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A Novel Approach with Artificial Intelligence for Brain Stroke Detection using MRI Scans

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ABSTRACT: Artificial Intelligence (AI) has emerged to solve problems in the real world applications. It is widely used in different domains including healthcare. The innovations in machine learning (ML) and deep learning paved way for exploitation of AI towards discovering intelligence for making well informed decisions. The existing approaches in AI have been used for different applications. In case of brain stroke detection, it is expected to make difference when AI is employed to detect probability of brain stroke.

However, there is room for improving existing models. In this paper, we proposed a framework based on CNN based deep learning for efficient detection of brain stroke. We also proposed an algorithm to realize the framework. The algorithm takes training and testing MRI scans of brain and learns from the training data to gain knowledge and then performs prediction process. The algorithm is found to be more efficient than existing ML algorithms like Support Vector Machine (SVM) and Random Forest (RF). The proposed AI approach based on CNN has achieved 97% accuracy. It can be used in the clinical decision support systems in healthcare units with further standardization of the model.

KEYWORDS: Artificial Intelligence, Magnetic Resonance Imaging, Brain Stroke Detection, Machine Learning

I. INTRODUCTION

The innovations in machine learning (ML) and deep learning paved way for exploitation of AI towards discovering intelligence for making well informed decisions. The existing approaches in AI have been used for different applications. In case of brain stroke detection, it is expected to make difference when AI is employed to detect probability of brain stroke. There are supervised and unsupervised methods that help in different applications. Machine learning helps algorithms and applications to become intelligence. Often supervised ML methods are used in order to have training and testing phases. In the training phase, the algorithm gains knowhow and in the testing phase, the algorithm uses its intelligence for making predictions. In other words, in the testing phase, ML algorithmpredicts class labels or performs actual classification.

The existing literature has many methods supporting automatic brain stroke detection. Guberina *et al*. [4] focused on the early detection of infarction signs using ML based approaches. Saber *et al*. [5] explored predictive analytics and ML for stroke detection. Pereira *et al*. [6] focused on the stroke lesion detection using deep learning approach such as Convolutional Neural Network (CNN). Subudhi *et al*. [7] investigated on the detection of ischemic stroke automatically using MRI images and Delaunay Triangulation. Acharya *et al*. [8] used higher order spectra features in brain MRI images for ischemic stroke detection. Karthik *et al*. [9] focused on the deep learning and neuroimaging for automatic stroke detection. Acharya *et al*. [18] used MRI images and higher order spectra for brain stroke detection. Raghavendra *et al*. [19] used non-linear index and accurate and automatic detection of haemorrhagic brain stroke with the help of CT imagery. Chauhan *et al*. [20] focused on stroke patients to identify cognitive performance using deep learning models.From the literature, it is understood that there are plenty of existing methods that operated on both MRI and CT scan imagery. The literature includes both ML and deep learning models. However, it is possible to have further research with AI to improve the state of the art in brain stroke detection. Our contributions in this paper are as follows.

1. We proposed an AI enabled framework for prediction of brain stroke automatically using MRI images.
2. We implemented CNN based algorithm for brain stroke detection process.
3. A prototype application is built in order to evaluate the framework with the underlying models.

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The remainder of the paper is structured as follows. Section 2 reviews literature on the existing methods used for brain stroke detection. Section 3 presents the proposed deep learning based framework. Section 4 presents results of empirical study. Section 5 concludes the paper and gives directions for future work.

II. RELATED WORK

This section presents review of literature on the existing methods for brain stroke detection. Sirsat *et al.* [1] investigated on the brain stroke detection using machine learning approaches. Shafaat *et al.* [2] on the other hand used AI for ischemic stroke detection. Heo *et al.* [3] used NLP and ML techniques on radiology reports for prediction of brain ischemic brain stroke. Guberina *et al.* [4] focused on the early detection of infarction signs using ML based approaches. Saber *et al.* [5] explored predictive analytics and ML for stroke detection. Pereira *et al.* [6] focused on the stroke lesion detection using deep learning approach such as Convolutional Neural Network (CNN). Subudhi *et al.* [7] investigated on the detection of ischemic stroke automatically using MRI images and Delaunay Triangulation. Acharya *et al.* [8] used higher order spectra features in brain MRI images for ischemic stroke detection. Karthik *et al.* [9] focused on the deep learning and neuroimaging for automatic stroke detection. Dourado *et al.* [10] studied IoT based approaches and applied them along with deep learning for detection of stroke automatically using CT scan images.

