Literature Review

Applications of Deep Learning

Group ID G20

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Abstract

Deep learning (DL) is a powerful machine learning field that has achieved considerable success in many research areas. Especially in the last decade, the-state-of-the-art studies on many research areas such as computer vision, object recognition, speech recognition, natural language processing were led to the awakening of the artificial intelligence from deep sleep. Nowadays, many researchers are trying to find solutions to many problems in various fields under the light of DL methods. In this study, we present important knowledge to guide about DL models and their applications. We investigated DL studies which are made in the most popular and challenging fields such as Disease Prediction, Medical İmage Processing, Big Data. The contribution of this study is that to list the most challenging subjects that can be studied with DL. The goal of this work is to help researchers learn various applications of Deep Learning in various sectors.

Introduction

With recent improvements in computational power and the amount of memory available in modern computer architectures, an advancement to traditional ML approaches has arisen called Deep Learning (DL). Deep learning represents a fundamental shift in the manner by which machines learn patterns from data by automatically extracting salient features for a given computational task as opposed to relying upon human intuition. Deep Learning approaches are characterized by architectures comprised of several layers that perform mathematical transformations on data passing through them. These transformations are controlled by sets of learnable parameters that are adjusted using a variety of learning and optimization algorithms. These computational layers and parameters form models that can be trained for specific tasks by updating the parameters according to a model's performance on a set of training data. Given the immense amount of structured and unstructured data in software repositories that are likely to contain hidden patterns, DL techniques have ushered in advancements across a range of tasks in software engineering research including automatic program repair, code suggestion, defect prediction, malware detection, feature location, among many others.

Keywords

1-5: sports, medical, business model, weather forecast
6-10: machine learning, deep learning, exercise, segmentation, body points
11-15: deep learning, brain, security, neural implants, diseases

Paper Sources

IEEE, Springer, Elsevier, Wiley, Hindawi, Science Direct, Research Gate

Literature Review

Paper 1

a. **Paper Title:** ECG Signal Preprocessing and SVM Classifier-Based Abnormality Detection in Remote Healthcare Applications
b. **Authors:** C. VENKATESAN , P. KARTHIGAIKUMAR, ANAND PAUL , S. SATHEESKUMARAN AND R. KUMAR
c. **Publications:** IEEE
d. **Year of Publication**: 2018
e. **Objective:** Medical expert systems are part of the portable and smart healthcare monitoring devices used in day-to-day life. Arrhythmic beat classification is mainly used in electrocardiogram (ECG) abnormality detection for identifying heart related problems. In this paper, ECG signal preprocessing and support vector machine-based arrhythmic beat classification are performed to categorize into normal and abnormal subjects. In ECG signal preprocessing, a delayed error normalized LMS adaptive filter is used to achieve high speed and low latency design with less computational elements. Since the signal processing technique is developed for remote healthcare systems, white noise removal is mainly focused. Discrete wavelet transform is applied on the preprocessed signal for HRV feature extraction and machine learning techniques are used for performing arrhythmic beat classification. In this paper, SVM classifier and other popular classifiers have been used on noise removed feature extracted signal for beat classification. Results indicate that the performance of SVM classifier is better than other machine learning-based classifiers.
f. **Conclusion:** The obtained results of the preprocessing, feature extraction and classification are used to conclude the proposed technique. In ECG signal preprocessing, DENLMS algorithm based adaptive filter is utilized to obtain better filtering performance with low computational complexity. In R-peak detection, Coiflet wavelet is used to extract all the possible R-peaks and provides the more accurate beat rate. The obtained beat rate and HRV Frequency domain features are applied to SVM classifier for arrhythmic beat classification which is simpler than other machine learning approaches. Various classification techniques based on PCA, ANN, knowledge based system, KNN and SVM are used using parameters such as ECG and HRV. The maximum classification accuracy of 94.2% has been achieved using these techniques. But the experimental result of SVM based classifier gives a maximum accuracy of 96 % on classifying normal and arrhythmic risk abnormal subjects
g. Methodology:
   A. DENLMS ALGORITHM
   B. DWT BASED FEATURE EXTRACTION
h. **Results and Analysis:** The maximum classification accuracy of 96% has been achieved using these techniques. But the experimental result of SVM based classifier gives a maximum accuracy of 96% on classifying normal and arrhythmic risk abnormal subjects.
i. References:

