

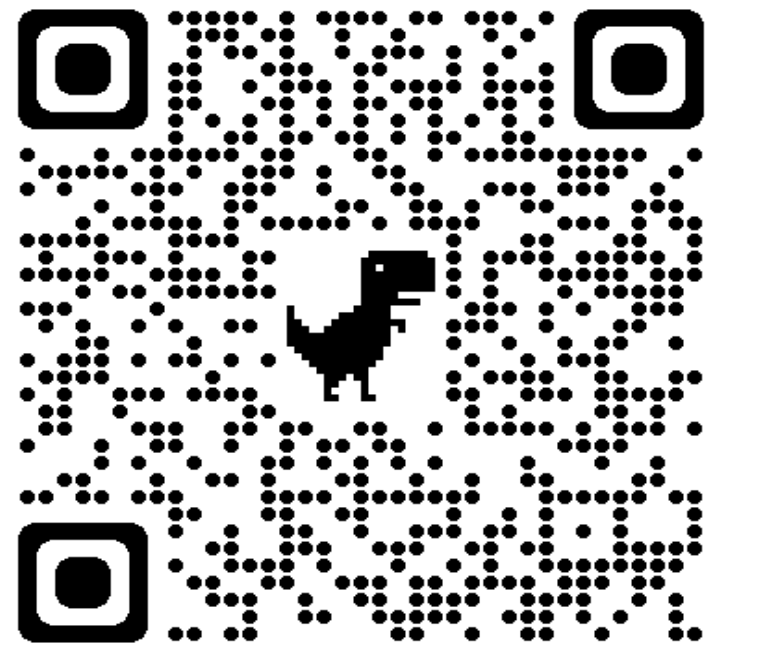
CoMoSeg: ANATOMICAL CONSISTENCY AND CROSS MODALITY GUIDANCE FOR ROBUST BRAIN TUMOR SEGMENTATION USING PARTIALLY LABELED MR SEQUENCES



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BACKGROUND

- Accurate **MR Images brain tumor segmentation** is critical for diagnosis and treatment planning.
- Multi-modality MR sequences** offer distinct features, aiding in precise tumor identification.

CHALLENGES

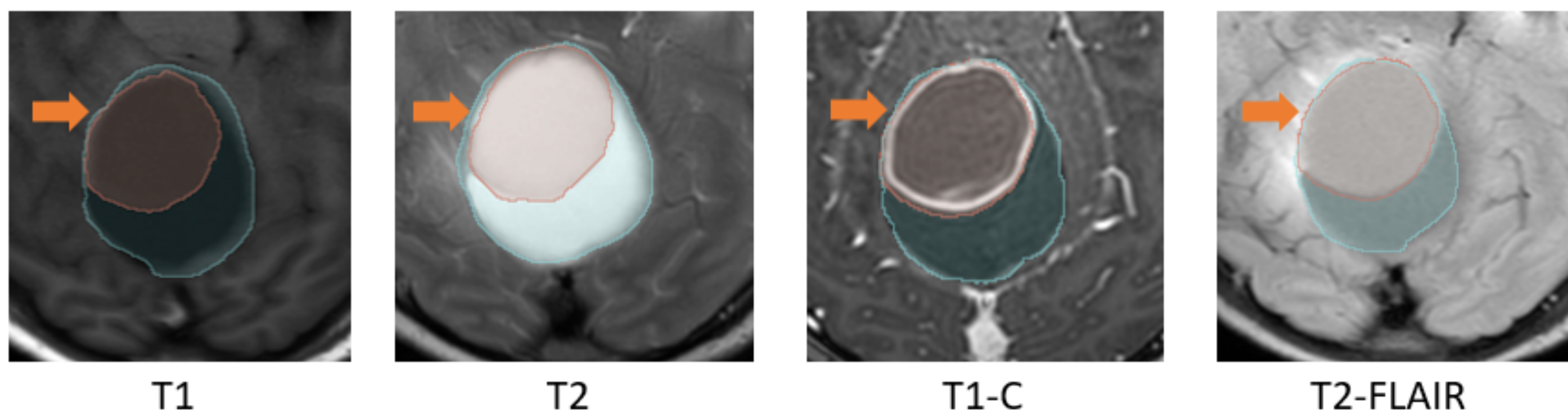


Fig. 1. Tumor annotations in different sequences of the same subject. Red: tumor core; blue: edema. Notice the slight differences of masks across different modalities.

