Representing Anatomical Trees by Denoising Diffusion of Implicit Neural Fields

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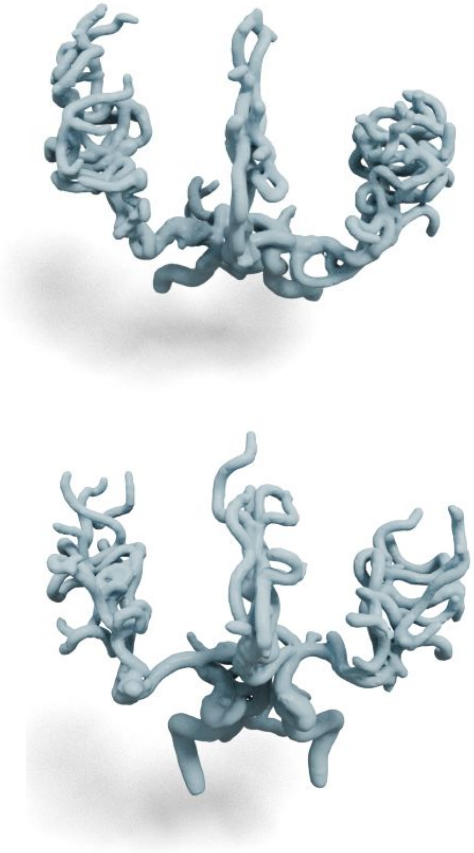
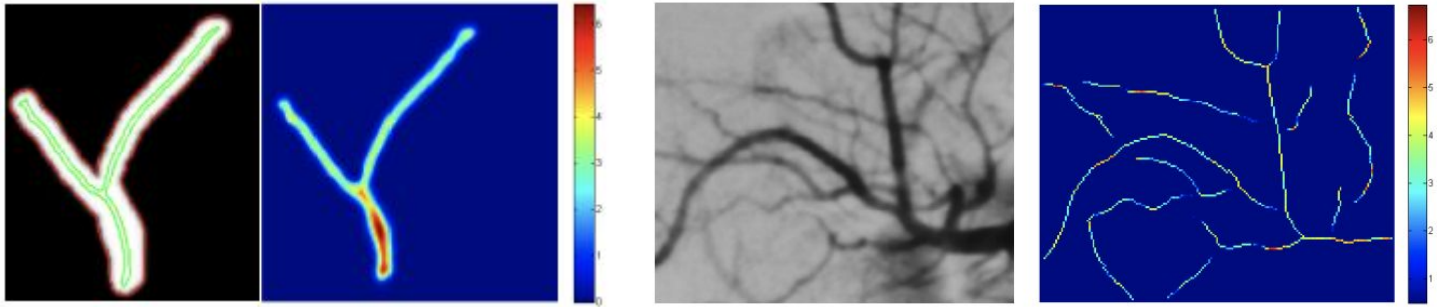
Motivation

- Anatomical trees are ubiquitous, eg., brain vessels and airways.
  - Clinical diagnosis and surgical planning.
- Difficult to represent
  - Varying and complex topology and geometry.
- Traditional medical imaging methods
  - Limited resolution, inefficient



Tree Representations

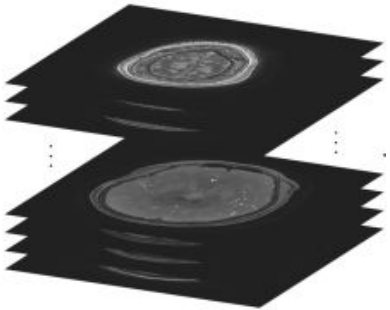
Medial Axis



Minimal Paths

Tree Representations...

