ID: LB150

Machine Learning-Based Computational Magnetic Resonance Models for Rapid Diagnosis of Corona Virus Disease 2019 (COVID-19) Using Magnetic Resonance Fingerprinting Data

Michael Dada, Federal University of Technology, Minna, Nigeria, dadamichael@futminna.edu.ng

---

Category: Computational & Data Science

Abstract Body : Coronavirus 2019 (COVID-19) caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) is a respiratory track disease characterized by fever, dry cough, fatigue, and gastrointestinal symptoms. Currently, there is no definite treatment for COVID-19 although some drugs are under investigation. To promptly identify patients and prevent further spreading, they must be diagnosed in time and extra care has to be taken to ensure healthcare providers are not infected at all. Early detection and diagnosis of COVID-19 increases the chances of recovery of patients and this can be achieved through the use of computed tomography (CT) and magnetic resonance imaging (MRI) scanning. Although chest CT and digital radiography (DR) is important in the diagnosis and treatment of COVID-19, MRI is crucial for not just diagnosis of the disease but also for detection of other complications. MRI examinations for COVID-19 patients, protection of medical personnel and disinfection of MRI equipment is a challenging due high contingency of the disease. In addition to these problems, MRI examinations are costly. In order to overcome these challenges, this study proposes a computational method based of magnetic resonance fingerprinting (MRF) data, Bloch NMR response and machine learning. Clinical MRF were obtained from a recent experimental study on COVID-19. Since the specific MRF measurements in individual patients are not currently available, R computer codes were developed to simulate the measurements per subject. Taking the simulated data as individual data points, the time-independent NMR Bloch flow equation was solved analytically (as shown in equations (1) to (6)) and employed to compute the MRI signal for each subject based on spleen analysis data. The simulations were also done for cardiac MRI, hepatic panel test and brain volume data. The dataset generated from these simulations were then splitted into two (80% as training set and 20% as test set). As shown in figure 1, machine learning algorithms were then used to train the dataset. Support vector machine, logistic regression, decision tree and gradient boosting classifier returned accuracies of 88%, 82%, 88% and 88% respectively for spleen analysis dataset. For the hepatic panel test, cardiac MRI and brain volume datasets, these algorithms all returned 100% accuracies. Logistic regression model was then selected to do deploy the machine learning algorithm with streamlit and Heroku. COVID-19 detection app making use of computed spleen analysis dataset is shown in figure 2. The advantage of the developed app is that it does not require costly MRI scanners but a significantly cheaper NMR relaxometer can be used to take MRF data and with the app, diagnosis can be done quite easily and remotely. Swabs can be taken by patients and sent for MRF analysis and diagnosis with the machine learning app developed, with which disinfection is now much easier with lower risks of infection on healthcare providers. Despite the results that have been obtained in this study, the algorithm will benefit from training with larger amount of

data for improved detection efficiency. Also, a ground truthing process in clinical settings may be done to confirm that the simulated data points are realistic for real-time diagnosis.

References: 1. Raman, B., Cassar, M. P., Tunnicliffe, E. M., Filippini, N., Griffanti, L., Alfaro-Almagro, F.,Okell, T., Sheerin, F., Xie, C., Mahmod, M. and Mózes, F. E., Lewandoski, A.J.,Ohuma, E. O., Holdsworth, D., Lamlum, H., Woodman, M.J., Krasopoulus, C., Mills, R., McConnell, F.K., Wang, C., Arthofer, C., Lange, F.J., Anderson, J., Jenkinson, M., Antoniades, C., Chanon, K.M., Shanmuganthan M., Ferreira, V.M., Piechnik, S.K., Klenerman, P., Brighthing, C., Talbot, N.P Petousi, N., Rahman, N.M., Ho, L.P., Saunders, K., Geddes, J.R, Harrison, P.J., Pattison, K., Rowland, M.J., Angus, B.J., Glesson, F., Paulides, M., Koychev, I., Miller, K.L., Mackey, C., Tezzard, P., Smith, S.M.,& Neubauer, S. (2021). Medium-term effects of SARS-CoV-2 infection on multiple vital organs, exercise capacity, cognition, quality of life and mental health, post-hospital discharge. EClinicalMedicine, 31, 100683. 2. Awojoyogbe, O. B., Dada, O. M., Faromika, O. P., & Dada, O. E. (2011). Mathematical concept of the Bloch flow equations for general magnetic resonance imaging: A review. Concepts in Magnetic Resonance Part A, 38(3), 85-101. 3. Ayodele, T. O. Types of Machine Learning Algorithms, New Advances in Machine Learning, Yagang Zhang (Ed.), InTech, 2010, DOI: 10.5772/9385. Available from: http://www. intechopen. com/books/new-advances-in-machinelearning/types-of-machinelearning-algorithms.

