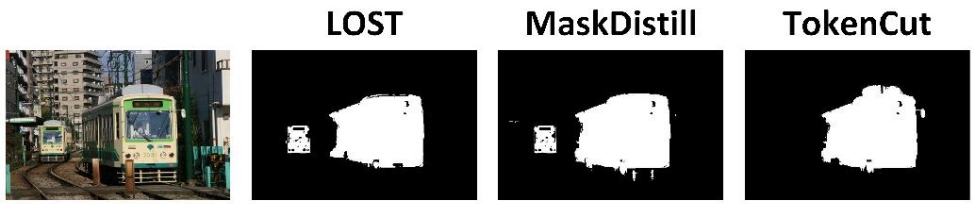
COMP2005

Metrics for Image Segmentation

Why do we need metrics for image segmentation?



- **Which algorithm is the best?**

  Hard to answer by looking at the results ...

- **What we can do with metrics?**
  - Automatic evaluation
  - Comparison between different approaches
  - Evaluation from multiple perspectives

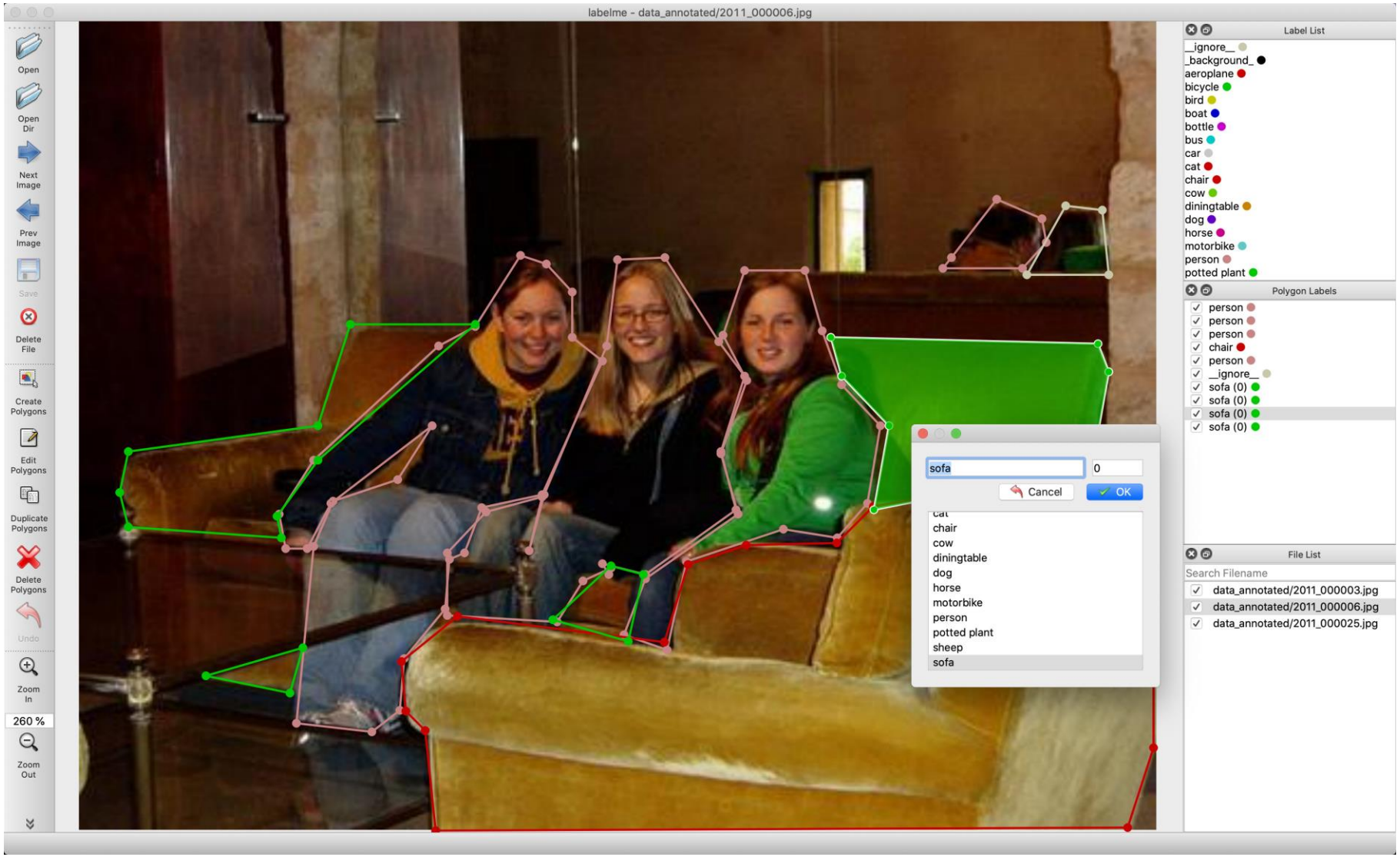
  ...

