Comparative Performance Analysis of two Deep-Learning Training Approaches using a Panoramic Radiograph Multiclass Dataset


**ABSTRACT**

**Objectives**: To compare the diagnostic performance of a Deep-Learning Convolutional Neural Network (DL-CNN) in terms of object detection and segmentation following two different training approaches.

**Material and Methods**: A total of 300 orthopantomographies (OPGs) were randomly selected for this study. To establish ground truth, images were manually annotated by a single previously trained and calibrated operator using an Artificial Intelligence training tool (COCO Annotator v.11.0.1). Annotating classes included: maxilla, mandible, maxillary sinus, inferior alveolar nerve, tooth, both plastic and metallic restorations, crowns and pontics, root canal treatments and implants. The full dataset was divided into training and validation subsets and were used to train the same neural network for object detection (YOLOv5 Small) and segmentation (YOACT ++) following two different approaches: a) including all annotated classes at once (AC) and b) separating tooth classes (TO) from the rest (RC). Validation-phase performance analysis for object detection was calculated using Mean Average Precision (mAP) at two confidence levels intervals (0-0.5 and 0.5-0.95), F1 Curve and Confusion Matrix. For object segmentation, instead, only mAP at both before-mentioned intervals was calculated for task performance evaluation.

**Results**: Object Detection mAPs (0-0.5 and 0.5-0.95) for both first and second training strategies were as follows: AC mAP (0-0.5)=0.36, AC mAP (0.5-0.95)=0.22; TO mAP (0-0.5)=0.99, TO mAP (0.5-0.95)=0.67; RC mAP (0-0.5)=0.65, RC mAP (0.5-0.95)=0.39. Object Segmentation mAPs for both first and second training strategies were as follows: AC mAP (0-0.5)=0.34, AC mAP (0.5-0.95)=0.19; TO mAP (0-0.5)=0.38, TO mAP (0.5-0.95)=0.16; RC mAP (0-0.5)=0.30, RC mAP (0.5-0.95)=0.16.

**Conclusions**: Second training strategy described in this study should be considered for achieving better results in object detection tasks. For object segmentation, albeit more training data is needed in order to increase software's precision, first training approach seems to be the best choice in case of developing a DL-CNN for diagnostic purposes.