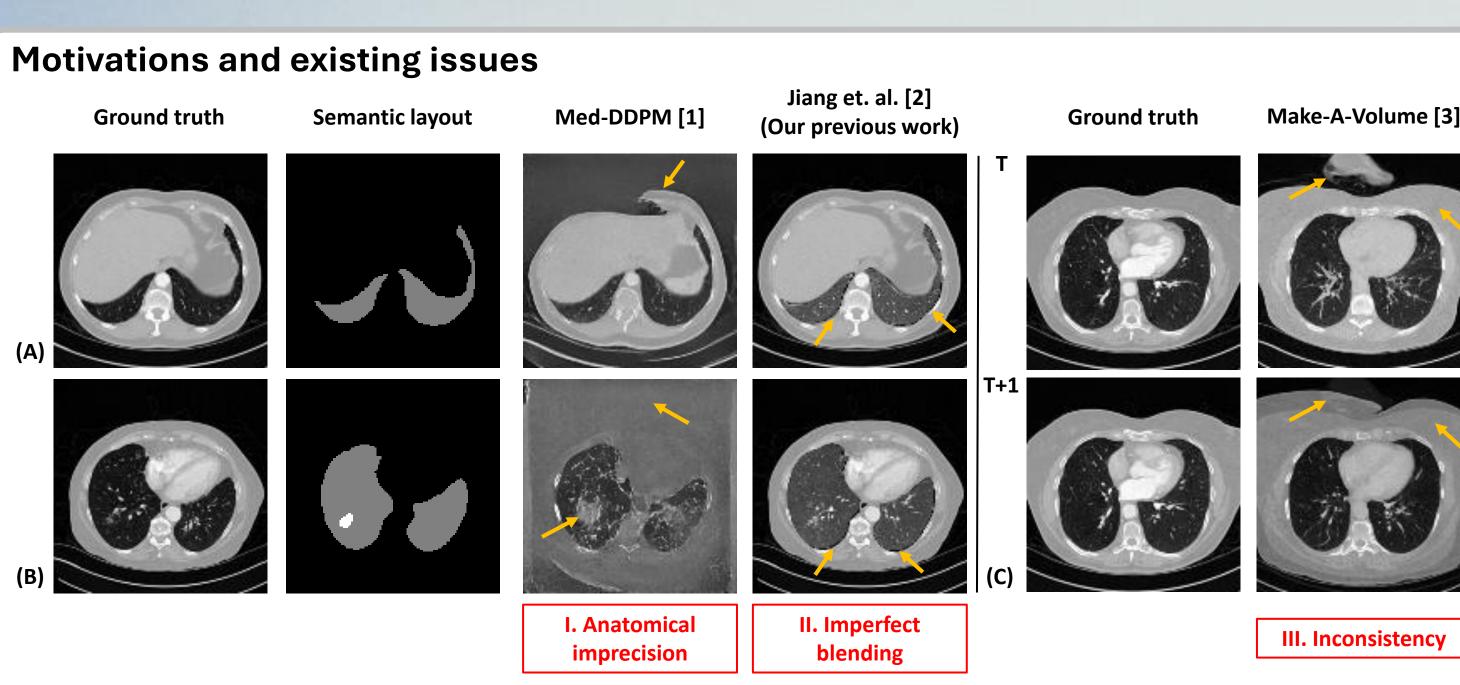


Lung-DDPM: Semantic Layout-guided Diffusion Models for **Thoracic CT Image Synthesis**

