Lesion In-aNd-Out Painting for Medical Image Augmentation

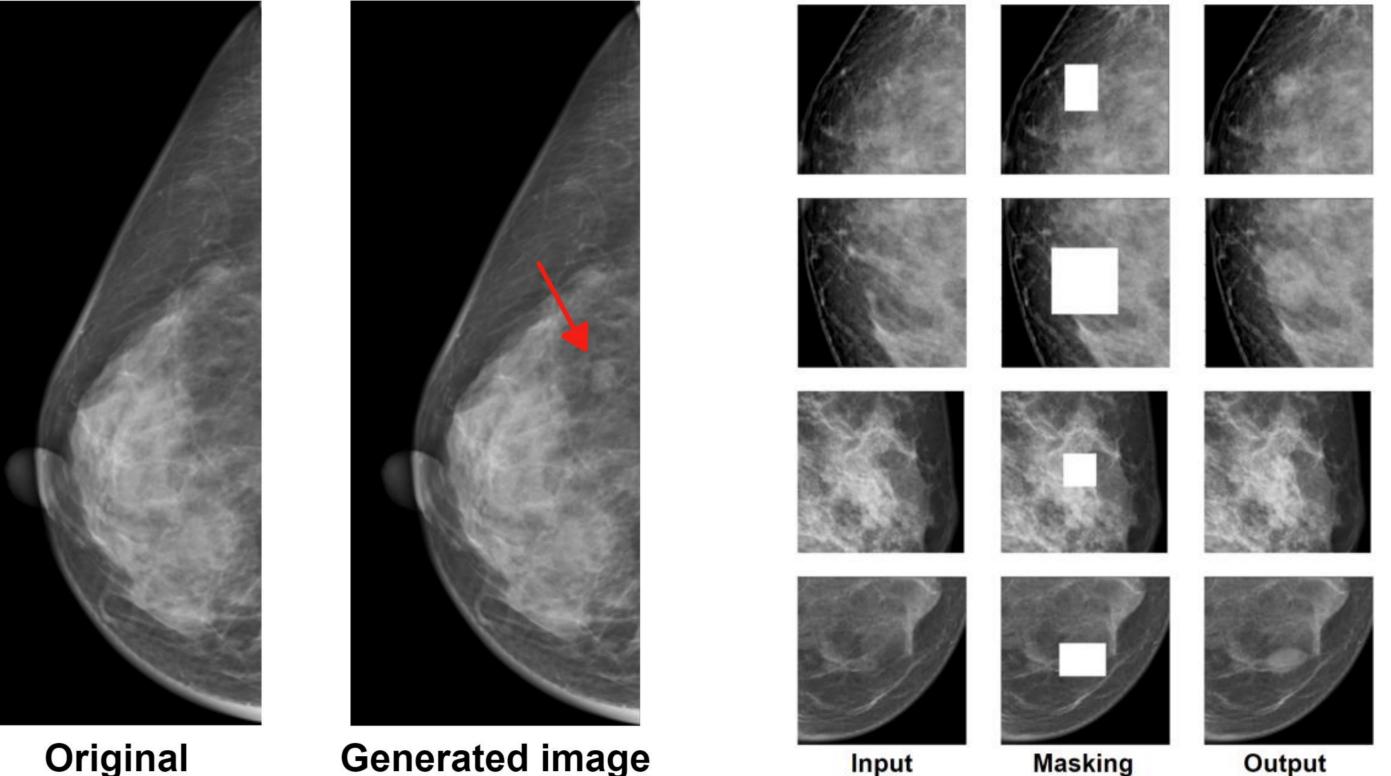**Yisak Kim[1,2], Kyungmin Jeon[2], Soyeon Kim[1,2], Chang Min Park[1,2,3]**

