

# cOOpD: Reformulating COPD classification on chest CT scans as anomaly detection using contrastive representations

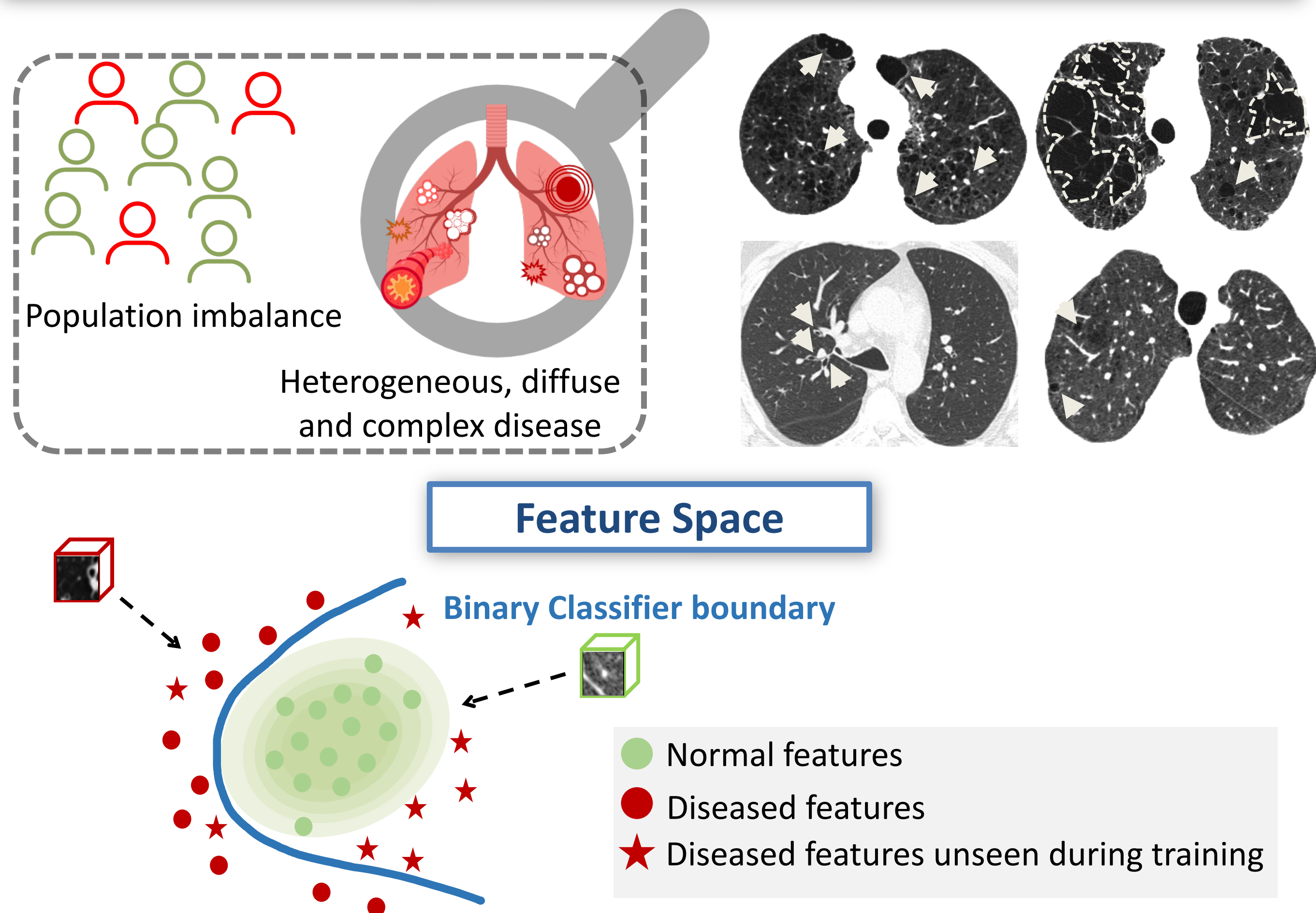
SD Almeida<sup>\*1,2,3</sup>, CT Lüth<sup>\*4,5</sup>, T. Norajitra<sup>1,3</sup>, T. Wald<sup>1,5</sup>, M. Nolden<sup>1</sup>, P. F. Jaeger<sup>4,5</sup>, C. Peter Heussel<sup>3,6</sup>, J. Biederer<sup>3,7</sup>, O. Weinheimer<sup>3,7</sup>, and K. Maier-Hein<sup>1,3,5</sup>

