MIDL Montréal 2020

4D Semantic Cardiac Magnetic Resonance Image Synthesis on XCAT Anatomical Model

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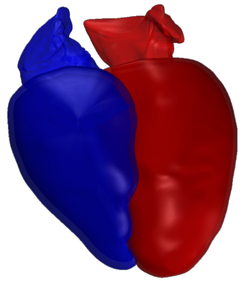

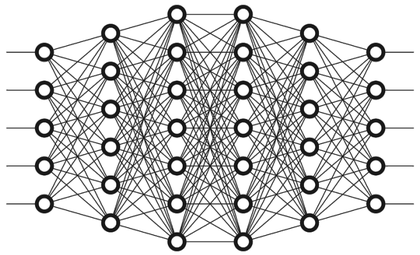

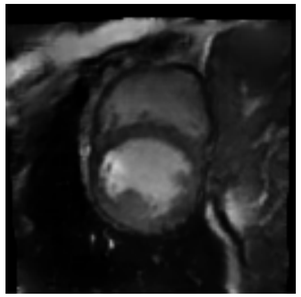

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Motivation

Expensive data acquisition

Rare properly annotated data

Subjective annotations

Restrictive sharing policy

Physic-based image simulation
&
Data-driven image synthesis

To augment the data

To develop new algorithms

To improve domain generalization and adaptation

To validate and benchmark

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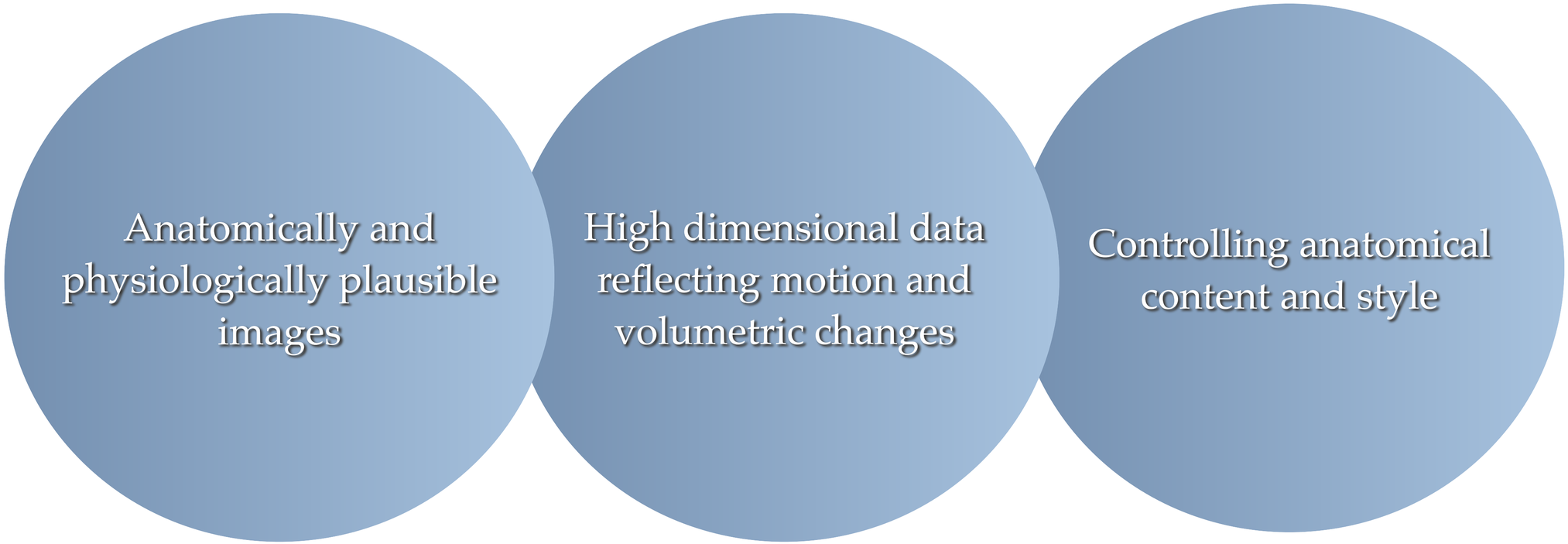
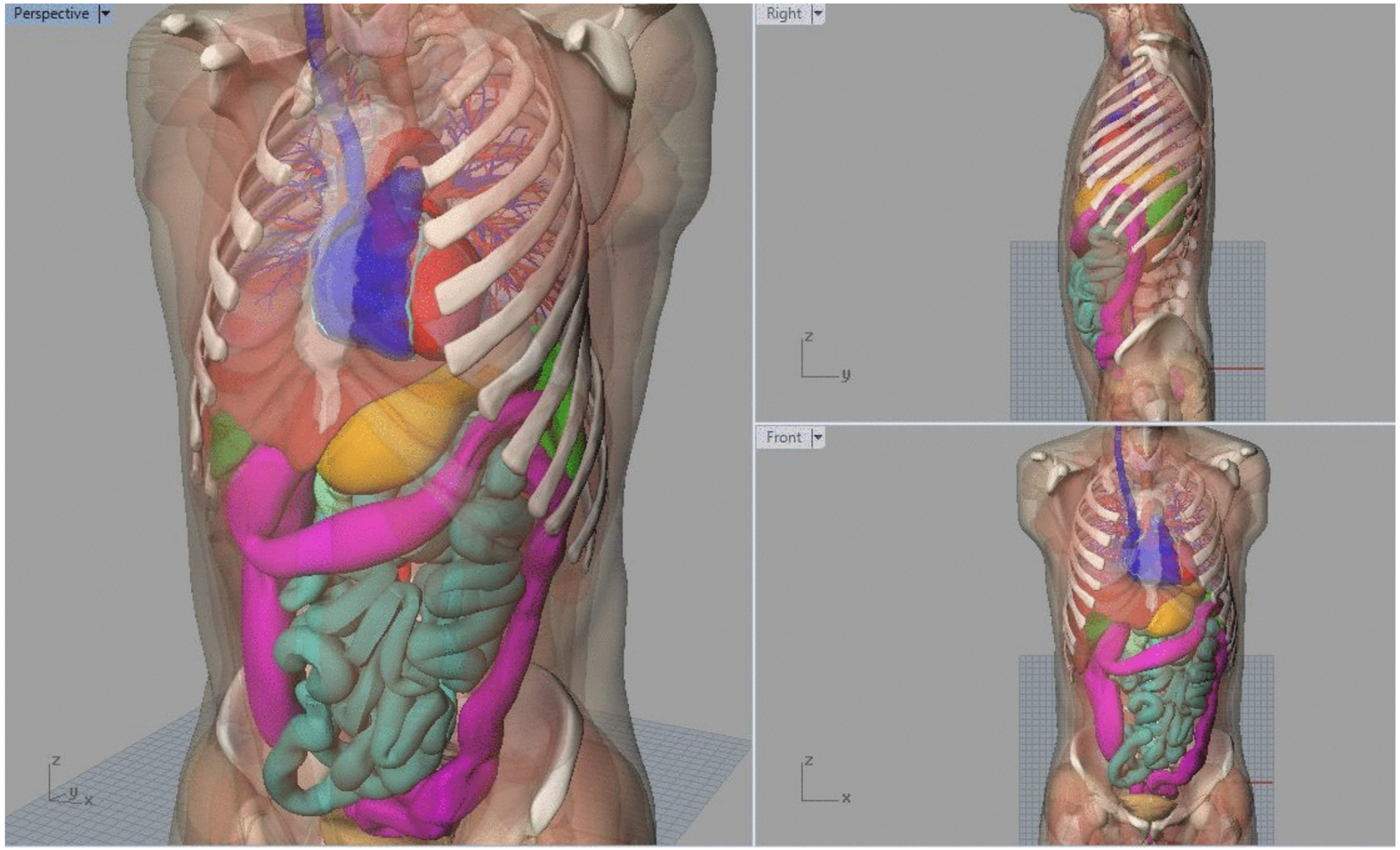
Limitations in Image Synthesis



XCAT: eXtended Cardiac and Torso computerized human phantom



- Controllable 4D voxelized heart model:
  - scaling factors in 3D
  - orientation & translation
  - cardiac cycle timing
  - etc.