Siméoni, Oriane, et al. "Localizing Objects with Self-Supervised Transformers and no Labels." BMVC 2021-32nd British Machine Vision Conference. 2021.

Van Gansbeke, et al. Discovering object masks with transformers for unsupervised semantic segmentation. arXiv preprint arXiv:2206.06363 (2022).

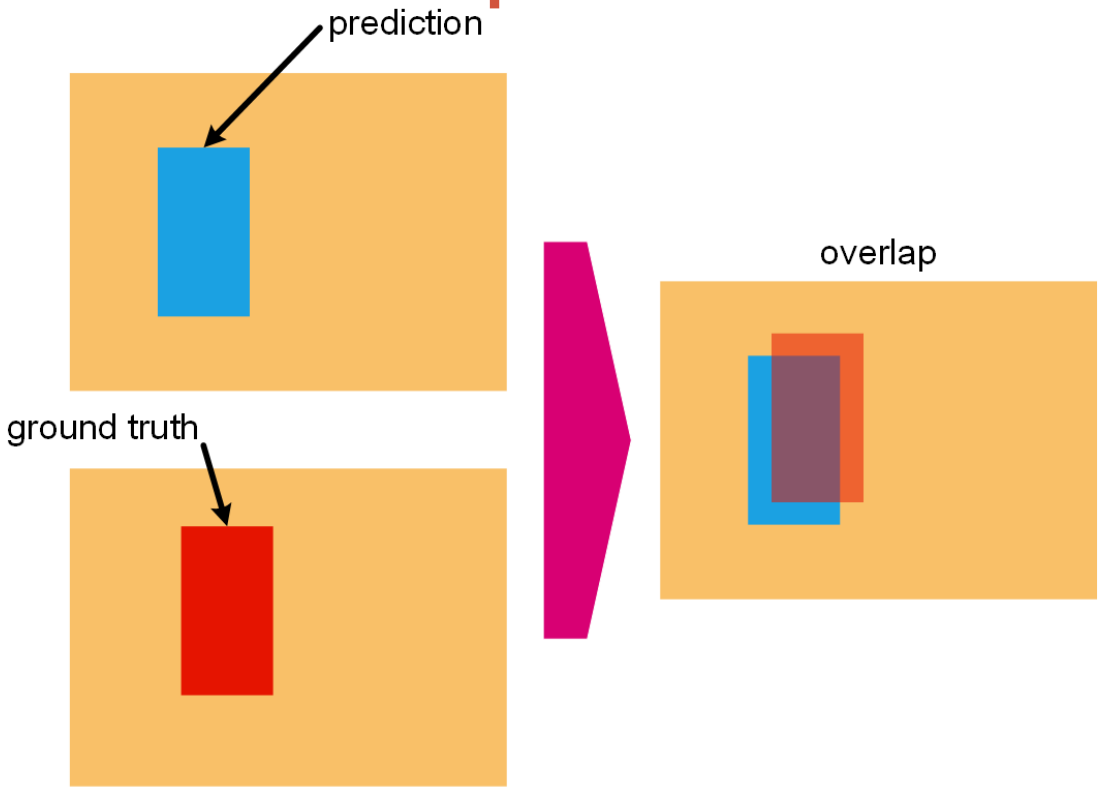
Wang, Yangtao, et al. "Tokencut: Segmenting objects in images and videos with self-supervised transformer and normalized cut." IEEE Transactions on Pattern Analysis and Machine Intelligence (2023).