1. German Cancer Research Center (DKFZ), Division of Medical Image Computing, Heidelberg, Germany
2. Medical Faculty, Heidelberg University, Heidelberg, Germany
3. Translational Lung Research Center (TLRC), Member of the German Center for Lung Research (DZL), Heidelberg, Germany
4. German Cancer Research Center (DKFZ), Interactive Machine Learning, Heidelberg, Germany
5. Helmholtz Imaging, German Cancer Research Center, Heidelberg, Germany
6. Diagnostic and Interventional Radiology with Nuclear Medicine, Thoraxklinik at University Hospital, Heidelberg, Germany
7. Diagnostic and Interventional Radiology, University Hospital, Heidelberg, Germany

Making use of large, homogenous healthy populations to find diseased cases in unlabeled datasets via anomaly detection in the representation space

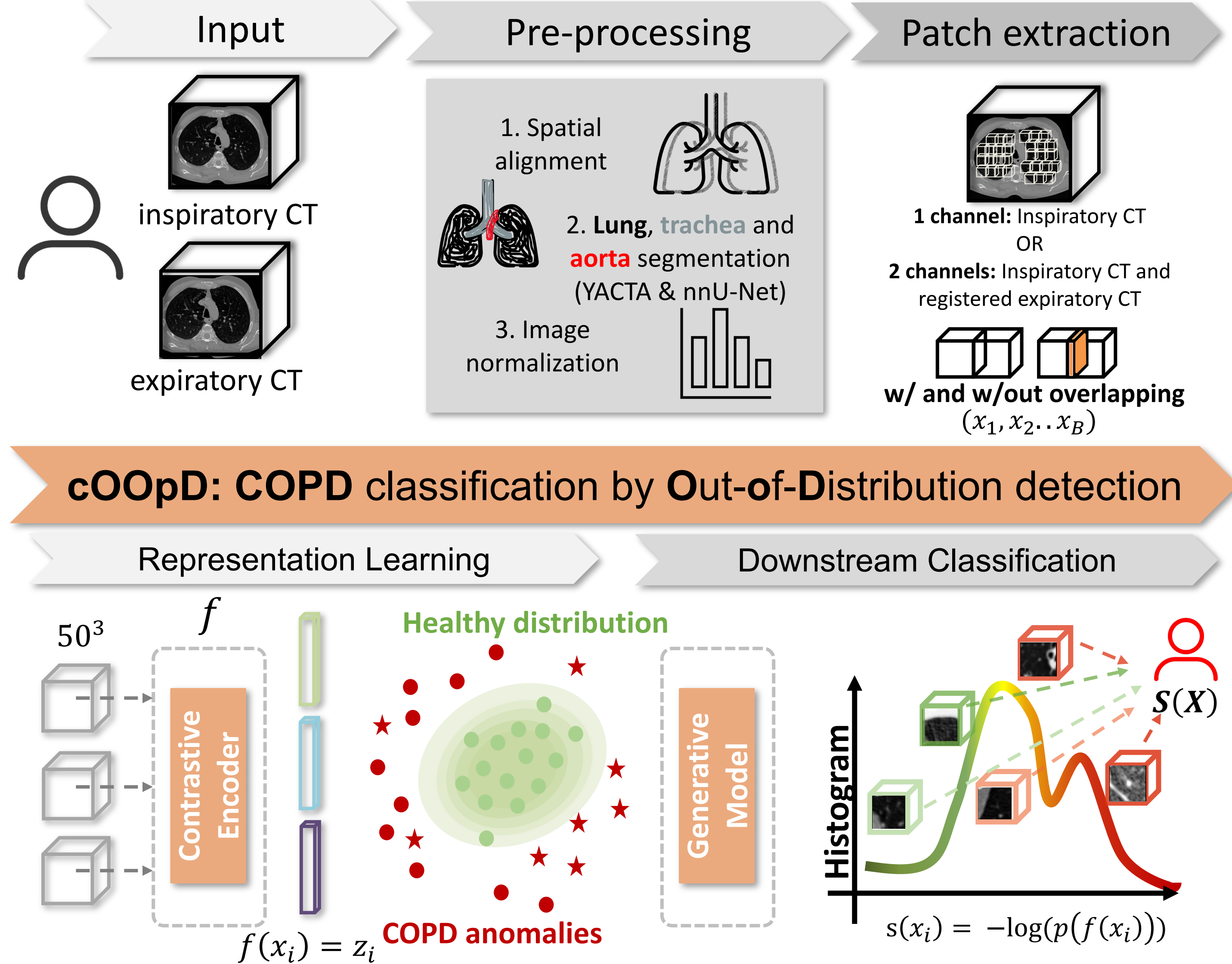
## Introduction

Chronic Obstructive Pulmonary Disease (COPD) appearance on CT challenges supervised binary classification.



