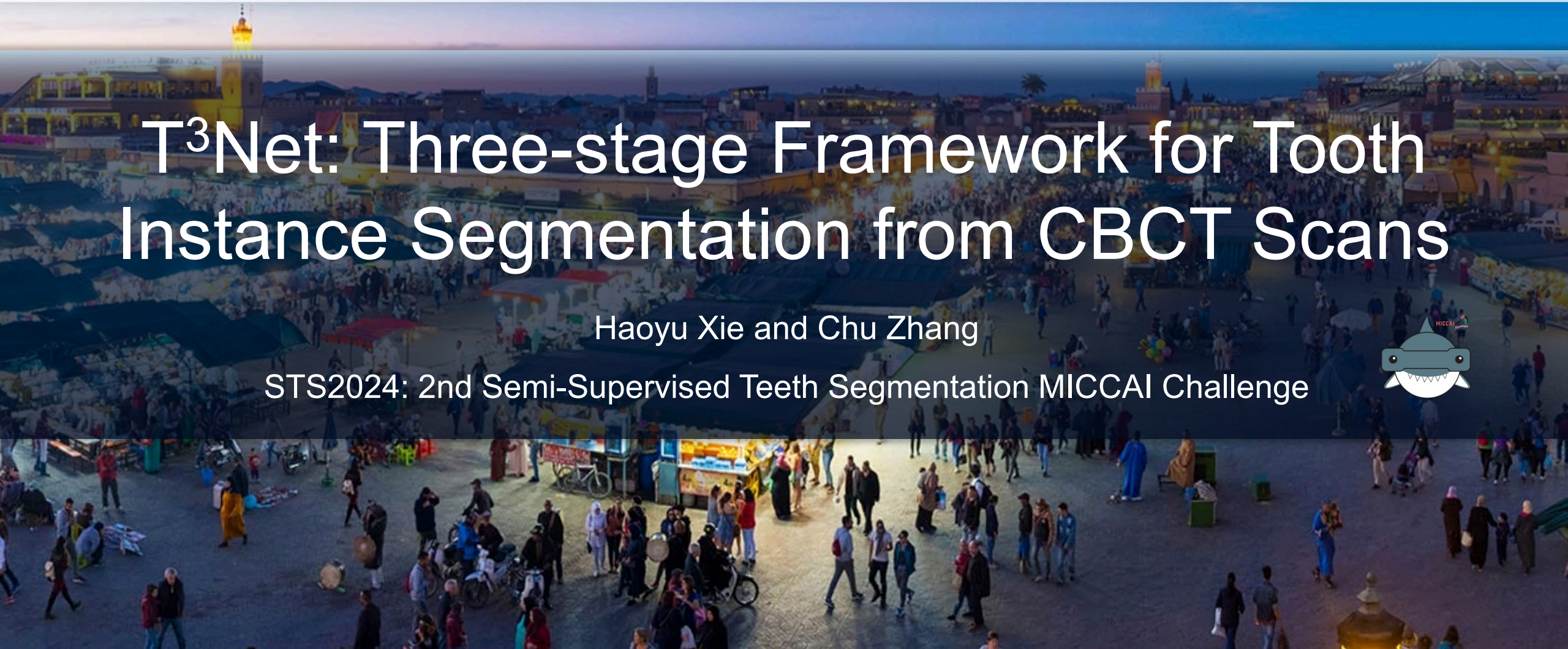
MICCAI 2024 Marrakesh MOROCCO

27th INTERNATIONAL CONFERENCE ON MEDICAL IMAGE COMPUTING AND COMPUTER ASSISTED INTERVENTION

6-10 October 2024 · MARRAKESH / MOROCCO



T^3Net: Three-stage Framework for Tooth Instance Segmentation from CBCT Scans

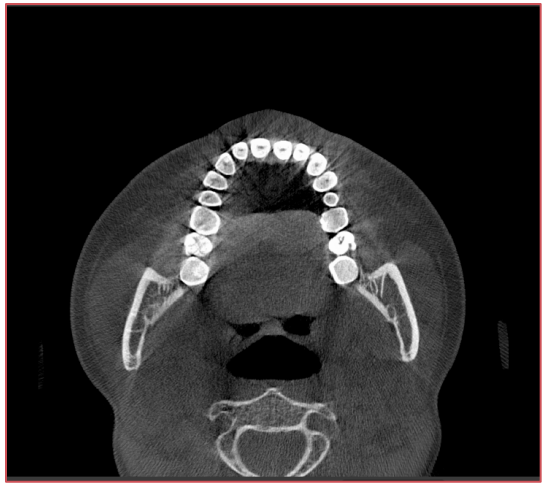
Haoyu Xie and Chu Zhang

STS2024: 2nd Semi-Supervised Teeth Segmentation MICCAI Challenge

Tooth Instance Segmentation Task

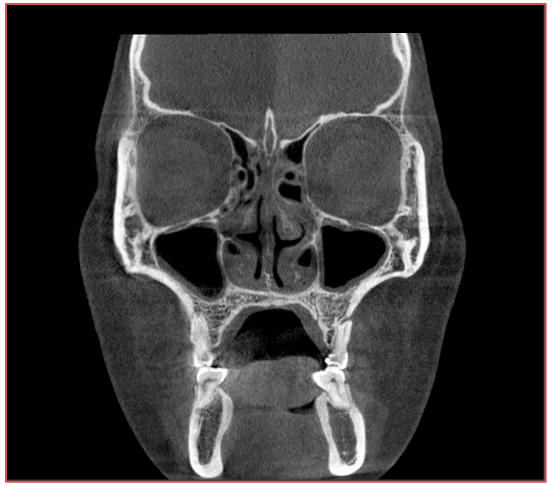