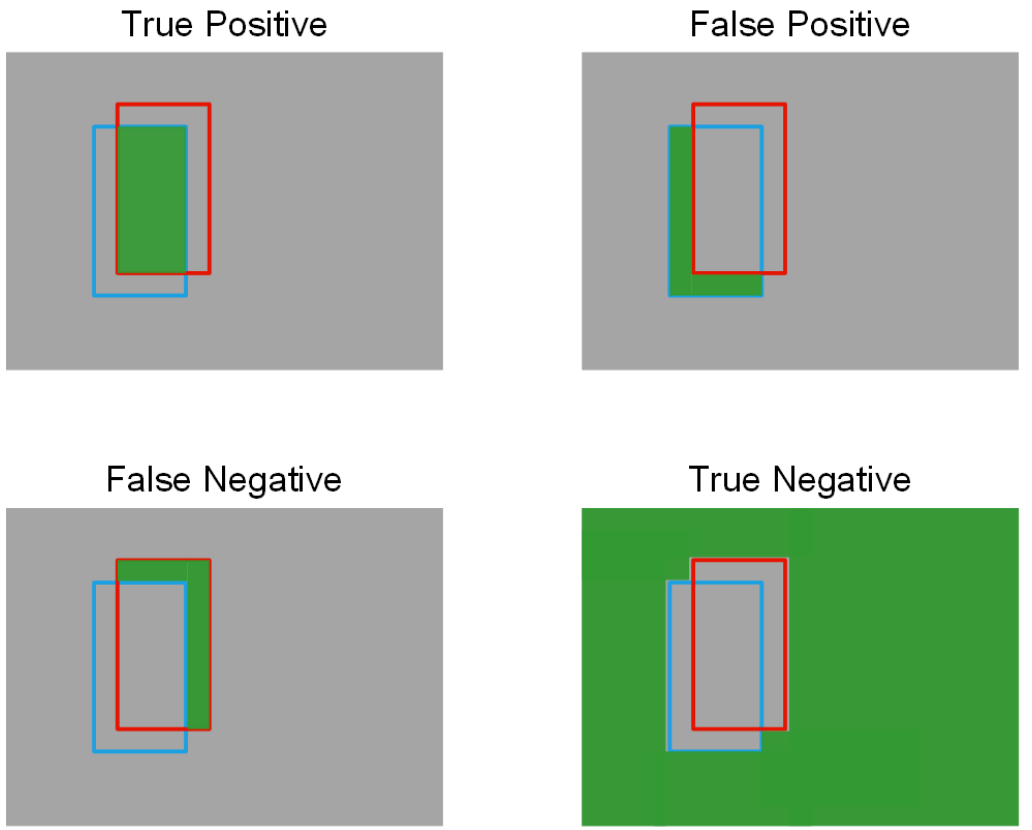
First thing to do: preparing ground truth



labelme. https://github.com/wkentaro/labelme Accessed March 13, 2024.

