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Medical Image Processing of Alzheimer

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Abstract **- A progressive disease Alzheimer is the leading source of dementia in the world, and its frequency continues to increase, in part due to the aging of the world's population. The process of this disease is naturally characterized by two characteristic pathologies. The diagnosis is constructed on clinical presentation and fluid and imaging biomarkers that meet several criteria. There was a requirement to automatically diagnose definite diseases based on medical images and subjects. This helps doctors and radiologists take further steps to treat the disease. Alzheimer's disease was chosen for this purpose. Alzheimer's disease is the leading cause of dementia and forgetfulness. Major cause of Alzheimer's disease is by the atrophy of a particular brain region and the death of brain cells. MRI scans give this information, but the areas of atrophy vary from person to person,making diagnosis a bit more difficult and are often misdiagnosed by doctors and radiologists. Provided by KAGGLE with more than 6400 subjects. Kernel convolution and neural networks are combined to create convolutional neural networks (CNN) . Kernel convolution is a technique for recognizing and segmenting images based on features using filters. A neural network represents a single classifier and consists of neurons loosely based on human brain neurons that are interconnected by weights, have different biases, and are activated by some activation function. Using a convolutional neural network solves the problem with a minimal error rate. The primary purpose of this theory is to demonstrate a novel method for classifying Alzheimer's disease (AD) built with TensorFlow and convolutional neural networks (TF and CNN). The network has three layers: a convolutional layer for removing AD characteristics, a flattening layer for bringing proportionsdown, and two fully connected layers for categorizing the withdrawn features. TensorFlow's primary goal is to build computational graphs. Two of his main contributions were made to improve the performance of classification: data enrichment and multi-optimizer. Data augmentation helps reduce overfitting and improve model performance. Images in the training dataset are enhanced by normalization, rotation, and cropping.**

Keywords – Dementia, Alzheimer's disease, radiological methods, diagnosis, Weight maps, CNN graph, TensorFlow, anatomical MRI

I. INTRODUCTION

Accepting and analyzing pictures shapes a huge portion of people's typical brain action amid their waking life. In truth, more than 99% of human brain movement is included in handling pictures from the cerebral cortex. The visual picture is wealthy in data. Confucius said, "A picture is worth a thousand words," and it was seen that typically a modest representation of the truth[20]. At a complex level, individuals deliver, record and transmit pictures. From the most punctual days of science, analysts have attempted to record what they have seen and indeed their thoughts around photography. Leonardo da Vinci was an extraordinary supporter of the visualsymbolism of his time: he gave full significance to the picture over the composed word. As of late, innovation has significantly extended its visual capabilities. Photography makes it conceivable to record pictures precisely, keeping scenes for afterward, rehashed, and maybe indeed more cautious[21]. Electromagnetic radiation is regularly utilized in imaging frameworks. Radiofrequency band is utilized in space science and attractive reverberation imaging (MRI).Upcoming clinical criteria may facilitate diagnosis in living patients. When provided at the appropriate stage of the disease process, these medications have been demonstrated to improve both patients' and guardian's quality of life[22]. However, neither the sickness course nor the rate of decline alters. Treatment currently focuses on symptomatic therapy, but there is ongoing research aimed at reducing the generation and all the burden of the pathology in the brain cells and progressive loss of cognitive rational function, subsequently leading to verbal and visual abilities that are often accompanied by various behavioral deficits[23]. Today, significant improvements in high performance computing have made training neural networks easier. We wanted to take advantage of this situation and use this technology to solve real problems. Python's popularity in data science has soared, particularly in terms of easily accessible tools and libraries for free. for the past three years, Python has been the preferred programming language among data scientists. According to a May 2018 survey by the authoritative website KDNuggets, Python is used by 65.2% of nearly 2,000 participants inthe top analytics, data science, and ML tools categories, compared to52.7% for RapidMiner, 48.5% is used in R Competitor[24]. You can use CPUs or GPUs to run your computations thanks to TensorFlow, a collection of open-source machine learning tools created by Google. Facebook and the Python programming language help Pytorch produce projects. The CNTK library is a set of Microsoft resources that can be used in DL code, and there is a Python library that supports formulas that use spanners. A neural network library is called Keras. TensorFlow was developed to make it easier for academics to study the original generation approach more thoroughly. The training and inference are both supported by TensorFlow at scale. Fast training makes use of hundreds of powerful (GPU-enabled) servers, and inference locally running on mobile devices from large distributed clusters in data centers. It is also adaptable enough to support the development of new machine and system level learning models[25]. The Tensor flow library, which offers many features and performance characteristics for disease categorization by machine and deep learning algorithms, was the subject of this paper

II. LITERATURE REVIEW

A few analysts have proposed procedures based on picture handling to analyze dementia. Here is a brief audit of a few of the methodologies as detailed in literature.

