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# Deep Representations and Codes for Image Auto-Annotation : Appendix

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## Multi-label metrics:

- **Hamming Loss:** Computes the difference between true labels and predicted labels using the XOR operation:  $HL(x^{(i)}) = \frac{p^{(i)} \otimes y^{(i)}}{N_c}$ , where  $x^{(i)}$  is a datapoint,  $p^{(i)}$  the predicted full label for  $x^{(i)}$ ,  $y^{(i)}$  the target full label and  $N_c$  the total number of labels.
- **One Error:** Evaluates whether the most probable label prediction is part of the gold standard:  $OE = \frac{1}{N_x} \sum_i \mathbf{1}(l_1(x^{(i)}) \notin y^{(i)})$ , where  $N_x$  is the number of test set images,  $l_1$  is the first ranked label and  $\mathbf{1}()$  is the indicator function.
- **Coverage:** Evaluates how far away the predicted labels are from 'covering' the true labels:  $C = \frac{1}{N_x} \sum_i \max_{l \in y^{(i)}} \text{rank}(l, x^{(i)}) - 1$ , where  $\text{rank}(l, x^{(i)})$  denotes the position of label  $l$  in the ranked list for image  $x^{(i)}$ .
- **Ranking Loss:** The fraction of labelled pairs between true and irrelevant labels that are in reverse order:  $RL = \frac{1}{N_x} \sum_i \frac{F(x^{(i)})}{|y^{(i)}||\bar{y}^{(i)}|}$ , where  $F(x^{(i)}) = |\{(l, l') : \text{rank}(l, x^{(i)}) > \text{rank}(l', x^{(i)}), l \in y^{(i)}, l' \in \bar{y}^{(i)}\}|$  is the number of reverse ordered pairs of labels from the ranked list of  $x^{(i)}$ .
- **Average Precision:**  $AP = \frac{1}{N_x} \sum_i \frac{1}{|y^{(i)}|} \sum_{l \in y^{(i)}} \frac{G(x^{(i)})}{\text{rank}(l, x^{(i)})}$  where  $G(x^{(i)}) = |\{l' \in y^{(i)} : \text{rank}(l', x^{(i)}) \leq \text{rank}(l, x^{(i)})\}|$  is the number of gold standard labels ranked above label  $l$ .