Segars W. et al.: 4D XCAT phantom for multimodality imaging research. Medical physics, 37 (9), 4902–4915 (2010)

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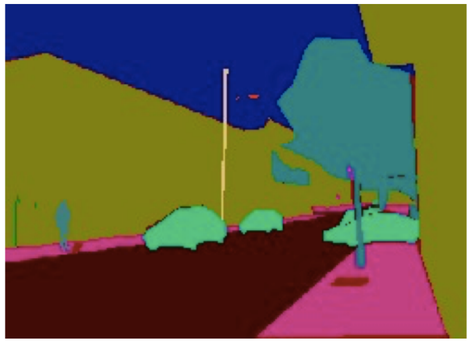
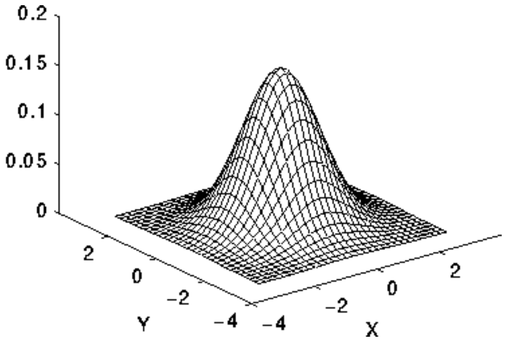
Conditional Image Synthesis