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Paper 2

a. **Paper Title:** Smart Financial Management System Based on Data Ming and Man-Machine Management
b. **Author:** Maotao Lai
c. **Publication:** Hindawi
d. **Year of publication:** 2022
e. **Objective:** To begin, the architecture of an intelligent financial management system is thoroughly investigated, and a new architecture of an intelligent financial management support system based on data mining is developed. Second, it goes over the definition and structure of a data warehouse and data mining, as well as how to use data mining strategy and technology in financial management. Data mining in relation to technology is being investigated, as is the development of an intelligent data mining algorithm. The flaws of the intelligent data mining algorithm are discovered through an analysis and summary of the algorithm, and an improved algorithm is proposed to address the flaws. Related mining experiments are carried out on the improved algorithm, and the experiment shows that it has certain advantages. Then, using an intelligent forecasting financial management decision as an example, the intelligent financial management based on data mining is thoroughly investigated, the basic design framework for intelligent financial management is established, and the application of a data mining model in decision support system is introduced.
f. **Conclusion:** First to introduce the relevant basic knowledge of data mining, such as the definition, the process of data mining, and data mining algorithms for mining, through the analysis and summary of intelligent data mining algorithm, is found that its deficiencies and put forward the improved algorithm, aiming at the shortcomings of the algorithm and the improved algorithm on the mining experiment, and experiment results show that has certain advantages.
g. **Methodology:** At present, relatively mature data mining tools can be roughly divided into two types, one is similar to SPSS, SAS, LBS Capital Management, and other Management software, and the other is the use of relatively popular new technologies, such as decision tree algorithm, genetic algorithm, artificial neural network, expert system technology, and other tools, such as Neural network Browser, CBR, Fidelity Stock Selector, SPSS Clementine, and other tools
h. References:

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Y. Cui, "Intelligent recommendation system based on mathematical modeling in personalized data mining," *Mathematical Problems in Engineering*, vol. 2021, no. 3, Article ID 6672036, 11 pages, 2021.View at: Publisher Site | Google Scholar

C. Geng, Y. Xu, and N. Metawa, "Intelligent financial decision support system based on data mining," *Journal of Intelligent and Fuzzy Systems*, vol. 2, pp. 1–10, 2021.View at: Publisher Site | Google Scholar

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Y. Deng, W. Sun, M. Chen, and Y. Yang, "Knowledge management and e-learning in virtual learning community based on social network analysis," *Library Hi Tech*, vol. 37, no. 4, pp. 906–917, 2019.View at: Publisher Site | Google Scholar

L. Lu and J. Zhou, "Research on mining of applied mathematics eucational resources based on edge computing and data stream classification," *Mobile Information Systems*, vol. 2021, no. 7, Article ID 5542718, 1238 pages, 2021.View at: Publisher Site | Google Scholar

Paper 3

a. **Paper Title:** Computational Intelligence in Sports: A Systematic Literature Review
b. **Authors:** Robson P. Bonidia, Luiz A. L. Rodrigues, Anderson P. Avila-Santos, Danilo S. Sanches and Jacques D. Brancher
c. **Publication:** Hindawi
d. **Year of Publication:** 2018
e. **Objective:** Recently, data mining studies are being successfully conducted to estimate several parameters in a variety of domains. Data mining techniques have attracted the attention of the information industry and society as a whole, due to a large amount of data and the imminent need to turn it into useful knowledge. However, the effective use of data in some areas is still under development, as is the case in sports, which in recent years, has presented a slight growth; consequently, many sports organizations have begun to see that there is a wealth of unexplored knowledge in the data extracted by them. Therefore, this article presents a systematic review of sports data mining. Regarding years 2010 to 2018, 31 types of research were found in this topic. Based on these studies, we present the current panorama, themes, the database used, proposals, algorithms, and research opportunities. Our findings provide a better understanding of the sports data mining potentials, besides motivating the scientific community to explore this timely and interesting topic.
f. **Methodology:** Systematic Review Planning, Research Planning and Execution Planning
g. **Results and Analysis:** 31 articles relevant that were separated into nine thematic types, whose highest frequency of publication was in the years 2014 and 2016. We also present the most cited articles, their datasets, and results. Regarding data mining techniques, the classification was most applied. Finally, possible areas to be explored were reported, such as swimming, athletics, hockey, boxing, fencing, and tennis. It is expected that this article provides an important source of knowledge for future researches, beyond encouraging new studies.
h. **Conclusion:** sports data mining has evolved. Consequently, many sports organizations have noticed that there is a wealth of unexplored knowledge in the data extracted by them. This is because even a small additional view of the variables can decide several factors, thus increasing the competitive advantage of the teams over their rivals. That is, data mining transfers to sports a higher degree of professionalism and reliability. Therefore, this article covered the last eight years (2010-2018) of papers available in relevant databases. The review issues considered methods, information, and applications. Thereby, the current panorama, temporal distribution, themes, the datasets used, proposals, and results of these revised works were presented. Moreover, techniques, algorithms, methods, and research opportunities have been reported.