[1]Interdisciplinary Program in Bioengineering, Seoul National University Graduate School, Seoul, Republic of Korea
[2]Department of Radiology, Seoul National University Hospital, Seoul, Republic of Korea
[3]Department of Radiology, Seoul National University College of Medicine, Seoul, Republic of Korea

Purpose

- **The medical imaging field suffers from lack of usable data** compared to natural image because of the private and sensitive nature of medical data.
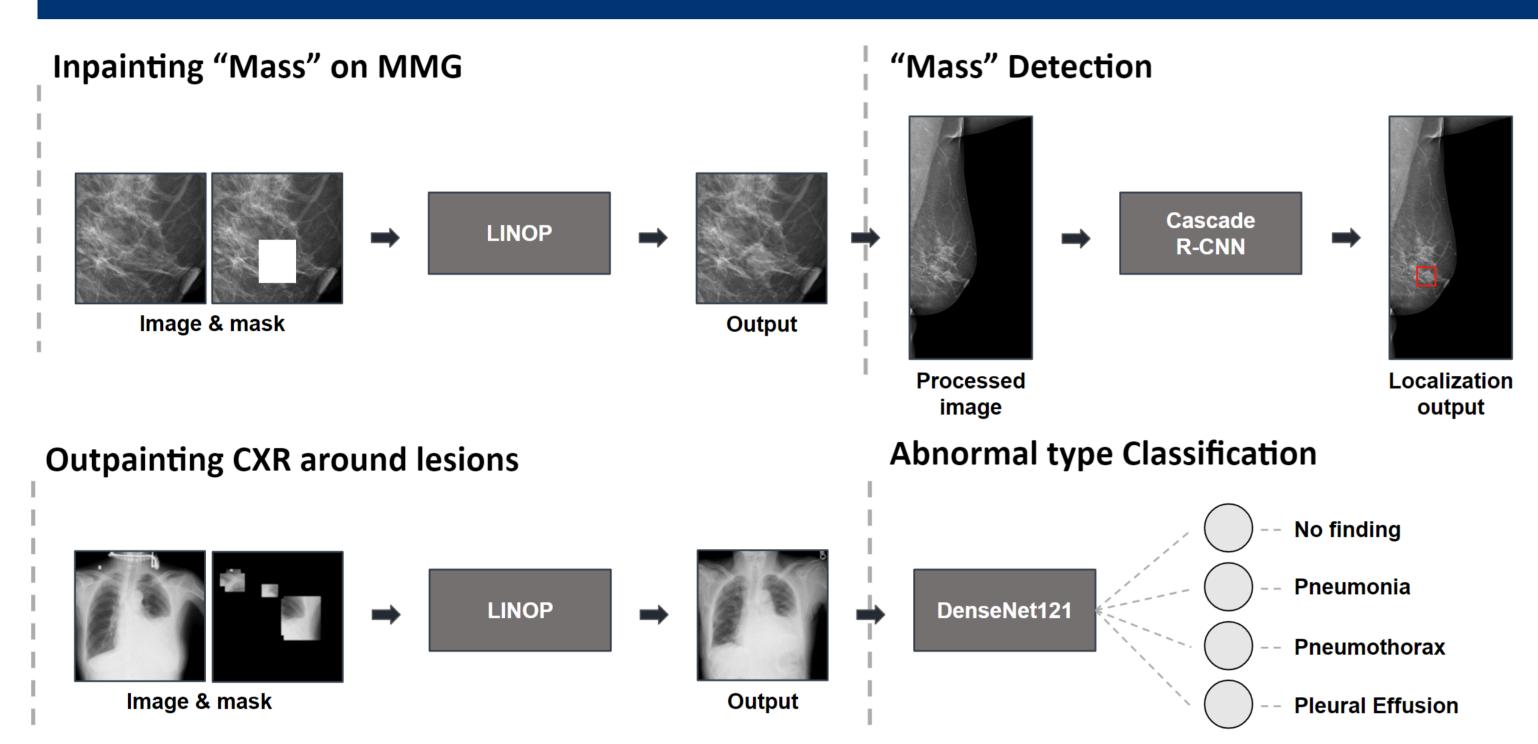- To address these problems **synthetic data** generated from DL models is considered to be a promising solution. **But generating images showing certain types of disease is challenging and difficult to ensure that the imaging feature of certain disease has been correctly generated.**
- In this study, we present **Lesion In-aNd-Out Painting (LINOP)** to generate synthetic medical images for data augmentation. Using **the inpainting method, it is possible to accurately generate a lesion of the desired size in the desired location.** Also, using **the outpainting method, the imaging feature of the disease can be clearly preserved.**