Han *et al.* [11] also used deep learning techniques for stroke region finding through segmentation of CT scans. Akkus *et al.* [12] investigated on brain MRI segmentation techniques based on deep learning. Feinerer *et al.* [13] used deep learning models along with CNN for brain stroke detection. Xu *et al.* [14] proposed a model based on Internet of Medical Things and deep learning for brain stroke detection using CT scans.

Lundervold*et al.* [15] studied deep learning in medical imaging on MRI scans. Heo *et al.* [16] used ML and NLP for detection of stroke probability. Talo *et al.* [17] proposed deep learning along with transfer learning to find abnormalities in human brain using MRI imagery. Acharya *et al.* [18] used MRI images and higher order spectra for brain stroke detection. Raghavendra *et al.* [19] used non-linear index and accurate and automatic detection of haemorrhagic brain stroke with the help of CT imagery. Chauhan *et al.* [20] focused on stroke patients to identify cognitive performance using deep learning models. From the literature, it is understood that there are plenty of existing methods that operated on both MRI and CT scan imagery. The literature includes both ML and deep learning models. However, it is possible to have further research with AI to improve the state of the art in brain stroke detection.

III. PROPOSED SYSTEM

The proposed system is based on AI approach. It exploits a CNN based deep learning model with optimizations towards efficient detection of brain stroke. It is the supervised learning model that has training and testing phases for prediction of brain stroke. It has pre-processing and feature extraction methods for improving quality in training process. Once the training process is completed, the CNN based classifier gains required knowhow that is further used for detection of brain stroke.

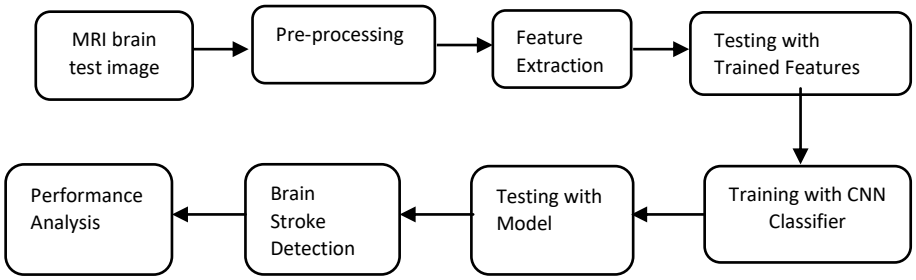

Figure 1: The overview of the proposed methodology

As presented in Figure 1, the proposed CNN based classifier is used for brain stroke detection. It has provision for improving quality of training with pre-processing and feature extraction. The feature extraction process identifies

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features that are able to determine class labels. It is very useful for dimensionality reduction and improve quality in training. The functional flow of the proposed deep learning based model is provided in Figure 2.