**Hypothesis:** Could COPD be more accurately detected if considered as an **anomaly** from the distribution of healthy lungs?

## Methods



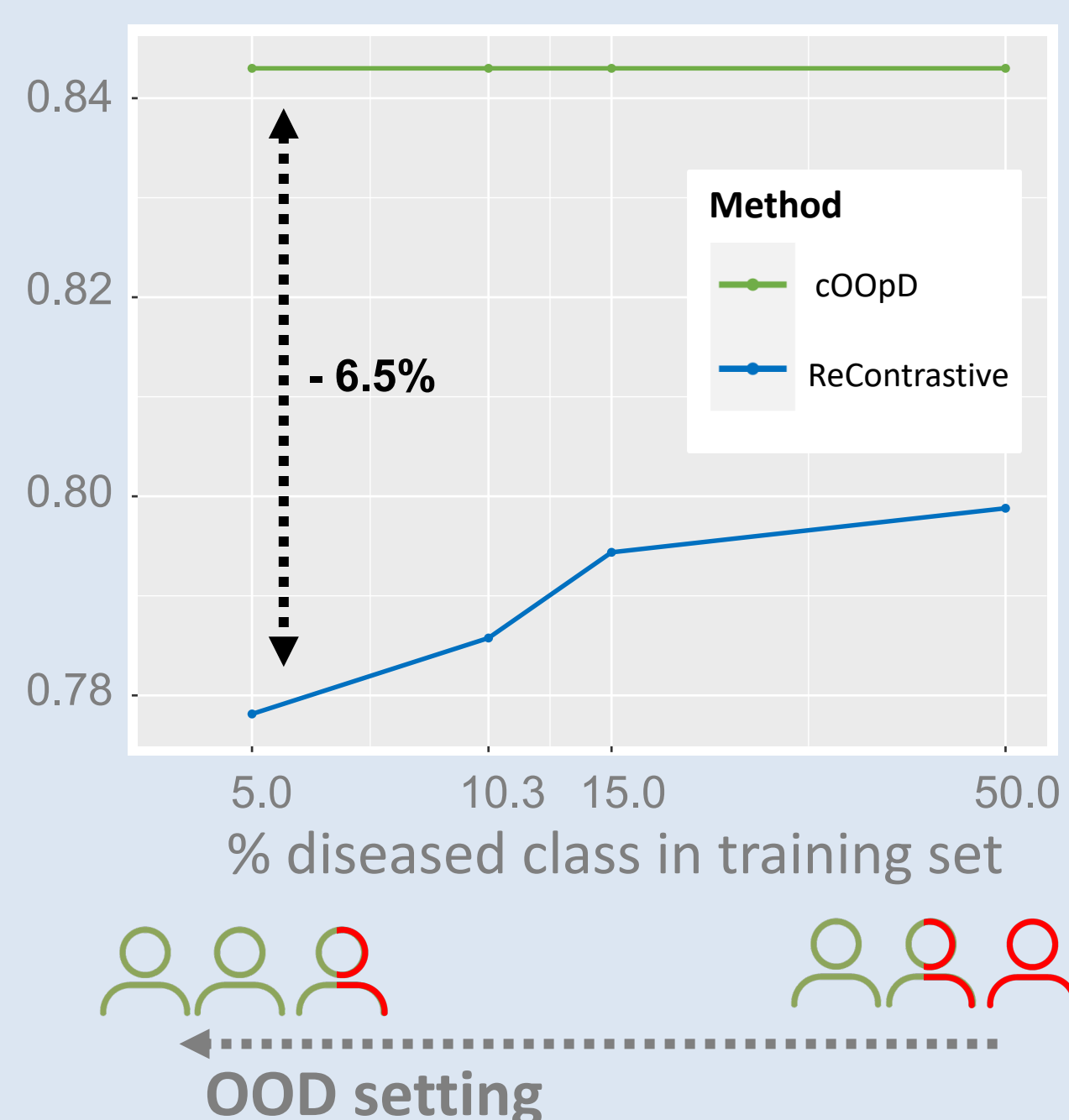
**Fitting Generative Models** for representation of patches of a SimCLR like trained Encoder:  $\downarrow$  complexity of data-distribution.