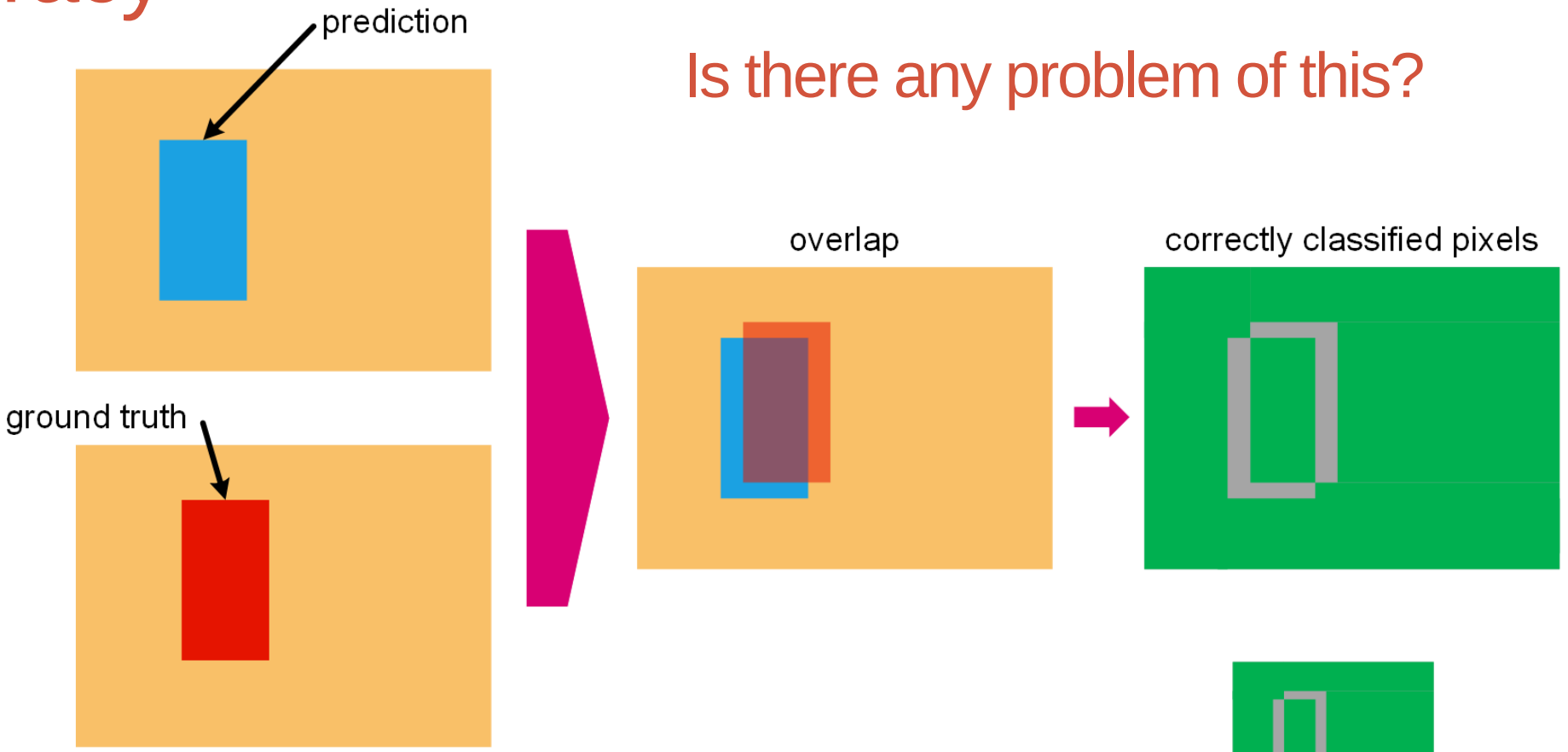
Core concepts





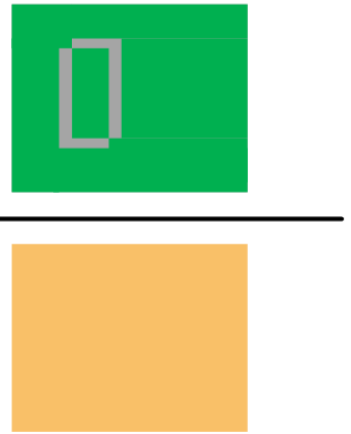
- True Positive (TP): prediction is positive and correct
- False Positive (FP): prediction is positive but incorrect
- False Negative (FN): prediction is negative but incorrect
- True Negattive (TN): prediction is negative and correct