In [1], a survey paper on therapeutic picture handling is given in order to illuminate us of the sensational extension confronted by restorative picture preparation utilizing computer helped forms to extend the quality of pictures for distant better; a much better; a higher; a stronger; an improved understanding.

In [2], a diagram on dementia was given. Within the survey, the clinical sorts, pathophysiology and pharmacotherapy were

summarized. It too illuminates approximately different basic maladies that are the root cause of the disorder of dementia.

In [3], The creator's goal was to check the demonstrable plausibility of the records of dementia found in connected EHRs. The study's conclusion was that the majority of people with dementia records in connected UK EHRs had some authenticating evidence. Compared to forecasts based on the population, the measured dementia risk was greater. demonstrating that EHR were a valuable source of information for dementia research.

In [4], Clinical Significance and Contribution to Coordinated Anatomic and Atomic Imaging was the topic of the paper. It provides information on several imaging techniques, including fundamental imaging, atomic imaging, etc.

In [5], On the basis of approximately available data on weight maps, radiological categorization of dementia from anatomical MRI is examined.

This gadget may affect how junior radiologists perceive symptoms and may be a coordinate within the clinical scheduling procedure was the outcome of this search.

In [6], an audit paper on dementia determination analyzes the current writing on dementia conclusion. A look was performed in Sci-ELO and Pub-MED utilizing “dementia AND diagnostic” as it were writings distributed within the final 5 a long time were considered.7 articles drawn nearer the subject of intrigued.

In [7], Conclusion and Management of Dementia: Assessment that appropriately objects acquired cognitive misfortune in many cognitive domains to impact social or word-related jobs. In conclusion, several methods may be utilized to investigate the origin of dementia, including therapy history, cognitive and physical examinations, testingat research facilities, and brain imaging.

In [8], a comprehensive review was conducted of all the publications on aging, dementia, and other late-life mental health disorders that were published in the Indian Journal of Psychiatry (IJP) between 1958 and 2009. It illuminates the importance of assessing the risk factors for dementia and depression as modification of these factors could help in lowering the frequency of these conditions.

III. METHODOLOGY

a) Machine Learning

AI enhances the intelligence of a machine. ML is a branch of AI research. Several researchers believe that knowledge cannot be produced without learning. Figure 1 illustrates the various forms of ML Techniques. Reinforcement, Evolutionary Learning, Supervised, Unsupervised, Semi-Supervised. ML approaches include deep learning and reinforcement learning. ML algorithms were created and used to analyze medical data sets. The digital revolution has provided comparatively low-cost and accessible means for data collection and storage, especially in recent years. Medical data sets were observed using ML algorithms. The digital revolution has providedcomparatively low-cost and accessible means for data collection and storage, especially in recent years. The study of algorithms and mathematical models used by computer systems to improve their performance over time on a particular task is known as machine learning (ML). Several ML algorithms do particularly well in thediagnosis of heart, asthma, liver, malaria, and hepatitis illnesses.[9]

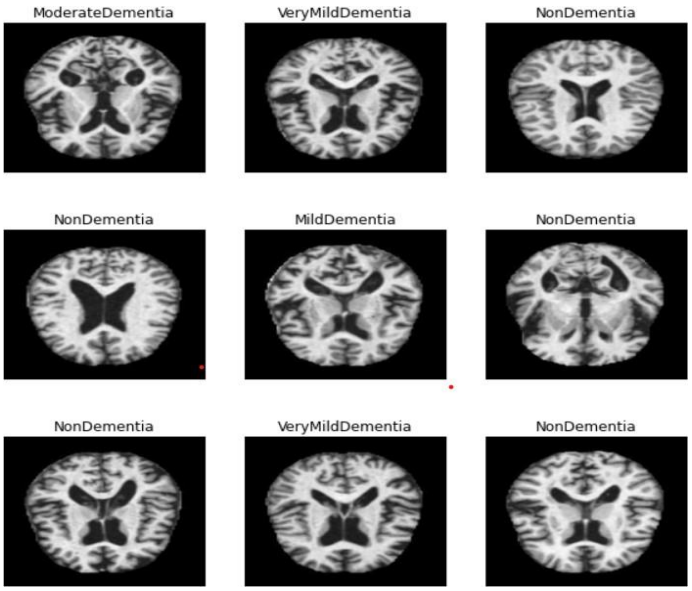
Frameworks for disease diagnostic systems DL and ML models from these libraries are used to train using data and model parallelism.Below are some of the best-known methods for diagnosing the disease.The source code for this method, formerly called DistBelief, has been revised and is now an application-based library. TensorFlow was rebranded and open sourced by Google in 2015. Simply put, TensorFlow is a machine learning and deep neural networks library that can be used to solve very complex mathematical problems. It can be thought of as a programming method in which equations are interpreted as data flow diagrams, first creating a program that he can run in one session. TensorFlow has many benefits for your application. The C/C++ backend makes it run faster than pure Python code. TensorFlow supports parallel computation on both CPUs and GPUs[10].

