



CLASSIFICATION OF DIFFERENT TYPES OF DDR RAM USING TRANSFER LEARNING IN CONVOLUTIONAL LEARNING NETWORKS

Jessica S. Velasco¹, Jonathan Michael A. Manalo¹, Marc Anthony Christopher L. Abana¹,
 Kenji Gabriel B. Ebron¹, Jovencio V. Merin² and Jomer V. Catipon¹

¹Department of Electronics Engineering, College of Engineering Technological University of the Philippines, Manila, Philippines

²Department of Electrical Engineering, College of Engineering Technological University of the Philippines, Manila, Philippines

E-Mail: jessica.velasco@tup.edu.ph

ABSTRACT

Technology, specifically computers play an important role in modern society. People who are new to computers can determine what type of RAM they have, which can be used to avoid confusion on what type of RAM their computer needs with the help of an Android device. For this study, a powerful computer with a Graphics Processing Unit (GPU) needed to be used to shorten the amount of time that the deep learning process takes. The study gathered images of 4 types of Random Access Memory for a RAM classification system. There were 1000 images in total for DDR1, DDR2, DDR3, and DDR4 RAM. The study utilized transfer learning to RAM type classification with pre-trained models such as VGG16, VGG19, Inception V3, and Xception. The data that was gathered showed that Xception is the best classifier with an initial average accuracy of 85.034% and a 100% Val_Accuracy even though the model had the longest loading time with 12 seconds.

Keywords: RAM classification (Random Access Memory), deep learning, convolutional neural networks, transfer learning, python.

Manuscript Received 27 December 2023; Revised 5 March 2024; Published 15 April 2024

INTRODUCTION

Technology is a body and form of knowledge that is committed to creating and innovating tools, processing and developing systems, and the extraction of numerous materials. This term is wide and broad and can be defined by everyone as people have different ways of understanding and defining its meaning. It allows people to accomplish various tasks in their daily lives, in brief; we can describe technology as products and processes used to simplify our daily lives. The use of technology allows its user to extend their abilities, making people the most crucial part of any technological system. Over the years, the concept of technology has progressed drastically, and it still is developing exponentially. As one of the major keys that played in the development of society is the introduction of computers.

[15] Computers today are a vital tool in society, it helps increase productivity as well as connect someone to the internet, which unlocks the full potential of the computer as it allows one to access information beyond what is currently accessible to someone for computers can store enormous amounts of data digitally which can reduce waste. Computers can also help sort through and organize information which can save time in doing particular tasks. A computer is defined as an electronic device that works with information. It is derived from the Latin term “*computare*” which is said to calculate or is a programmable machine. Computers are complex electronic devices that take raw data as input from the user and then process the data under a set of instructions called a program give a result and save it for future use. Computers can process both numerical and non-numerical calculations. [16] An article defines computers as devices

that manipulate data and can store, retrieve, and process data.

Modern computers are called digital computers wherein the basic components are an Input and Output Device, a Central Processing Unit (CPU), a mass storage device, and memory (Thakur, n.d.). Computers have both hardware and software. Hardware is any physical component of the computer, with examples being the keyboard and mouse of the computer whereas software is a set of instructions that tell the computer what to do and how to do certain things such as compute arithmetic problems and browse the internet.

Random Access Memory, otherwise known as RAM, is defined as hardware in a computing device where the operating system and any programs or applications currently in use are kept so that the device’s processor can easily access them. It is the main memory of a computer and is faster to read and write from compared to other kinds of storage. RAM functions like the short-term memory of a person, which is focused on immediate work. The term random access is applied to RAM as any storage location can be accessed directly. It is important to note, however, that once the computer is turned off, all the memory on the RAM is lost. [12]

According to an article [6], classification is the process of determining the class of given data points. These classes are sometimes called targets or categories. A classifier is a machine learning tool where the learned attribute is categorized. It is used after the learning process to classify new records or data by giving them a suitable target attribute or prediction.

The article “Article Intelligence History” defines Artificial Intelligence or AI as something that enables



machines to learn from experience, allowing them to adjust to new inputs and perform tasks like humans, the article also gives a brief history of Artificial Intelligence dating back to 1956 where the term was first coined. AI research in the 1950s explored topics more on problem-solving until the 60s when the US Department of Defense began training computers to mimic basic human reasoning. What makes Artificial Intelligence so important is that it allows analysis of more and deeper data, it can also automate repetitive learning and discovery through data as well as adding intelligence to applications such as smartphones, with Siri being an example.

