

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

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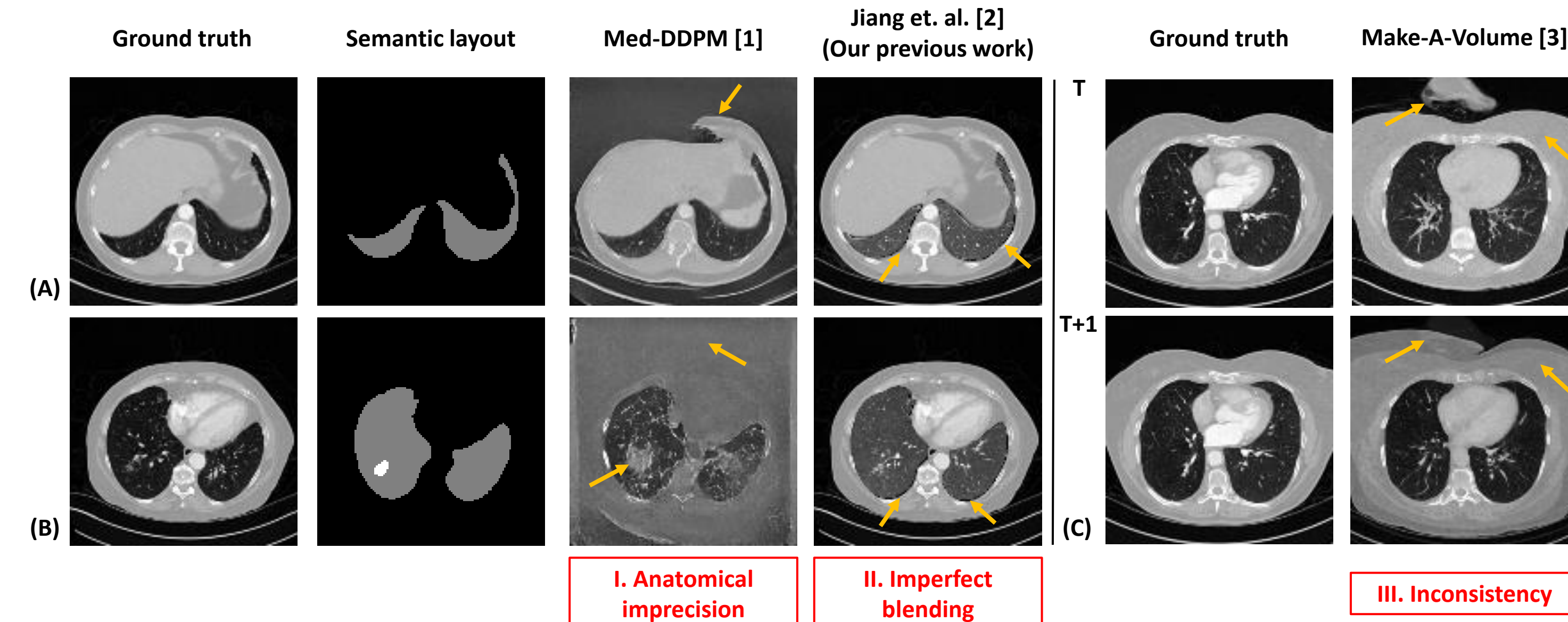