b) TensorFlow Structure

TensorFlow structure is based on the execution of data flow graphs. Nodes and edges are the two basic entities of this last entity. The first describes the mathematical procedure and the second identifies tensors, which are multidimensional arrays. As mentioned above, a common use of the TensorFlow architecture is to run a session afterthe graph has been created[11].

Graph computations are transformed, sent to the appropriate environment, and run on the GPU or CPU throughout the session [16]. For example, Z and Y are tensors. MatMul is used in the program (these are the processes performed on the tensors Z and Y) to add and finally add the result to the tensor X. Each work's outgoing tensor repeats the next work until it reaches the desired result W. Finally, the software creates a session to run the graph and calculate the results.So, what does tensor mean? Tensors seem to be a very common unit in mathematics whose meaning is represented in vector spaces, especially in poly linear algebra and differential geometry. Can be used to identify multi-sector or multi-linear applications. A tensor is a multidimensional array that can have zero, one, two, or more dimensions. Tensors allow developers to freely form datasets by encoding information stored in images[12].

The primary goal of our work is to examine and improve the effectiveness of MRI image classification for DL and CNN early AD diagnosis. This research involves developing and assessing a disease diagnostic method based on CNN-DL technology and MRI feature extraction in order to automatically categories AD. Following that, the tested model will be used in tests to evaluate it using the characteristics that CNN collected from the fully connected layer. To build an AD diagnostic approach, employ the methodology's subsequent phases.The first is the phase of acquiring MRI data. Every MRI pictureunderwent a second level of image preprocessing to scale it for the CNN model. Following that, MRI image features were extracted using pre-trained Convolution neural networks in order to be used in the feature extraction stage's classification step. Finally, different outcomes were looked at, the effectiveness of each strategy was reviewed using assessment criteria, and the results were compared to those of recent research. Kaggle datasets will be used in this investigation. The primary goal of the Kaggle dataset is to evaluate theonset of early Alzheimer’s disease. The Kaggle Dataset contains 6400 weighted MRI images with AD. The aim of the study was to assess thefeasibility of using MRI scans as an outcome measure in clinical trials of Alzheimer’s therapy. Each participant underwent many scans at intervals ranging from two weeks to two years. There are 6400 scansin all. In our tests, different photos from the same patient are handled separately, as though they were for different patients. It was important to determine the patient's Alzheimer’s stage and whether the patient had the disease based on these photographs[13].



To meet the input size requirements of the pretrained CNN, the MRI dataset preprocessing phase seeks to turn the data into a more optimum representation.. First, the brain was extracted by removing the skull from the MRI 3D images and denoising to improve the model's performance. MRI smoothing techniques are then often applied to reduce image noise and produce less pixelated images.