- Lesion appearances vary across MR sequences
- Precise annotations often require tedious delineation

EXPERIMENTS & RESULTS

Mask	Metric	V-Net(T2)	V-Net(T1-C)	gMIS	CoMoSeg
Edema	Dice	86.36±12.02	-	83.10±12.63	87.18±8.97*
	Recall	91.67±11.51	-	83.56±14.19	88.59±9.89
	Precision	83.76±13.88	-	84.90±13.05	87.49±11.72*
Tumor Core	Dice	-	82.29±19.76	80.68±19.72	86.58±12.58*
	Recall	-	86.22±19.52	77.53±21.37	85.36±15.57
	Precision	-	82.28±21.13	87.87±15.30	89.95±9.60*

Table.1. Comparison of different models

Modality	Method	Tumor Core		Edema	
		Dice	Recall	Dice	Recall
T1	IIC	62.14±24.38	56.75±25.63	74.52±15.59	69.05±18.22
	CoMoSeg	64.07±24.02	60.46±25.42	75.11±17.11	71.51±19.20
T1-C	baseline	80.56±22.72	78.69±22.95	-	-
	IIC	82.19±23.53	80.59±24.52	74.13±15.47	68.82±17.87
	CoMoSeg	86.58±12.58	85.36±15.57	76.61±14.88	74.88±17.37
T2	baseline	-	-	83.88±14.09	83.11±15.04
	IIC	63.11±25.70	60.17±26.37	82.16±15.00	78.43±16.15
	CoMoSeg	66.02±23.91	67.06±22.61	87.18±8.97	88.59±9.89
T2-FLAIR	IIC	63.20±24.34	62.68±25.49	76.67±17.33	74.88±19.23
	CoMoSeg	66.78±24.58	71.82±22.06	79.91±15.89	84.91±17.11

Table.2. Ablation of IIC and CMG

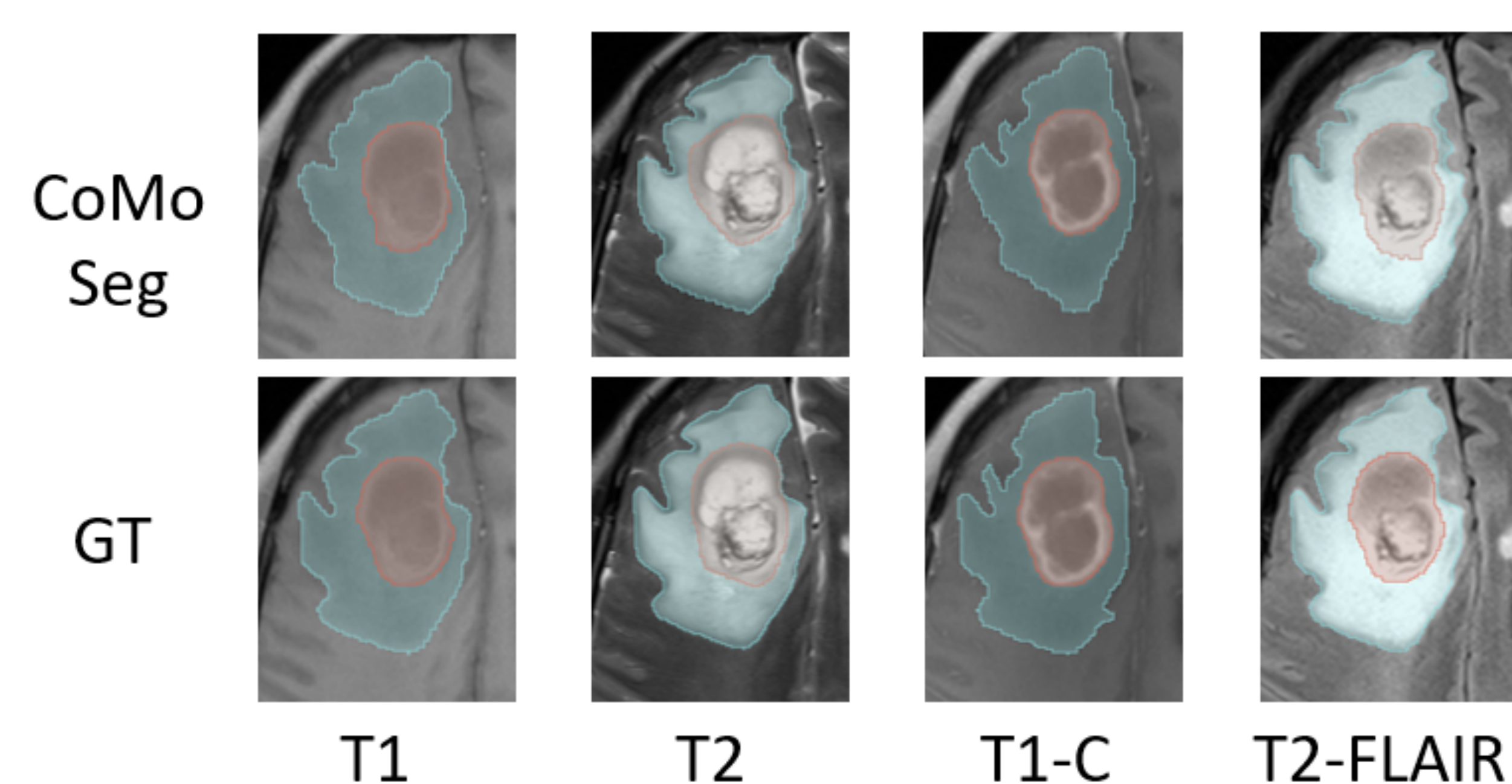


Fig.3. Typical segmentation results. Top: CoMoSeg result; bottom: Ground truth.

