Revolution in Detecting Tuberculosis using Radiology with Application of Deep Learning Algorithm

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ABSTRACT

Radiology is a medical examination of internal body parts using data imaging to interpret an illness. Many illnesses can be detected using this medical discipline; one of the diseases is tuberculosis caused by *Mycobacterium tuberculosis* bacteria. The supreme ability of Artificial Intelligence and Machine learning has amazed the radiologist in analyzing big data-based information. A better deep learning algorithm can lead radiologist to accurate results. This article will review ten (10) research papers that use a deep learning algorithm in the application to detect tuberculosis by data processing technique. The goal is to know the best type of data processing in deep learning to detect TB.

Keywords: Deep learning, early detection, radiology, tuberculosis,

ABSTRAK

Radiologi adalah pemeriksaan bagian dalam tubuh menggunakan data pencitraan untuk interpretasi suatu penyakit. Banyak penyakit dapat dideteksi menggunakan disiplin medis ini; salah satunya adalah tuberkulosis yang disebabkan oleh bakteri *Mycobacterium tuberculosis* yang menyerang paru. Ahli radiologi tertarik atas kemampuan *Artificial Intelligence* dan *Machine Learning* untuk analisis data yang akurat. Artikel ini akan mengulas sepuluh (10) makalah penelitian aplikasi algoritma *deep learning* untuk deteksi tuberkulosis menggunakan teknik pengolahan data. **Putri Gabriella Angel Natalia Satya, Arli Aditya Parikesit. Revolusi Deteksi Radiologi Tuberkulosis Menggunakan Aplikasi *Deep Learning Algorithm***

Kata kunci: *Deep learning,* deteksi dini, radiologi, tuberkulosis,

INTRODUCTION

Medical health using Artificial Intelligence and Machine Learning is developing every day, especially in the radiology field. Many scientists and researchers are cooperating to study the gaps and limitations in the data processing technique and to provide answer to the shortfall, for the benefit to both the people and the patients. In radiology, images are vital to determine a patient's illness; deep learning algorithm can bring to more accurate interpretations by minimizing errors.[1] Before using the deep learning method, data processing and analysis use machine learning techniques.[1-3] This can be seen from the extensive utilization of data processing techniques in the radiology field, more specific in treating tuberculosis.

The machine learning workflow is using a set of algorithms to accept various kinds of input data to find conclusions based on potentially unclear relationships between inputs, and it is considered to be smarter in the past years.[1] Machine learning (ML) is developed over time into a deep learning (DL) method in which the difference will be explained in Figure 1. The first person completed the task for differing both algorithms in 2012 is Krizhevsky.[4]

Figure 1 showed that machine learning relies on meticulous features in it and requires particular human expertise and optimization

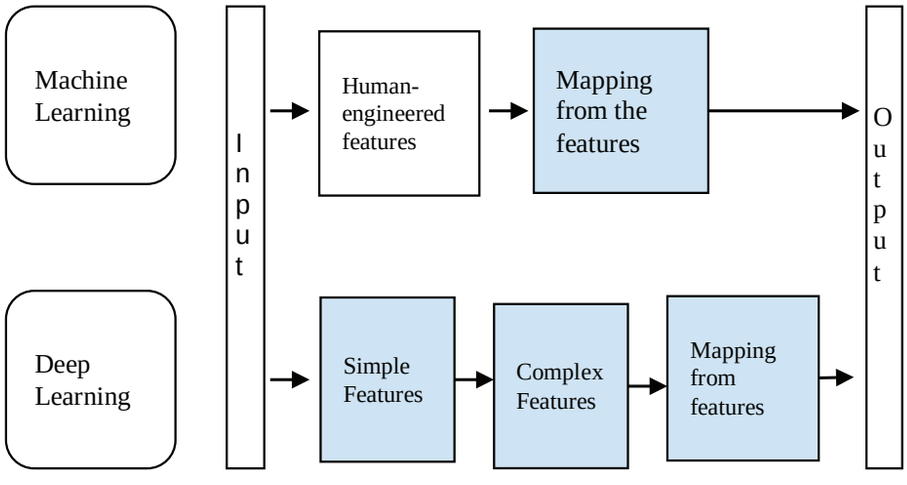

Figure. The difference in ML and DL. Figure was inspired from Copeland[5]

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of complex tasks. In contrast, the new methods of using deep knowledge have achieved attention in the performance, such as image classification.[6] The coloured boxes mean the elements learned by matching a model with data samples. The representation of deep learning not only determines the mappings of features to desired outputs but to learn and optimize the elements themselves.[6] This is due to deep learning examines input using end-to-end method of simple features (such as signal intensity, edges, and texture) as elements while sophisticated functions (such as shapes, lesions, or organs) will be annotated based on general features.[7] The consequences of the aforementioned fine-grained classifier will eventually enables deep learning to process big data in medical informatics.