The article "Some Key Machine Learning Definitions" by Bhattacharjee shows key terms in machine learning and describes each. Models are described in the articles as machine learning models that can be a mathematical interpretation of a real-world process. Algorithms are defined as the hypothesis set that is taken before training starts with data from the real world. Training is when an individual passes an algorithm with training data. The algorithm then finds patterns in the training data that input parameters corresponding to the target. The output is produced, which can be used by an individual to make predictions.

The findings in this project will benefit people who are not that knowledgeable about computers with the reason that people who are new to building their computers may mistake one type of RAM for another, leading to a waste of effort and resources. Therefore, people who will use the application made by us may substantially benefit from this regarding saving time and money, as well as being able to distinguish different versions or generations of RAM. This study will also be of benefit for the researchers for it allows us to gain more knowledge regarding computers as well as RAM types. We propose this to visually predict the type of DDR RAM by obtaining images from accessible websites and then classify each image into the correct type of DDR RAM category via transfer learning.

CONCEPTUAL LITERATURE

[10] An article defines transfer learning as making use of knowledge gained while solving one problem and applying it to a different problem whereas [5] a different article defines transfer learning as a process in machine learning where a model that was designed for a certain task is reused as a starting point for another model for another task. In this study, Python was used as the main programming language, with Keras and Tensorflow being the back-end of the program and Pycharm being the software used to run the models of VGG16, VGG19, Inception_V3, and Xception.

[3] Keras is a minimalist Python library that is used for deep learning and can run on top of either Theano or Tensorflow. It was developed to make the implementation of deep learning models as fast and as easy as possible for research and development. Keras was made by a Google developer named Francois Chollet with the guiding principles that Keras be modular, minimalistic, extensive, and use native Python.

[9] Python is a programming language created by Guido van Rossum in 1991, it is a programming that is used for server-side web development, software development, mathematics, and system scripting. Python can be used to develop web applications on a server and can handle big data and perform complex mathematics [17].

Pycharm is an Integrated Development Environment (IDE) that is used in computer programming and was developed by JetBrains in 2010. This IDE was created from Python but is also available for other programming languages such as Java. Some of the features include code analysis, and graphical debugging, and can be used for development in data science in conjunction with Anaconda, which is a free and open-source distribution of R programming and Python that is typically used for data science as well as machine learning applications, etc. [7]

A. VGG16

VGG16 is a convolutional neural network also known as OxfordNet, proposed by K. Simonyan and A. Zisserman, both from the University of Oxford in their paper "Very Deep Convolutional Networks for Large-Scale Image Recognition". VGG16 is a model that achieves 92.7% accuracy in ImageNet [14]. [13] In the study "Subclass Separation of White Blood Cell Images Using Convolutional Neural Network Models", the researchers used VGG16 along with other models such as LeNet and AlexNet architecture for their classification of White Blood Cell images. The results showed that VGG16 had an accuracy of 27.34% with a loss rate of 13.862%.

B. VGG 19

To describe VGG19, it is a convolutional neural network that is trained on more than a million images on ImageNet. VGG19 has 19 layers. The network has a wide range of images with an input size of 224 by 224 [2]. [8] In the study "Fundus Image Classification using VGG-19 Architecture with PCA and SVD", the researchers used VGG-19 was used as the model. In their study, the accuracies reached 92.31, 97.96, 98.13, and 98.34% respectively. The researchers in that study concluded that VGG-19 was a deeper and more reliable model for the VGGNet offers a deeper and more reliable architecture for ImageNet compared to AlexNet.

C. Inception_V3

[1] Inception_V3 is defined as a Deep Learning Convolutional Architecture which was trained using a dataset of 1,000 classes from the original ImageNet which has over a million training images. [11] In the study "Classification of Breast Cancer Histology Images Using Transfer Learning" in which the researchers compared Inception V3 to ResNet 50. In their abstract, Inception V3 achieved an average test accuracy of 97.08%, which outperformed ResNet 50 with an average test accuracy of 96.66%.