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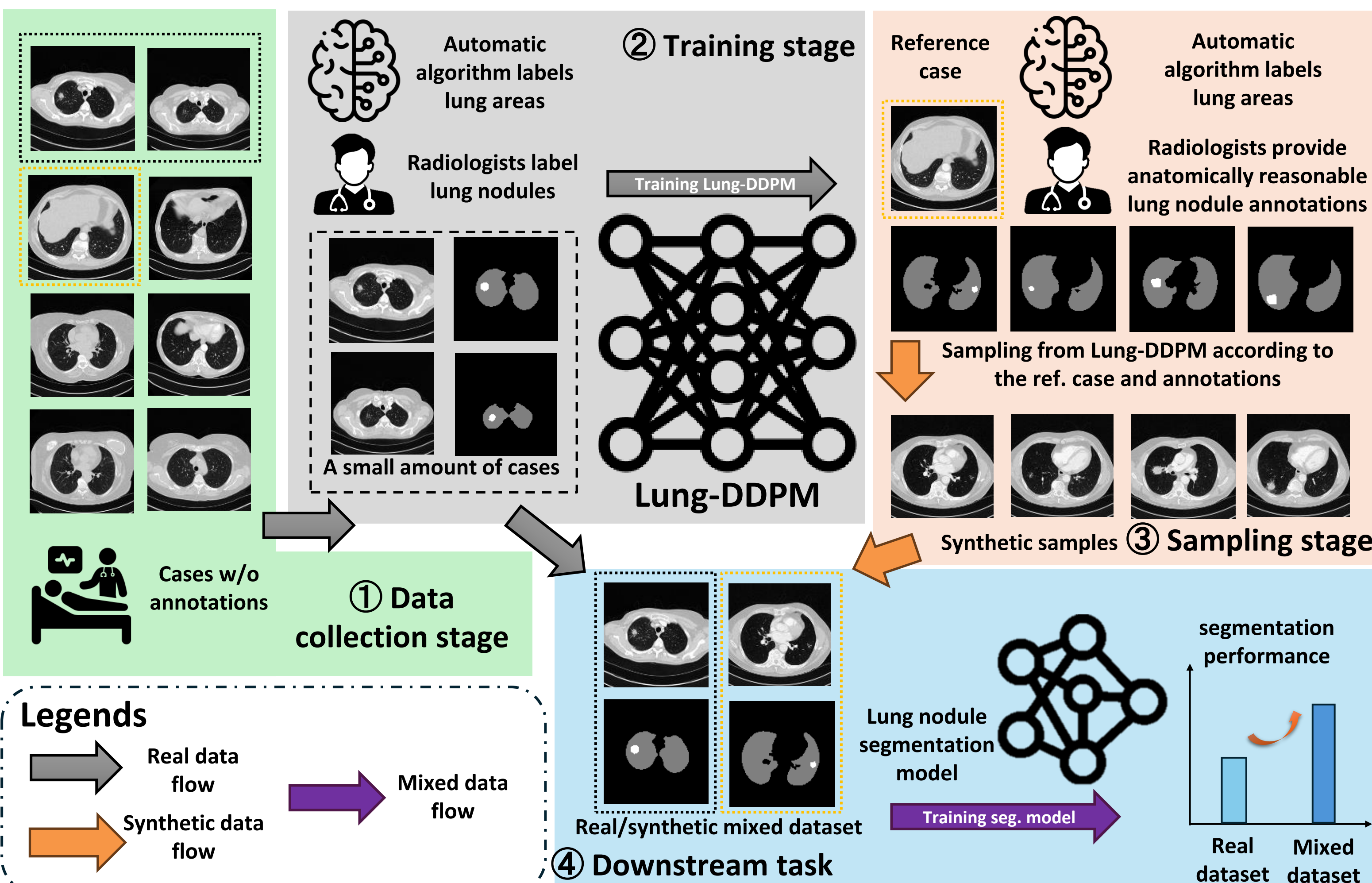
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Motivations and existing issues



