Review of Clinical Decision Support and Informatics applications in disease diagnosis applications in disease diagnosis

Sams Khan
College of Computing
Kennesaw State University
Marietta, Georgia 30060
Email: ssamskhann@gmail.com

***Abstract*—Diagnosis of a disease and classifying certain anomalies is one of the most important jobs, doctors have to do and hope to do as accurately as possible. Certain diseases and anomalies are hard to diagnose due to ambiguous symptoms, test results and personal experience of the physician. Being able to automate this task with relatively high accuracy in one of the biggest leaps in medical technology we can hope for. In this paper we review some papers that try apply computational methods to automate and accurately diagnose certain diseases and anomalies. The 2 specific methods highlighted in this paper are the usage of CNNs(Convolutional Neural Networks) which yielded highly accurate results from extracting features and classifying image data.**

I. Introduction

Clinical Decision Support and Informatics is a broad umbrella of research, the goal is to create applications or tools that can be used to automate tasks in clinical biology or help professionals in making decisions and collecting information. In this paper i will review different papers that propose multiple methods to diagnose patients of certain diseases. Doctors usually make a diagnosis of a patient by arriving at conclusions based on some clinical evidences such as symptoms, different signs and even their own clinical experience. But to attain such features in a computational aspect is quite challenging because there are just so many cases that it must go through to make a diagnosis like a doctor does.

II. Related Works

A. CNN-based image analysis for malaria diagnosis Malaria is a major global threat and the standard way of diagnosing is by visually examining blood smears for parasite infected blood under a microscope. In this paper proposes a robust solution using Convolutional Neural Network/(CNN) to automatically classify blood samples as infected or uninfected. This method has high computational cost and takes long time to train the model.

B. Biomedical Image analysis for early diagnosis of Breast Cancer This paper discusses and compares 6 different types of classification algorithms that can early diagnose breast cancer. It isn't a normal paper where it just talks about one method but compares and contrasts 6 different ones and talks about which one is the best for microarray based data-sets and image based datasets.

C. Knowledge acquisition for medical diagnosis using collective intelligence The wisdom of the crowds is when you take into account a collective opinion of a group instead of a single expert. This paper uses a technique similar to this to collect diagnosis information in Diagnosis Decision Support System. Since a lot of the times diagnosis of a patient not only requires knowing what to look for and what symptoms they may be playing. A professional's personal opinion and experience plays a key role into making this decision. The main problem behind the scenario in this paper is that even when the diagnostic criteria can change from one physician to another, they are not sure if these changes are enough to imply a sufficient change in the modeling of the diagnostic criteria.

D. Intelligent Diagnosis Method of Cardiovascular Anomal ies Using Medical Signal Processing The goal of this work is to make an automatic diagnosis based on the ICG corresponding to the Aorta impedance variation and ECG signal during the heart cycle activity. This entire process is designed to be non-invasive and automatic diagnosis using a graphical UI made using MATLAB. Biggest limitation to this method is that it requires a database of different cardiac diseases and anomalies and their ICG and ECG data.

E. Localization and diagnosis framework for pediatric cataracts based on slit-lamp images using deep features of a Convolution Neural Network Through the implementation of deep learning convolutional neural networks in ophthalmology, it is possible to detect and examine pediatric cataracts based on slit-lamp images. The referenced model provides a potentially automatic diagnosis utility for ophthalmologists which would not only save time and energy but also allow for quicker treatment options. Based on current observations, the deep learning model performed exceptionally well in both accuracy and efficiency compared to traditional diagnosis methods. Furthermore, the CNN is capable of self-corrections and is constantly improving its reliability. However, one limitation is the training of the CNN using labeled cataract image data is very computationally heavy and may take a long time. This will also require the use of a very powerful GPU.

F. Pre-Trained Convolutional Neural Network Based Method for Thyroid Nodule Diagnosis Pre-trained convolutional neural networks present a new clinical method for the diagnosis of thyroid nodules. The aforementioned process revolves around the fusion of two separately trained convolutional networks which would be integrated with layered filters and feature maps. The convolutional neural networks allows for a real-time and non-invasive administration and performed with a diagnostic accuracy of 83.02

III. Methods

1) Method 1: C. Knowledge acquisition for medical diagnosis using collective intelligence : Each physician has their own knowledge base that they can make changes to and put in different criteria for diagnosing disease. We then use this data to build the consensus knowledge base and collective intelligence.

Consensus process 1: Signs coincidence The first process takes into account the expert's coincidence in the findings, so it finds things that are the same between multiple physicians. This is based on the percentage scale, so only findings in the 70% or more of the cases are taken into account for building the consensus ontology.

Consensus process 2: Pairwise similarity

The second method makes comparisons between pairs of individual knowledge bases bearing in mind that the pairs have the highest level of similarity. This is done by: 1) Making the union of all of them. 2) Making the intersection of them.

They use this to find the biggest value and then use the opinion that has the largest value similarity and then adds it to the consensus knowledge base.

Consensus process 3: Modification ranking

This counts he modification each physician makes to their personal knowledge base, to do this they use 2 methods: Global and local methods. In the global method, weights are assigned to each expert physician. The local method is similar except that the weights are assigned to the findings themselves rather than the diseases, and this is repeated for each disease.

The evaluation of the consensus methods is performed by comparing the diagnosis result taken from the consensus knowledge base. PRAS *Precision , Recall, Accuracy, Specify and MCC* metrics are used to evaluate several aspects of the resulting knowledge base. The paper talks about using the pre-made evaluation method listen in the paper's sources.

Pros: This method can vastly improve the accuracy of a particular knowledge base and can represent the opinions and personal experience of multiple physicians in a single place.

Cons: Diagnostic criteria can change from physician to physician, and the modification made by each physicians, we don't know for sure if this is enough to imply a significant change in the modeling of the database.