D. Xception

[4] The author of the article compared the Inception model with the Xception in which it stated that Xception is a model that is inspired by Inception with the difference being that Xception is a model that replaces Inception's modules with depthwise separable convolutions. The article shows that while Xception has the same number of parameters as Inception V3, the performance gain of Xception comes from more efficient use of model parameters rather than increased capacity.

E. Convolutional Neural Network

[22] The term Deep Learning or Deep Neural Network refers to Artificial Neural Networks (ANN) with multilayers. Over the last few decades, it has been considered to be one of the most powerful tools and has become very popular in the literature as it can handle a huge amount of data. The interest in having deeper hidden layers has recently begun to surpass classical methods performance in different fields; especially in pattern recognition. One of the most popular deep neural networks is the Convolutional Neural Network (CNN). It takes this name from the mathematical linear operation between matrixes called convolution. CNN has multiple layers; including a convolutional layer, non-linearity layer, pooling layer, and fully-connected layer. The convolutional and fully connected layers have parameters, but pooling and non-linearity layers don't have parameters. The CNN has an excellent performance in machine learning problems.

F. Activation Function

[18] A function is added to the artificial neural network to help the network learn complex patterns in the data. The function in the output signal is taken from the previous cell and turned into a form that is interpreted into another result.

As stated in the CNN (Convolutional Neural Network), they are algorithms that take the input given to them which is used to read the images fed into the program. Breaking down each pixel of the image and correlating the gathered data with the necessary information. Some of the following activation functions as stated are used to compute the procured results. It allows the value, if not restricted to a certain limit, to go very high in magnitude which is especially found in deep neural networks which contain millions of parameters.

[19] Equation 1 shows the sigmoid activation function formula that is used in the created program to differentiate and classify the different models of DDRs.

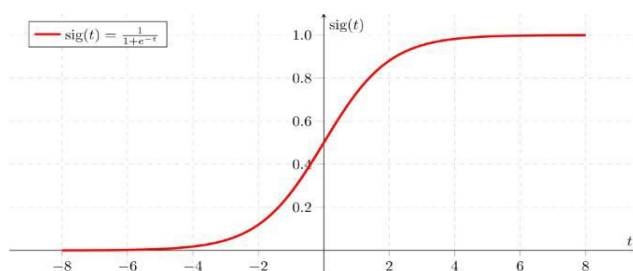


Figure 1. Sigmoid.

[20] Equation 2 shows the ReLu (Rectified Linear Unit) activation function to help with the computations involved in the gathered data.

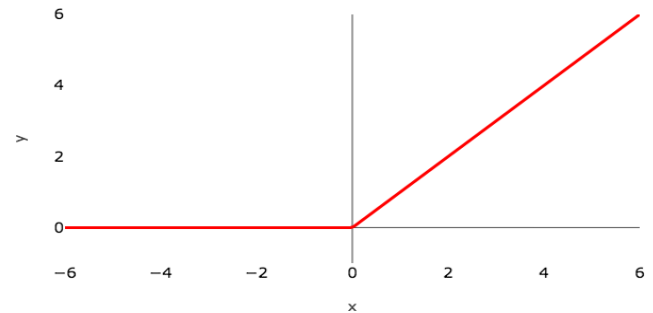


Figure-2. ReLu (Rectified Linear Unit).

[21] Equation 3 shows the SoftMax activation function which is used in multi-class classification problems and helps distinguish the differences among the numerous models of DDRs.

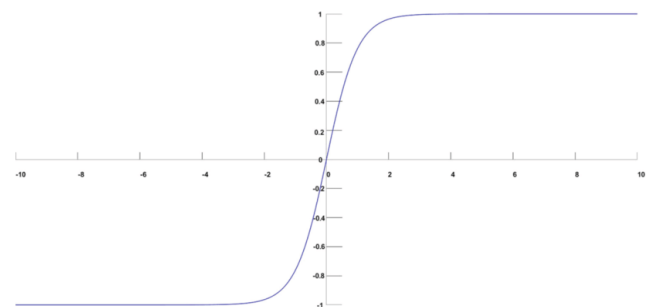


Figure-3. Soft Max.

METHODOLOGY

Dataset

The images that were needed for the project were collected from Google Images. Figure-4 shows images of different types of RAM.



Figure-4. Images of DDR1, DDR2, DDR3, and DDR4 RAM.