Tuberculosis (TB) is an infectious disease that still causes a significant morbidity and mortality. TB is caused by *Mycobacterium tuberculosis* bacteria attacking humans lungs.[8] The general symptoms are chronic cough, pain in the chest, haemoptysis, weakness or fatigue, weight loss, fever, and night sweats, depend on types of TB.[9] There was more or less 10.000.000 cases of tuberculosis in 2018, and the mortality reach 1.500.000, while drug resistance in TB is exceeding 450.000 cases.[10] Lack of treatment and errors in diagnosis can be factors affecting the case rate. Rapid and accurate diagnostics for the patients' radiograph repository are needed. This article will discuss the deep learning method as a solution in TB diagnosis.[11]

METHODS

The source materials were taken from PubMed (https://pubmed.ncbi.nlm.nih.gov/) and google scholar (https://scholar.google.com/) using "deep learning and radiology" as the keywords search. The journals range from 2017-2019. From 10 journal articles found, 3 of them used machine learning algorithms which develops and leads to deep learning to diagnose tuberculosis disease. The summary review papers were presented in Table.

RESULTS, DISCUSSION, AND FUTURE PERSPECTIVES

Based on the reviewed literatures in the Table 1, the most common algorithm to annotate radiograph is the convolution neural networks (CNNs). This is because of its ability to deal with noise and taking advantage of distortions and those features are essential in the radiology applications.[21] The AUC value of near 1 on the general application of the CNNs means that it elicit high probability of providing actual positive results.[22] Moreover, the pipeline could be applied for scanning the chest radiograph of more than 500 patients.

The application of deep learning in the future has enormous potentials. The reason for using deep learning algorithms in medical health, especially in detecting TB, is because it has been proven that it is less error prone compared to human reading. With the increasing method of and its interest on deep learning, it attracts many researchers to explore these methods in health sciences. Also, the result of machine learning which is always getting smarter is eliciting hope for something big later in radiology. However, the role of human supervisor is still essential to observe the computational process.

This review article discusses the development of algorithms from machine learning to the deep learning in detecting TB. The forms of deep learning algorithms in detecting early TB depend on the employed algorithm. All of them showed good potential and were very helpful. However, researchers need to consider some limitations, so that it can still provide the

Table. The reviewed radiology methods with deep learning annotation

Author	Sample	DL Algorithm	Application	Result
Lakhani, Sundaram, 2017[12]	HIPAA-compliant datasets, consisted of 1007 posteroanterior chest radiographs	convolutional neural networks CNN, or ConvNet	Classify the images as having manifestations of pulmonary TB or as healthy	DCNNs accurately classify TB with AUC of 0.99
Hwang, *et al*, 2019[13]	Six external multi-center, multi-national datasets	DLAD algorithm, CRs model	Comparing the performances between DLAD and physicians	DLAD demonstrated excellent and consistent performance
Hooda, Sofat, Kaur, Mittal, Meriaudeau, 2017[11]	Montgomery and Shenzhen datasets	CNN architecture	Potential method in TB detection	Adam optimizer accuracy 94.73%
Becker, *et al*, 2018[14]	138 patients with diagnosed TB	ROC analysis, classification confusion matrix	Evaluate the feasibility of DL-based detection and classification of pathological patterns in digital photographs of CXR.	CXR is a promising tool.
Alcantara, *et al*, 2017[15]	Patients' radiology images	CNN	To develop an X-ray image database and annotation software	The results approach is promising
Stirenko, *et al*, 2018[16]	Dataset from Shenzhen hospital	CNN architecture	Demonstrate the efficiency of lung segmentation, lossless and loss data augmentation for CADx of tuberculosis	Obtained better segmentation, data
Singh, *et al*, 2018[17]	874 de-identified frontal CXR from 724 adult patients (>18 years)	CXR	Assessing accuracy for detection of abnormalities on routine frontal chest radiographs (CXR),	DL algorithms can aid in interpretation of CXR findings.
Rajpurkar, *et al*, 2018[18]	ChestX-ray8 dataset, 420 images and 50 cases	CheXNeXt, CNN	Investigating the performance of DL on pathologies detection compared with practicing radiologists.	Achieved statistically significantly higher AUC performance
Ting, Yi & Hui, 2018[19]	Both positive and negative TB images has 75 data patients	CNNs	Developing a promise algorithm to (TB) on chest radiographs	Great potential in these findings
Heo, et al, 2019[20]	Data from medical surveillance for workers at Yonsei University	CNNs	Detect tuberculosis in chest radiographs in annual workers' health	Able to facilitate the detection of tuberculosis in chest X-rays, and demographic factors

smallest risk. Three categories of problems that need to be seen in the implementation of deep learning in clinical diagnosis are: security hacks, privacy breach, and morality issues.[4] In the future, deep learning algorithms may be used as an effect of image resolution; it will have a better image resolution and possibly leads to a relieve into the relative difficulties in identifying various radiological finding.[23] The advent of COVID-19 pandemic has pushed scientists to apply TB deep learning classifier to COVID-19 radiograph.[24] Further research is needed to meet the needs of health science in radiology using deep learning algorithms. It will be interesting to see how eventually the experience from the TB radiography will assist the medical care for treating COVID-19 patients. The ability to do massive scan of lung radiograph with the deep learning-based tools will facilitate better symptom observation of the COVID-19 patients

CONCLUSION

Deep learning will bring discoveries that will fill the gap in previous research. Hopefully, the implementation of deep learning methods can help early detection in TB with least possible error so that it will be easier to monitor patient's treatment.

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