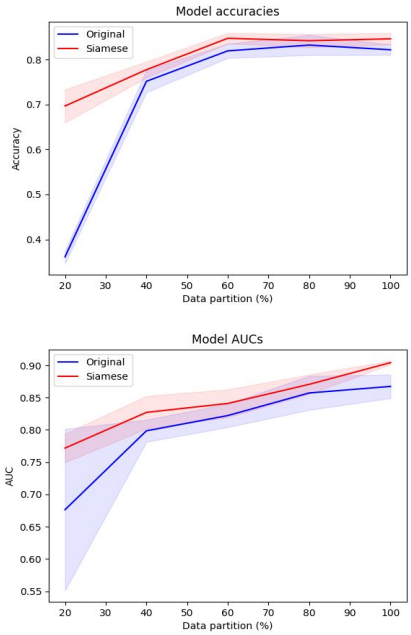

Figure 2: Performance comparison of original and elastic deformation method on various amounts of training data

As we see in Figure 2, our elastic deformation method outperforms the model using the original architecture by a slight margin on the larger data partitions. On the smaller partitions however, the differences become more pronounced. This indicates that our method is especially helpful for increasing data efficiency in situations where data availability is scarce. This is in line with expectations, as every sample is used twice; once to compute supervised loss, and once to learn invariance under elastic deformation. We hope our research provides more insight in exploration of the MedMNIST dataset and in learning invariance to elastic deformation.

	BreastMNIST		ChestMNIST		OrganMNIST		PneumoniaMNIST	
	ACC	**AUC**	**ACC**	**AUC**	**ACC**	**AUC**	**ACC**	**AUC**
Original	0.822	0.867	0.946	0.666	0.873	0.990	0.832	0.947
Elastic	0.846	0.904	0.947	0.659	0.882	0.991	0.848	0.950

Figure 3: Comparison of original and elastic deformation method on various datasets

References: [1] Chicco, Davide. “Siamese neural networks: An overview.” Artificial Neural Networks (2021): 73-94.

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