A Novel Deep Learning System for Scoliosis Assessment: Automatic Extraction of Skeletal Maturity Using Region Proposal and Compound Scaling Convolutional Neural Networks

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Scoliosis is a condition of abnormal spinal curvature with approximately 60,000 U.S. pediatric patients undergoing surgery or being placed into braces each year. Skeletal maturity assessment is critical for determining the treatment of pediatric scoliosis, and the most traditional method of evaluation is an independent hand x-ray. However, this x-ray leads to additional radiation and cost for patients. Other skeletal maturity classifications such as the humeral head ossification system and modified Oxford Bone Score (mOBS) can measure bone age using regions already present in scoliosis x-rays, but they have not been widely used for growth estimation due to their error-prone and time-consuming natures. In order to address this issue, I developed a machine learning system that uses convolutional neural networks to evaluate the humeral head stage and mOBS on pediatric scoliosis radiographs. After annotating 1197 de-identified scoliosis radiographs, a Faster R-CNN Inception V2 model was trained to detect the regions and an EfficientNet model was trained to classify the growth stages. Region detection had an F1 Score of 0.99. Staging classification had an overall accuracy of 89% and ICC score of 0.84. Based on published literature, this model is the first to automatically extract multiple skeletal maturity classifications from single scoliosis radiographs, yielding comprehensive data to determine indications for treatment. The machine learning system may also be used in epidemiological studies to automatically describe population distributions of skeletal maturity. This study holds promise for a reliable AI approach during surgical planning in pediatric scoliosis where reducing harmful radiation is crucial.

Awards Won:

Third Award of $1,000