RESULTS AND DISCUSSIONS

A. Confusion Matrix

For the results, the models along with the datasets were run in Pycharm, there were a total of 40 epochs run, with each model having 10 epochs, the averages of each epoch were then encoded. Figure 5-8 shows the confusion matrices for each model. It is important to note that a darker shade of color would indicate a higher accuracy



compared to that of lighter shades of color, indicating lower accuracy. Furthermore, the models that were able to show better results among others were Inception, VGG 16, Xception, and VGG 19 in that order. Factors that might have affected the interpretation of the data might have been the image quality, and the number of observations per category (DDR1, DDR2, DDR3, and DDR4).

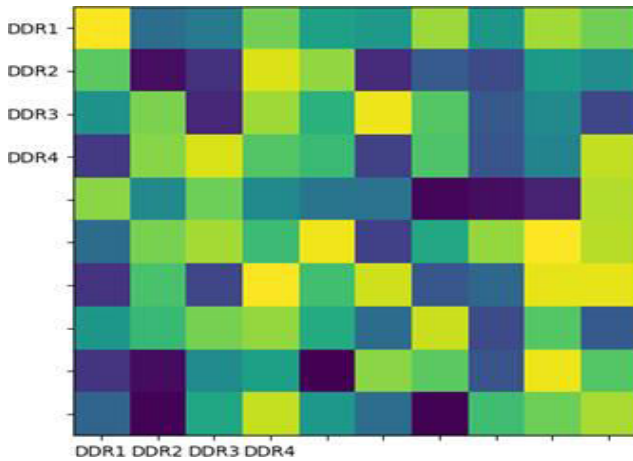


Figure-5. VGG16 confusion matrix.

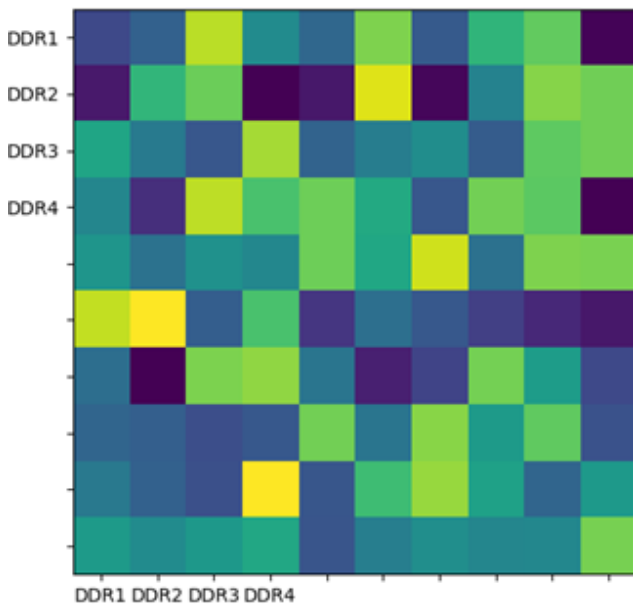


Figure-6. VGG19 confusion matrix.

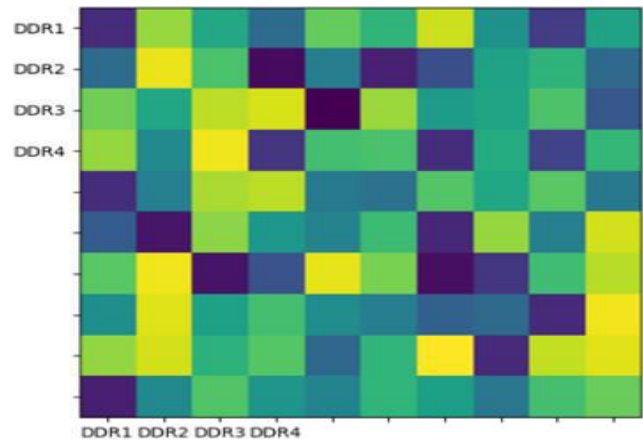


Figure-7. Inception confusion matrix

For the methods of the study, the researchers first gathered images from the internet as the basis for the data set which will be then converted into the XML format and then to CSV format. After that procedure had been done, the researchers installed Python 3.6 and Anaconda as the programming language to be used. Tensorflow, Keras, OpenCV, plus Seaborn packages were also used for programming with Tensorflow and Keras being used as the back-end of the program. After the installation, the models VGG 16, VGG 19, Inception, and Xception were used as models for programming the image classifier.