Paper 4

a. **Paper Title:** Review of the Complexity of Managing Big Data of the Internet of Things
b. **Authors:** David Gil, Magnus Johnsson, Higinio Mora and Julian Szymański
c. **Publication:** Hindawi
d. **Year of Publication:** 2019
e. **Objective:** There is a growing awareness that the complexity of managing Big Data is one of the main challenges in the developing field of the Internet of Things (IoT). Complexity arises from several aspects of the Big Data life cycle, such as gathering data, storing them onto cloud servers, cleaning and integrating the data, a process involving the last advances in ontologies, such as Extensible Markup Language (XML) and Resource Description Framework (RDF), and the application of machine learning methods to carry out classifications, predictions, and visualizations. In this review, the state of the art of all the aforementioned aspects of Big Data in the context of the Internet of Things is exposed. The most novel technologies in machine learning, deep learning, and data mining on Big Data are discussed as well. Finally, we also point the reader to the state-of-the-art literature for further in-depth studies, and we present the major trends for the future.
f. **Conclusion:** a key issue that we really want to emphasize in this study is the aspects related to Big Data which transcend the academic area and that, therefore, are reflected in the company. An observation is that more than 50% out of 560 enterprises thinks Big Data will help them increase their operational efficiency as well as other things [60]. This indicates that there are a lot of opportunities for Big Data. However, it is also clear that there are many challenges in every phase of the knowledge discovery procedure that need to be addressed in order to achieve a continued and successful progress within the field of Big Data.
g. Methodology:
-THE IOT AND COMPLEXITY HANDLING: ARCHITECTURE FOR BIG DATA
-KNOWLEDGE DISCOVERING PROCEDURE

h. **Result and Analysis:** The trend for the future seems to be that more investigations will be carried out in such areas as (a) techniques for data integration, again the V of Variety; (b) more efficient machine learning techniques on big data, such as Deep Learning and frameworks such as Apache's Hadoop and Spark, that will probably have a crucial importance; and (c) the visualization of the data, with, e.g., dashboards, and more efficient techniques for the visualization of indicators.

Paper 5

a. **Paper Title:** A comprehensive review of image analysis methods for microorganism counting: from classical image processing to deep learning approaches
b. **Authors:** Jiawei Zhang, Chen Li, Md Mamunur Rahaman, Yudong Yao, Pingli Ma, Jinghua Zhang, Xin Zhao, Tao Jiang And Marcin Grzegorzek
c. **Publication:** Springer
d. **Year of Publication:** 2021
e. **Objective:** Microorganisms such as bacteria and fungi play essential roles in many application fields, like biotechnique, medical technique and industrial domain. Microorganism counting techniques are crucial in microorganism analysis, helping biologists and related researchers quantitatively analyze the microorganisms and calculate their characteristics, such as biomass concentration and biological activity. However, traditional microorganism manual counting methods, such as plate counting method, hemocytometry and turbidimetry, are time-consuming, subjective and need complex operations, which are difficult to be applied in large-scale applications. In order to improve this situation, image analysis is applied for microorganism counting since the 1980s, which consists of digital image processing, image segmentation, image classification and suchlike. Image analysis-based microorganism counting methods are efficient comparing with traditional plate counting methods.
f. **Conclusion:** a comprehensive review of image analysis methods for microorganism counting is proposed. The counting methods are summarized and grouped based on the types of microorganisms, including bacteria counting and other microorganisms counting. Then the methods are separated based on segmentation approaches, such as thresholding methods, edge detection methods, third-party tools and deep learning based methods. By reviewing all the related works, we can find that the classic methods in Sects. 2.1 and 3.1 are developed from the 1980s to 2000s, such as the Otsu thresholding method, watershed algorithm and edge detection methods, which shows a blooming development of digital image processing for microorganism analysis. Since the 2010s, the development of deep learning carries out the microorganism counting results with high accuracy.
g. **Methodology:** method based on image enhancement, method based on thresholding, method based on edge detection, method based on watershed, method based on color segmentation
h. **Future Work:** In the future, deep learning based microorganism counting methods are promising. Since the COVID-19 broke out in 2019, people pay increasing attention to microorganism analysis. There is still a considerable limitation and opportunity in microorganism research. This review can contribute a lot to the research of microorganism counting for future researchers.

Paper 6

5.1 Paper Title :
Squat Angle Assessment Through Tracking Body Movements
5.2 Authors
MOHD ASYRAF ZULKIFLEY 1, (Member, IEEE), NUR AYUNI MOHAMED,AND NURAISYAH HANI ZULKIFLEY
5.3 Publication - IEEE
5.4 Year of Publication - 2019
5.5 Objective - To Make Deep Learning Algo. that captures from single camera system that captures video from the frontal view to measure the squat angle continuously according to the
number of frames per second.
5.6 Methodology - The system will provide knee angle measurements for every frame taken based
on a combined approach of deep learning tracking and deep belief networks regressor
5.7 Results and analysis - video-based squat angle assessment has been successfully developed for knee angle measurement, with the method TCNN having lowest Mean Error.
5.8 Research Gap - Cannot Conclude
5.9 Future Works - The Work Here is Complete.