c) CNN

The proposed architecture for the pretrained CNN model consists of pooling layers, fully connected (FC) layers, and five layers of conv blocks. Convolutional and pooling layers are utilized in the feature extraction step, and fully linked layers in the image classificationstage. CNN employs local links and a pooling of recognized local characteristics to aggregate related local features into one feature.
On the other hand, FC slices are used to compute the output for each input MRI picture. The FC layer can be replaced with other classifiers, such as SVM or RF, to further improve the classification process.
The dataset is divided into three groups: training, validation, and test sets after data collection and picture processing. As there were few examples in the training dataset, data augmentation techniques were used to help. There are currently 6400 pictures on Kaggle as a consequence. A training set (labeled dataset) is used to train a CNN model for a certain task, such as: B. Feature extraction, in which fully linked layers of the CNN model are used to generate MRI feature vectors. The feature vectors are then input to three different classifiers. The validation set provides an unbiased evaluation of the model fit on the training data set while the model is being improved. Pre-trained CNNs were applied to MRI scans using the TensorFlow application as opposed to building a CNN from scratch, which requires vast datasets. Additionally, this aids in avoiding the overfitting problems brought on by small datasets. The ResNet 50 model was chosen because, over the preceding five years, it was undoubtedly the most significant advancement in the computer vision/DL community. With ResNet, you may train at countless levels. As these levels get deeper, the performance gets better. The CNN model approach for each layer set is briefly described in the paragraphs that follow[14].

1. Convolutional Layer

An essential component and fundamental building block of DL CNNs is convolutional layers. It is in charge of feature extraction, and the output set of 2D matrices it produces is known as feature maps. Each convolutional layer is made up of a predetermined number of filters that operate as feature detectors and extract features from the input picture. During the training phase, each filter develops the abilityto recognize low-level characteristics (colors, edges, blobs, corners, etc.) in the analyzed picture[15-18].

2. Pooling Layer

Following the convolutional layer comes a pooling. A subsampling layer reduces the size of the feature map produced by the convolutional layer. The most popular pooling procedure, known as max pooling, decreases feature maps by enlarging a tiny portion of the image by its maximum value. In order to maximize pooling efficiency,the image is split into a set of 2 2 non-overlapping sections. Each region's maximum value is taken. The size of the feature map is cut in half by a 22-pooling layer, or by a factor of 4. In order to prevent overfitting, a max-pooling procedure is used to provide a summary of the picture representation region. By lowering the number of parameters, it also reduces the amount of calculation. A different kind of pooling is average pooling layers.

3. Batch Normalization Layer

Using a stack normalization layer, the output of a convolutional layer is normalized by setting the stack's mean to 0 and variance to 1. By adopting a higher learning rate, this technique quickens the training process. It also prevents gradients inside the models from dissipating during backpropagation. Batch normalization layers also increase the resistance of DL models to improper weight initialization.

4. Dropout Layer

In order to prevent the overfitting issue, a dropout layer is used. The logic behind this method involves randomly deleting neurons while training. The number of neurons lost is controlled by the Dropout Rate parameter. The likelihood that a neuron will be eliminated is determined by this. Only while training is taking place are neurons destroyed.

5. Fully Connected Layer

The ResNet50 network's full connectivity layer is the top layer. It serves as a classifier and connects the network's layers to produce the classification result at the end. A final layer with a normalized exponential function is typically added after this. His ResNet50 was updated to improve this layer's classification of Alzheimer's disease.

IV. EXPERIMENTS AND RESULTS

The setup and results of the experiments are described in this section after their description. Before the results of model training and validation are provided, a brief description of the experimental setup, including the software and hardware parameters, is made. The results of feature extraction using the CNN model are covered in the third subsection.

V. EXPERIMENTAL SETUP

The Python programming environment for the tests was the Google Colab Pro platform. This is a Google cloud service that enables users to create and execute Python programs on hosted GPUs. The OpenCV DL Python library, TensorFlow, and NumPy were used to create the suggested fix. Additionally, for the analysis of MRI data, the Python packages pandas, matplotlib.pyplot, and PIL were employed. 6400 participants from the Kaggle dataset were used in this investigation. 1279 of them are utilized for model testing, and 5121 are used for

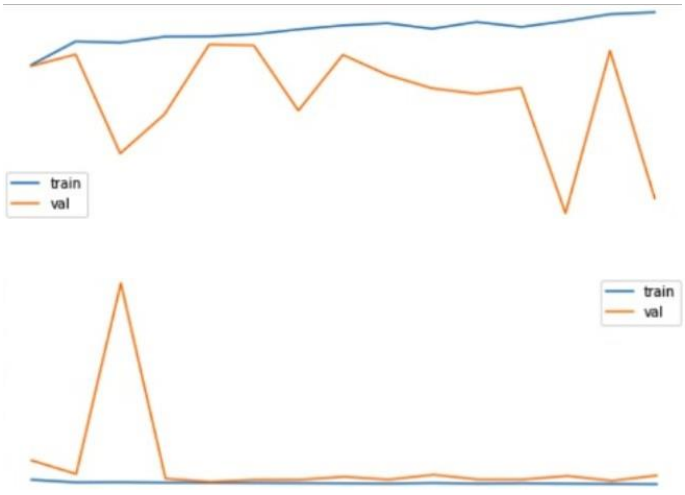
model training.
79% of the dataset was used for training in our study, and 21% was used for testing. The dataset's specifics are displayed in Table 2 below.

