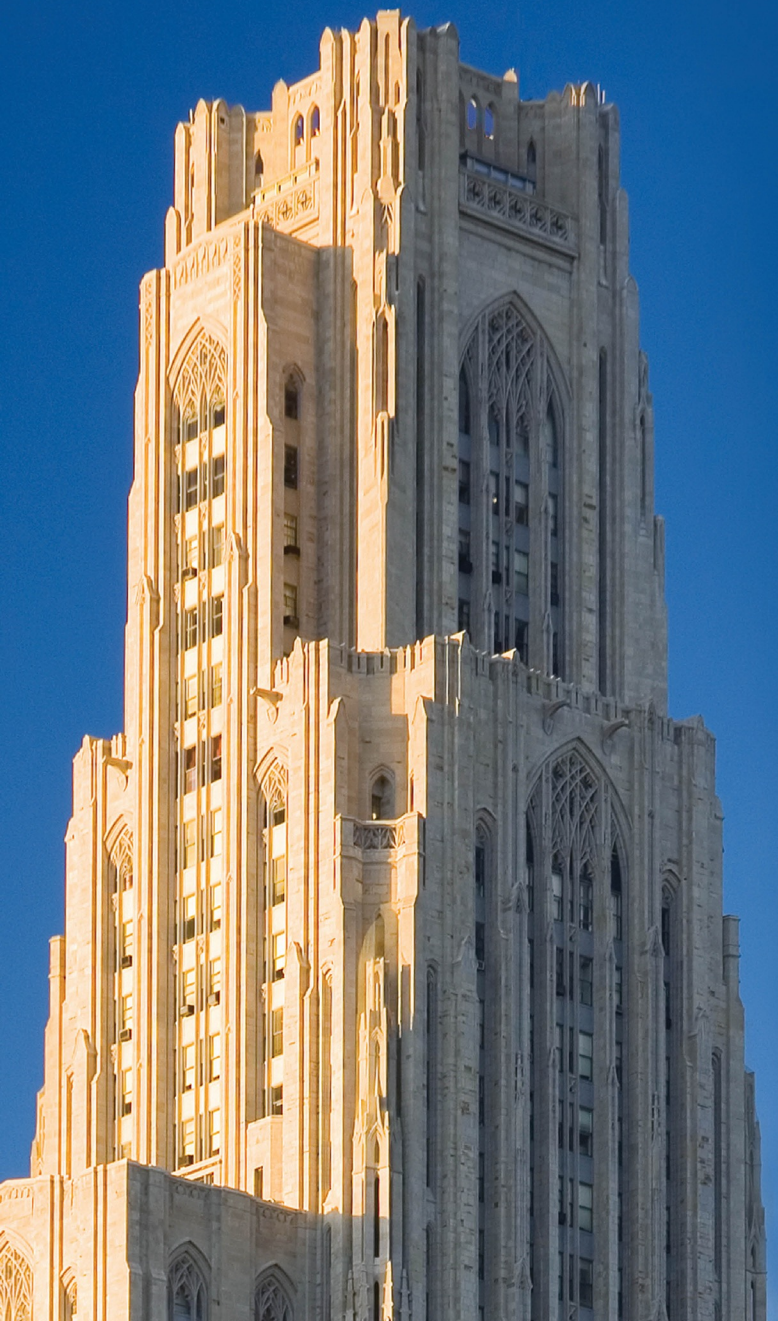

Pitt HexAI Mini Summer Camp 2023

Intersection Over Union (IoU)

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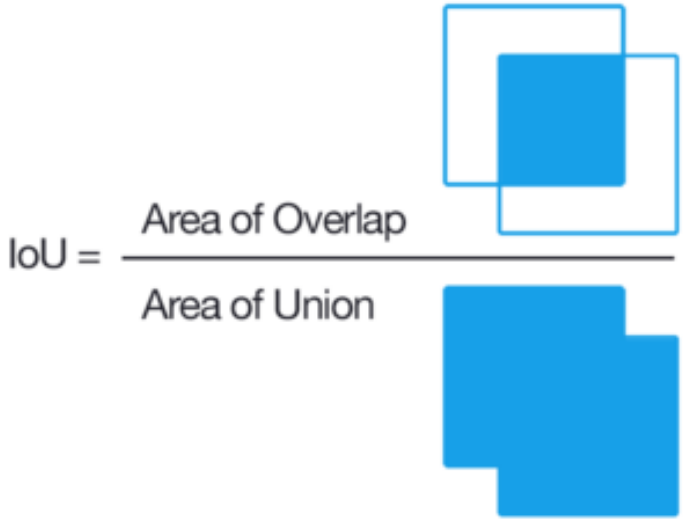
Intersection Over Union (IoU): What and why?