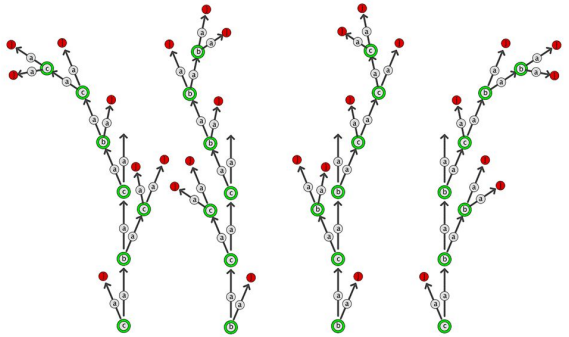
Volumes



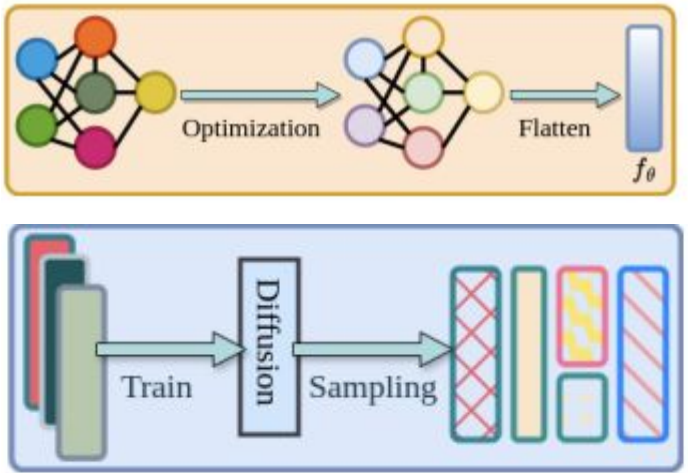
Meshes

Complete model

L-System

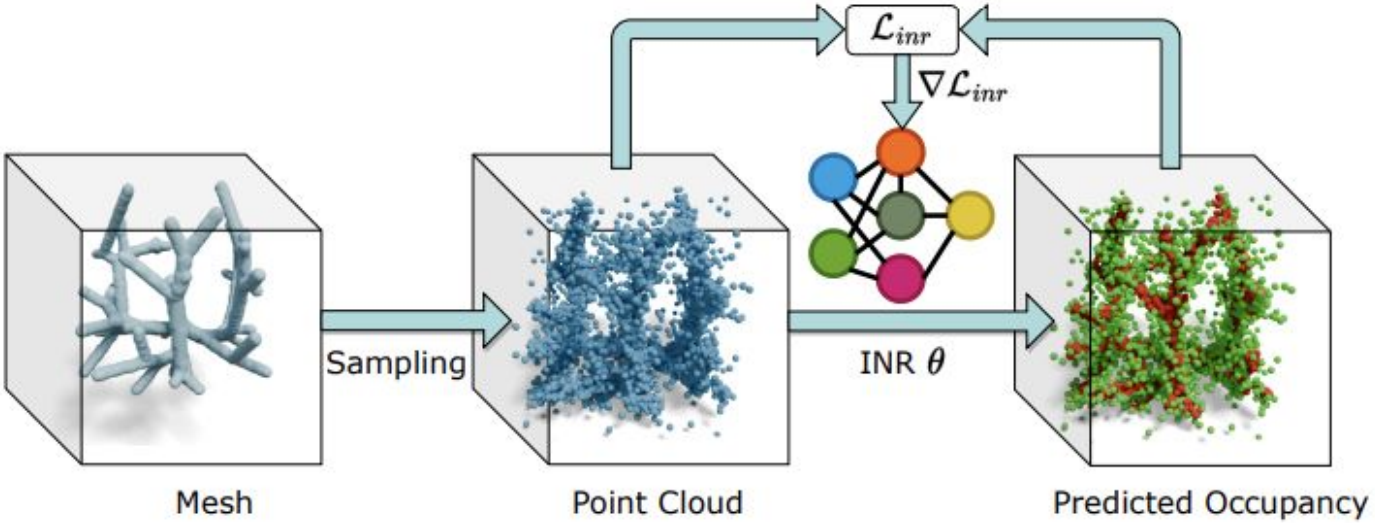