Data Set	Size	Training (78.7%)	Testing (21.3%)
Kaggle	6400	5041	1359

The suggested CNN model retains the structure of the ResNet50 model, but numerous modifications have been made to avoidoverfitting and improve the model's performance. A stack normalization layer was added to the output to normalize it after the final convolutional layer and each fully connected layer.
Even using the supplied hyperparameters, set the epoch to 100 before training the model. The model was evaluated using the accuracy and categorical cross-entropy (loss) of classified MRI pictures of AD and healthy participants. The goal of the loss function is to quantify the amount that the training model aims to minimize. The effectiveness of the pre-trained CNN models suggested by training and validation on the Kaggle datasets is depicted in the picture below.

```
252/252 [==============================] - 61s 244ms/step - loss: 0.8765 - auc: 0.8522
Epoch 15/100
  1/252 [..............................] - ETA: 57s - loss: 0.7701 - auc: 0.8906
  2/252 [..............................] - ETA: 1:04 - loss: 0.7616 - auc: 0.9006
  3/252 [..............................] - ETA: 59s - loss: 0.7385 - auc: 0.9144
  4/252 [..............................] - ETA: 58s - loss: 0.7250 - auc: 0.9229
  5/252 [..............................] - ETA: 57s - loss: 0.8016 - auc: 0.8901
  6/252 [..............................] - ETA: 57s - loss: 0.8176 - auc: 0.8827
  7/252 [..............................] - ETA: 56s - loss: 0.8099 - auc: 0.8859
```

The graph up top displays epochs and loss. The graph below, however, plots accuracy against epochs. Blue represents training outcomes, whereas orange represents validation results; the epoch is set to be 100.



The suggested model performs admirably on the Kaggle dataset, as was already demonstrated in the previous section. The first study question about the effectiveness of the suggested model requirements was satisfactorily answered, and the model was evaluated to determine its efficacy.
This can be accomplished by contrasting its performance with some of the cutting-edge techniques outlined in the literature review. On his MRI of the Kaggle dataset, the methodology of similar investigations was evaluated. Results from the proposed approach and Kaggle were compared.
Following model evaluation, the accuracy achieved was 80.34%, with a loss of 1.1773.

```
_ = model.evaluate(test_ds)
```

```
86/86 [==============================] - 6s 69ms/step - loss: 1.1773 - auc: 0.8034
```

VI. CONCLUSION

In this work, MR images were classified into Alzheimer's illness, mild delusions, moderate delusions, non-delusions, and very mild delusions using a three-layered CNN and TensorFlow. This model has been evaluated against the MR Brain Imaging Database for Alzheimer's disease (6400 images).
It appears that this device can rapidly progress symptomatic execution for a few clinically troublesome analyzes. This work demonstrates the potential of the approach to help detection of Alzheimer. All things considered; future reviews got to be performed to completely illustrate the esteem of the approach. This future study shall incorporate more contrasts. The broad benefits of progressing open well being measures have yielded a diminish in age- related events but the continuous statistical move implies endeavors on all fronts must be intensified in the event that were to be analyzed, treated, and cared for those with Alzheimer's disease[19].

VII. REFERENCE

[1]. Shruthishree et. al., "A REVIEW PAPER ON MEDICAL IMAGE PROCESSING", Vol.5 (Iss.4: RACSIT)] ISSN- 2350-0530(O), ISSN- 2394-3629(P) ICV (Index Copernicus Value) 2015: 71.21, April 2017.

[2]. Nitin Bansal and Milind Parle, "Dementia: An Overview", DOI: 10.15415/jptrm.2014.21003, 03 August 2017.

[3]. Mar Pujades-Rodriguez, Valentina Assi, Arturo Gonzalez-Izquierdo, Tim Wilkinson, Christian Schnier, "The diagnosis, burden and prognosis of dementia", a record-linkage cohort study in England. PLoS ONE 13(6): e0199026, June 26, 2018.

[4]. Kunal P. Patel, David T. Wymer, Vinay K. Bhatia, https://doi.org/10.1148/rg.2020190070, Jan 9 2020.

