Segmentation

IoU vs. Dice Score

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IoU vs. Dice Score

- A: Ground truth mask
- B: Predicted mask
- **IoU** and **Dice Score** are both used to evaluate **overlap between predicted and ground truth regions**.
- **Dice is typically higher than IoU** for the same prediction.
- Both range from 0 (no overlap) to 1 (perfect overlap).

$$\text{IoU} = \frac{|A \cap B|}{|A \cup B|}$$

$$\text{Dice} = \frac{2|A \cap B|}{|A| + |B|}$$

$$\text{Dice} = \frac{2 \cdot \text{IoU}}{1 + \text{IoU}} \quad \text{and} \quad \text{IoU} = \frac{\text{Dice}}{2 - \text{Dice}}$$

IoU

- **Object detection** tasks (**bounding boxes**)
- **Instance segmentation**
- Evaluations on benchmarks like **COCO**, **Pascal VOC**

$$\text{IoU} = \frac{|A \cap B|}{|A \cup B|}$$

- **Why IoU?** Penalizes overprediction (large false positives) more heavily than Dice.
- Example: If your model predicts bounding boxes or masks for individual objects and you're interested in **how well those regions match** the ground truth, **IoU** is the go-to.

Dice Score

- **Medical image** **or** **fine-grained** **segmentation** (e.g., tumor, organ segmentation)
- **Binary or multi-class segmentation** tasks
- **Imbalanced data scenarios** (when foreground is much smaller than background)

$$\text{Dice} = \frac{2|A \cap B|}{|A| + |B|}$$

- **Why Dice?**
- More sensitive to **small overlaps**, e.g. medical or fine-grained segmentation.
- When in **class imbalance** (e.g., small target in large image).
- Numerically more stable when ground truth areas are small.
- Example: segmenting tumors in MRI scans, and the tumor area is tiny compared to the background.

Comparison / Practical Rule of Thumb

- Use **IoU** if your task is **detection-focused** (especially in competitions or using **bounding boxes**).
- Use **Dice Score** if your task is segmentation-focused and you're dealing with **fine boundaries** or **class imbalance**.

Metric	Best For	Sensitive To	Good When...
IoU	Object detection, instance segmentation	Union area (over- and under-prediction)	Comparing masks of similar sizes
Dice	Medical imaging, semantic segmentation	Overlap in small objects	Foreground is small or class imbalance