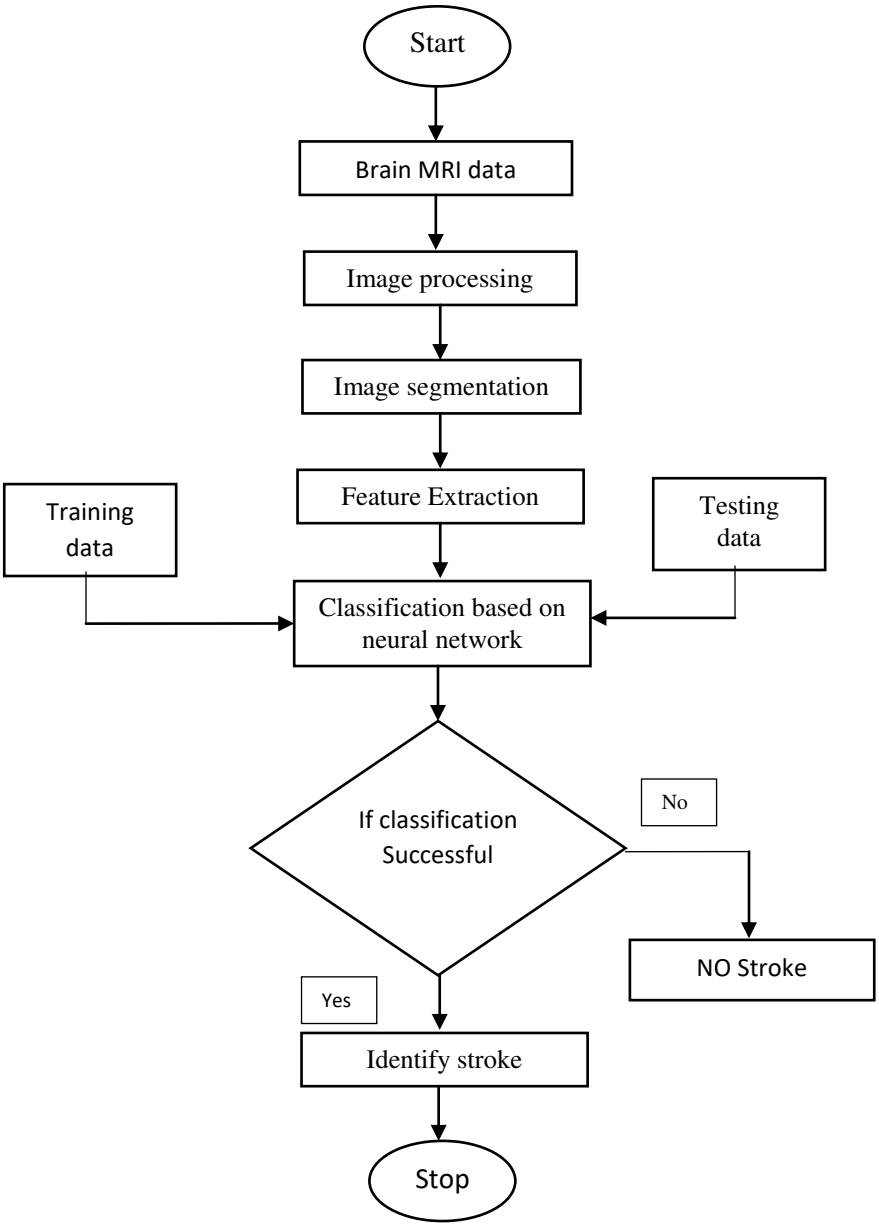

Figure 2: Functional flow of the proposed system

As presented in Figure 2, it is evident that the proposed system has a series of functionalities to detect brain stroke accurately. It takes MRI based training data and test data. It learns from the training data and performs prediction later with the learned knowledge.

Algorithm: A Novel Approach with AI for Brain Stroke Detection using MRI scans (AI-BSD)
Inputs: test image I, Deep learning Model
Output: Brain stroke detection results R

1. Start
2. Initialize feature map F
3. F← GetFeatureMap(I)
4. Add convolutional layers

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5. Add max pooling layers
6. Add flattening
7. Add dropouts
8. M ← TrainModel(F, p)
9. For each Epoch e in n
10. For each batch b in m
11. Update M
12. End For
13. M' ←FitModel(M)
14. R ← Prediction of Diseases(M', I)
15. Print R
16. End For
17. Stop

Algorithm 1: Shows the proposed algorithm

As presented in the Algorithm 1, it takes the brain MRI image to be tested and with the help of training knowledge, it could predict results of brain stroke detection. It has an iterative process with number of epochs for updating model with learning from time to time and gain the required knowledge. Once the training is completed, the discovered knowhow is used in order to make prediction of brain stroke from given test samples.

IV. EXPERIMENTAL RESULTS

Experiments are made with a prototype application to evaluate the proposed framework. The observations are made in terms of precision, recall, F1-score and accuracy. The results revealed that the proposed model shows acceptable performance in brain stroke detection.