## Results

### Dataset

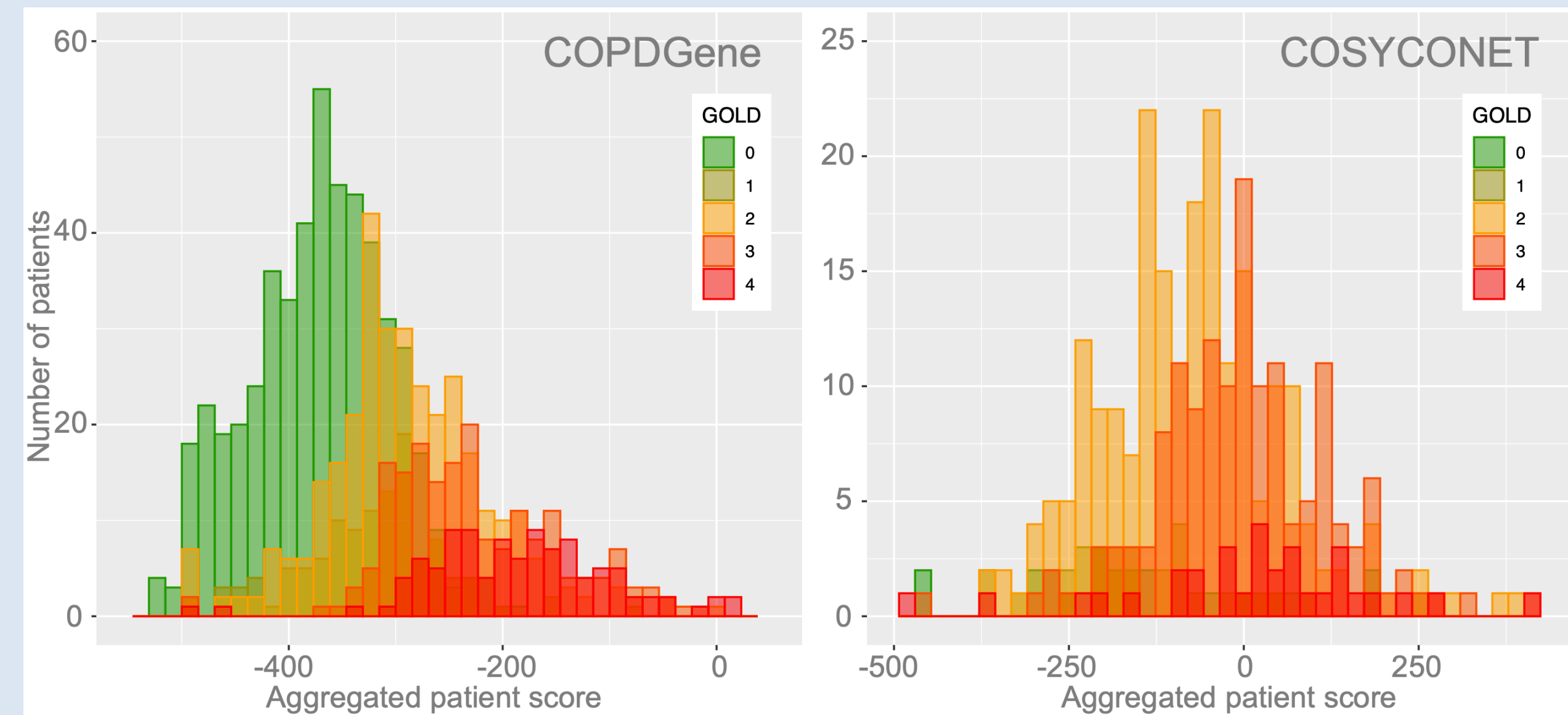
5244 from COPDGene (57% COPD)  
484 from COSYCONET (85% COPD)