Input	One 3D CBCT Volume

Output	Tooth Instance Mask

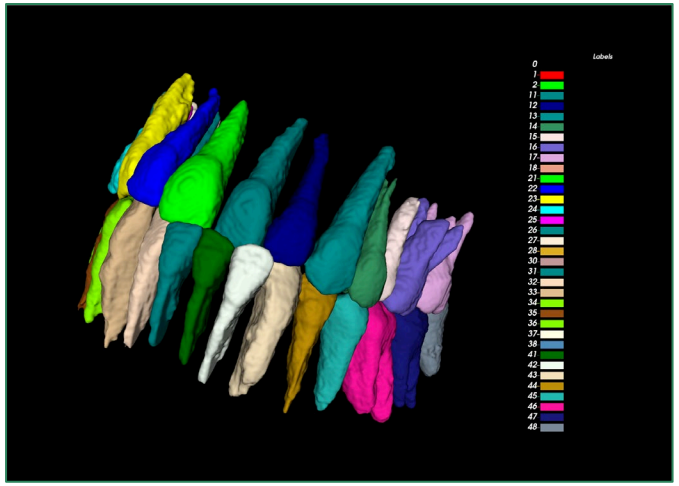


Transverse

Sagittal



Coronal

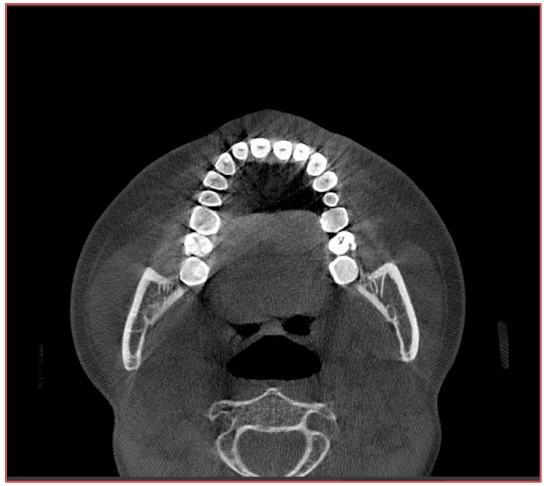


Segmentation Mask

Tooth Instance Segmentation Task

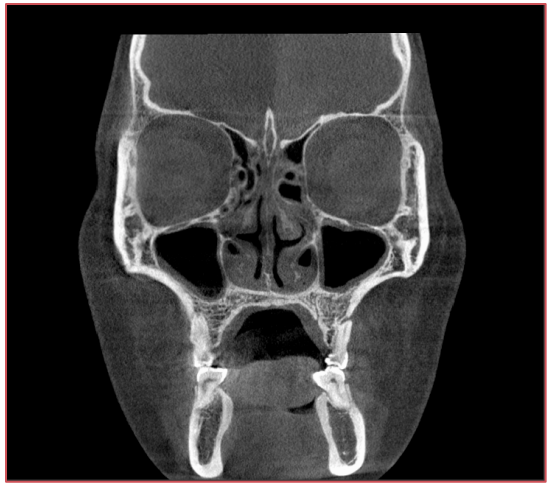
Input	One 3D dental CBCT Volume

Output	Tooth Instance Mask



Transverse

Sagittal



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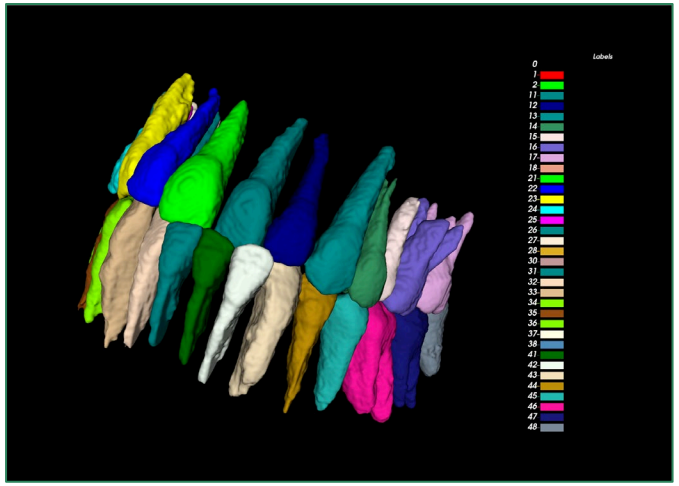
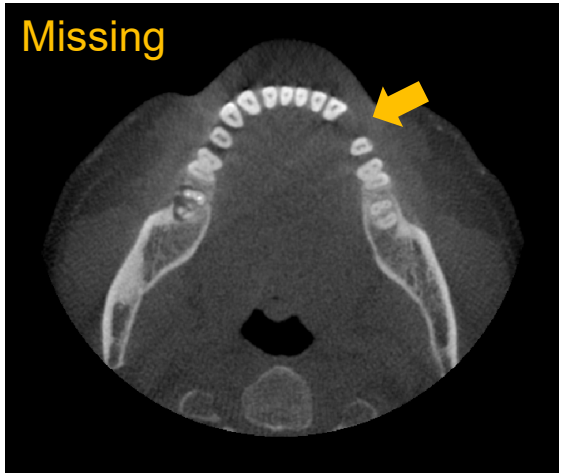