Materials and Methods

Inpainting "Mass" on MMG / "Mass" Detection / Outpainting CXR around lesions / Abnormal type Classification

- We train and validate **a lesion inpainting pipeline on mammography dataset, VinDR-Mammo**. We used 730 of "Mass" only images to train the lesion inpainting model, and 11,753 of "No finding" images to generate inpainting results for data augmentation.
- **For lesion outpainting pipeline on CXR, VinDR-CXR was used**; 10,478 of "No finding" only images from training set to train the outpainting model, and 4,522 not "No finding" images to generate outpainting results for data augmentation.

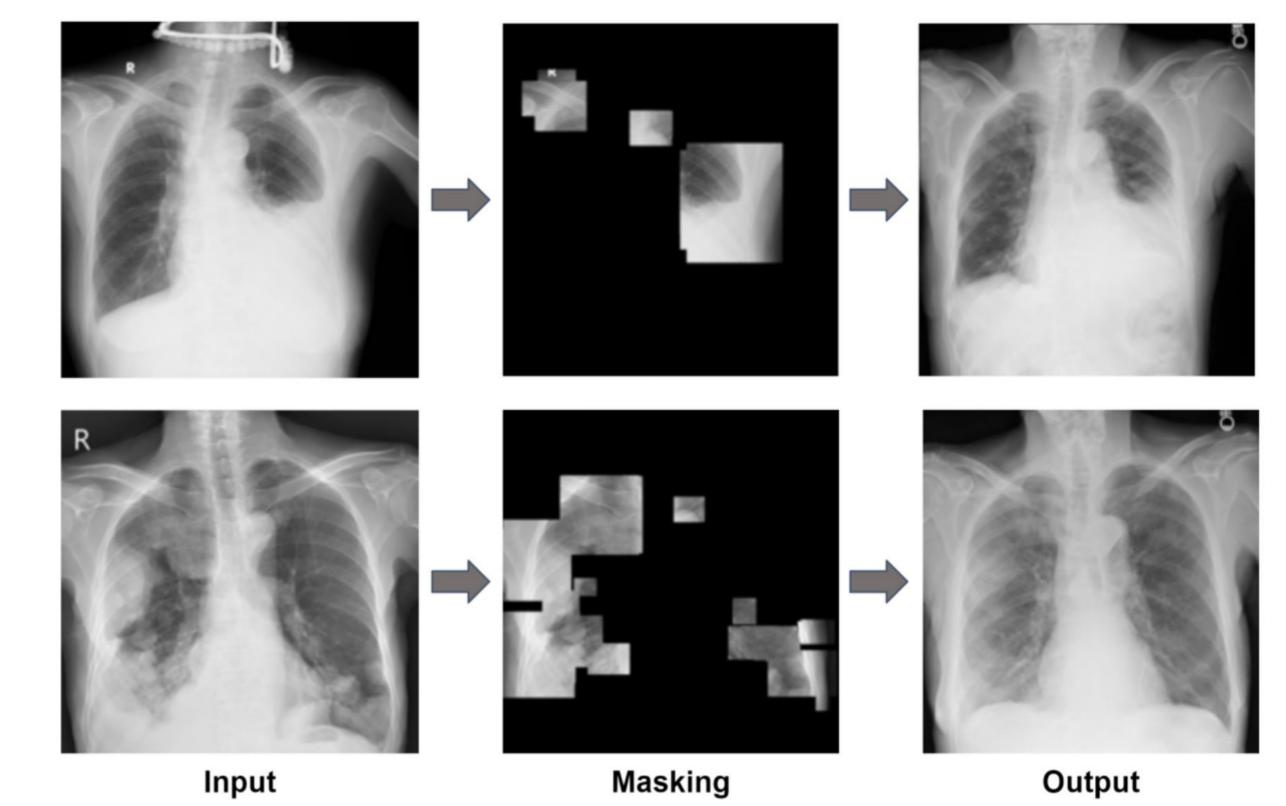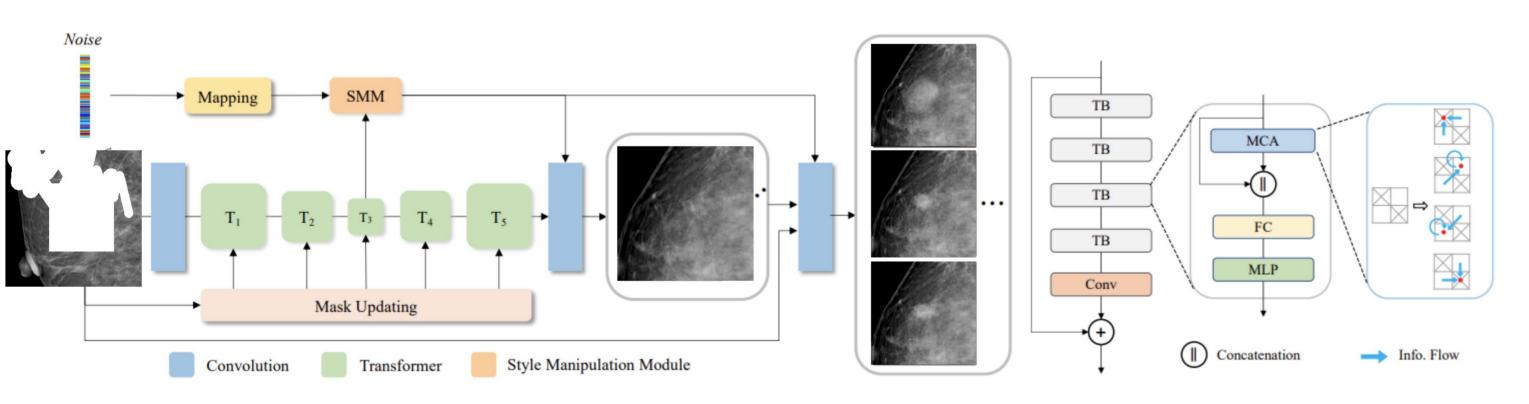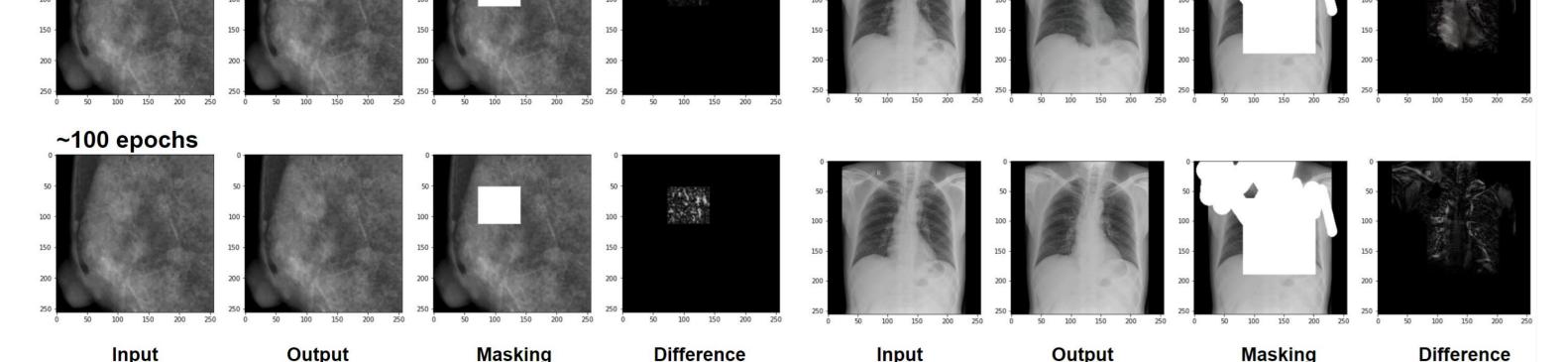- To perform realistic-looking inpainting and outpainting, we used a **DL-model based on MAT architecture**. It consists of a convolutional head designed for tokenization, a transformer body that extracts information through multi-head contextual attention and window shifting, and a Conv-U-Net used for reconstruction.
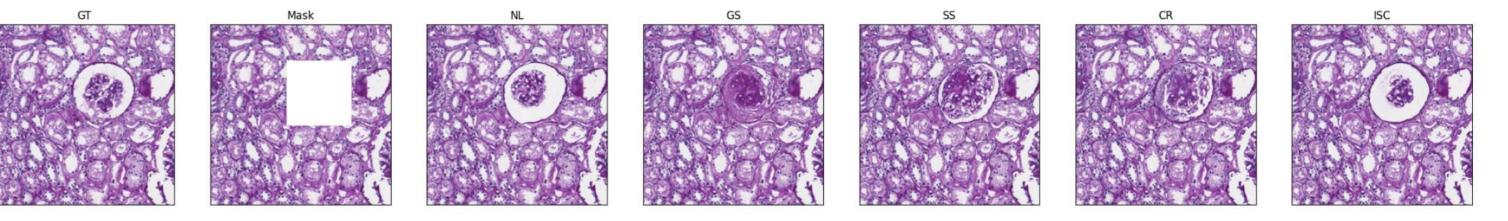