Tl;Dr



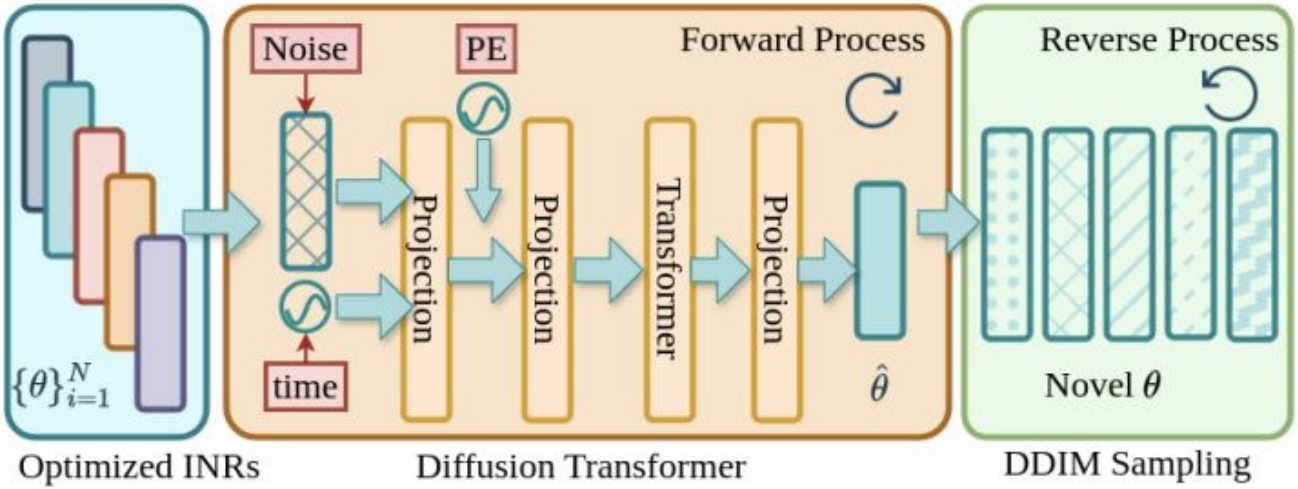
Pipeline

Stage 1

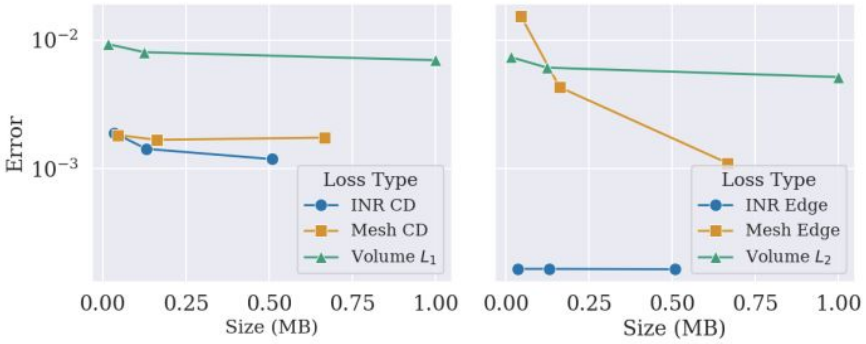


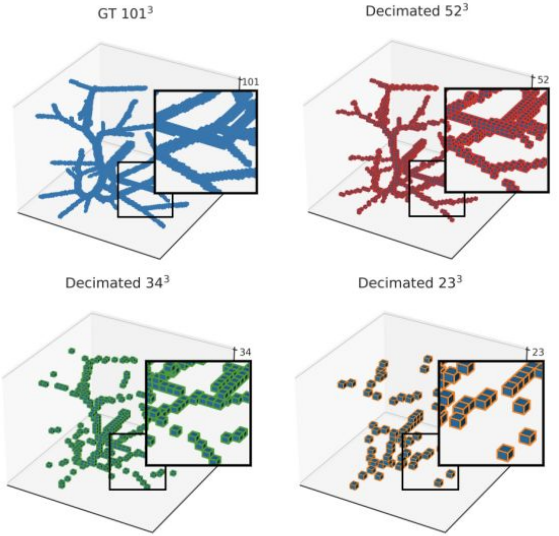
Pipeline...