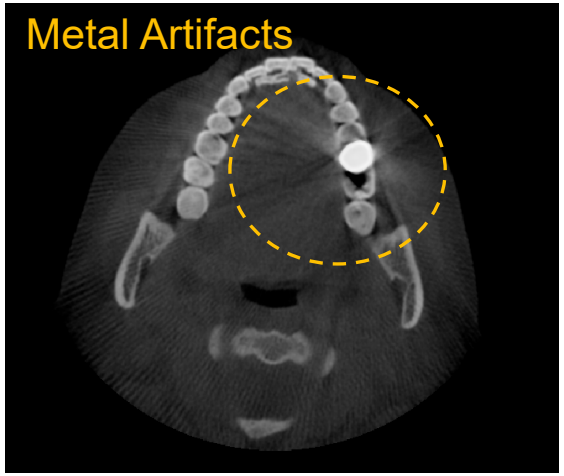
Segmentation Mask

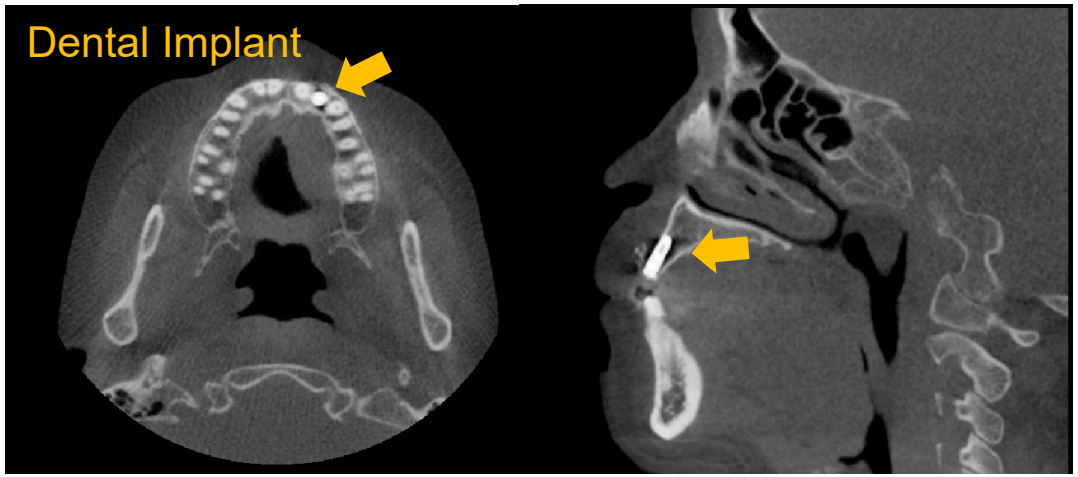
Segmentation

Classification

Existing Challenges







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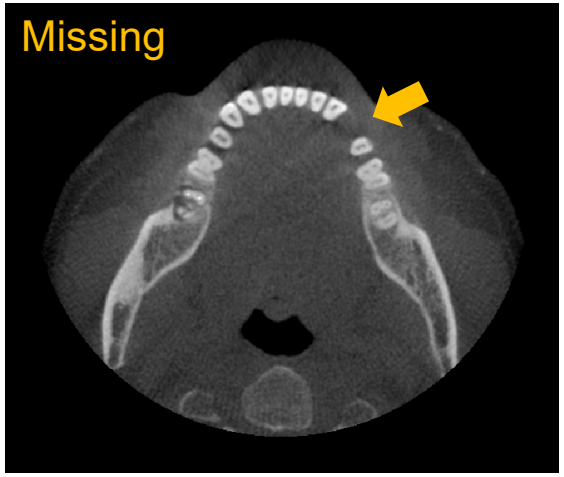