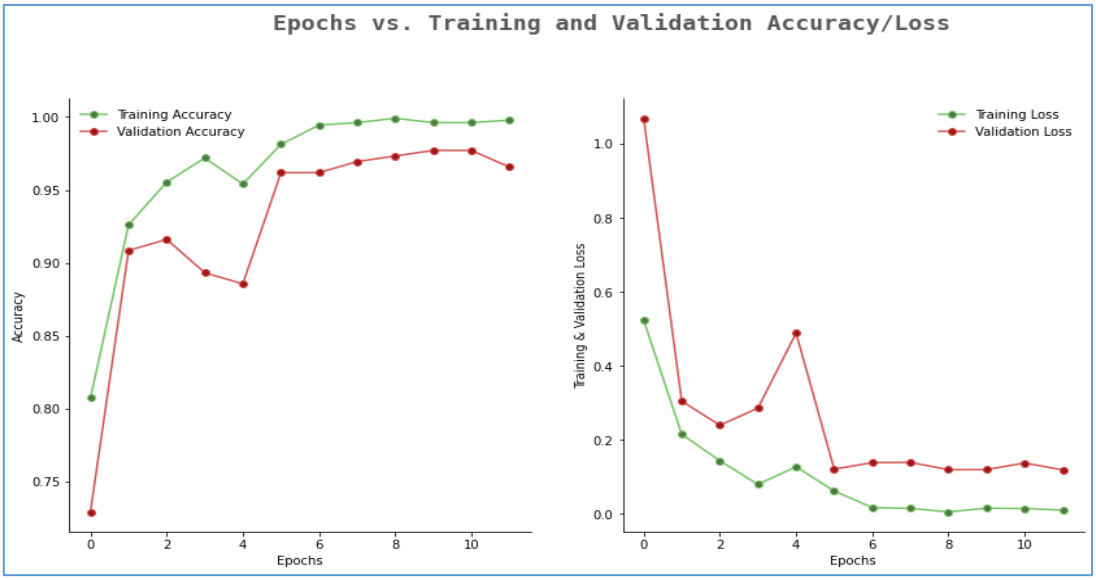

Figure 3: Shows training accuracy, validation accuracy, training loss and validation loss against epochs

As presented in Figure 3, it is evident that there is accuracy measure and loss measure against epochs. The training accuracy and validation accuracy are increased as the number of epochs increase. In the same fashion, the training loss and validation loss are decreased as the number of epochs increased. These trends reflect the prediction performance is improved as the number of epochs is increased.

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Model	Accuracy	Precision	Recall	F1-score
Proposed CNN	0.97	0.96	0.98	0.96
SVM	0.89	0.97	0.95	0.94
Random Forest	0.91	0.95	0.96	0.97

Table 1: Performance comparison

As presented in Table 1, the performance of different AI models is compared in terms of precision, recall, accuracy and F1-score.

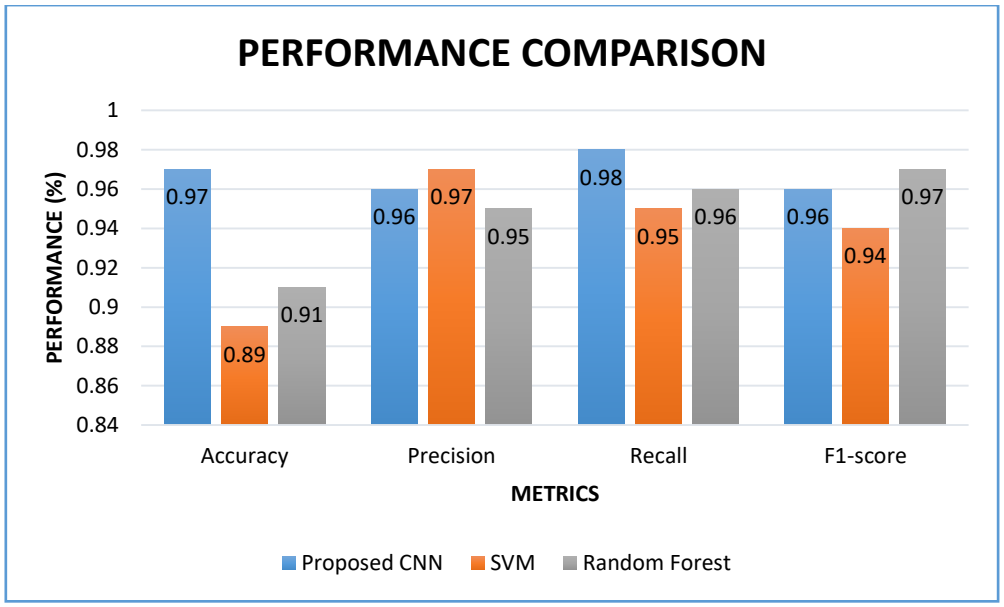

Figure 4: Performance comparison of all models

As presented in Figure 4, performance of the models used for brain stroke detection is visualized. The accuracy of SVM models is least with 89% while RF showed 91% accuracy. Highest accuracy is exhibited by the proposed CNN based model with 97% accuracy.