The workflow of Lung-DDPM



Anatomically aware sampling (AAS) process

Forward diffusion process: $q(x_t|x_{t-1})$

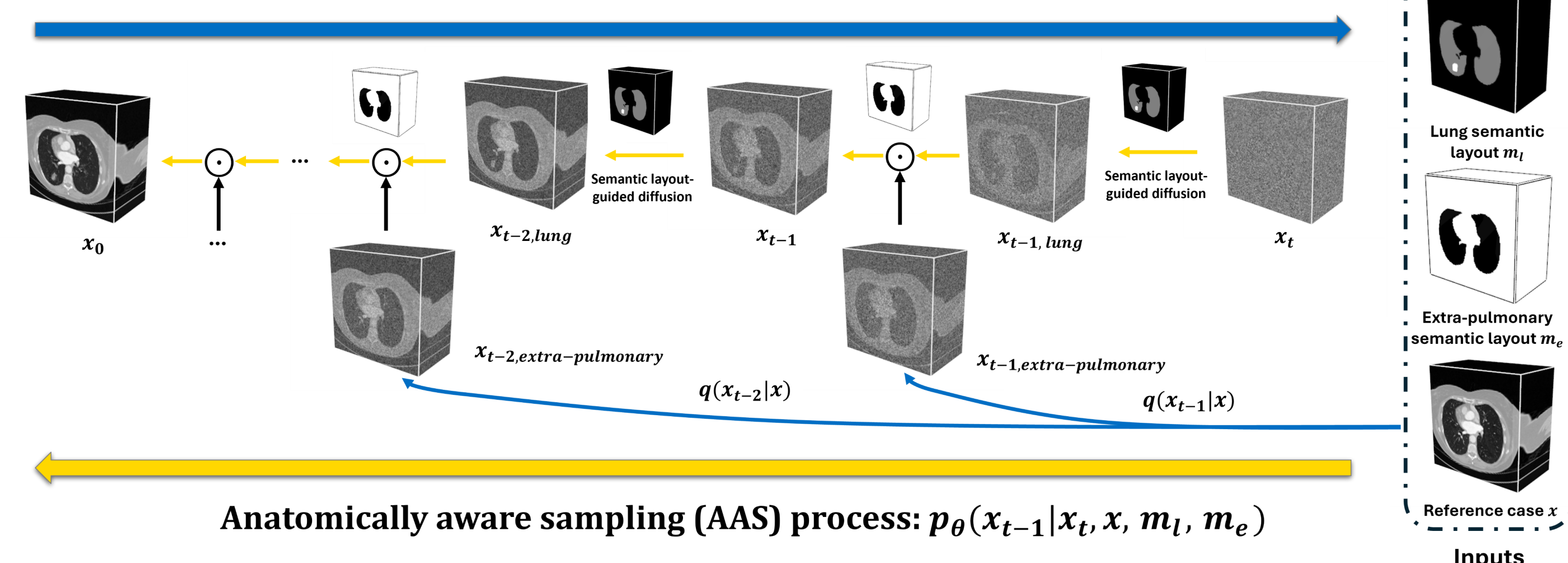


Image quality evaluation

Validation cohort	Condition	IUCPQ			LIDC-IDRI		
		FID (↓)	MMD (↓)	MSE (↓)	FID (↓)	MMD (↓)	MSE (↓)
HA-GAN [4]	N/A	0.0403±0.0002	0.1063±0.0002	0.1081±0.0003	0.0510±0.0000	0.1277±0.0000	0.0834±0.0000
Pix2pix3D [5]	Seg.	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]	Seg.	0.0464±0.0328	0.6806±0.0118	0.0707±0.0011	0.0371±0.0015	0.4039±0.0144	0.0767±0.0006
MAV [3]	Seg.	0.1497±0.0134	1.4442±0.0074	0.1143±0.0001	0.0652±0.0009	0.5463±0.0034	0.1072±0.0002
GEM-3D [6]	Seg. & Ref.	0.0557±0.0140	0.6312±0.0349	0.1484±0.0014	0.0313±0.0063	0.2897±0.0222	0.0803±0.0020
Lung-DDPM (OURS)	Seg. & Ref.	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 (↑)
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
800 R. + 400 S.: 100% discovery cohort (upstream) + 50% validation cohort (IUCPQ)	Lung-DDPM (OURS)	0.3908±0.0452	0.4393±0.1386	0.9999±0.0001
	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
800 R. + 800 S.: 100% discovery cohort (upstream) + 100% validation cohort (IUCPQ)	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
	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

Organization of our datasets

Cohort	Patient number	Stage
discovery (upstream)	800	②
validation (IUCPQ)	800	③
validation (LIDC-IDRI)	366	③
discovery (downstream)	800~1600	④
test	IUCPQ: 800 R. + 0~800 S. LIDC-IDRI: 800 R. + 0~366 S. 249	⑤

Illustration of embedded synthetic samples using multidimensional scaling (MDS)