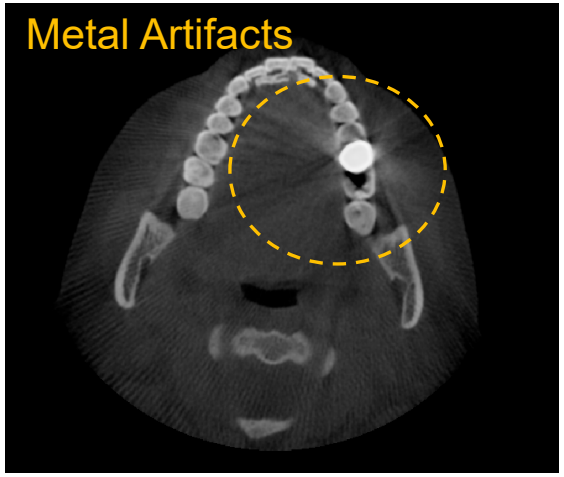

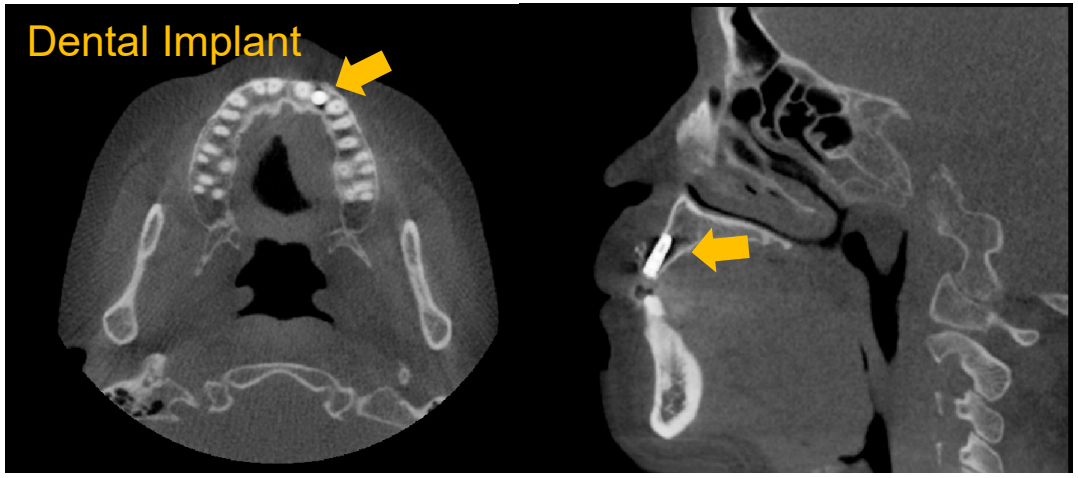

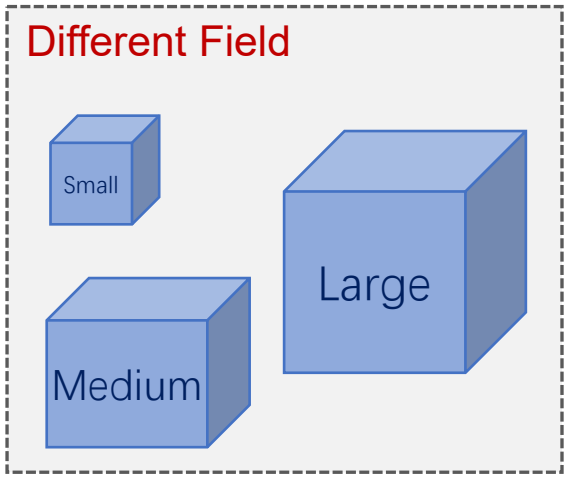

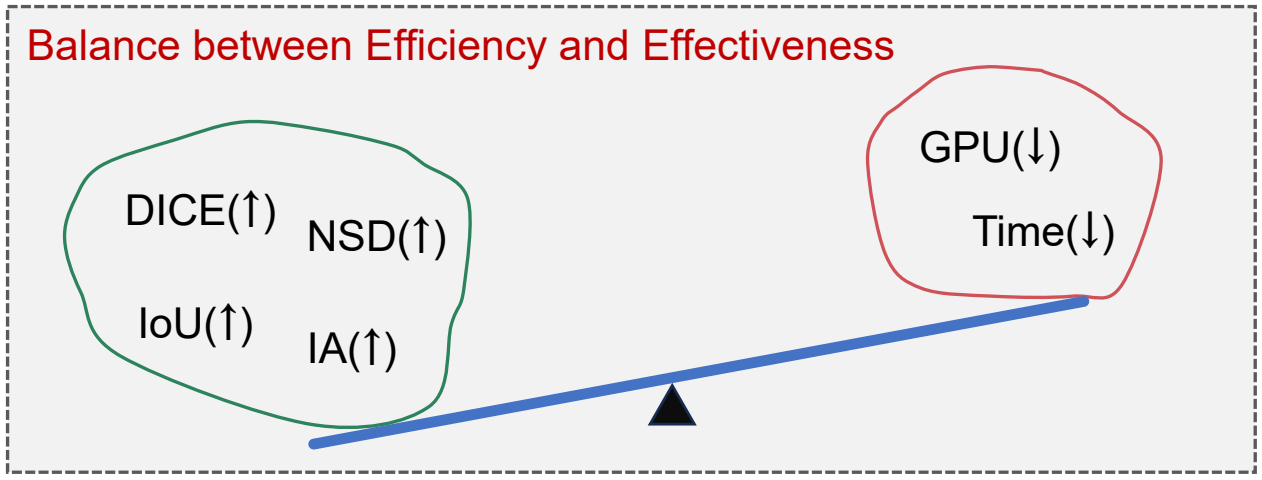

Cui, Zhiming, et al. "A fully automatic AI system for tooth and alveolar bone segmentation from cone-beam CT images." *Nature communications* 13.1 (2022): 2096.