Stage 2



Evaluation: Fidelity and Compactness





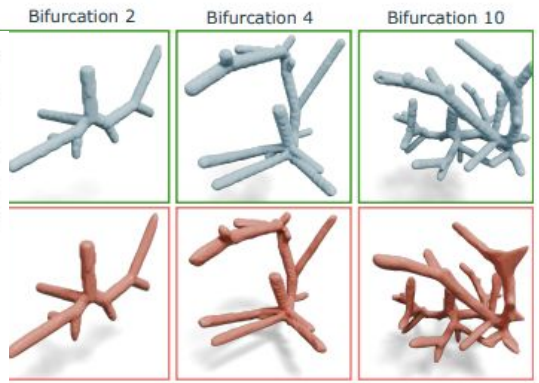
Evaluation: Versatility

VascuSynth Bronchial Airways IntRA Retinal Vessel Circle of Willis Whole Body MRA

Table 2: Quantitative results on tree structures present in different medical imaging modalities represented using INRs. We report the relative percentage error (%) between the reconstructed signal and ground truth.

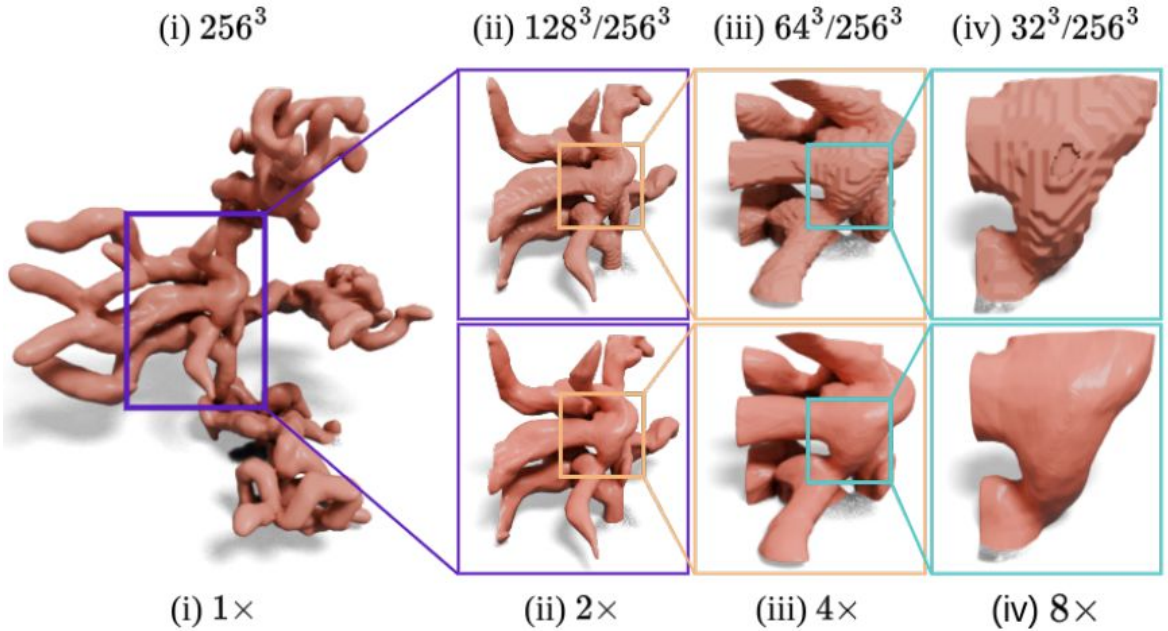
Modality	Rel. Error (%)	Input Size (MB)	INR Size (MB)
DRIVE (RGB) [32]	0.018	$0.37_{\pm 0.0055}$	$0.066_{\downarrow \times 5.60}$
DRIVE (Mask) [32]	1.204	$0.02_{\pm 0.0013}$	$0.003_{\downarrow \times 6.60}$
BraTS [20]	0.039	$68.11_{\pm 0.00}$	$0.753_{\downarrow \times 90.45}$
HAN-Seg [26]	5.627	$12.1_{\pm 1.55}$	$0.630_{\downarrow \times 19.20}$