2) Method 2: E. Localization and diagnosis framework for pediatric cataracts based on slit-lamp images using deep features of a Convolution Neural Network
:

A. Slit lamp photography method

A high-intensity light source instrument, is used to shine a thin sheet of light into the eye to examine the anterior segment and posterior segment of the human eye. Slit lamp photography image data was used to train the CNN.

B. Diagnosis Framework

The framework offers 3 parts, automatic localization for lens, classification and three-degree grading. First, using Candy detection and Hough transformation the lens ROI is localized.Then it is fed into the CNN to extract high level features and apply classification and grading.

C. Deep Convolutional neural network

The overall architecture of the CNN used in this method has 5 convolution and overlapping max pooling layers followed by 3 fully connected layers. Th first 7 layers are used to extract multidimensional and high-level features from the input image, and the softmax layer is applied to classification and grading.

The assumption for this method was to accurately detect cataracts using the CNN and then classify it.

Pros: Highly accurate, this method and usage of CNN's and classification had high results of accuracy and level of classification.

Cons: Required a long time to train, this neural net took a long time to train and was very computationally heavy, it required a NVDIA GTX Titan x to train.

1) Method 3: F. Pre-Trained Convolutional Neural Network Based Method for Thyroid Nodule Diagnosis:

D. Image Aquisition and Pre-processing

8148 anonymous thyroid nodule ultrasounds were collected from 4782 patients who have gone through surgeries. These were used as ground truth. 15000 Thyroid nodule pre-surgery images were taken from multiple systems and were used in training the CNN's.

E. Architectures of CNNs

In this study a combination of 2 CNNs were used. The first CNN was based on the CADx framework, this was used for feature learning and classification. In feature learning it uses 3 convolutional layers with normalization and pooling functions to extract features, then for classification it uses Softmax with the fully connected layer feature map the thyroid nodules. The second CNN had 5 convolutional layers and 3 fully connected layers, and the other layers are the same as the first CNN.
The point of having 2 different CNNs with 2 different architectures were because they can learn different features. The first network can learn the low level features and the 2nd deep network can learn all the high level features. The features are then fused by a sumlayer and trains a softmax layer.

Because of the low quality of the ultrasound images, it makes it really hard to properly classify thyroid nodules. By using this implementation the researchers successfully managed to classify the the ultrasound images to a reputable degree.

Pros: Highly accurate results and classification, to make it successfully automate the task of diagnosing malignant thyroid nodules.

Cons: This paper does not list many cons to their method.

IV. Conclusion

The challenges in automating diagnosis pose a plethora of challenges. Usage of similar methods mentioned in this paper and much more can let us get closer and closer to having a much more accurate way of helping doctors diagnose patients. The methods listed above have a lot of limitations, but the results are still promising and can be used in this area of research. The usage of modern methods of deep learning shown in papers E and F show very little limitation once the network is trained on accurate labeled data and the results are in the high upper bounds. The objective of the paper was to review different ways of diagnosing disease and different methods of helping physicians do it, and based on the papers reviewed in this paper, the papers with the most future prospects and highest levels of accuracy is the methods that used Convolution Neural Networks.

References

[1] Junbing, Li. "Application of BP Neural Network Algorithm in Biomedical Diagnostic Analysis." International Journal Bioautomation, vol. 20, no. 3, July 2016, pp. 417-426. EBSCOhost, proxy.kennesaw.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=119098971&site=eds-live&scope=site.

[2] CNN-based image analysis for malaria diagnosis. (2016). 2016 IEEE International Conference on Bioinformatics and Biomedicine (BIBM), Bioinformatics and Biomedicine (BIBM), 2016 IEEE International Conference on, 493. doi:10.1109/BIBM.2016.7822567

[3] Nahar, Jesmin, et al. "Computational Intelligence for Microarray Data and Biomedical Image Analysis for the Early Diagnosis of Breast Cancer." Expert Systems with Applications, vol. 39, 15 Nov. 2012, pp. 12371-12377. EBSCOhost, doi:10.1016/j.eswa.2012.04.045.

[4] Hernndez-Chan, G., Rodrguez-Gonzlez, A., Alor-Hernndez, G., Gmez-Berbs, J. M., Mayer-Pujadas, M. A., & Posada-Gmez, R. (2012). Knowledge acquisition for medical diagnosis using collective intelligence. Journal Of Medical Systems, 36 Suppl 1S5-S9. doi:10.1007/s10916-012-9886-3

[5] "Intelligent Diagnosis Method of Cardiovascular Anomalies Using Medical Signal Processing." 2015 World Congress on Information Technology and Computer Applications (WCITCA), Information Technology and Computer Applications Congress (WCITCA), 2015 World Congress on, 2015, p. 1. EBSCOhost, doi:10.1109/WCITCA.2015.7367032.

[6] Liu, X., Jiang, J., Zhang, K., Long, E., Cui, J., Zhu, M., & ... Lin, H. (2017). Localization and diagnosis framework for pediatric cataracts based on slit-lamp images using deep features of a convolutional neural network. Plos ONE, 12(3), 1-18. doi:10.1371/journal.pone.0168606

[7] Improving convolutional neural network using accelerated proximal gradient method for epilepsy diagnosis. (2016). 2016 UKACC 11th International Conference on Control (CONTROL), Control (CONTROL), 2016 UKACC 11th International Conference on, 1. doi:10.1109/CONTROL.2016.7737620

[8] Ma, Jinlian, et al. "A Pre-Trained Convolutional Neural Network Based Method for Thyroid Nodule Diagnosis." Ultrasonics, vol. 73, 01 Jan. 2017, pp. 221-230. EBSCOhost, doi:10.1016/j.ultras.2016.09.011.