Algorithm Pipeline

Our **T^{3}Net** method presents an automated pipeline for instance-level segmentation and numbering of teeth and implants in CBCT images, consisting of a cascaded three-stage network:

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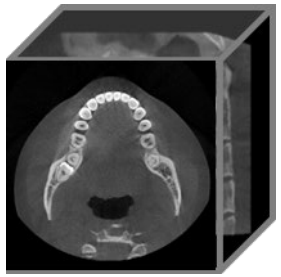

128×128×128

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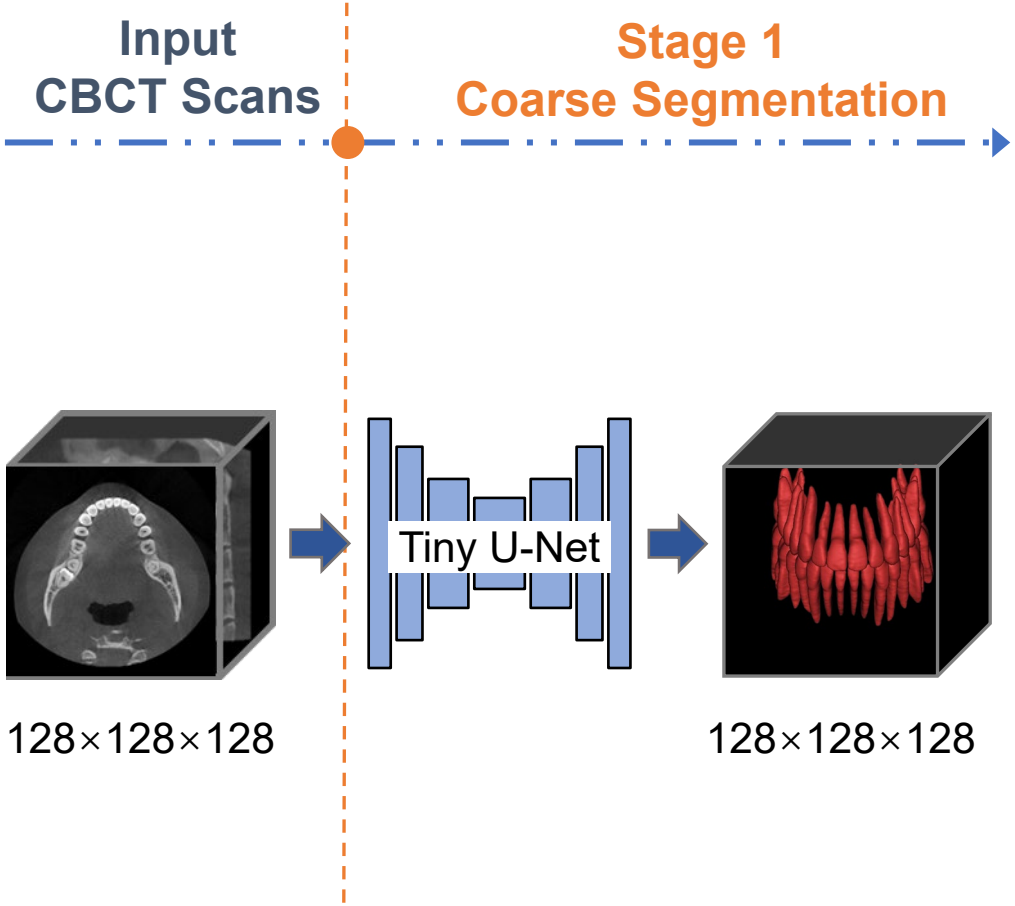