(a) Various anatomical sites and imaging modalities

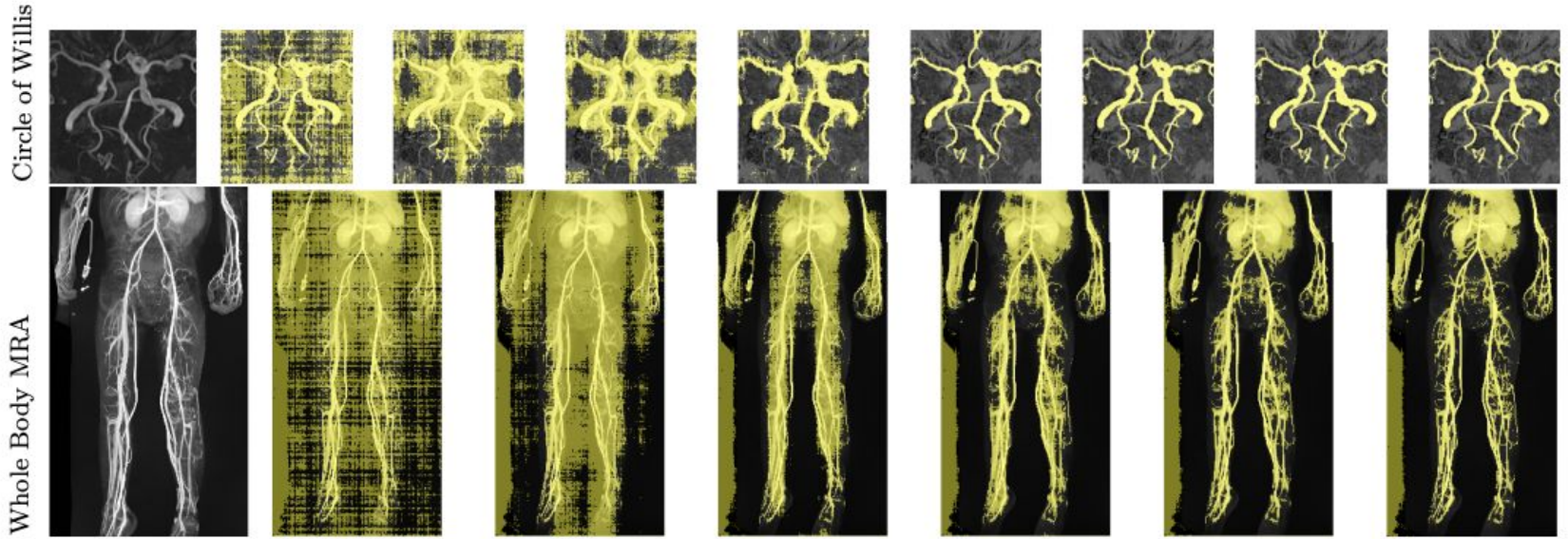


(b) Various complexities

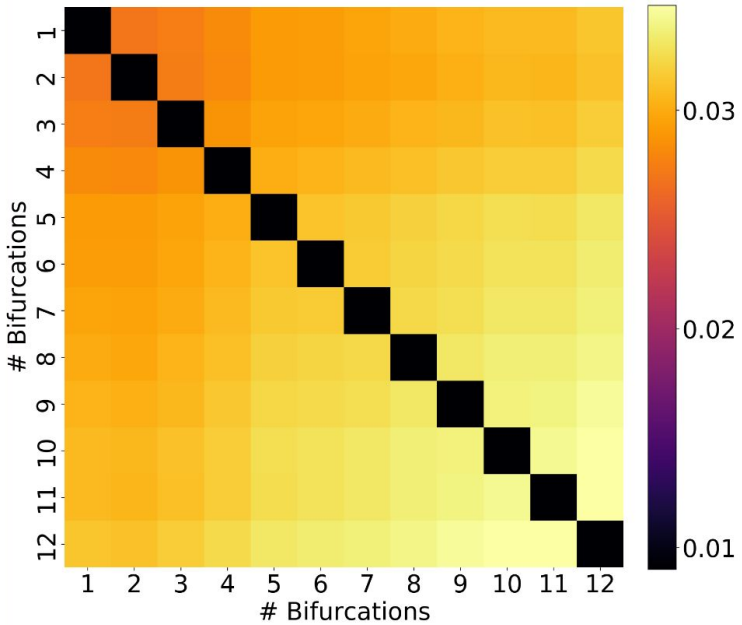