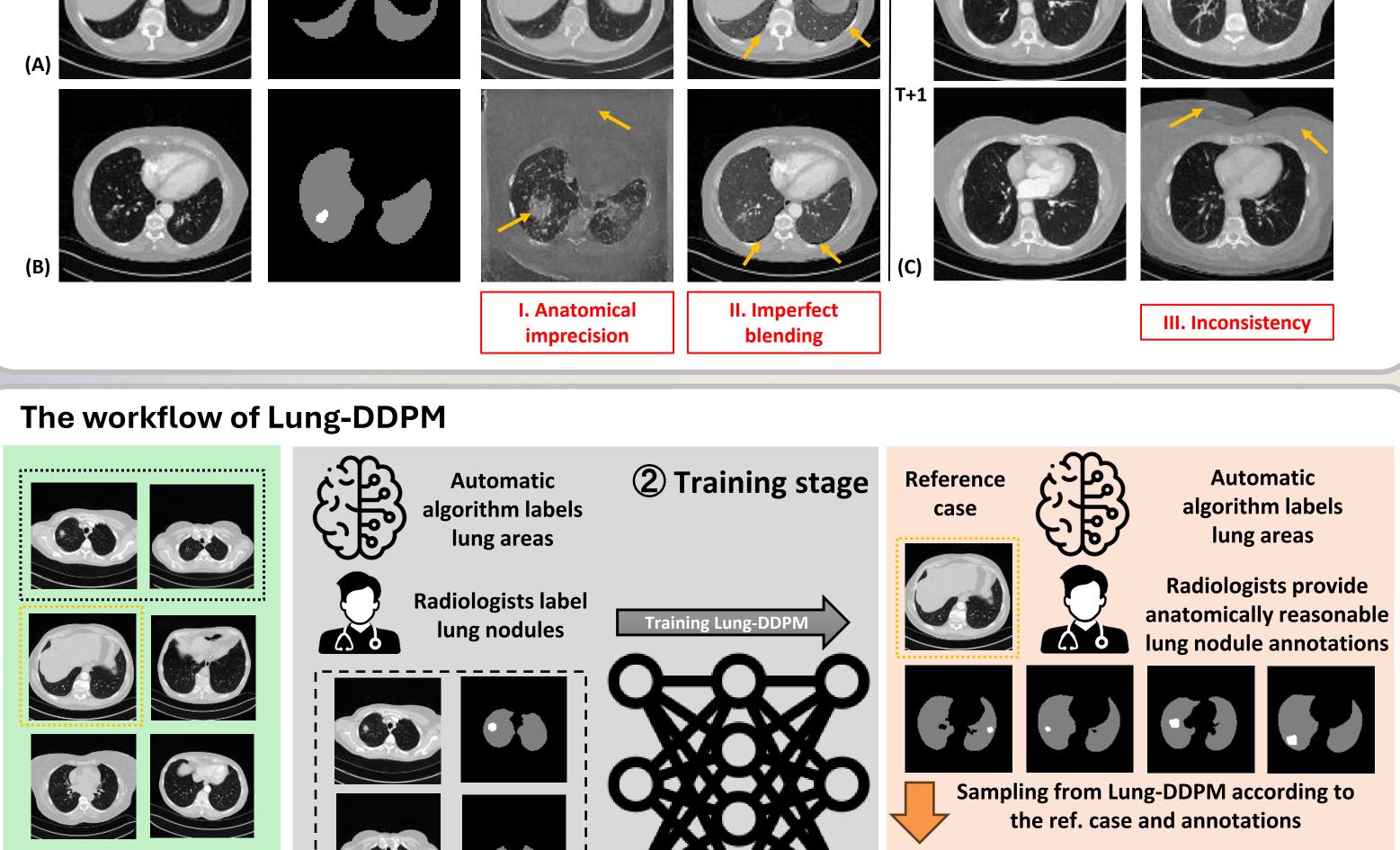
Yifan Jiang^{1,2,4,5}, Yannick Lemarchal^{3,6}, Josée Bafaro⁶, Jessica Abi-Rjeile⁶, Philippe Joubert^{2,6}, Philippe Després^{3,5,6}, Venkata Manem^{1,2,4,5}

- ¹ Centre de recherche du CHU de Québec-Université Laval, Canada
- ² Department of Molecular Biology, Medical Biochemistry and Pathology, Université Laval, Canada
- ³ Department of Physics, Engineering Physics and Optics, Université Laval, Canada
- ⁴ Cancer Research Center, Université Laval, Canada
- ⁵ Big Data Research Center, Université Laval, Canada
- ⁶ Quebec Heart & Lung Institute Research Center, Canada