Image/Figure:

https://s3.amazonaws.com/amz.xcdsystem.com/1E8A4501-BB41-A02A-1D3B9882B798BFAA_abstract_File10414/LB150_ImageFigure_0809024124.png

Image/Figure Caption: Model equations, machine learning algorithm performance and deployed app

First Name: Michael

Last Name: Dada

Email: dadamichael@futminna.edu.ng

Organization: Federal University of Technology, Minna, Nigeria

Country: Nigeria

ID: LB151
Development of Brain Atlas for Quantitative Comparison of Anatomical Parcellations

Michael Dada, Federal University of Technology, Minna, Nigeria, dadamichael@futminna.edu.ng

---

Category: Neuroscience

Abstract Body : Various research efforts have reported reference discrete macro-anatomical regions of the brain which were delineated according to specific brain atlas or parcellation protocol. For now, there is no widely accepted standards for partitioning the cortex and subcortical structures as well as assigning labels to the resulting regions. Previous attempts to reconcile neuroanatomical nomenclatures have been mostly qualitative while concentrating on the development of thesauri or simple semantic mappings between terms. In order to overcome this problem, we have developed a brain atlas method which is suitable for different quantitative analysis of the brain. The interaural 11.28mm and bregma 2.28mm region of rat brain in stereotaxic coordinates has been employed to demonstrate this method. The magnetic resonance imaging (MRI) scan of this brain region was imported into the Surfer (Golden Software, LLC) application. Each brain regions were traced and polygons were superimposed on these regions. The polygons were then encoded with region names as well as location information. The polygons were then exported as shapefile and the shapefile was read into python IDE using the geopandas library (the result is shown in figure 1(A)). For segmentation, each brain regions were labelled with unique numbers while for other brain feature analysis, experimental measurements were prepared as unique columns in microsoft excel data sheets. The data sheets were then merged with shapefile to get the final form of the atlas. Using the numerical data, the atlas was then reconstructed using python codes. The two cases of brain segmentation are shown in figures 1(C) and 1(D) while the case of tissue feature distribution across the rat brain are presented in figure 1(B). The advantage of the method used for this study is the memory management and how fast results can be obtained. Furthermore, this method can easily be extended to the human brain.

References: 1. Bohland, J. W., Bokil, H., Allen, C. B., & Mitra, P. P. (2009). The brain atlas concordance problem: quantitative comparison of anatomical parcellations. PloS one, 4(9), e7200. 2. Paxinos, G., & Watson, C. (2006). The rat brain in stereotaxic coordinates: hard cover edition. Elsevier. 3. Jiang, T. https://blogs.biomedcentral.com/bmcseriesblog/2018/03/05/the-human-brain-atlas-present-and-future/

Image/Figure:

https://s3.amazonaws.com/amz.xcdsystem.com/1E8A4501-BB41-A02A-1D3B9882B798BFAA_abstract_File10414/LB151_ImageFigure_0809110318.png

Image/Figure Caption: Developed brain atlas for segmentations and quantitative brain feature visualization.

First Name: Michael

Last Name: Dada

Email: dadamichael@futminna.edu.ng

Organization: Federal University of Technology, Minna, Nigeria

Country: Nigeria