Evaluation: Resolution

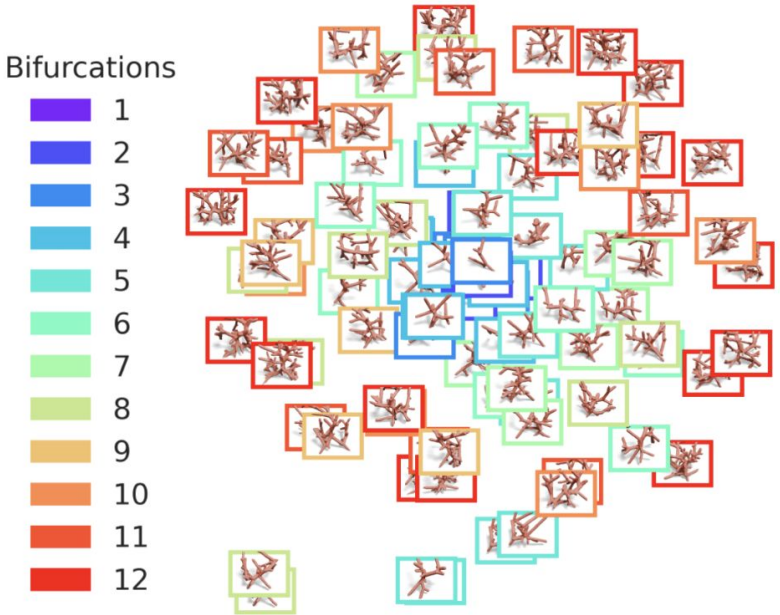


Evaluation: Unsupervised Segmentation

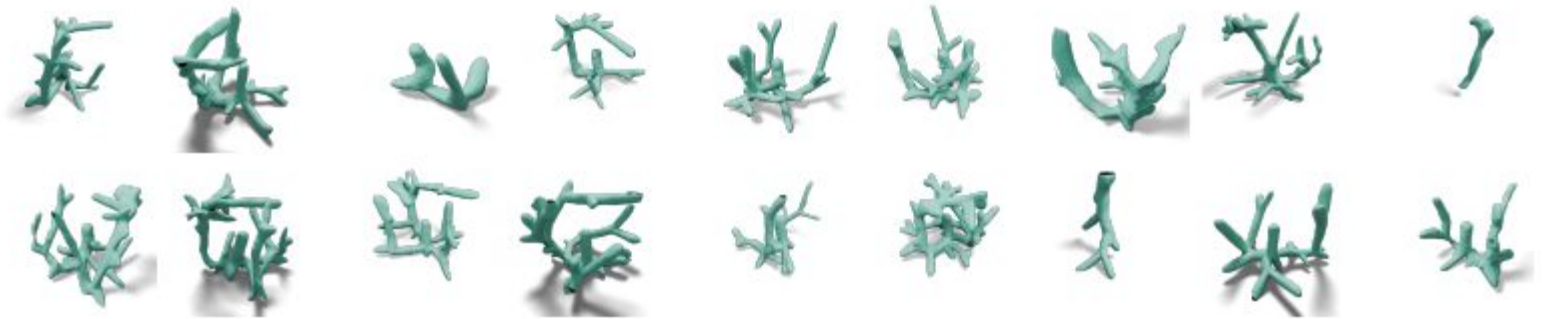


Evaluation: Tree Statistics