Volume [3]	
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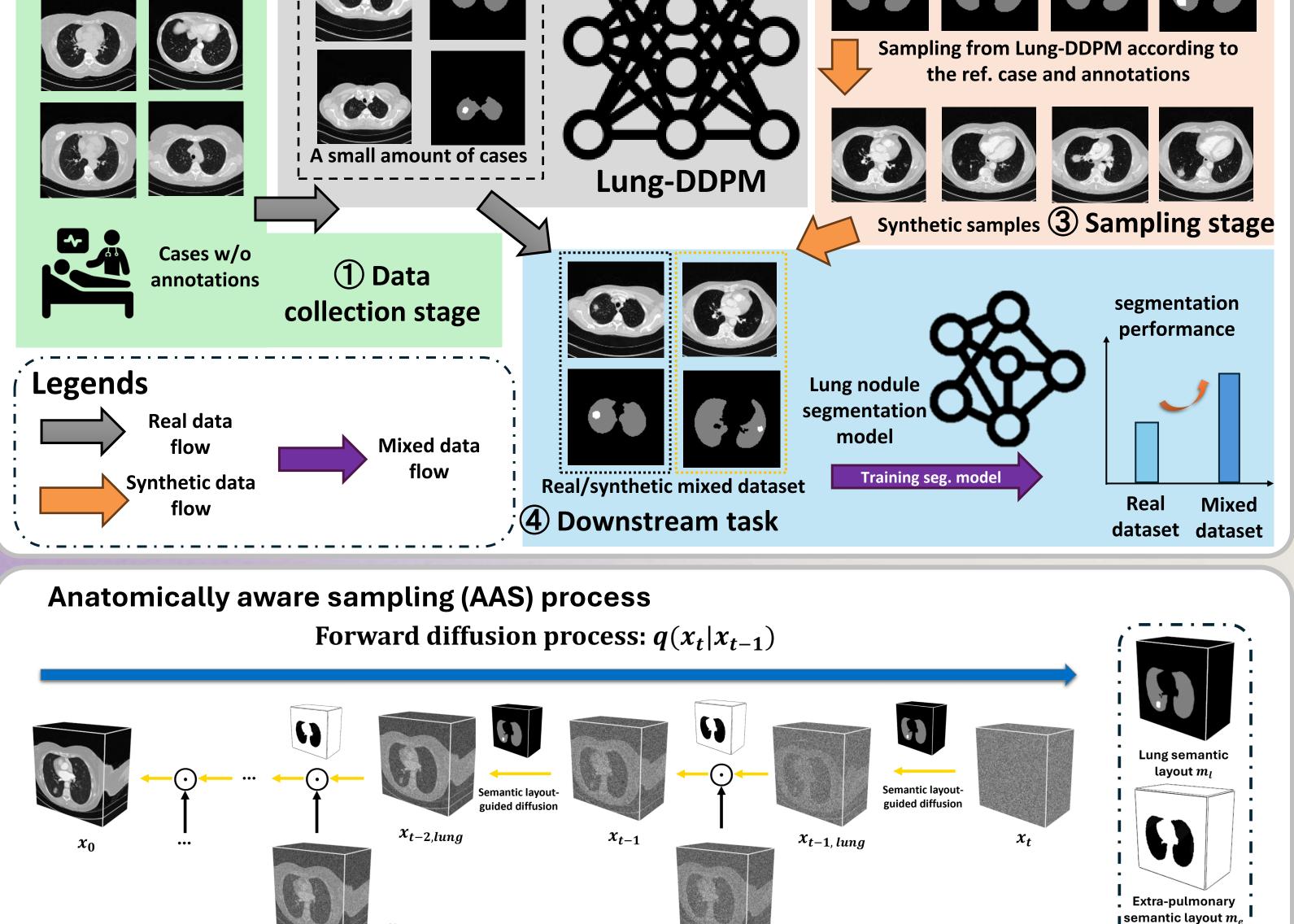