Accuracy

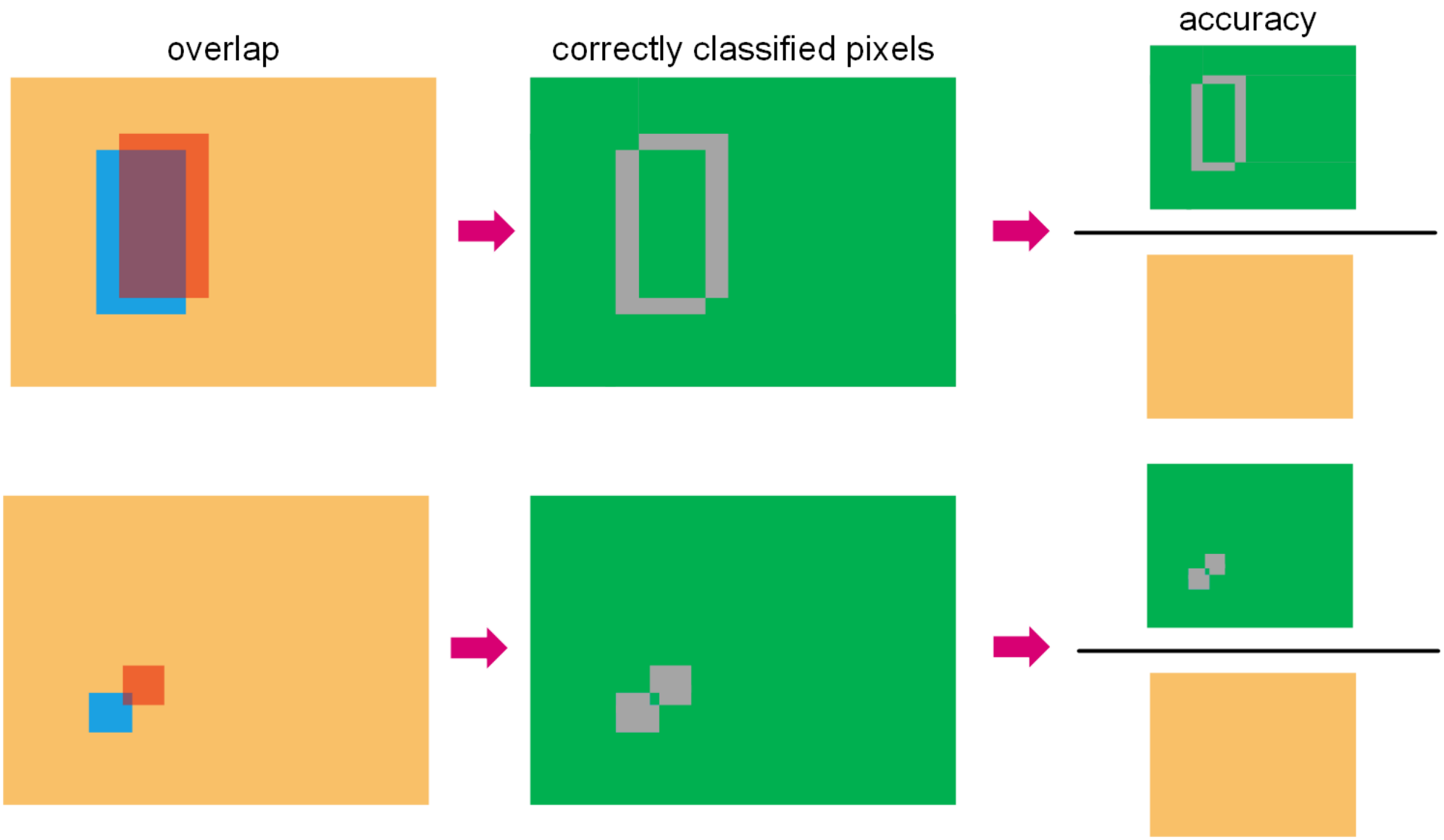


Is there any problem of this?

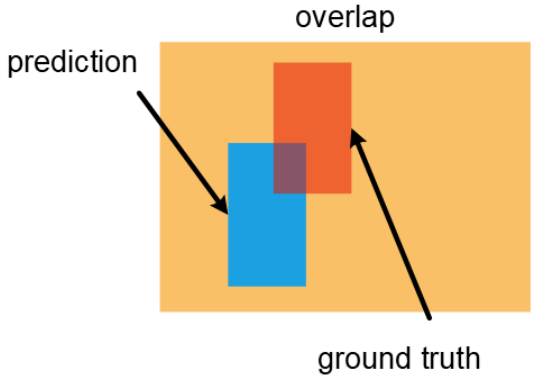
$$\frac{TP+TN}{TP+TN+FP+FN} = \text{accuracy} = \frac{\text{the number of correctly classified pixels}}{\text{the total number of pixels}} =$$