- To evaluate the effectiveness of inpainting augmentation, **mass localization of mammography was performed.** Cascade R-CNN was trained for object detection, and the 976 inpainting data was used.
- To evaluate the effectiveness of outpainting augmentation, **4 class classification of CXR was performed** on images corresponding to normal, pleural effusion, pneumothorax and pneumonia among the total data.

Results

- **The best FID score remarks 6.76 for mammography mass inpainting.**

Original / Generated image / Input / Masking / Output

- **Proposed augmentation showed improvement on mAP@50, up to 30.3% increases.**

Ground Truth / Prediction

Dataset	mAP@50
Baseline	0.228
+ 50% of inpainting augmentation	0.2814
+ 100% of inpainting augmentation	**0.297**

- **The best FID score remarks 3.83 for CXR lesion outpainting.**

Input / Masking / Output

- **For all portions, proposed augmentation showed improvement both on accuracy and AUROC, up to 11.2% and 10.3% increases.**

Portion of dataset used:		100%	50%	25%	12.5%
Baseline	Accuracy	0.8113	0.7506	0.723	0.661
	AUROC	0.933	0.8845	0.8387	0.8023
Outpainting augmentation	Accuracy	**0.8571**	**0.8349**	**0.7912**	**0.7102**
	AUROC	**0.9638**	**0.9528**	**0.9255**	**0.8619**

Conclusions

- **Generate a lesion of the desired size in the desired location or keep the imaging features of the disease accurately.**
- Can improve the reliability, utilization and controllability compared to the generating entire images.
- **Future direction**: Apply to other modalities such as brain tumor and digital pathology images

GT / Mask / NL / GS / SG / CR / BC

Contact information

- Yisak Kim (yisakk@snu.ac.kr)