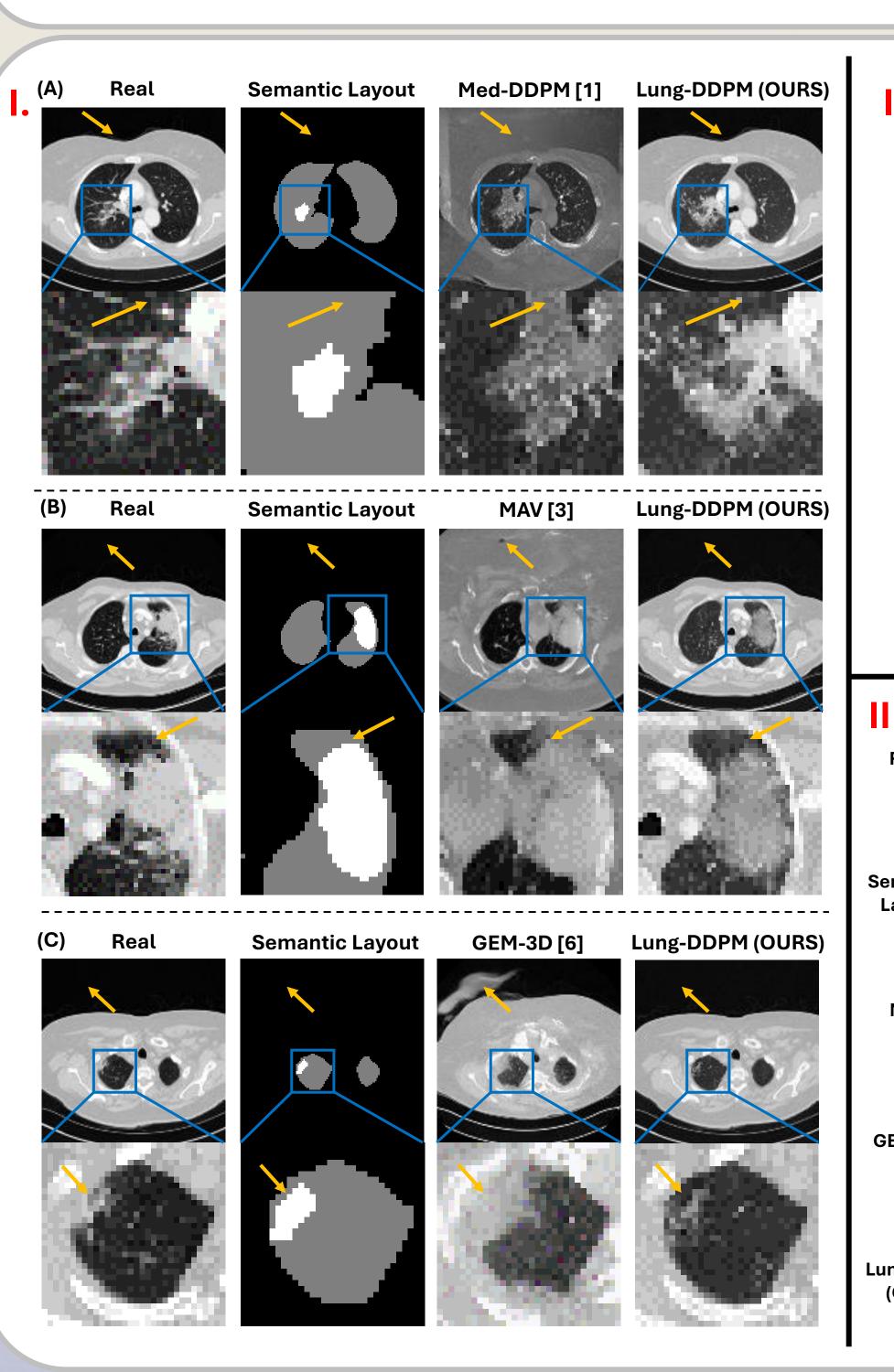
Image quality evaluation LIDC-IDRI **IUCPQ** Validation cohort MSE (↓) MSE (FID (↓) MMD (↓) FID (↓) MMD (↓) Condition Method 0.1063 ± 0.0002 0.1081 ± 0.0003 0.0510 ± 0.0000 0.1277 ± 0.0000 0.0834 ± 0.0000 HA-GAN [4] Pix2pix3D [5] 0.0346 ± 0.0300 0.0217 ± 0.0000 0.0712 ± 0.0000 0.0129 ± 0.0002 0.0497 ± 0.0000 0.0581 ± 0.0000 Med-DDPM [1] 0.0464 ± 0.0328 0.6806 ± 0.0118 0.0707 ± 0.0011 0.0371 ± 0.0015 0.4039 ± 0.0144 0.0767 ± 0.0015 MAV [3] 0.1497 ± 0.0134 1.4442 ± 0.0074 0.1143 ± 0.0001 0.0652 ± 0.0009 0.5463 ± 0.0034 0.1072 ± 0.0009 0.0557 ± 0.0140 0.6312 ± 0.0349 0.1484 ± 0.0014 0.0313 ± 0.0063 0.2897 ± 0.0222 0.0803 ± 0.0008 0.0047 ± 0.0080 0.0070 ± 0.0002 0.0024 ± 0.0000 0.0083 ± 0.0077 0.0240 ± 0.0011 0.0032 ± 0.0000 Lung nodule segmentation evaluation