Label map



Real

Discriminator

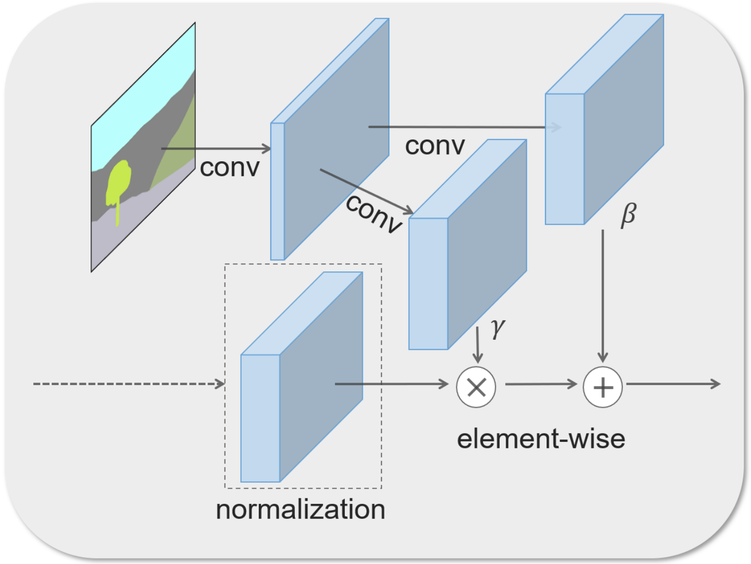


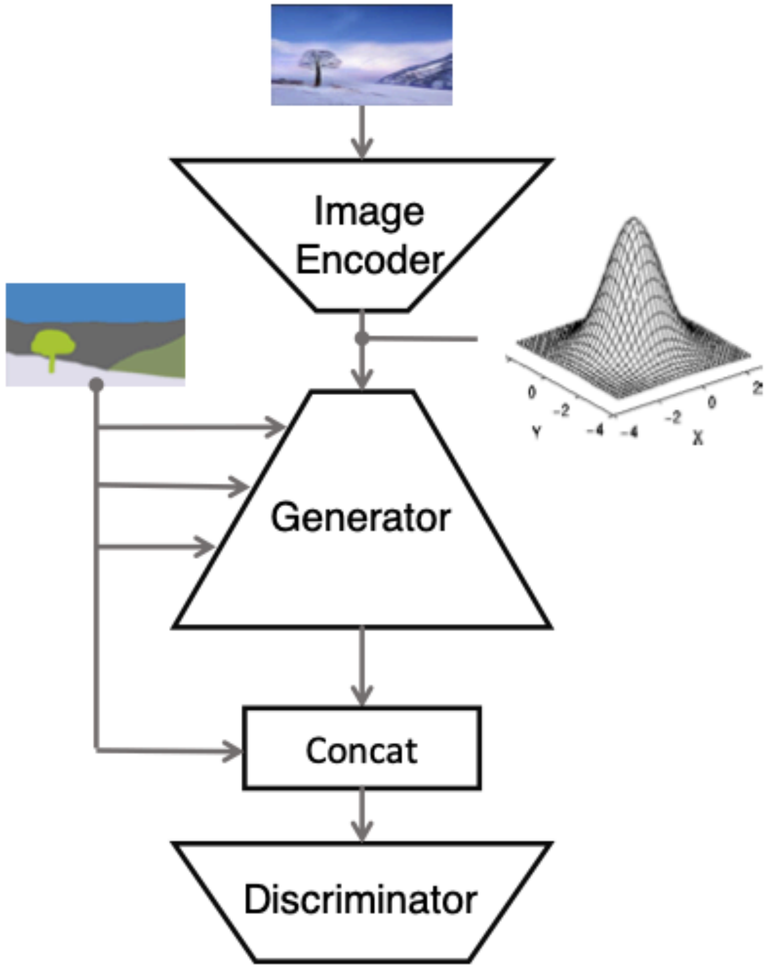
Generator

Synthetic image

Conditional Image Synthesis

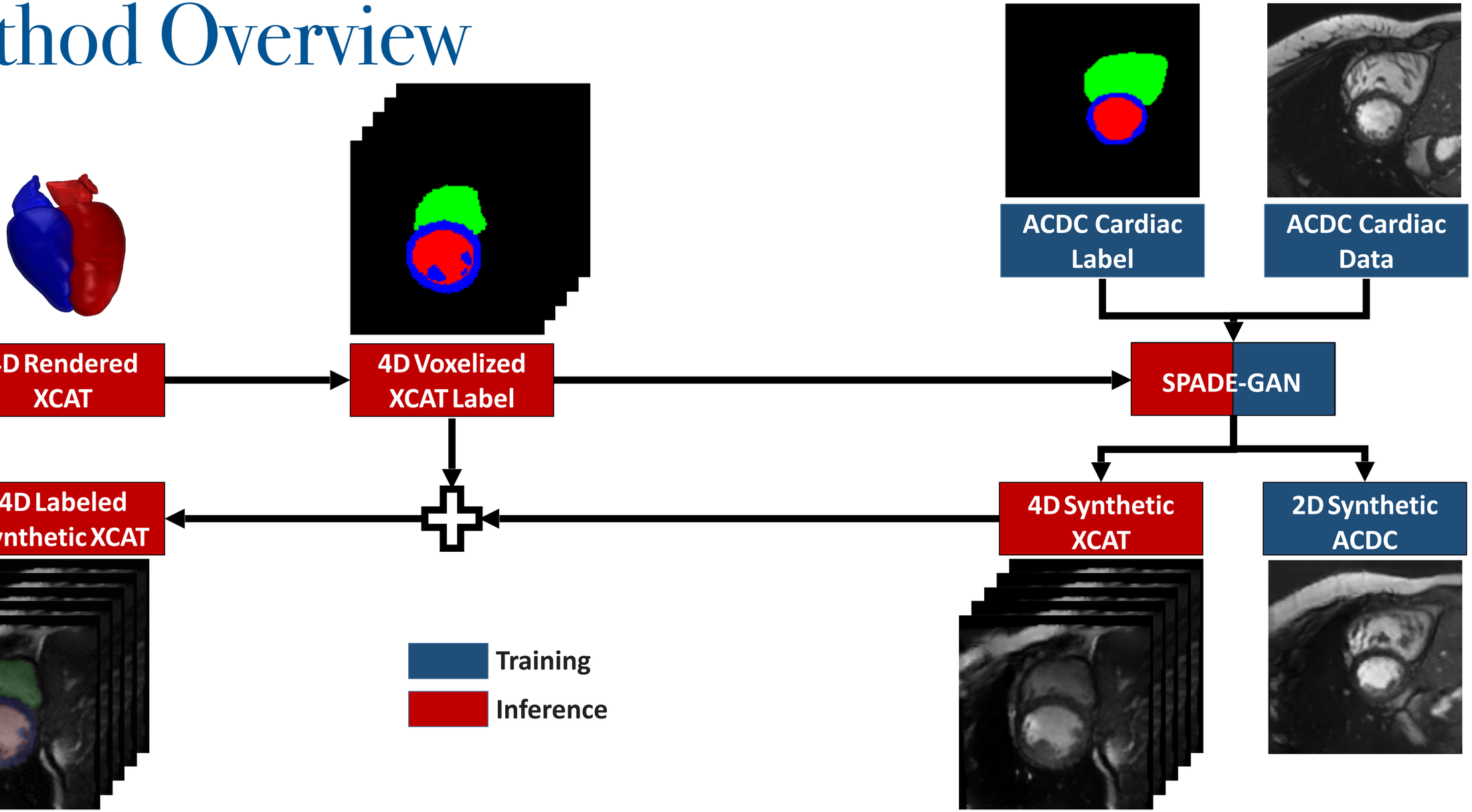
SPADE: SPatially-Adaptive (DE)normalization





Park T. et al., Semantic image synthesis with spatially-adaptive normalization. CVPR, pages 2332–2341, 2019.