Link:https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8686074

Paper 7

5.1 Paper Title :
Tracking a single cyclist during a team changeover on a velodrome track with Python and OpenCV
5.2 Authors
Jun Burden1, Malcolm Cleland1, Martin Conway1, Malcolm Falconer1, Richard Green2, J.J. Geoff Chase1, Chris Hann1, Mark Jermy1*, Craig Palmer3
5.3 Publication - ELSEVIER
5.4 Year of Publication - 2019
5.5 Objective - Tracking a single cyclist during a team changeover on a velodrome track with Python and OpenCV
5.6 Methodology - This paper describes a video tracking system
designed to determine the path of the rider moving from the lead to the rear, to aid teams and coaches
in improving changeover manoeuvres
5.7 Results and analysis - Testing was performed at the Invercargill ILT indoor velodrome. Three riders performed a standard changeover
at near full racing velocity. The code was designed to track cyclists using a front disk wheel, however during this
testing a deep rim wheel was used and the code was able to track this accurately
5.8 Research Gap - Cannot Conclude
5.9 Future Works - the variation in magnification over the field of view is not taken into account.
In the Future team will work on this.
Link:https://pdf.sciencedirectassets.com/278653/1-s2.0-S1877705810X00030/1-s2.0-S1877705810003449/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEHkaCXVzLWVhc3QtMSJIMEYCIQDpOTCUbgHpBCtHFlESIIfNZAm2eYy9NgVdcUg5CIGzwgIhAIwMgZ8TSyfzw3UmjmFt12RweMt16C7OexqYLHb9%2Fhx8KoMECPH%2F%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEQBBoMMDU5MDAzNTQ2ODY1IgxTFfHcdSL1jSuTqHEq1wPcu6VjRVQXcFkDEd392gO5QNBf3VPnHoVcfcEfPjIe8Wmg5CCQwLeEAMvMtKpHxmr83nHhOn2OW0WrOy7wr3Znv%2FZfao4pGjeKPpZ3JuHy9KPmoplZ%2BJcyJzjtXOk0O97OgXfO14cGndwXrkChBe82ggSAqxociSBxYMtuy2zP5zY4pToZeUe%2FdG1kX9DTYewH2kl%2Fr2XE07NvLnTt%2BpFT6Izi8MDrZV2D8w7AXlwA%2FCrsd4hLlOuYEEQb%2FwcVVBAMOxB9lGThJGThjeQRCY2ua3e7GAbT9x4gkMSCf%2FYGEIVTAHN8OObRG%2FlUEMUV40jzpc6MoSIYT0WB4S84cju4xfBf%2B0ZrtyXWPXNrVIhe6UCc4KRSGaQ8A4%2FGTQ4m7JBIYV7cEsauDmpnzEaCKcIodWrf%2FpYh9OuLNqFnglt4%2FhbTTC%2F1h3EuscJmE88GSGgWgz1SMVB26D8Yg526IbjwSBxV49rCrfBT5M7B5HeSO9%2FT4UcMoaNPzRp7kNJRYMXCaBH4f%2FSk35NYWjRP%2BNIliLe8HTfFXPXGKd4bFkyD014KDvYER1B11KWIkZrs3bOlE4Z4m16WVdANkjQuUQKJ49JQ7PilBTEJ5cJ3lkxWPJIc%2BR2TC0Yw5qLdkQY6pAEeZ8GzoJNfpZ4QNUahb08xzwwRlGl6aR5E0CCpV4zYO%2FxEVeYEfFQZy%2BFQHIa%2FIkkQXlQYgARHMh%2BQlCUpmzkFHBn1tif%2FWmsuitJh8ac97jbQfPLa0H3S91LIUas9LJgo5%2BO6CITKB9oOKqnb1LbzyxsWLRDzanUIRlpC3LU4kar89V5e7K52%2BGKD1TgPLJFCjh1QmoDdJ374VLEswgIGqdmEsA%3D%3D&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20220320T170758Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-

Credential=ASIAQ3PHCVTYRGX3ZOVM%2F20220320%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=b7b7db49834e12dff3d7c7e726445e6291f072d03bd6ba244fc198b3db6a7ec0&hash=6767bc8956899b1f3a2e8726ae6de22229417d8114016742dbb158bbf6bf44b5&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S1877705810003449&tid=spdf-e2557bf3-1bb7-4a0a-a64f-0483340a7eea&sid=e8289bd27cc7764dfd7bfc78c44a87055cd7gxrqb&type=client&ua=500006575e0255055707&rr=6ef00c0d8b788b0f

Paper 8

5.1 Paper Title - Machine Learning and Deep Learning Approaches to Analyze and Detect COVID-19
5.2 Authors - T. Aishwarya & V. Ravi Kumar
5.3 Publication - Springer
5.4 Year of Publication - 2020
5.5 Objective - Machine Learning and Deep Learning Approaches to Analyze and Detect COVID-19
5.6 Methodology - To spot Covid-19 affected regions in the chest radiographs, a NABLA-N model was used for the segmentation of regions of the chest alone
5.7 Results and analysis - This model predicted with 0.90 area under the Receiver Operating Characteristic curve, auROC with an accuracy of 95% for the prospective test range.
5.8 Research Gap - Cannot Conclude
Link:https://link.springer.com/article/10.1007/s42979-021-00605-9