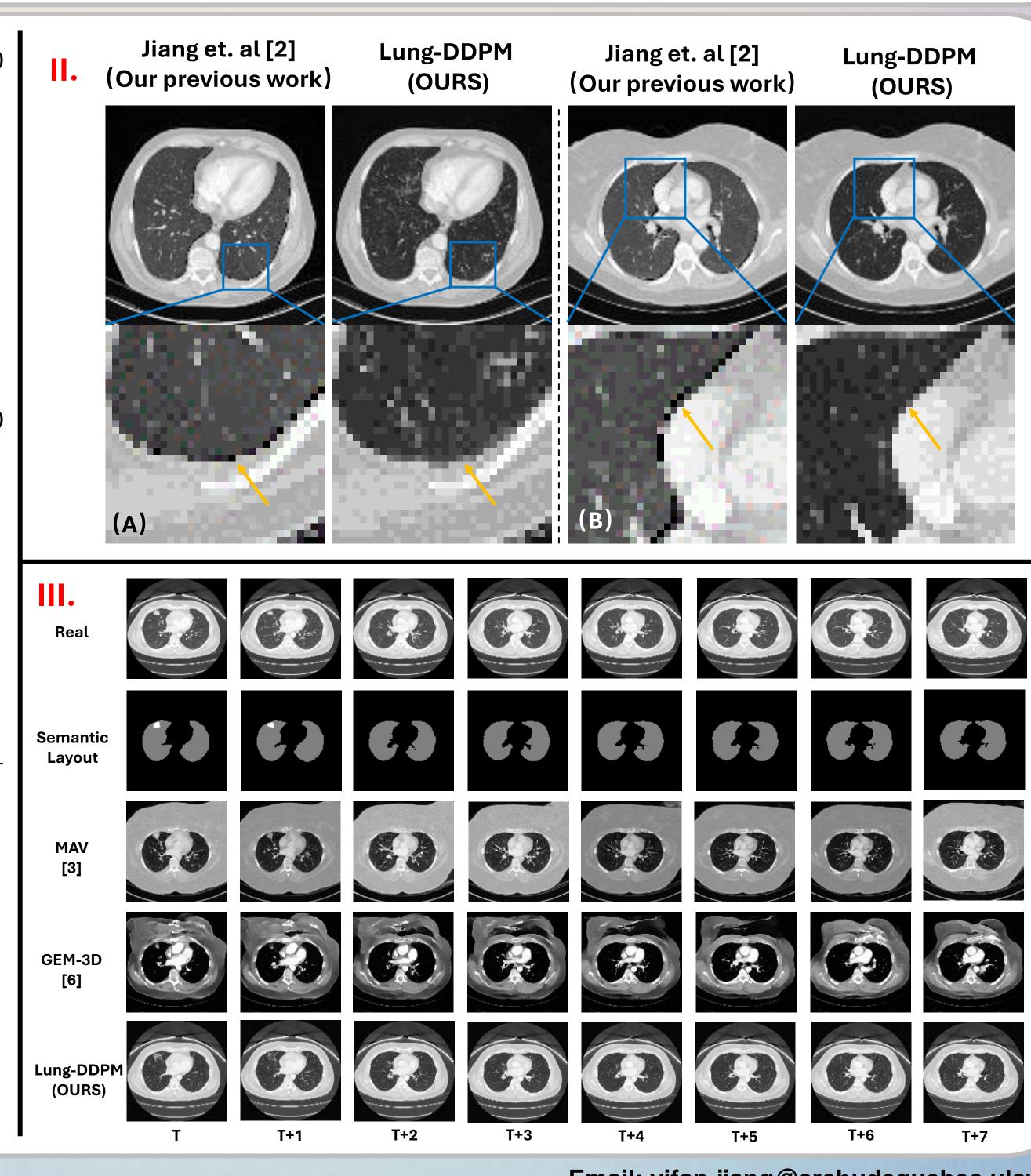
Discovery cohort (Downstream)	Method	Dice (↑)	Sensitivity (↑)	Specificity (1)
800 R.: 100% discovery cohort (upstream)	N/A	0.3598 ± 0.0976	0.3704 ± 0.1094	0.9999 ± 0.0000
800 R. + 183 S.: 100% discovery cohort (upstream) + 50% validation cohort (LIDC-IDRI)	MAV [3]	0.3190 ± 0.1594	0.3290 ± 0.1688	0.9999 ± 0.0000
	GEM-3D [6]	0.2991 ± 0.2047	0.3487 ± 0.1398	0.9980 ± 0.0051
	Med-DDPM [1]	0.3537 ± 0.1003	0.4046 ± 0.2032	0.9998 ± 0.0002
	Lung-DDPM (OURS)	0.3908 ± 0.0452	0.4393 ± 0.1386	0.9999 ± 0.0001
800 R. + 400 S.: 100% discovery cohort (upstream) + 50% validation cohort (IUCPQ)	MAV [3]	0.3196 ± 0.2232	0.3380 ± 0.2389	0.9999 ± 0.0001
	GEM-3D [6]	0.3852 ± 0.0553	0.4030 ± 0.0509	0.9999 ± 0.0000
	Med-DDPM [1]	0.3804 ± 0.0534	0.3835 ± 0.0695	0.9999 ± 0.0000
	Lung-DDPM (OURS)	0.3866 ± 0.0293	0.3917 ± 0.0449	0.9999 ± 0.0000
800 R. + 800 S.: 100% discovery cohort (upstream) + 100% validation cohort (IUCPQ)	MAV [3]	0.3577 ± 0.0255	0.3674 ± 0.0430	0.9999 ± 0.0000
	GEM-3D [6]	0.3584 ± 0.0682	0.3891 ± 0.0638	0.9998 ± 0.0003
	Med-DDPM [1]	0.3638 ± 0.0530	0.3729 ± 0.0589	0.9999 ± 0.0000
	Lung-DDPM (OURS)	0.3914 ± 0.0282	0.4078 ± 0.0519	0.9999 ± 0.0000