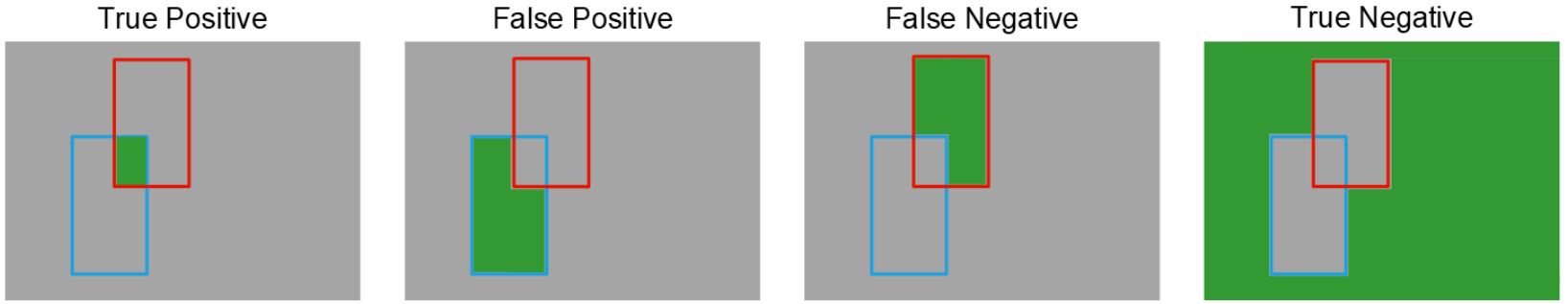


Accuracy cannot deal with class imbalance

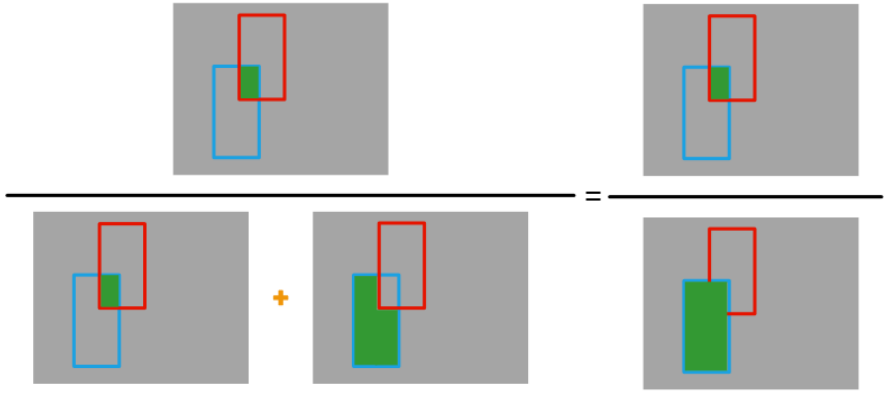


Precision, Recall, and F1 score

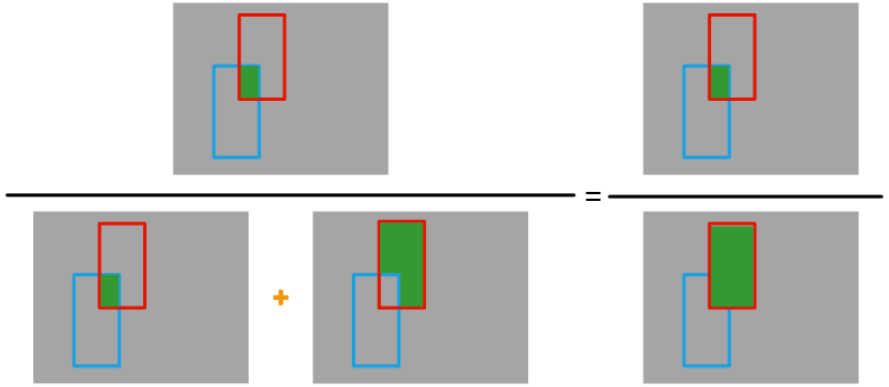




$$\text{precision} = \frac{TP}{TP + FP} =$$



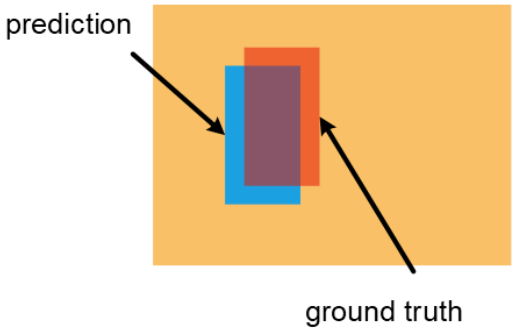
$$\text{recall} = \frac{TP}{TP + FN} =$$

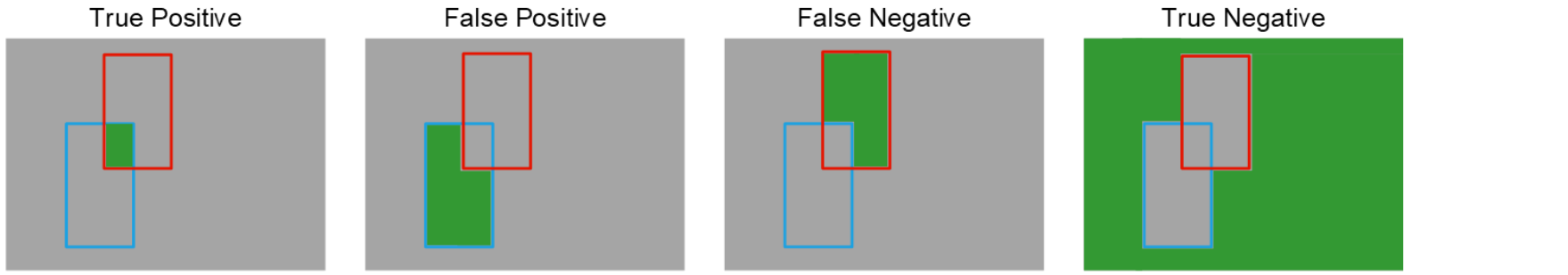


$$\text{F1 score} = \frac{2 * \text{precision} * \text{recall}}{\text{precision} + \text{recall}}$$