Paper 9

5.1 Paper Title - Diabetes detection using deep learning algorithms
5.2 Authors - SwapnaG.VinayakumarR.SomanK.P.
5.3 Publication - Science Direct
5.4 Year of Publication - 2018
5.5 Objective - This research paper presents a methodology for classification of diabetic and normal HRV signals using deep learning architectures.
5.6 Methodology - Proposed Architecture contains 5 CNN layers and each layer follows maxpooling.
5.7 Results and analysis - The maximum accuracy value of 95.7% was obtained for CNN 5-LSTM with SVM network.
5.8 Research Gap - Cannot Conclude
Link:https://www.sciencedirect.com/science/article/pii/S2405959518304624

Paper 10

5.1 Paper Title - Development of Deep Learning Model for the Recognition ofCracks on Concrete Surfaces
5.2 Authors - Tien-Thinh Le ,1,2Van-Hai Nguyen,1,2and Minh Vuong Le
5.3 Publication - Research Gate
5.4 Year of Publication - 2021
5.5 Objective - This paper is devoted to the development of a deep learning- (DL-) based model to detect crack fractures on concrete surfaces
5.6 Methodology - Dedeveloped model for the classification of images was based on a DL Convolutional Neural Network (CNN)
5.7 Results and analysis - CNN model may be consideredvalid because it performs the classification of cracks wellusing the validating data.
5.8 Research Gap - Cannot Conclude
Link:https://www.researchgate.net/publication/350438130_Development_of_Deep_Learning_Model_for_the_Recognition_of_Cracks_on_Concrete_Surfaces

Paper 11

Paper Title
A Novel Deep Learning Strategy for Classifying Different Attack Patterns for Deep Brain Implants

Authors
Heena Rathore, Abdulla Khalid Al-Ali, Amr Mohamed, Xiaojiang Du, Mohsen Guizani

Publication
IEEE

Year of publication
20 February 2019

Objective
To design and train a long short term memory, a deep learning classifier to predict and forecast consecutive brain simulation pattern.
To emulate different types of attack patterns and classify them in deep brain implants, i.e., determine or classify the type of attack strategy used by the attacker. More specifically, a prediction mechanism is developed by emulating different attack patterns that can be utilized by the attacker. Once the attack has been predicted by the classifier, patient is notified about the attack.

Methodology
Deep brain stimulators (DBSs), a widely used and comprehensively acknowledged restorative methodology, are a type of implantable medical device which uses electrical stimulation to treat neurological disorders.
This paper presents a deep learning methodology to predict different attack stimulations in DBSs.
The prediction helps in diagnosing fake versus genuine stimulations. The effect of deep brain stimulation was tested on Parkinson tremor patients. The proposed methodology was able to detect different types of emulated attack patterns efficiently and thereby notifying the patient about the possible attack.
The methodology proposed in this paper brain tunes DBS with the help of its own replica, i.e., a biologically neural inspired model, to develop an efficient, robust and secure solution.

Conclusion
Deep brain stimulators (DBS), a type of wireless implantable medical device, treats neurological disorders by giving stimualtions inside the patients brain. DBS have progressively benefited patients, yet they have posed in parallel certain security implications. Security for such devices is important since they can directly affect the mental and physical orientation of patients. This paper utilizes Long Short Term Memory, a type of recurrent neural network, to predict and forecast the pattern of DBS. Rest Tremor Velocity (RTV) is examined to study the intensity of neurological disorders. For this, we studied and examined RTV values to design and train the neural network. Various attack patterns were introduced

in the DBS framework to emulate and classify different attack strategies. The results show that the model was able to classify different attack patterns in the DBS with smaller loss values and minimal training time.

Results and analysis

A. Data Analysis and Insights From Physionet Data: Rest Tremor Velocity (RTV) is the most important feature for evaluating the Parkinson tremor intensity. It is considered as the first sign of neurological disorder. RTV value is negligible or close to zero for normal individuals and controlled Parkinson disease patients

B. Adversary Attack Strategies: The emulated pattern is made by changing the deep brain parameters such as stimulation rate, intensity, pulse width, mode etc. as explained earlier. RTV is the obervable pattern or outcome of simulations.

Attack	Training-Loss	Validation-loss	Training Duration(ms)
Spike Attack	56.87	239.48	84.28
Outlier Attack	60.47	43.67	81.9 7
Stuck at Attack	13120.94	27.24	199.77
Incremental Attack	22.67	176.65	80.101
Chronic Attack	122.66	3.36	79.49
Noise Attack	2839.15	3473.6162	80.07
Unusual Attack	388.07	44.65	79.86

Future works

In the near future, the proposed framework will be implemented on a real deep brain stimulator environment with real RTV measurements. To evaluate the performance of the framework in terms of accuracy and reliability, genuine and fake measurements will be classified and predicted at run time.

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4. *Deep Brain Stimulators (DBS) Market Analysis By Application (Pain Management Epilepsy Essential Tremor Obsessive Compulsive Disorder Depression Dystonia Parkinsons Disease) And Segment Forecasts To 2020*, 2015.