V. CONCLUSION AND FUTURE WORK

The existing approaches in AI have been used for different applications. In case of brain stroke detection, it is expected to make difference when AI is employed to detect probability of brain stroke. However, there is room for improving existing models. In this paper, we proposed a framework based on CNN based deep learning for efficient detection of brain stroke. We also proposed an algorithm to realize the framework.

The algorithm takes training and testing MRI scans of brain and learns from the training data to gain knowledge and then performs prediction process. The algorithm is found to be more efficient than existing ML algorithms like Support Vector Machine (SVM) and Random Forest (RF). The proposed AI approach based on CNN has achieved 97% accuracy. It can be used in the clinical decision support systems in healthcare units with further standardization of the model. In future we intend to improve our deep learning based model with transfer learning and region of interest (ROI) for further improvement in prediction performance.

REFERENCES

[1]Sirsat, Manisha Sanjay; Ferma, Eduardo; Cacmara, Joana (2020). Machine Learning for Brain Stroke: A Review. Journal of Stroke and Cerebrovascular Diseases, 29(10), 105162.

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[2]OmidShafaat;Joshua D. Bernstock;AmirShafaat;Vivek S. Yedavalli;GalalElsayed;SakshamGupta;EhsanSotoudeh;Haris I. Sair;David M. Yousem;HoumanSotoudeh; (2021). Leveraging Artificial Intelligence in Ischemic Stroke Imaging . Journal of Neuroradiology,

[3]Heo, Tak Sung; Kim, Yu Seop; Choi, JeongMyeong; Jeong, YeongSeok; Seo, Soo Young; Lee, Jun Ho; Jeon, Jin Pyeong; Kim, Chulho (2020). Prediction of Stroke Outcome Using Natural Language Processing-Based Machine Learning of Radiology Report of Brain MRI. Journal of Personalized Medicine, 10(4), p1-11.

[4]Guberina, Nika; Dietrich, U.; Radbruch, A.; Goebel, J.; Deuschl, C.; Ringelstein, A.; Köhrmann, M.; Kleinschnitz, C.; Forsting, M.; Mönninghoff, C. (2018). Detection of early infarction signs with machine learning-based diagnosis by means of the Alberta Stroke Program Early CT score (ASPECTS) in the clinical routine.Neuroradiology, p1-13.

[5]Saber, Hamidreza; Somai, Melek; Rajah, Gary B.; Scalzo, Fabien; Liebeskind, David S. (2019). Predictive analytics and machine learning in stroke and neurovascular medicine.Neurological Research, p1–10.

[6] Pereira, Danillo Roberto; Filho, Pedro P. Reboucas; de Rosa, Gustavo Henrique; Papa, Joao Paulo; de Albuquerque, Victor Hugo C. (2018). [IEEE 2018 International Joint Conference on Neural Networks (IJCNN) - Rio de Janeiro, Brazil (2018.7.8-2018.7.13)] 2018 International Joint Conference on Neural Networks (IJCNN) - Stroke Lesion Detection Using Convolutional Neural Networks., p1–6.

[7]Subudhi, Asit; Acharya, U. Rajendra; Dash, Manasa; Jena, Subhransu; Sabut, Sukanta (2018). Automated approach for detection of ischemic stroke using Delaunay Triangulation in brain MRI images.Computers in Biology and Medicine, p1-35.

[8]RajendraAcharya, U.; Meiburger, Kristen M.; Faust, Oliver; En Wei Koh, Joel; Lih Oh, Shu; Ciaccio, Edward J.; Subudhi, Asit; Jahmunah, V.; Sabut, Sukanta (2019). Automatic detection of ischemic stroke using higher order spectra features in brain MRI images. Cognitive Systems Research, p1-19.

