# Abstract

Metastatic bone disease (MBD) is a secondary bone cancer that affects 70%-80% of prostate and breast cancer patients. Metastatic bone disease affects the quality of life (QoL) of patients through symptoms of bone pain and can lead to more adverse complications, called skeletal-related events (SREs). The current treatment therapies mainly involve mitigating the symptoms of pain. A crucial factor in improving patient outcomes and QoL is the early and accurate detection of bone metastases. The gold standard in diagnosing bone metastases is whole-boy magnetic resonance imaging (WB-MRI) due to its high sensitivity and specificity. However, whole-body MRIs are large datasets and increase the already heavy workload of radiologists. This can affect the quality and safety of patient care. Therefore, a fully automated detection system could aid in decreasing the workload and potentially improve the sensitivity and specificity of early bone lesion detection.

In this thesis, a deep learning model, RetinaNet, is investigated as an automated detection system for detecting bone lesions from multi-parametric WB-MRIs. This model achieves state-of-the-art detection results on the LUNA16 dataset. The LUNA16 dataset is a widely used benchmark in medical detection and involves the detection of lung nodules from thoracic CTs. This dataset serves as a benchmark for the results of the MBD dataset. 4 different RetinaNet models are investigated, the first model is trained on 3 modalities: a T1-weighted scan, an ADC map, and a diffusion-weighted image with b-value 1000 $s/mm^2$, called TAB. The second model is called TAB-skeleton and contains a skeleton mask as an additional channel. The third model trains and infers on regions of interest that are around the pelvis, spine, femur, and clavicle. This model is also called the ROI-based model. The final model, ReducedBackbone, incorporates a reduced backbone and is trained on T1, ADC, b1000, and skeleton mask. The best model on MBD dataset is compared with U-net, the state-of-the-art detection model for MBD on multi-parametric WB-MRIs.

The results of the thesis show that incorporating a skeleton mask as a channel significantly improves the detection performance. The ReducedBackbone performs best with a sensitivity of $0.48 \pm 0.29$ and $F_2$-score of $0.29 \pm 0.16$. However, the model detects around 60% of the lesions of the training data. The reduced backbone and limited learning from training data potentially imply that the complexity of the task exceeds the model's capabilities to detect bone lesions. More data is needed to fully harness the model's potential for detecting bone lesions. The ReducedBackbone model has a higher mean false positives per image compared to the U-net model ($p \leq 0.001$), but a similar sensitivity ($p = 0.06$). The U-net model remains the state-of-the-art detection model for MBD from WB-MRI.