5. *Deep Brain Stimulators Market Worth \$1.6 Billion by 2020*, 2015.

Paper 12

Paper Title
A deep learning framework for glaucoma detection based on robust optic disc segmentation and transfer learning

Authors
Deepa Natarajan, Esakkiranjan Sankaralingam, Keerthiveena Balraj, Selvakumar Karuppusamy

Publication
Wiley

Year of publication
2022

Objective
A lightweight model for glaucoma detection demon strating high accuracies for OD segmentation and glau coma detection.

Methodology
Super pixel segmentation: In this article, super pixel segmentation is performed as a part of the OD segmentation process. This process groups the images based on their intensity values and geometric distances to form arbitrary shaped regions of semantically similar pixels.

Cuckoo search algorithm: In the recent years, many image processing problems with nonlinear constraints are formulated as optimization problems, which are solved by bioinspired methods. CSO is a kind of meta heuristic algorithm based on the brood parasitism of cuckoo species. Several studies have testified the convergence characteristics of CSO and simplicity in implementation, due to the minimum number of tuning parameters. This method employs the Levy flights to generate new solutions by iteratively searching the entire solution space to prevent stagnation with local optima.

Conclusion
This article presents a novel transfer learning based two stage framework called UNet-SNet for glaucoma detection leveraging the bio-inspired GMM super pixel segmentation for OD segmentation. The glaucoma detection framework realized as a cascade of a semantic segmentation network based on the regularized UNet, and a SqueezeNet-based classifier model demonstrates best generalization potential with arbitrary test data. It is shown that the generalization and optimization capabilities of segmentation networks can be considerably improved by including a regularization term in the loss function. Furthermore, the deep features extracted from the disc region are shown to be sufficient for glaucoma detection, contrary to the deep learning networks trained with hand crafted features such as CDR. The proposed system is trained and tested with benchmark datasets and compared with state of the art models. The training performances, OD segmentation and glaucoma detection accuracies, and the ROC characteristics prove this model as a prospective automated solution for

glaucoma detection in the pursuit of alleviating blindness. In clinical examination of fundus images, size of OD, rim thickness, and deformations are considered for glaucoma detection.

Results and analysis

	Performance measures for glaucoma detection					
	ACRIMA		DRISHTI-GS1		RIM-ONE v1	
Pretrained models	Accuracy	AUC	Accuracy	AUC	Accuracy	AUC
AlexNet	96.23	99.85	70.00	81.48	74.87	69.21
GoogleNet	91.51	96.49	70.00	79.89	94.74	91.03
InceptionV3	93.87	99.36	70.00	65.08	71.05	76.92
XceptionNet	81.58	88.14	**98.11**	99.80	66.67	66.67
ResNet-50	95.75	99.56	73.33	78.31	92.11	98.08
SqueezeNet	95.75	98.84	56.67	76.19	97.37	**100**
ShuffleNet	96.23	99.75	86.67	78.84	92.11	97.44
MobileNet	98.58	99.96	76.67	73.02	92.11	99.36
DenseNet	99.53	99.98	73.33	78.31	94.74	99.04
InceptionResNet	96.23	98.84	70.00	68.78	68.42	61.86
NasNet-Large	96.23	99.85	70.00	69.31	86.84	95.19
SqueezeNet (Proposed)	99.86	99.99	97.05	99.90	100	100

Future works

Attributed to its segmentation and classification accuracies, this framework can be extended to the extraction of these features in the treatment protocols of several ocular disorders. Further the progression of glaucoma can be examined by various modalities such as scanning laser polarimetry, optical coherence tomography, visual fields test, and stereo imaging in future.

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Paper 13

Paper Title
Intelligent Model for Brain Tumor Identification Using Deep Learning

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Hindawi

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Objective
This article proposes a new machine learning (ML) model to overcome this precise segmentation of brain tumors. The proposed intelligent detection model for identifying brain tumors has been classified into four classes: no-tumor, glioma, meningioma, and pituitary. A total of 3264 images has been used in the model, including 926, 937, and 901 for glioma, meningioma, and pituitary, respectively, and 500 for the no-tumor class.

Methodology
Convolutional Neural Networks method has been utilized and implemented via the TensorFlow library in this study. It has been shown that the faster CNN method can yield an accuracy of 91.66%, which is higher than the related work. Regularized Extreme Learning Machine (RELM). The method first preprocessed images so that the system can read them with ease.