[5]. HAL Id: hal-02641005 https://hal.archives-ouvertes.fr/hal-02641005, 28 May 2020.

[6] M.A. Bannach," Literature view on dementia, vol.357, supplement1, E132, E133, October15,
DOI: https://doi.org/10.1016/j.jns, 2015 08.

[7] Zoe Arvantikis," Diagnosis and Management of Dementia: Review", JAMA, 22/29, (16): 1589-1599 .
DOI:10.1001/jama.2019.4782, October 2019

[8] Shaji KS,"Indian research on aging and dementia". DOI:10.4103/0019-5545.69227, source Pub-MED, January 2010

[9] Castellazzi, G Cuzzoni, MG. Cotta-Ramzino, M.; Martinelli, D.; Denaro, F.; Ricciardi, A.; Vitali, P. Anzarone, N.; Bernini, S.; Palesi, F.; and others. A machine learning approach with MRI selection features for the differential diagnosis of Alzheimer's disease and vascular dementia. front. Neuroinform. 14th and 25th, 2020 [CrossRef]

[10] A Alsalman, Firdews, Shler Farhad Khorshid, and Amira Bibo Sallow. "Disease diagnosis systems using machine learning and deep learning techniques based on tensorflow toolkit: a review." *AL-Rafidain Journal of Computer Sciences and Mathematics* 16.1 (2022): 111-120.

[11] Kundaram, Swathi S., and Ketki C. Pathak. "Deep learning-based Alzheimer disease detection." *Proceedings of the Fourth International Conference on Microelectronics, Computing and Communication Systems: MCCS 2019*. Springer Singapore, 2021.

[12] Ganesh, C. HSCA Rama, et al. "Multi class Alzheimer disease detection using deep learning techniques." *2022 International Conference on Decision Aid Sciences and Applications (DASA)*. IEEE, 2022.

[13] Farooq, Ammarah, et al. "A deep CNN based multi-class classification of Alzheimer's disease using MRI." *2017 IEEE International Conference on Imaging systems and techniques (IST)*. IEEE, 2017.

[14] Yamashita, R., Nishio, M., Do, R.K.G. *et al.* Convolutional neural networks: an overview and application in radiology. *Insights Imaging* **9**, 611–629 (2018). https://doi.org/10.1007/s13244-018-0639-9.

[15] Wen, Junhao, et al. "Convolutional neural networks for classification of Alzheimer's disease: Overview and reproducible evaluation." *Medical image analysis* 63 (2020): 101694.

[16] Wang, Shui-Hua, et al. "Classification of Alzheimer's disease based on eight-layer convolutional neural network with leaky rectified linear unit and max pooling." *Journal of medical systems* 42 (2018): 1-11.

[17] Tufail, Ahsan Bin, Yongkui Ma, and Qiu-Na Zhang. "Multiclass classification of initial stages of Alzheimer's Disease through Neuroimaging modalities and Convolutional Neural Networks." *2020 IEEE 5th Information Technology and Mechatronics Engineering Conference (ITOEC)*. IEEE, 2020.

[18] Zhang, Jie, et al. "A 3D densely connected convolution neural network with connection-wise attention mechanism for Alzheimer's disease classification." *Magnetic Resonance Imaging* 78 (2021): 119-126.

[19] Methods of detecting Alzheimer's disease using MRI. Available online:https://www.verywellhealth.com/can-an-mri-detect Alzheimer'ss-disease-98632

[20] Scott, Biljana. "Picturing irony: The subversive power of photography1." *Visual Communication* 3.1 (2004): 31-59.

[21] Kemp, Martin. *Leonardo da Vinci: the marvellous works of nature and man*. OUP Oxford, 2007.

[22] Heßmann, Philipp, et al. "Health-related quality of life in patients with Alzheimer's disease in different German health care settings." *Journal of Alzheimer's disease* 51.2 (2016): 545-561.

[23] Wareham, Lauren K., et al. "Solving neurodegeneration: common mechanisms and strategies for new treatments." *Molecular neurodegeneration* 17.1 (2022) .

[24] Stančin, Igor, and Alan Jović. "An overview and comparison of free Python libraries for data mining and big data analysis." *2019 42nd International convention on information and communication technology, electronics and microelectronics (MIPRO)*. IEEE, 2019.

[25] Pointer, Ian. *Programming pytorch for deep learning: Creating and deploying deep learning applications*. O'Reilly Media, 2019.