- When doing object detection, we need a way to measure how well the predicted bounding box matches the ground truth bounding box
- **Intersection Over Union** (IoU) measures the overlap between the predicted bounding box and the ground truth bounding box
- The better the overlap between the bounding boxes the better the prediction
  - A perfect prediction will have an IoU score of 1.



IoU Algorithm

- Calculating the IoU scores for a set of test images is done by:
  1. Getting the prediction from the model
  2. Comparing the predicted bounding box with the ground truth
  3. Calculate the area of overlap between the annotations and the area of the union
  4. Divide the overlap between the bounding boxes by their union
  5. Analyze the obtained value
  6. Repeat steps 1-5 for additional test images
  7. Average the IoU scores to get the final overall average for the test set

Example IoU Scores

Image source: interstellarengine

IoU Calculations

- Step 1: Extract bounding box coordinates for annotators
- Step 2: Find the intersection coordinates of the bounding boxes

$$x_{I_0} = \max(x_0^A, x_0^B)$$
$$y_{I_0} = \max(y_0^A, y_0^B)$$
$$x_{I_1} = \min(x_1^A, x_1^B)$$
$$y_{I_1} = \min(y_1^A, y_1^B)$$

- Step 3: Calculate area of the intersection:

$$A \cap B = (x_1^I - x_0^I) * (y_1^I - y_0^I)$$

- Step 4: Calculate area of the union

$$Area\ A = \left(x_1^A - x_0^A\right) * (y_1^A - y_0^A)$$
$$Area\ B = (x_1^B - x_0^B) * (y_1^B - y_0^B)$$
$$A \cup B = AreaA + AreaB - A \cap B$$

- Step 5: Calculate IoU

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

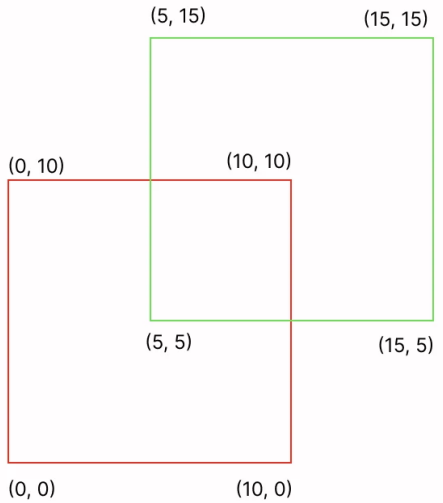
Calculating IoU Example

- Step 1: Extract Bounding Box Coordinates
  - A = (5, 15), (15, 5), B = (0, 10), (10, 0)
- Step 2: Find the intersection coordinates of the bounding boxes

$$x_{I_0} = \max(5\ , 0) = 5$$
$$y_{I_0} = \max(15, 10) = 15$$
$$x_{I_1} = \min(15, 10) = 10$$
$$y_{I_1} = \min(5, 0) = 0$$

- Step 3: Intersection Calculation
- $A \cap B = (x_1^I - x_0^I) * (y_1^I - y_0^I)$

$$A \cap B = (10 - 5) * (0 - 15) = 5 * 15 = 75$$



Calculating IoU Example

- Step 4: Calculate area of the union

$$Area\ A = (15 - 5) * (5 - 15) = 10*\text{-}10 = 100$$

$$Area\ B = (10 - 0) * (0 - 10) = 10 * \text{-}10 = 100$$

$$A \cup B = 100 + 100 - 75 = 125$$

- Step 5: Calculate IoU

$$IoU = \frac{75}{125} = 0.6$$