A novel multiple-instance learning-based approach to computer-aided detection of tuberculosis on chest x-rays

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To reach performance levels comparable to human experts, computer-aided detection (CAD) systems are typically optimized following a supervised learning approach that relies on large training databases comprising manually annotated lesions. However, manually outlining those lesions constitutes a difficult and time-consuming process that renders detailedly annotated data difficult to obtain. In this paper, we investigate an alternative approach, namely multiple-instance learning (MIL), that does not require detailed information for optimization. We have applied MIL to a CAD system for tuberculosis detection. Only the case condition (normal or abnormal) was required during training. Based upon the well-known miSVM technique, we propose an improved algorithm that overcomes miSVM's drawbacks related to positive instance underestimation and costly iteration. To show the advantages of our MIL-based approach as compared with a traditional supervised one, experiments with three X-ray databases were conducted. The area under the receiver operating characteristic curve was utilized as a performance measure. With the first database, for which training lesion annotations were available, our MIL-based method was comparable to the supervised system (0.86 versus 0.88). When evaluating the remaining databases, given their large difference with the previous image set, the most appealing strategy was to retrain the CAD systems. However, since only the case condition was available, only the MIL-based system could be retrained. This scenario, which is common in real-world applications, demonstrates the better adaptation capabilities of the proposed approach. After retraining, our MIL-based system significantly outperformed the supervised one (0.86 versus 0.79 and 0.91 versus 0.85 , and p=0.0002 , respectively).

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