Method Overview



Bernard O. et al.: Deep learning techniques for automatic MRI cardiac multi-structures segmentation and diagnosis: Is the problem solved? TMI, 37(11):2514–2525, Nov 2018.

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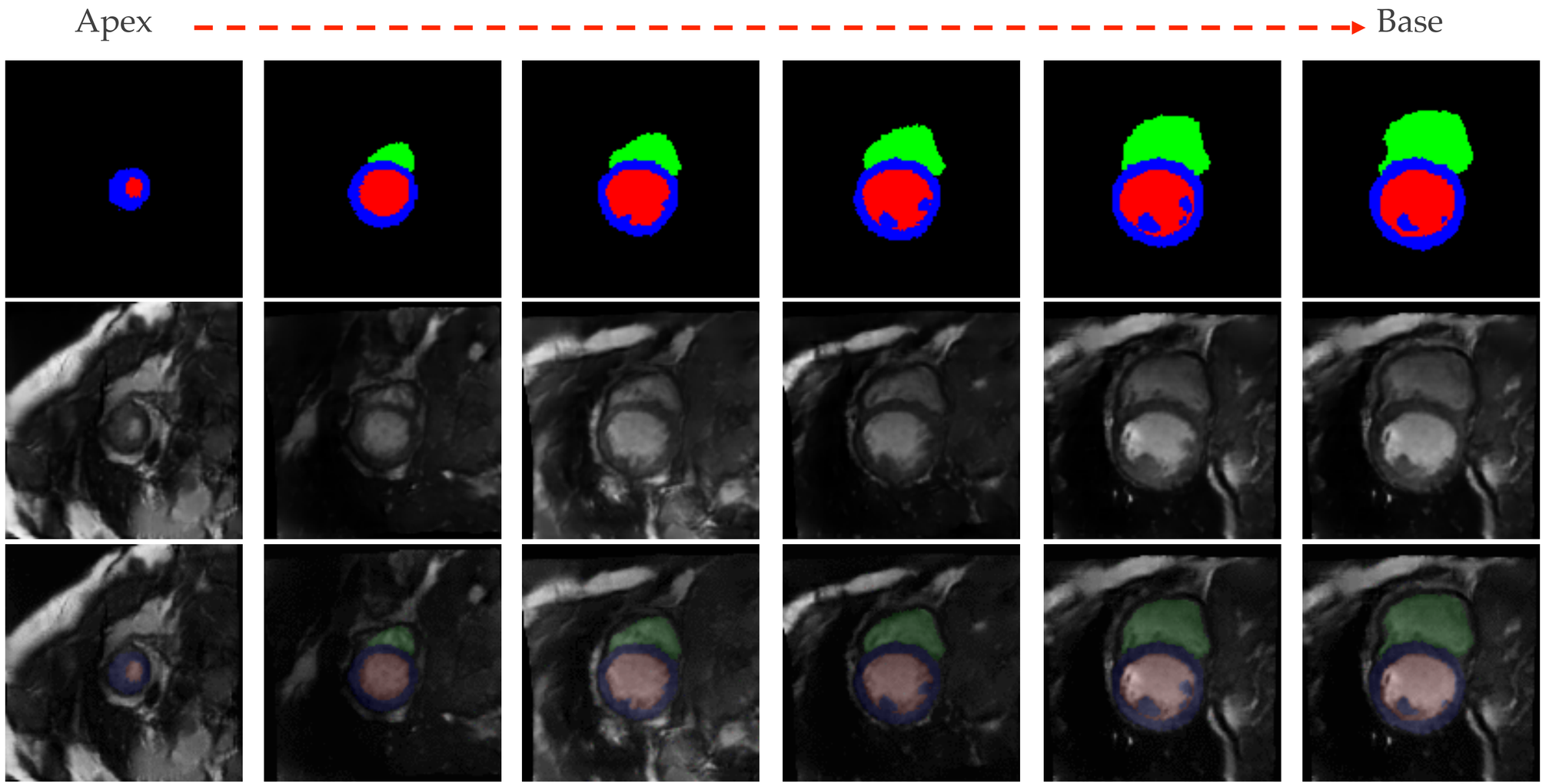
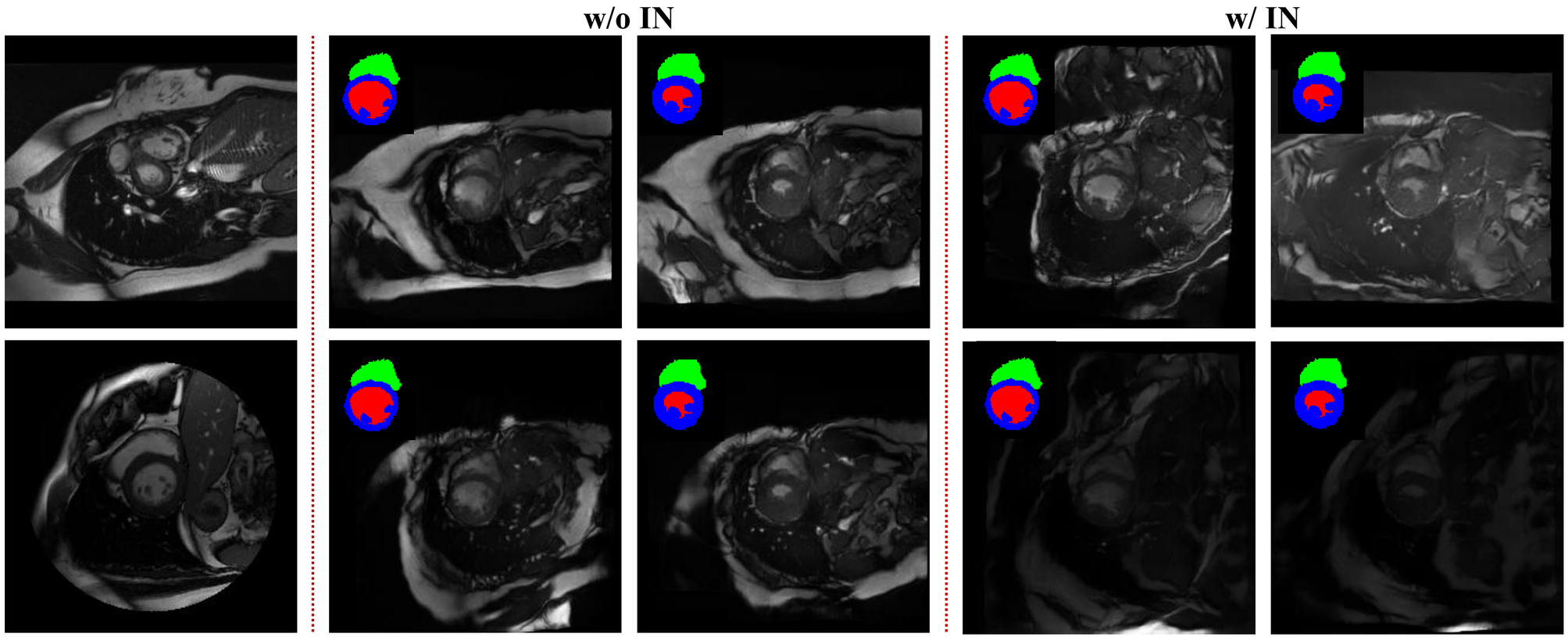
3D+t Image Synthesis: 25 time frames for 18 slice locations