METHOD

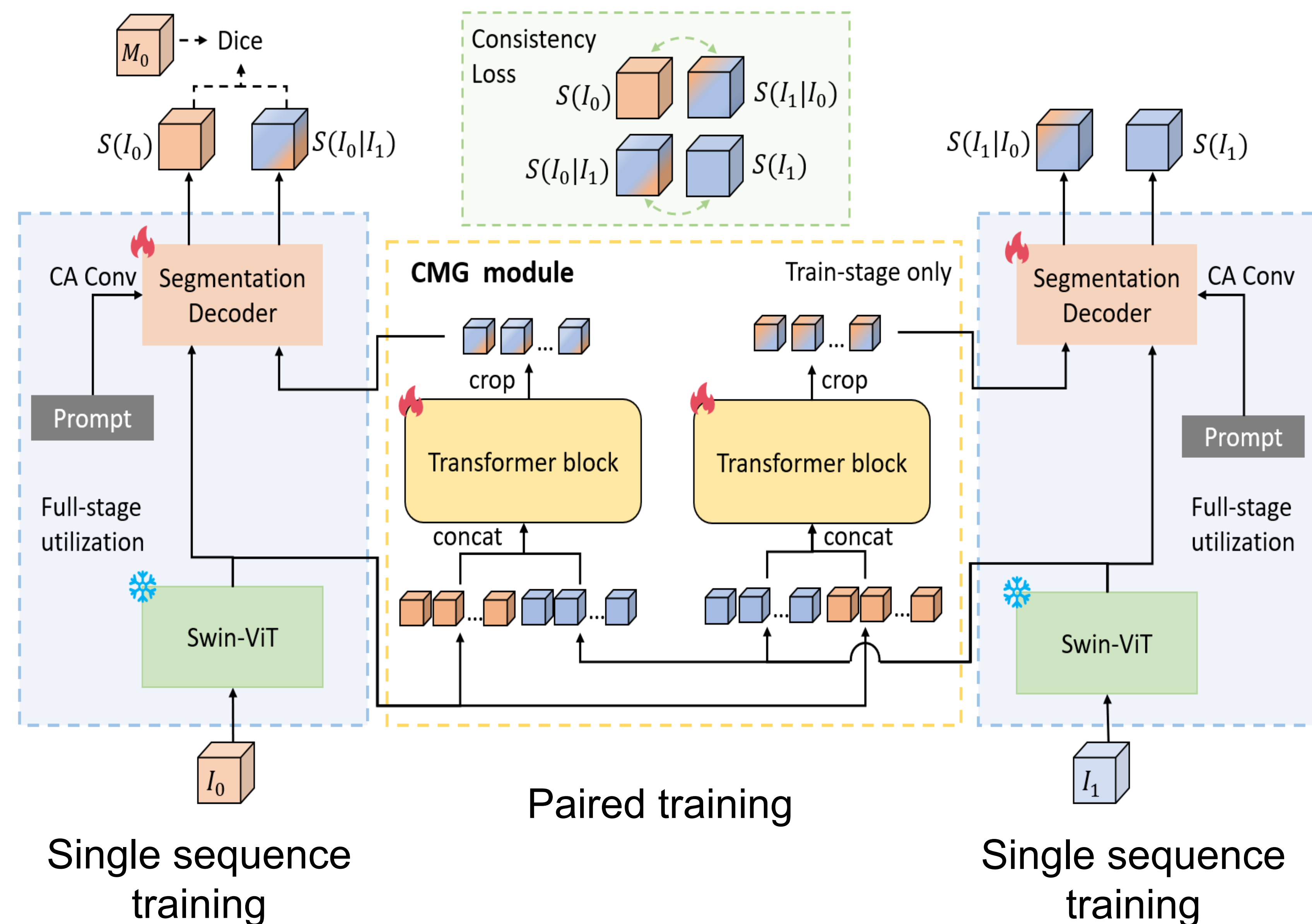


Fig. 2. The proposed CoMoSeg framework.

Framework:

- Single Sequence:** CoMoSeg generates a segmentation mask for a given MR sequence based on a text prompt, which is applied to two different sequences (I_0 and I_1 , See Fig. 2).
- Paired Sequences:** Used for partial labeled image. Fuse features between a pair of images, one with a mask and the other without (paired I_0 with I_1).
- Cross-Modality Guidance (CMG)** module accomplishes feature alignment between the two sequences.
- Swapping training strategy** ensures that the model is not overly reliant on any one modality's features for segmentation.
- Intra-Individual Consistency (IIC)** Loss uses the inherent relationships within the same subject's images.

CONCLUSION

- We have proposed CoMoSeg, which leverages CMG module and IIC loss to exploit anatomical consistency across MR sequences, enabling effective brain tumor segmentation with limited or partially labeled annotations.
- CoMoSeg was trained on **3,709 MR sequence pairs** and evaluated on **73 subjects** (each with 4 MR sequences) collected from multiple centers (4 hospitals and 2 public datasets).
- CoMoSeg significantly outperformed V-Net and gMIS in both Dice coefficient and precision (p -value < 0.05).
- The model shows strong potential for accurate brain tumor diagnosis and treatment planning through enhanced feature alignment and anatomical consistency.