	Cohort	Patient number	Stage
(\frac{1}{2})	discovery (upstream)	800	2
0.0000	validation (IUCPQ)	800	3
	validation (LIDC-IDRI)	366	3
0.0000		800~1600	
	discovery (downstream)	IUCPQ: 800 R. + 0~800 S.	4
0.0006		LIDC-IDRI: 800 R. + 0~366 S.	
	test	249	(5)
0.0002	Illustration of an	ahaddad aynthatia	o o mo ml
	illustration of en	nbedded synthetic	sampu
0.0020	using multidii	mensional scaling ((MDS)
	_	_	

Organization of our datasets

Real HA-GAN Pix2Pix3D Med-DDPM MAV GEM-3D Lung-DDPM





Inputs [1] Z. Dorjsembe, H.-K. Pao, S. Odonchimed, and F. Xiao, "Conditional diffusion models for semantic 3d brain mri synthesis," IEEE Journal of Biomedical and Health Informatics, 2024. [2] Y. Jiang, H. Chen, M. Loew, and H. Ko, "Covid-19 ct image synthesis with a conditional generative adversarial network," IEEE Journal of Biomedical and Health Informatics, vol. 25, no. 2, pp. 441–452, 2020. [3] L. Zhu, Z. Xue, Z. Jin, X. Liu, J. He, Z. Liu, and L. Yu, "Make-a-volume:Leveraging latent diffusion models for cross-modality 3d brain mrisynthesis," in International Conference on Medical Image Computingand Computer-Assisted Intervention. Springer, 2023, pp. 592-601.

 $x_{t-1,extra-pulmonary}$

 $q(x_{t-1}|x)$

Reference case x

[4] L. Sun, J. Chen, Y. Xu, M. Gong, K. Yu, and K. Batmanghelich, "Hierarchical amortized gan for 3d high resolution medical imagesynthesis," IEEE journal of biomedical and health informatics, vol. 26, no. 8, pp. 3966–3975, 2022. [5] T.-C. Wang, M.-Y. Liu, J.-Y. Zhu, A. Tao, J. Kautz, and B. Catanzaro, "High-resolution image synthesis and semantic manipulation with conditional gans," in Proceedings of the IEEE conference on computer visionand pattern recognition, 2018, pp. 8798-8807.

 $q(x_{t-2}|x)$

Anatomically aware sampling (AAS) process: $p_{\theta}(x_{t-1}|x_t, x, m_l, m_e)$

[6] L. Zhu, N. Codella, D. Chen, Z. Jin, L. Yuan, and L. Yu, "Generativeenhancement for 3d medical images," arXiv preprint arXiv:2403.12852,2024.

 $x_{t-2,extra-pulmonary}$