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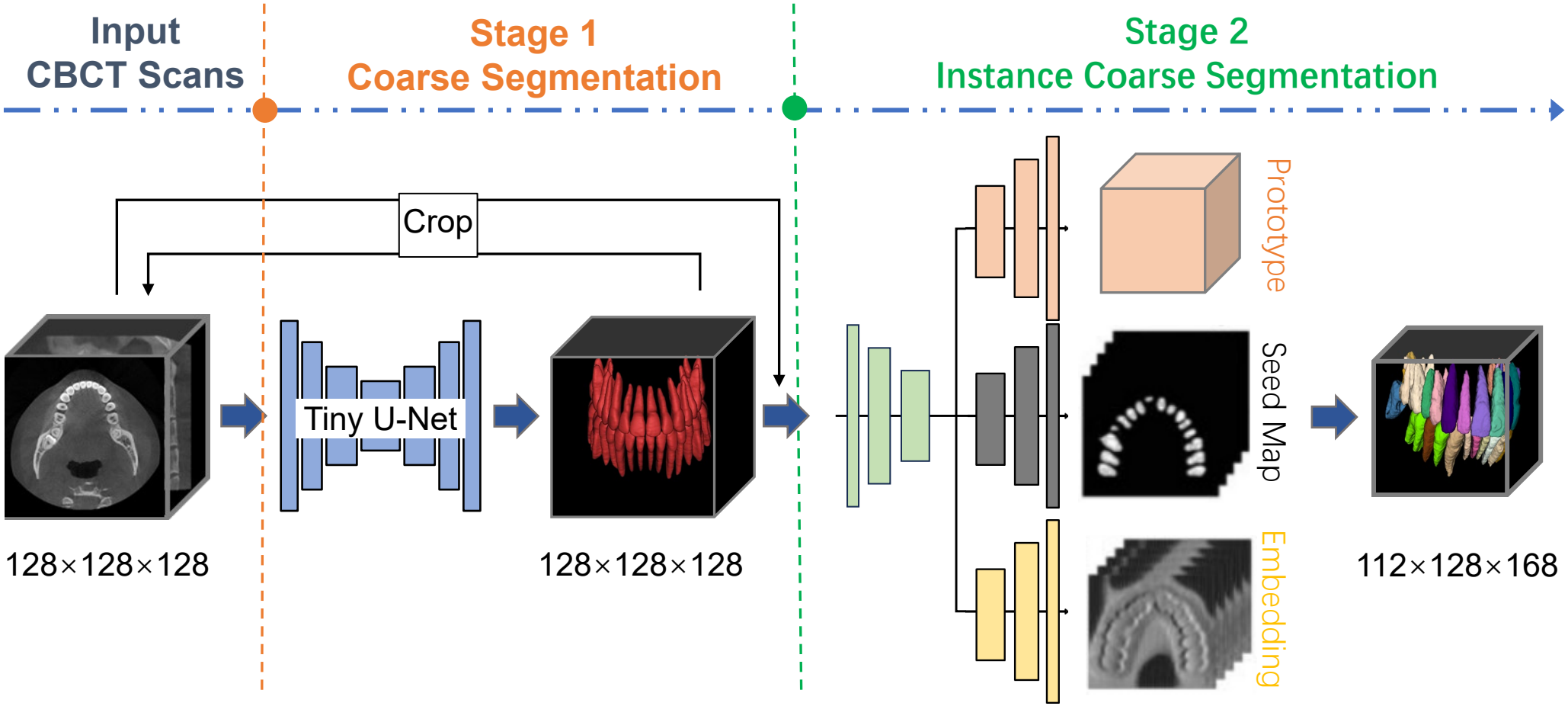

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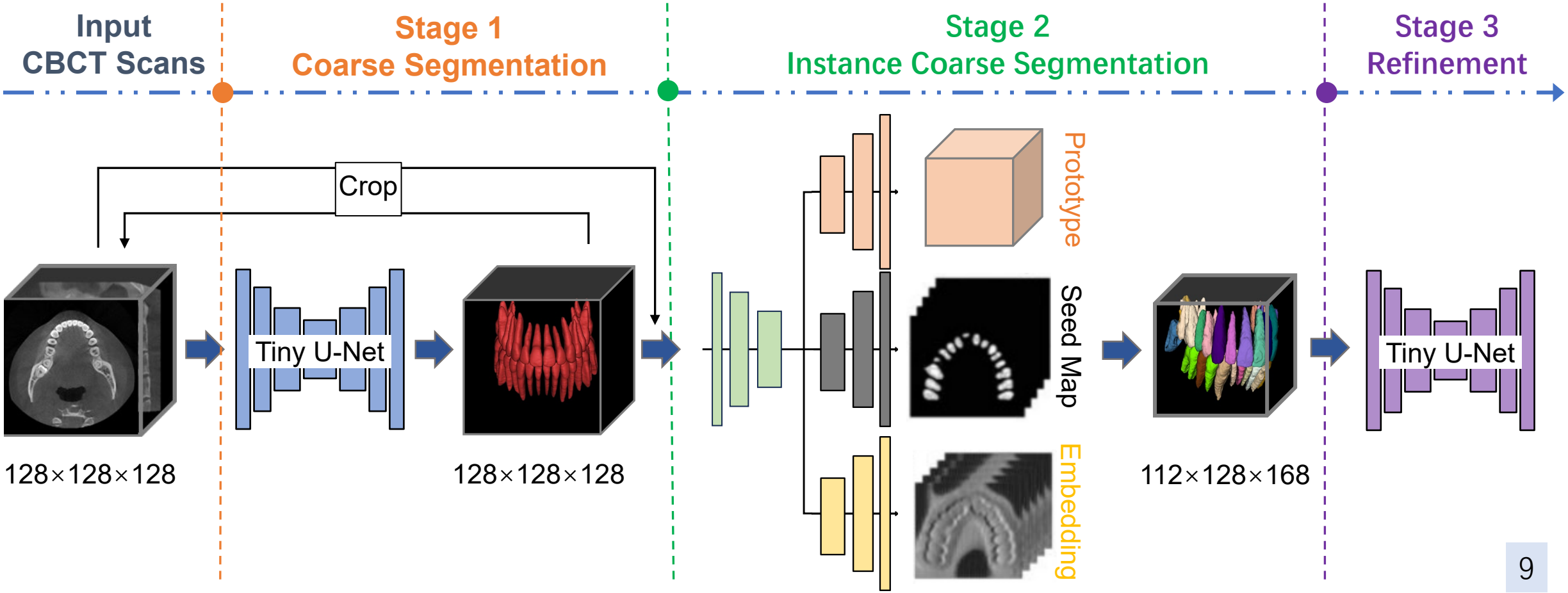


Implementation Details

Loss Function: The training of the first and third models was performed with a standard **Binary Cross Entropy** loss, and the second model with **Multi-class Cross Entropy**. Both can be formulated as:

$$L = -\frac{1}{N}\sum_{i=1}^{N}\sum_{c=1}^{C} g_i^c log s_i^c$$

Dataset Split and Augmentation: The Challenge released 330 CBCT images, including 30 cases with labels and 300 unlabeled cases. However, in our experiments, we **ONLY** used 30 labeled cases for supervised learning, of which 3 cases were used as internal validation sets. Besides, random rotation, scaling, elastic deformation, and cropping were applied as data augmentation strategies.