### Real-world performance

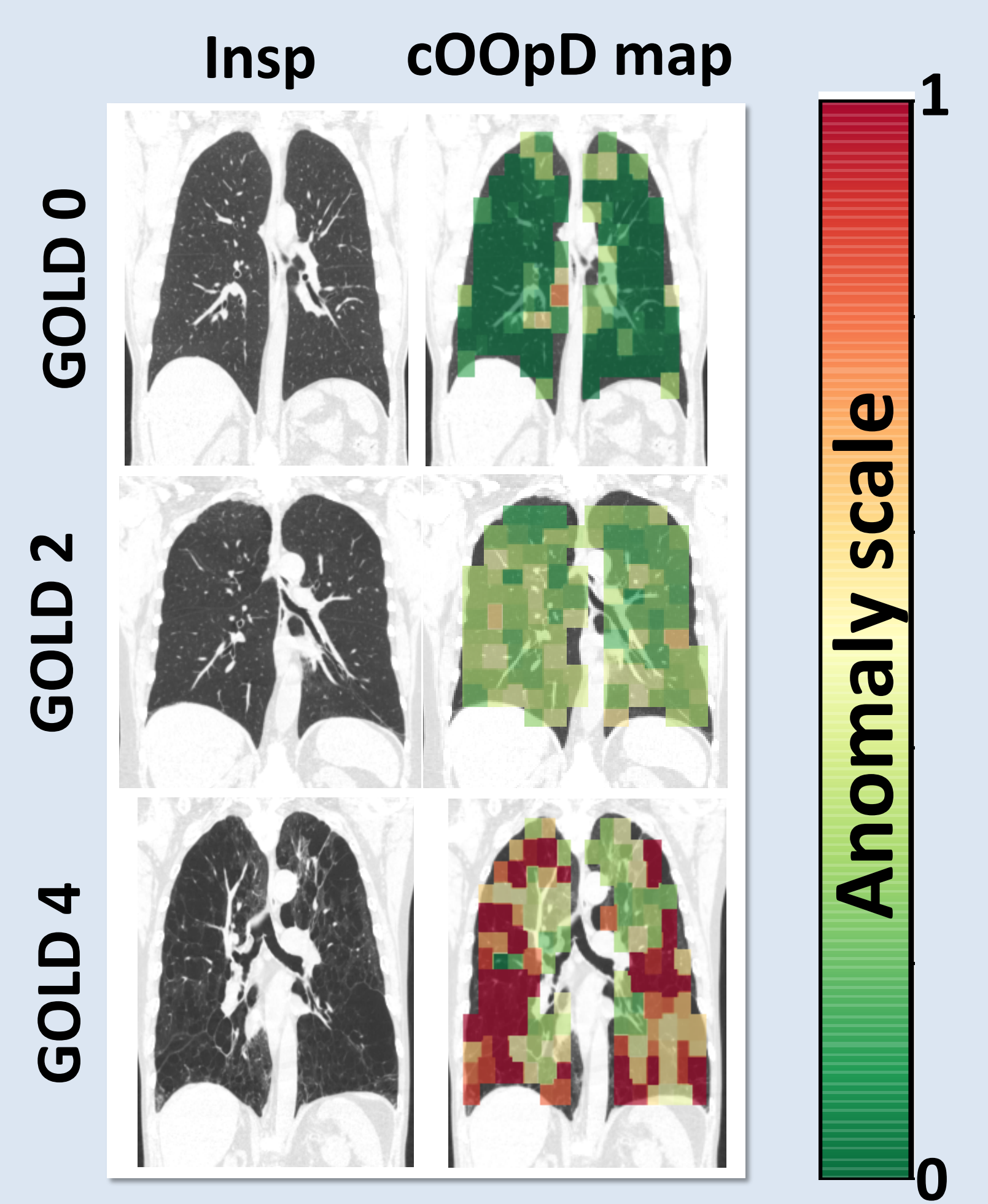


### Classifier evaluation in two large datasets

Input	Methods	COPDGene		COSYCONET	
		AUROC	AUPRC	AUROC	AUPRC
2D image	2D-CNN	55.6±2.5**	72.0±1.5**	57.0±8.0**	84.6±1.4**
	PatClass + RNN	76.1±0.2**	86.3±0.1**	56.2±0.7**	95.3±0.1*
	MIL + RNN	73.0±0.6**	84.5±0.5**	60.2±4.2*	95.7±0.4*
3D patch	MIL + Att	65.8±1.2**	80.9±0.8**	57.7±1.3**	95.1±0.2*
	ReContrastive (ours)	79.9±0.3**	88.5±0.2*	53.3±0.1**	95.0±0.1**
	cOOpD (ours)	84.3±0.3	89.7±0.2	67.9±0.7	96.5±0.4



### Visualization maps



## Discussion & Conclusion

- cOOpD demonstrates superior performance compared to SotA methods for COPD binary classification.
- Leveraging the contrastive latent space outperformed voxel-based classifiers.
- cOOpD performance stays stable compared with supervised methods given limited access to annotated diseased data.

Paper & Code Let's connect?

