VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Panagiotis Gonidakis**

The public defense will take place on **Monday 1st July 2024 at 4:00 pm** in room **D.0.03** (Building D, VUB Main Campus)

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DATA- AND LABLE-EFFICIENT DEEP LEARNING FOR MEDICAL IMAGE ANALYSIS
APPLICATION TO LUNG NODULE DETECTION ON THORACIC CT

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Abstract of the PhD research

Convolutional neural networks (CNNs) have been widely used to detect and classify various objects and structures in computer vision and medical imaging. In medical imaging, acquiring adequate amounts of labelled data, commonly a prerequisite for achieving good performance, can often be time consuming and costly. Therefore, reducing the need for data and in particular associated annotations, is of high importance for medical imaging applications. In this work we investigated whether we can lower the need of annotated data for a supervised learning classification problem.

We chose to tackle the problem of lung nodule detection in thoracic computed tomography (CT) imaging, as this widely investigated application allowed us to benefit from publicly available data and benchmark our methods. We designed a 3D CNN architecture to perform patch-wise classification of candidate nodules for false positive reduction. Its training, testing and fine-tuning procedure is optimized and compared with other state-of-the-art approaches.

Next, we explored how data augmentation can contribute towards more accurate and less data-demanding models. We observed that for certain cases after reaching a certain amount of training samples, data augmentation led to significantly better performance compared to adding unique samples.

Following, we investigated the benefit of combining deep learning with handcrafted features. For this fusion, we explored three strategies which significantly improved lung nodule detection performance in comparison to an independently trained CNN model. Comparatively larger increases in performance were obtained when less training data was available. Among the investigated handcrafted features, those that describe the relative position of the candidate with respect to the lung wall and mediastinum, were found to be of most benefit.

Finally, we investigated the combined effect of several methods aiming for data efficiency. We proposed a framework that utilizes both annotated and unannotated data, can be pretrained via self-supervision, and allows to combine handcrafted features with learned representations leading up to 68% less annotated data necessity compared to traditional supervised training.

Our findings indicate that the investigated methods allow considerable reduction of data and/or annotations while maintaining model performance for lung nodule detection from CT imaging. Future research should explore applying these techniques in other areas.