Environment Settings: All models were optimized using the Adam Optimizer with initial learning rate of 1e-4. Development environments and requirements are listed as follows:

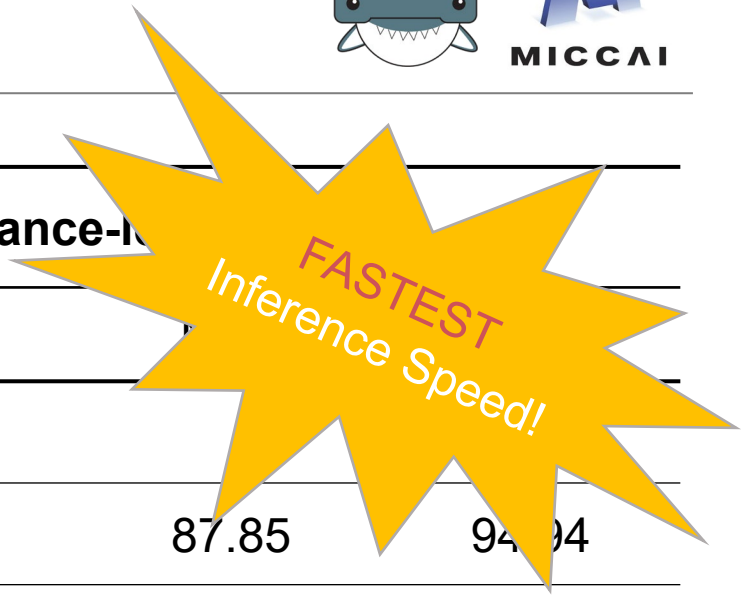
System	Ubuntu 18.04.5 LTS	Programming language	Python 3.20
GPU	One NVIDIA A100 80G	Deep learning framework	Torch 2.0, Torchvision 0.2.2

Results and Ranking

Team	Image-level			Intance-level			
	Dice	IoU	NSD	Dice	IoU	NSD	IA
Online Validation Leaderboard: Rank #5							
jichangkai	96.86	93.94	99.07	90.48	92.79	87.85	94.94
houwentai	95.21	90.96	97.81	89.07	91.61	85.11	95.68
ChohoTech	94.92	90.36	98.55	88.33	92.01	84.12	95.41
Guet-IICI	96.02	92.40	98.02	87.64	88.73	83.12	90.63
haoyuuuu	95.85	92.11	97.30	85.55	87.21	82.20	90.38
Hidden Test Set Result:							
haoyuuuu	61.76	54.26	63.09	54.16	50.13	54.88	56.05

Results and Ranking

MICCAI



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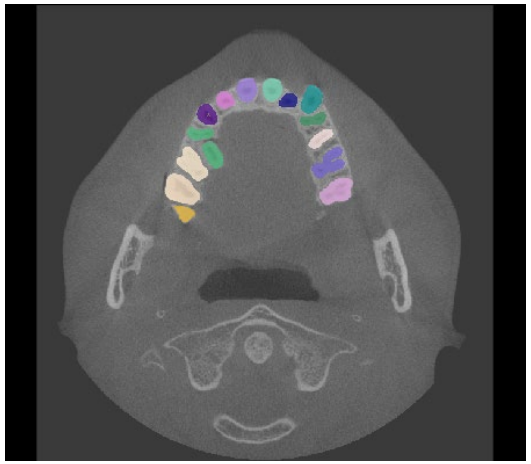
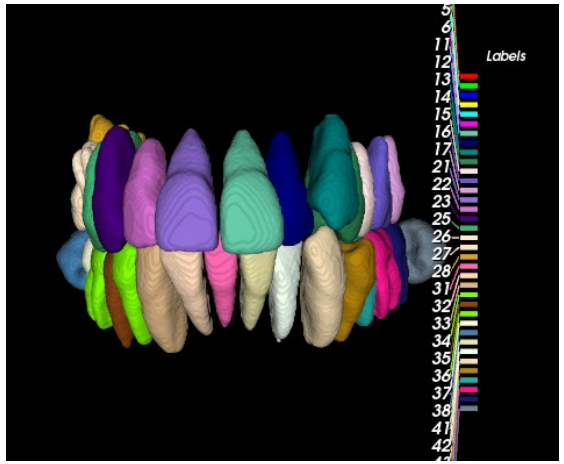
Results and Ranking

