CSC 578 – "Class Project", Part (B) Survey Paper
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Topic: Deep learning and Covid-19.

Overview

Started from the end of 2019, there has been global viral pneumonia, Covid-19, which is original from an unknown source in Wuhan, China. As of today, Covid-19 has been around for three years and has impacted our lives tremendously. Within these three years, from a statistic stand point, scientists have applied deep learning to a lot of aspects of the Covid-19 pandemic. In this survey paper, I will mainly focus on reviewing the literature on predicting and diagnosing the Covid-19 infection. During the literature review, I will start by learning the different models for certain cases and comparing the accuracy of different models.

Literature Review

Different ways to diagnose the potential patient with medical images, non-invasive measurements, and sound analysis; different deep learning models correspond to each situation.

The medical image results are important to treat Covid-19, not only to diagnose the illness but also can estimate the illness stage. Chest CT image is an essential step and the most common way to estimate whether the potential patient is diagnosed with pneumonia. After a patient was infected by Covid-19, their chest shadow changed on CT images. Using deep learning to analyze the CT image would help the doctor diagnose faster and more precise. They first used deep learning networks like U-Net, V-Net, and VB-Net, VNET-IR-RPN to classify CT image types. Then, a convolutional neural network (CNN) would apply at the first level to estimate the image features and attribution and then combined with the SVM, random forest, and multilayer perceptron methods to distinguish whether the patient got Covid. Based on this process, the system got about 92% AUC within 279 training patients (Alafif, Tehame, Bajaba, Barnawi, Zia, 2021.) To improve the efficiency of fast retrieving the features from the images, researchers tried to use CNN to find the best model, medRxiv, with 89.5% accuracy using 269 confirmed patients' CT images as the training dataset (Alafif, Tehame, Bajaba, Barnawi, Zia, 2021.) From another literature, the researchers used CNN to create the COVID-Net-CT to separate the patients into normal, common pneumonia (CP) and Covid disease infection(NCP). The accuracy of this method is attached to 98% accuracy with 1,280,000 training images (Zhao, Jiang, Qiu, 2021.)

In another way, doctors also can use chest X-rays to detect Covid patients. Compared to chest CT image, chest X-rays is easier to achieve for the clinical radiology department. Deep learning models like CNN, nCOVnet, and U-Net++ on X-rays are more efficient and cost less than CT images. The CNN method can detect six levels, and the accuracy is attached to 99.96% and 100% AUC. Other models perform 99.92% accuracy and 99% AUC. Even though these models all perform well, CNN performs better, and we definitely want to choose the best one since it considers human life (Alafif, Tehame, Bajaba, Barnawi, Zia, 2021.) Moreover, using the DNN model with DenseNet would help to analyze the stage of Covid from the shadows on X-ray images.

Besides these two methods to diagnose whether a patient has Covid-19, the doctor could also analyze the cough sound to detect the virus. Cough could be because of different types of illness,

not only from Covid-19. Using logistic regression, Gradient Boosting Trees, and SVM method to identify the type of the sound to improve the efficiency and then using GRU neural network with bidirectional bids could analyze patients' breathing sound, heart beating, digestive sound, etc.; and the accuracy can reach to 95% (Alafif, Tehame, Bajaba, Barnawi, Zia, 2021.)

Furthermore, besides using images and sounds to diagnose the Covid, deep learning is also applied to analyze the blood laboratory results. The author compared six different deep learning methods, including ANN, CNN, LSTM, RNN, CNNLSTM, and CNNRNN, from 5644 training patients (Alakus, Turkoglu, 2020.) From the table shown below at the left, it is clear to find that LSTM performs the best with 86.66% accuracy (Alakus, Turkoglu, 2020.) Moreover, after the author split the dataset into 80% as the training dataset and 20% as the validation dataset and applied ten folder cross-validation, from the table shown below at the right, the CNNLSTM performs the best with 92.3% accuracy, and LSTM becomes to the second-best model.

	Accuracy	F1-Score	Precision	Recall	AUC
ANN	0.8600	0.9134	0.8855	0.9578	0.5615
CNN	0.8800	0.9038	0.8948	0.9248	0.6149
CNNLSTM	0.8416	0.9001	0.8926	0.9214	0.5889
CNNRNN	0.8566	0.9120	0.8977	0.9423	0.6408
LSTM	**0.8666**	**0.9189**	**0.8675**	**0.9942**	**0.6250**
RNN	0.8416	0.9061	0.8783	0.9604	0.5245

	Accuracy	F1-Score	Precision	Recall	AUC
ANN	0.8690	0.8713	0.8713	0.8713	0.85
CNN	0.8735	0.8856	0.8847	0.8867	0.80
CNNLSTM	**0.9230**	**0.9300**	**0.9235**	**0.9368**	**0.90**
CNNRNN	0.8624	0.8755	0.8755	0.8755	0.69
LSTM	0.9034	0.8997	0.8997	0.8998	0.83
RNN	0.8400	0.8427	0.8428	0.8427	0.83

Alakus, Turkoglu, 2020

Discussions

From the four diagnosis methods mentioned above, CNN performs well in most situations, including CT images and X-rays, which conform that CNN is best for image classification. CNN could retrieve the features and use the pooling layer to reduce the dimensions. Compared to CNN, LSTM is easy to remember past data and solves gradient issues, an updated version of RNN. Combined with CNN and LSTM, CNNLSTM is best for analyzing laboratory results. The main reason that CNNLSTM performs well is that CNNLSTM builds the model on 3D and time, and it is good with consequence input data. To add the CNN layer as the first layer to encode data and retrieve the features, LSTM is for analyzing the features. Other than these two deep learning methods, GRU performs the best for sound analysis. The GRU is simpler than LSTM, which only includes two gates: rest and updates, while LSTM includes three gates.

Conclusion

Deep learning can apply to various areas, especially in the medical area. In the medical area, it can help doctors diagnose the illness more accurately and efficiently at a lower cost. CNN analyzes more accurately for images, X-rays and CT images. LSTM is good with memorizing the past data and solving consequence input data. Though analyzing laboratory results, CNNLSTM performs the best, and LSTM is the second best. Moreover, GRU is the best model to diagnose the illness through sounds. As technology advances, medical centers are able to combine new technology with statistics methods to better research on new or potential diseases, and thus helping the community to better prepare unforeseen viruses.

References

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