[9] Karthik, R.; Menaka, R.; Johnson, Annie; Anand, Sundar (2020). Neuroimaging and deep learning for brain stroke detection - A review of recent advancements and future prospects. Computer Methods and Programs in Biomedicine, 197(), p1-17.

[10] Dourado Jr, Carlos M.J.M.; da Silva, SuanePires P.; da Nóbrega, Raul Victor M.; da S. Barros, Antonio Carlos; Filho, Pedro P. Rebouças; de Albuquerque, Victor Hugo C. (2019). Deep learning IoT system for online stroke detection in skull computed tomography images. Computer Networks, 152(), 25–39.

[11] Han, Tao; Nunes, Virginia Xavier; De Freitas Souza, Luis Fabricio; Marques, Adriell Gomes; Silva, Iagson Carlos Lima; Junior, Marcos Aurelio Araujo Ferreira; Sun, Jinghua; Filho, Pedro P. Reboucas (2020). Internet of Medical Thingsâ€ ” Based on Deep Learning Techniques for Segmentation of Lung and Stroke Regions in CT Scans. IEEE Access, 8(), 71117–71135.

[12]Akkus, Zeynettin; Galimzianova, Alfiia; Hoogi, Assaf; Rubin, Daniel L.; Erickson, Bradley J. (2017). Deep Learning for Brain MRI Segmentation: State of the Art and Future Directions. Journal of Digital Imaging, p1-11.

[13] Ingo Feinerer, Enrico Franconi, and Paolo Guagliardo. (2015). Brain Stroke Detection Using Convolutional Neural Network and Deep Learning Models. IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING.27 (2), p504-517.

[14]Xu, Yongzhao; Holanda, Gabriel; Fabricio, Luis; Souza, de F.; Silva, Hercules; Gomes, Adriell; Silva, Iagson; Ferreira, Marcos; Jia, Chuanyu; Han, Tao; de Albuquerque, Victor Hugo C.; ReboucasFilho, Pedro P. (2020). Deep Learning-Enhanced Internet of Medical Things to Analyze Brain CT Scans of Hemorrhagic Stroke Patients: A New Approach. IEEE Sensors Journal, (), 1–10.

[15]SelvikvågLundervold, Alexander; Lundervold, Arvid (2018). An overview of deep learning in medical imaging focusing on MRI.ZeitschriftfürMedizinischePhysik, p1-26.

[16]Heo, Tak Sung; Kim, Yu Seop; Choi, JeongMyeong; Jeong, YeongSeok; Seo, Soo Young; Lee, Jun Ho; Jeon, Jin Pyeong; Kim, Chulho (2020). Prediction of Stroke Outcome Using Natural Language Processing-Based Machine Learning of Radiology Report of Brain MRI. Journal of Personalized Medicine, 10(4), p1-11.

[17]Talo, Muhammed; BaranBaloglu, Ulas; Yıldırım, Özal; Rajendra Acharya, U (2018). Application Of Deep Transfer Learning For Automated Brain Abnormality Classification Using Mr Images. Cognitive Systems Research, p1-27.

[18]RajendraAcharya, U.; Meiburger, Kristen M.; Faust, Oliver; En Wei Koh, Joel; Lih Oh, Shu; Ciaccio, Edward J.; Subudhi, Asit; Jahmunah, V.; Sabut, Sukanta (2019). Automatic detection of ischemic stroke using higher order spectra features in brain MRI images. Cognitive Systems Research, p1-19.

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[19] Raghavendra, U., Pham, T.-H., Gudigar, A., Vidhya, V., Rao, B. N., Sabut, S., … Acharya, U. R. (2021). Novel and accurate non-linear index for the automated detection of haemorrhagic brain stroke using CT images. Complex & Intelligent Systems, 7(2), 929–940.

[20]Chauhan, Sucheta; Vig, Lovekesh; De Filippo De Grazia, Michele; Corbetta, Maurizio; Ahmad, Shandar; Zorzi, Marco (2019). A Comparison of Shallow and Deep Learning Methods for Predicting Cognitive Performance of Stroke Patients From MRI Lesion Images. Frontiers in Neuroinformatics, 13, p1-12.

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