Morphological information extraction in medical imaging by deep learning interpretability: application on craniofacial dysmorphism

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Abstract :

Recent advances in the interpretability of convolutional neural networks (CNNs) have allowed applications in imaging as a novel method for visual feature extraction. We used this approach to investigate the impact of changing occlusal forces on craniofacial architecture in class II retrognathism pathology.

To address these challenges, we introduced a methodology for extracting morphological information with an interpretable CNN (MIE-ICNN) that combines:

1: a pre-processing step to train a deep CNN,

2: an interpretability step using the Score-CAM method to explain the areas of the radiographs used by the model to identify the pathological class, and
3: a calculation step to generate a global activation map, which represents an average activation map of all classifications.
The main conclusions of this study are as follows :
The proposed technique made it possible to find the anatomical areas affected by Retrognathia and already identified in the literature (i.e. the cranial base and the vertebrae), to confirm the involvement of a controversial area (the frontal sinus), and to identify a new structure (the parietal bone) as a biomarker This new information enriches the knowledge on the etiology of mandibular retrognathia and its interactions with the craniofacial architecture dear to Professor Delaire. Finally, through this application on craniofacial architecture, the proposed methodology appears as a new toolbox to extract and visualize complex morphological systems in imaging.