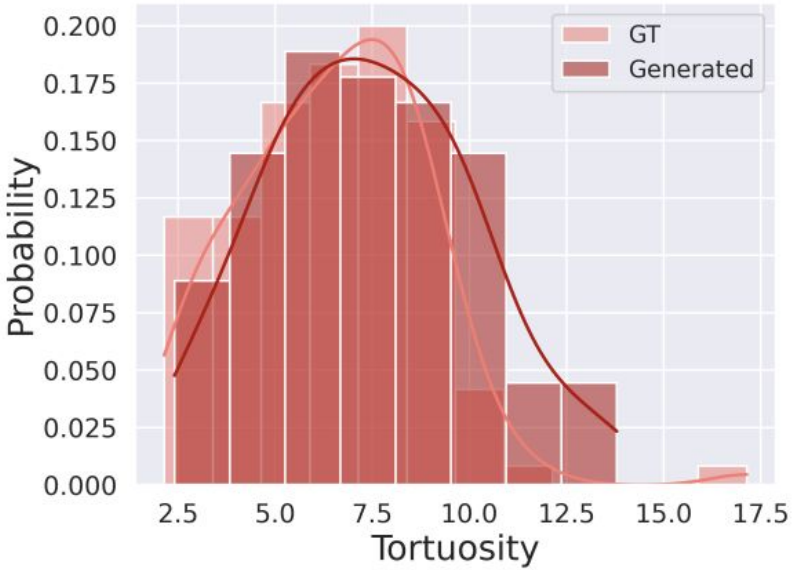


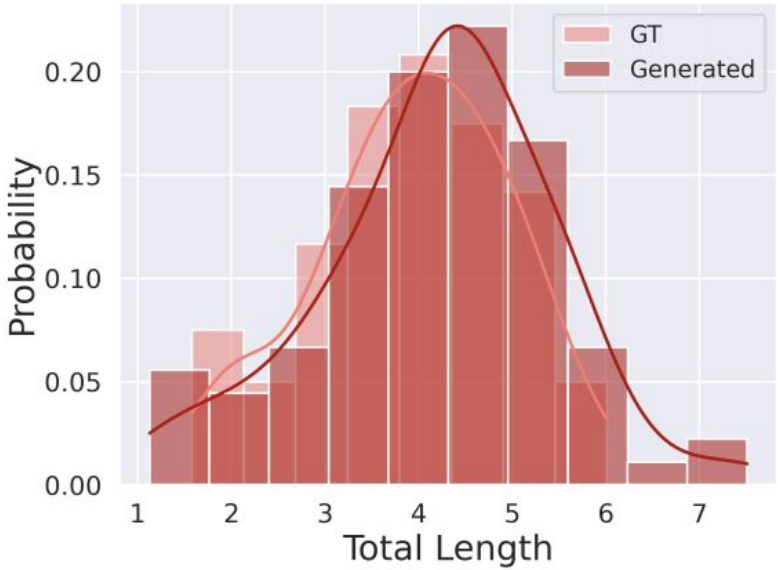


Evaluation: Tree Synthesis



Evaluation: Tree Plausibility





fin.