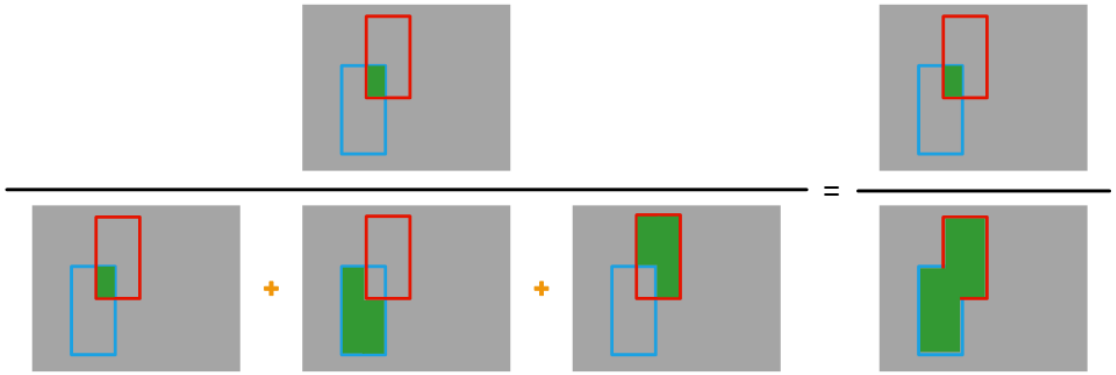
$$= \frac{2}{\frac{1}{\text{precision}} + \frac{1}{\text{recall}}}$$