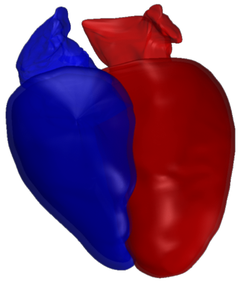


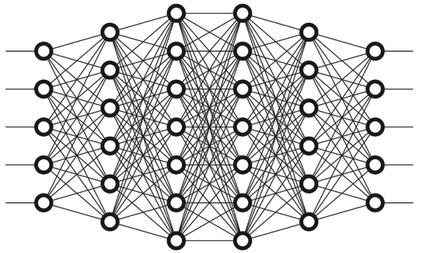
Stylized 4D labeled Synthetic Dataset

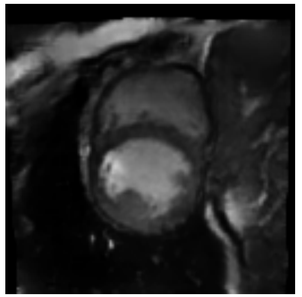


Summary

- 4D labeled cardiac synthetic MR images
- Wide range of anatomical and style variations
- Inconsistencies in the background
- Future work:
  - Improving image synthesis
  - Quantitative evaluation
  - Generating a large virtual population
- MICCAI2020:
  - *XCAT-GAN for Synthesizing 3D Consistent Labeled Cardiac MR Images on Anatomically Variable XCAT Phantoms*







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