Table 3: The experimental results of manually designed models and DNAS-designed models.

Dataset	Model	Model size (MB)	Input size	#Slices	Accuracy (%)	Precision (%)	Sensitivity (%)	F1-score
Clean-CC-CCII	ResNet3D101	325.21	128×128	32	85.54	89.62	77.15	0.8292
	DenseNet3D121	43.06	128×128	32	87.02	88.97	82.78	0.8576
	MC3_18	43.84	128×128	32	86.16	87.11	82.78	0.8489
	CovidNet3D-S	11.48	128×128	32	88.55	88.78	**91.72**	**0.9023**
	CovidNet3D-L	53.26	128×128	32	**88.69**	**90.48**	88.08	0.8926
MosMedData	ResNet3D101	325.21	256×256	40	81.82	81.31	97.25	**0.8857**
	DenseNet3D121	43.06	256×256	40	79.55	**84.23**	92.16	0.8801
	MC3_18	43.84	256×256	40	80.4	79.43	98.43	0.8792
	CovidNet3D-S	12.48	256×256	40	81.17	78.82	**99.22**	0.8785
	CovidNet3D-L	60.39	256×256	40	**82.29**	79.50	98.82	0.8811
Covid-CTset	ResNet3D101	325.21	512×512	32	93.87	92.34	**95.54**	0.9392
	DenseNet3D121	43.06	512×512	32	91.91	92.57	92.57	0.9257
	MC3_18	43.84	512×512	32	92.57	90.95	94.55	0.9272
	CovidNet3D-S	8.36	512×512	32	94.27	92.68	90.48	0.9157
	CovidNet3D-L	62.82	512×512	32	**96.88**	**97.50**	92.86	**0.9512**

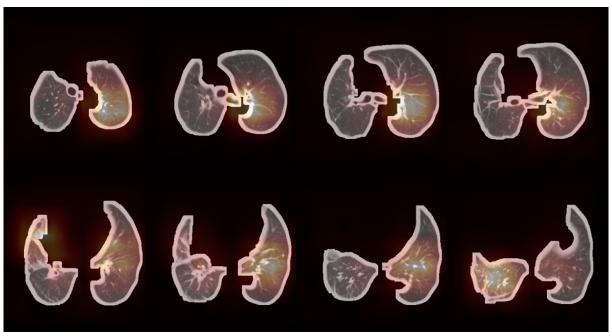

Figure 5: The class activation mappings generated on CovidNet3D on a chest CT scan of the Clean-CC-CCII dataset. Regions colored in red and brighter has more impact on model's decision to the class of COVID-19 while blue and darker region has less.

Interpretability

Although our model achieves promising result in detecting COVID-19 in CT images, classification result itself does not help clinical diagnosis without proving the inner mechanism which leads to the final decision makes sense. To inspect our CovidNet3D model's inner mechanism, we apply Class Activation Mapping (CAM) (**?**) on it.

CAM is an algorithm that can visualize the discriminative lesion regions that the model focuses on. In Fig. 5, we apply CAM on each slice of a whole 3D CT scan volume from Clean-CC-CCII dataset. Regions appear red and brighter have a larger impact on the model's decision to classify it to COVID-19. From the perspective of the scan volume, we can see that some slices have more impacts on the model's decision than the others. In terms of a single slice, the areas that CovidNet3D focuses on has ground-glass opacity, which is proved a distinctive feature of CT images of COVID-19 Chest CT images (**?**). CAM enables the interpretability of our searched models (CovidNet3D), helping doctors quickly locate the discriminative lesion areas.

Conclusion

In this work, we introduce the differentiable neural architecture (DNAS) framework combined with the Gumbel Softmax technique to search for 3D models on three open-source COVID-19 CT scan datasets. The results show that CovidNet3D, a family of models discovered by DNAS can achieve comparable results to the baseline 3D models with smaller size, which demonstrates that NAS is a powerful tool for assisting in COVID-19 detection. In the future, we will apply NAS to the task of 3D medical image segmentation to locate the lesion areas in a more fine-grained manner.

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