Intersection over Union (IoU) and Dice coefficient



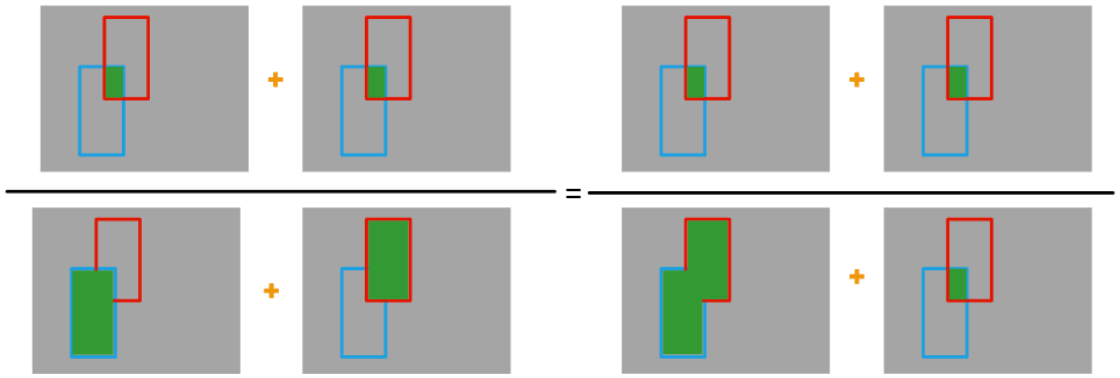


$$IoU = \frac{\text{Intersection}}{\text{Union}} = \frac{TP}{TP + FP + FN} =$$



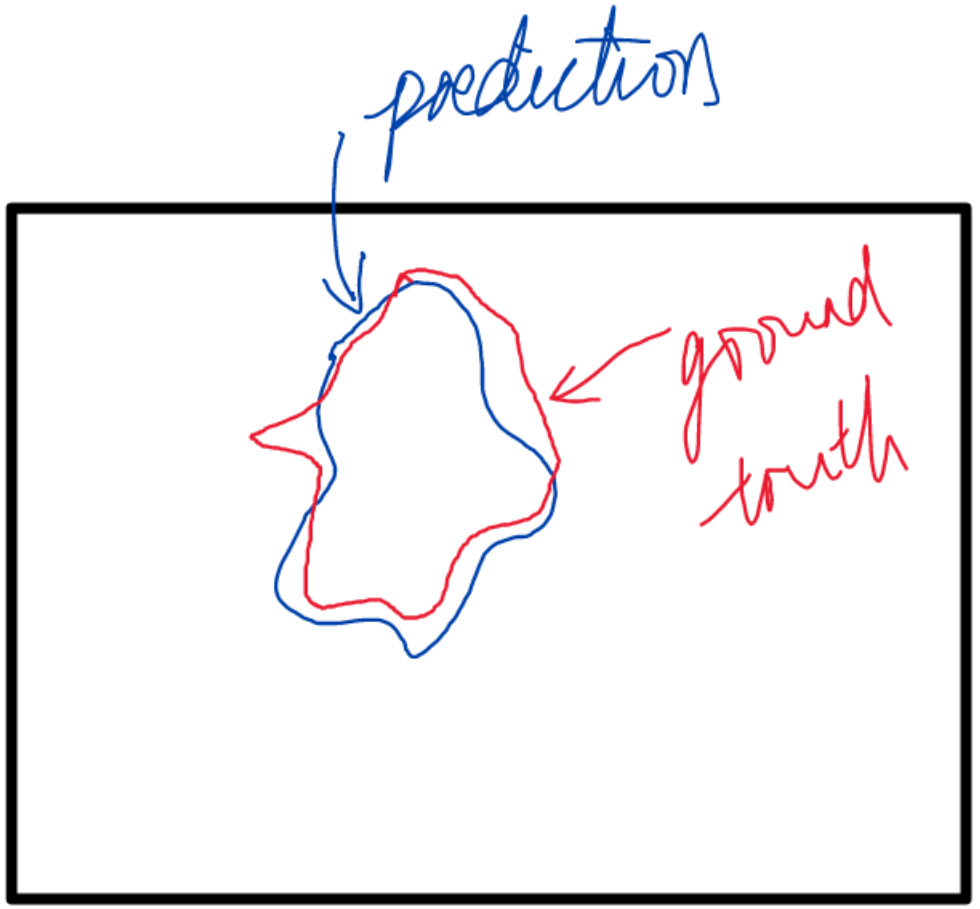
Is there any other potential problems?

$$Dice = \frac{TP + TP}{(TP + FP) + (TP + FN)} =$$

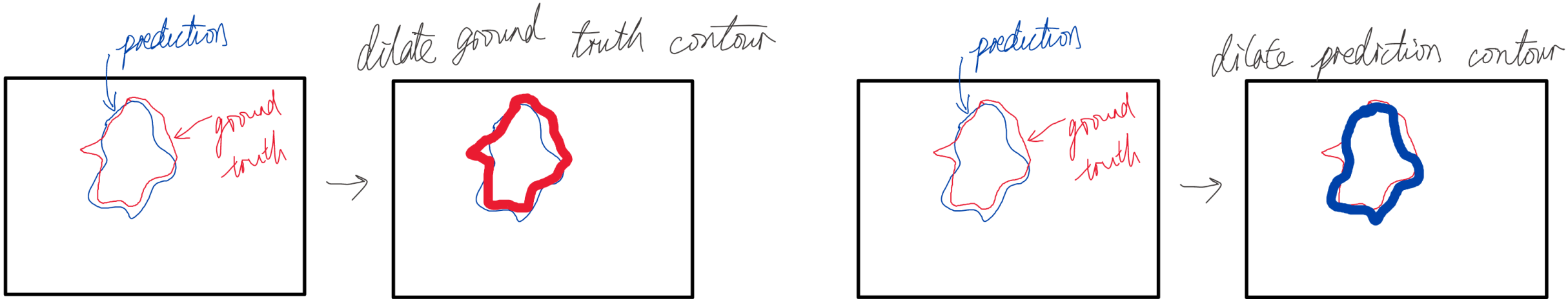


$$= \frac{2}{\frac{1}{IoU} + 1}$$

Contour doesn't match



F-measure



$$\text{contour precision} = \frac{\text{the number of blue contour pixels covered by the dilated red contour}}{\text{the total number of blue contour pixels}}$$

$$\text{contour recall} = \frac{\text{the number of red contour pixels covered by the dilated blue contour}}{\text{the total number of red contour pixels}}$$

$$\text{F measure} = \frac{2 * \text{contour precision} * \text{contour recall}}{\text{contour precision} + \text{contour recall}}$$