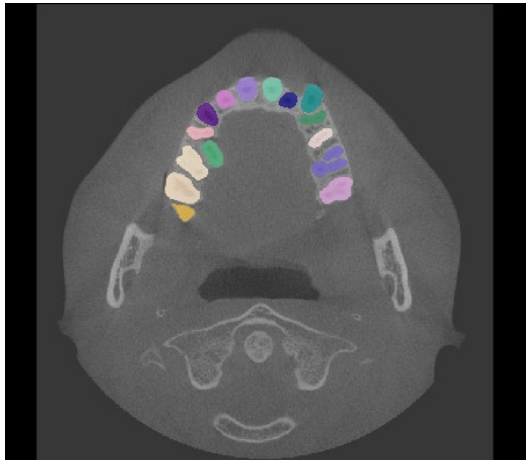
#STS24_Train_Labeled_0007

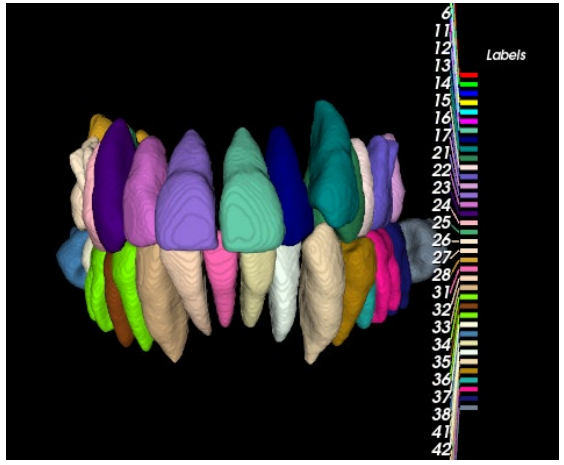
Prediction



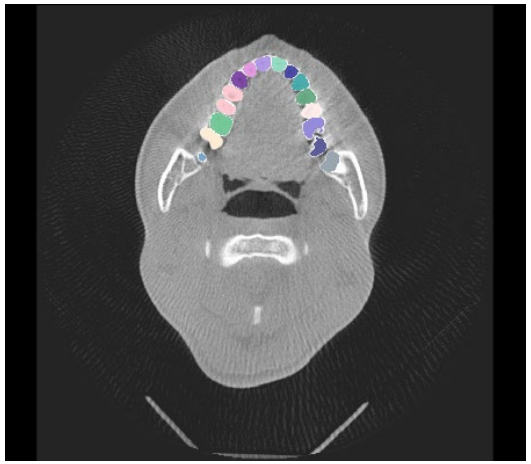


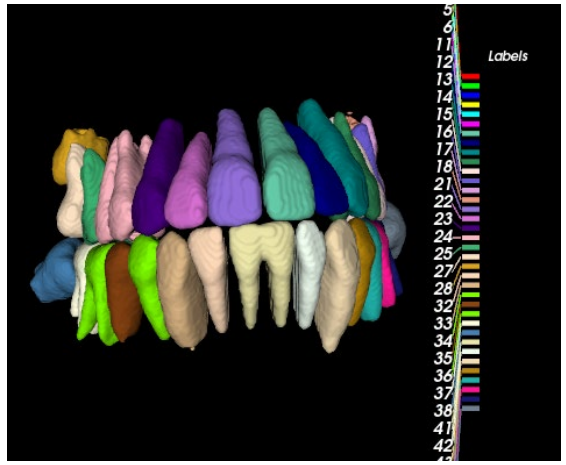
Ground Truth

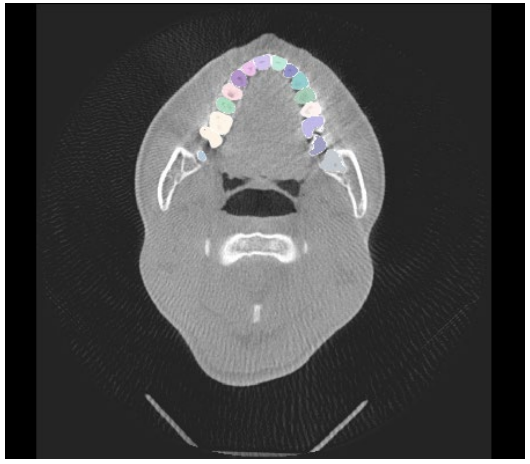


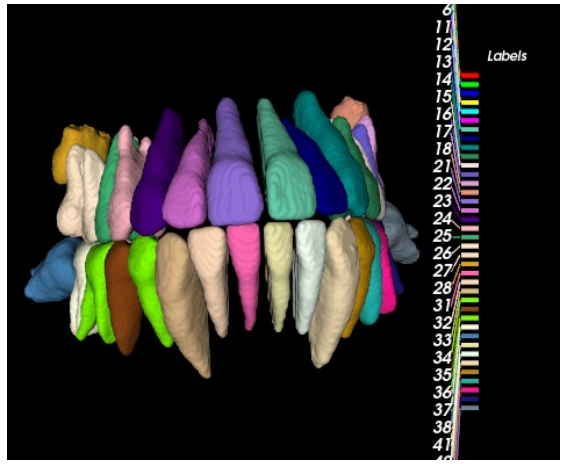


#STS24_Train_Labeled_0011









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Q&A

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