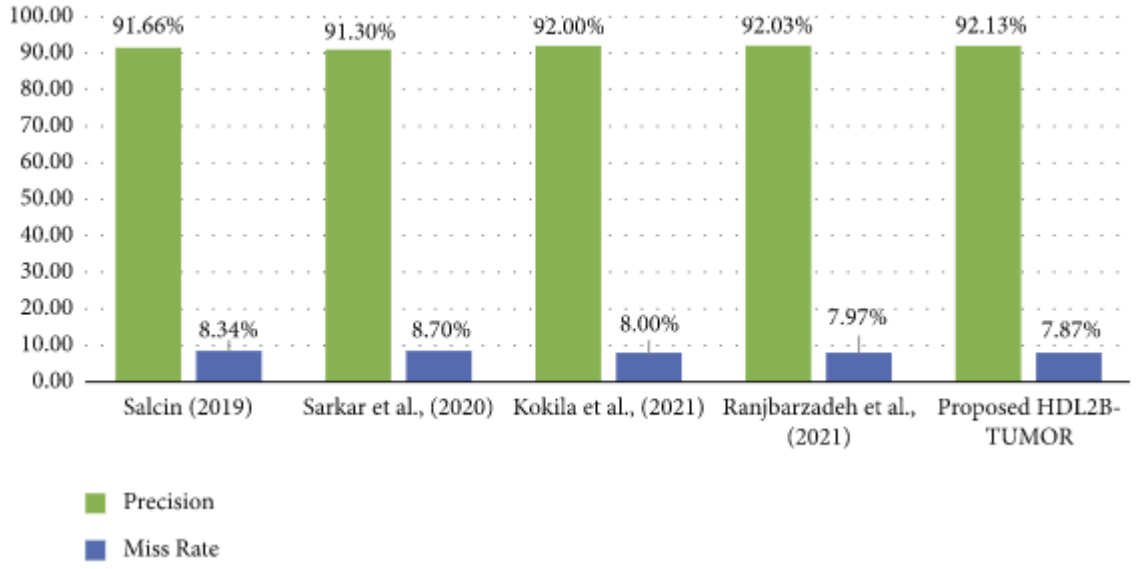
Conclusion
The brain tumour is considered to be fatal cancer in adults and children. The common types of primary tumours found in adults are glioma, meningioma, and pituitary. Numerous methods have been suggested and inspected in the literature for detection and classification of the brain tumour to expand the possibilities of treatment and endurance of the patients. A Hierarchical Deep Learning-Based Brain Tumour Classifier is proposed using CNN in the present study. The model classified the input into four classes: glioma, meningioma, pituitary, and no-tumour. The proposed model accomplished 92.13% accuracy, and MR was 7.87%, superior to existing brain tumour detection and segmentation methods. The system also classifies the tumour into different classes after tumour recognition. The proposed system will provide clinical support in the medical field.

Results and analysis
Table 1 shows the input matrix for the proposed HDL2B-TUMOR-CLASSIFIER. A total of 3264 images are used for training and validation purposes. In total, 2870 images, 87% of the total input, are used for the training phase, and the remaining 13%, i.e., 394 images, are

utilized in the validation phase. The input samples are further divided into 926, 937, 500, and 901, representing the glioma, meningioma, no-tumour, and pituitary.

Number of input images	Glioma	Meningioma	No tumor	Pituitary
Training phase	826	822	395	827
Validation phase	100	115	105	74
Total inputs	926	937	500	901

The proposed HDL2B-TUMOR-CLASSIFIER performance with other state-of-the-art algorithms showing the improved and enhanced accuracy. The accuracy values of Salçin, Sarkar et al., Kokila et al., and Ranjbarzadeh et al. are 91.66, 91.3, 92.00, and 92.03, respectively, and the proposed HDL2B-TUMOR-CLASSIFIER in this study showed 92.13% accuracy.



Future works

Study is completed.

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Paper 14

Paper Title
Application of Deep Learning in Neuroradiology: Brain Haemorrhage Classification Using Transfer Learning

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3 June 2019

Objective
We aim to transfer the knowledge acquired by AlexNet into a new target task: classifying the CT brain haemorrhage into haemorrhage or nonhaemorrhage images. Moreover, a CNN is created from scratch and a modified AlexNet combined with SVM are also employed to perform the same classification task. The goal of employing one CNN created from scratch and fine-tuning a pretrained model for the same classification task is to show that transfer learning-based network can perform better when data are not much. Also, it is aimed to show that sufficient fine-tuning of a pretrained model can eliminate the need for training a deep CNN from scratch which usually takes long time and requires large number of images to learn.

Methodology
In this work we decided to use data augmentation in order to multiply the number of images collected for the database, which can help in preventing the overfitting that may be encountered during training.
The model architecture and training settings for the CNN employed to perform the classification of brain haemorrhage are presented in this section. Extensive tests are performed to determine the best learning parameters that optimize the neural network. AlexNet is the pretrained model selected to be used in this research because of its effective power in feature extraction.
The architecture of the modified version of AlexNet, in which an SVM classifier is used instead of a neural network. Similarly, this modified network, AlexNet-SVM, is also trained with the same conditions and same number of images.

Conclusion
In this research, the detection of brain haemorrhage in CT images problem is solved using neural networks and the results sound robust and promising. One of the motivations behind this research is to address and attempt to overcome the difficulties that radiologists might encounter when diagnosing brain haemorrhage suspected images. Hence, we investigated the use of a potential deep convolutional neural network that can help the medical experts in making more accurate decisions. As a result, this may reduce the diagnosis error and boost

the accuracy of haemorrhage identification made by medical experts. The paper proposes a pretrained modified network "AlexNet-SVM" for the same classification task. The three models including the proposed model were trained on a relatively small database in order to examine the network performance. It is obvious that the application of deep learning networks in medical image analysis encounters several challenges. The most common challenge is the lack of large training data sets which can be considered as an obstacle. The experiments conducted in this study demonstrated that the transfer of knowledge into medical images can be possible, even though the deep networks are originally trained on natural images. The proposed model using the SVM classifier helps in improving the performance of AlexNet. Moreover, it was manifested that small number of data can be enough for fine-tuning a pretrained model, in contrast to a CNN created from scratch which needs a large number of data to be trained. Thus, the proposed model's performance is an indicator of how transfer learning-based networks can be considered in brain haemorrhage identification.

Results and analysis

The CNN, AlexNet, and AlexNet-SVM achieved different accuracies of 90.65%, 92.13%, and 93.48%, respectively. AlexNet-SVM was capable of achieving more accurate generalizing power on unseen data. However, a larger number of epochs was required to achieve such accuracy, which is relatively higher than that needed for CNN and AlexNet to achieve their highest accuracy. It is also noted that AlexNet-SVM reached a lower mean square error (MSE) (0.054) than that reached by AlexNet (0.087) and CNN (0.092); however, this also required longer training time.

Consequently, it is seen that all models are trained well, but the increase of depth of AlexNet and AlexNet-SVM makes it more difficult to train, i.e., it required longer time and more epochs to reach the minimum square error (MSE) and converge. Furthermore, it is important to mention that due to this difference in time and epoch number, the classifier of AlexNet-SVM resulted in a lower MSE and higher recognition rate than that scored by AlexNet and CNN.

Future works

Study is completed.

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Paper 15

Paper Title
Brain Decoding using fMRI Images for Multiple Subjects through Deep Learning

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Hindawi

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Objective
The goal of this study is to focus on a deep learning-based model to classify fMRI data. Existing deep learning models like VAE, transfer learning techniques, LSTM, and reconstructed fc7 layers take more training time which increases computational cost. So, to overcome this, we will use a denser convolutional neural network to train high-level features.

Methodology
The proposed model uses a 3D image acquired from a brain imaging experiment conducted by the Human Connectome Project (HCP). The performance of the model was examined by various performance matrixes such as F1 score, accuracy, and precision.

Conclusion
The brain decoding models like CNNs and VAEs are used for feature extraction of the brain images. This is a good approach as CNNs perform better than other existing deep learning models due to high efficiency when extracting features and then classifying the images using a classifier. CNN models give better accuracy when training the images, but this includes some major limitations. The main problem with using CNN models is the issues of vanishing gradients when back propagating the images. Similarly, large datasets often cause exploding gradient problems during model training. This issue is followed by the increased computational power as CNNs-based deep learning models are trained on GPUs. Various researchers propose the technique of training the model on CPU, but this approach has its limitations. Training the model on GPU with less computational cost is another challenge. Similarly, GPU-based models take more training time but give better accuracy results. So, various researchers proposed a model where increased density can give better accuracy and increase the performance of the model. Increasing the model's density increases the accuracy, but it also increases the training time and computation. So, the proposed CNN model was implemented where the images are trained by the combination of the best activation functions. The Swish activation function overcomes the problem of vanishing gradients. Moreover, Swish activation plays an important role in reducing the computation and training time of the model. After the extraction of the features, the images were flattened to a one-dimensional matrix where the multiple hidden layers reduced the parameters and extracted

the optimal features and predicted the classification results based on the extracted features using the "Softmax" classifier. Furthermore, the reliability of the proposed method was validated using the validation dataset during training followed by the testing dataset after the model training. In addition, the best-evaluated classifier followed by the existing machine learning approach was compared with the proposed model to validate the efficiency of the model. For the HCP dataset, the proposed model gave impressive results in terms of accuracy, efficiency, and specificity. The analysis of the model was also conducted in order to demonstrate the usefulness of the brain imaging analysis and feature extraction followed by classification of the model.

Results and analysis

The average test accuracy achieved across the cross-validation of 10-fold is 91% with a random chance of 20%.

At first, the generalizability shown on the HCP participants was very low with an accuracy of 30% followed by a low chance level of 12.5%. However, high variability was seen in WM and behavior tasks. The random initialization on the decoding model gave the results of 41%. The features when transferred gave an accuracy boost of 5%. The random initialization approach was used for the feature transfer. These results showed that the WM had a strong learning representation effect.

95% score was achieved for the language task whereas an average of 94% was achieved for motor tasks. The lowest accuracy was achieved by the relational tasks followed by the working memory task. The relational processing task achieved an 81% F1 score while the average of 83% F1 score was gained by the working memory task. Some misclassification was also observed in WM, relational, and emotion tasks.

Future works

Study is completed.

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Conclusion

In this literature review, we reviewed various applications of Deep Learning and studied methodologies and analysed which works the best.