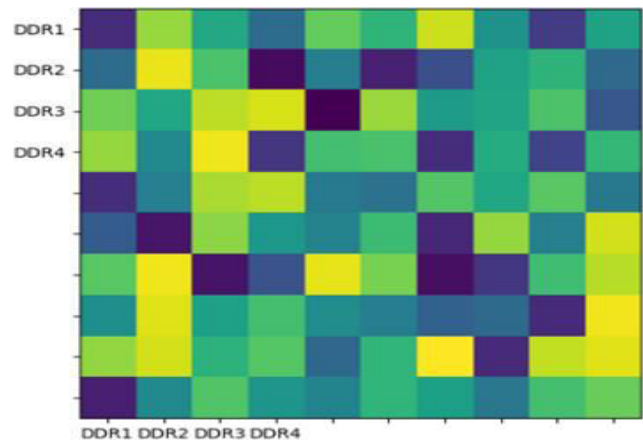


Figure-8. Xception confusion matrix.

B. Table of Values

Tables 1-4 show the Table of Values that were run in Pycharm, Results show that both VGG16 and VGG19 had the shortest loading time with an average of 3 seconds, with the longest loading time being Xception with 12 seconds. In the initial accuracy, it shows that the model with the highest accuracy is Xception with 85.034% and with the lowest being VGG19 with 45.573%. Almost all of the models had a Val_Accuracy of 100, with Inception being the only model not having a 100 Val_Accuracy.

The Table of Values in this paper shows the initial loss and accuracy, as well as the val_loss and the val_accuracy of the models. Val_loss is the value of the cost function for the cross-validation data and loss is the



value of the cost function for the training data. The same goes for the val_accuracy and accuracy of the models wherein the accuracy corresponds to the training data and the val_accuracy corresponds to the cross-validation data.

Table-1. VGG 16 results.

EPOCH	LOSS	ACC	VAL LOSS	VAL ACC
1	0.9886	0.5475	0.6931	1.0000
2	1.1561	0.4775	0.6931	1.0000
3	1.0791	0.5300	0.6931	1.0000
4	0.9246	0.5425	0.6931	1.0000
5	1.1561	0.4625	0.6931	1.0000
6	1.0018	0.5052	0.6931	1.0000
7	1.1561	0.5325	0.6931	1.0000
8	0.9247	0.5296	0.6931	1.0000
9	1.2689	0.4825	0.6931	1.0000
10	1.0018	0.4902	0.6931	1.0000

Loading Time: 3 seconds
Avg. Initial Acc.: 51%

Table-2. VGG 19 results.

EPOCH	LOSS	ACC	VAL LOSS	VAL ACC
1	1.1874	0.5000	0.6931	1.0000
2	0.9245	0.4900	0.6931	1.0000
3	1.0789	0.5498	0.6931	1.0000
4	1.0019	0.4700	0.6931	1.0000
5	1.1559	0.5200	0.6931	1.0000
6	1.0791	0.5200	0.6931	1.0000
7	1.0018	0.5098	0.6931	1.0000
8	0.9247	0.5050	0.6931	1.0000
9	1.0789	0.5102	0.6931	1.0000
10	1.1561	0.5025	0.6931	1.0000

Loading Time: 3 seconds
Avg. Initial Acc.: 45.573%

Table-3. Inception Results.

EPOCH	LOSS	ACC	VAL LOSS	VAL ACC
1	0.8068	0.6149	0.6888	1.0000
2	0.5635	0.7149	0.1922	1.0000
3	0.4653	0.7998	1.5782	0.0000e+00
4	0.4649	0.8249	0.5439	1.0000
5	0.3452	0.8303	0.0479	1.0000
6	0.1389	0.9700	0.0015	1.0000
7	0.2302	0.9199	2.0637e-04	1.0000
8	0.3693	0.8850	0.1106	1.0000
9	0.2045	0.9149	0.0033	1.0000
10	0.2487	0.9077	0.0076	1.0000

Loading Time: 6 seconds
Avg. Initial Acc.: 83.823%

Table-4. Xception results.

EPOCH	LOSS	ACC	VAL LOSS	VAL ACC
1	0.8608	0.4525	0.6527	1.0000
2	0.6574	0.6325	0.3579	1.0000
3	0.4500	0.8029	0.1714	1.0000
4	0.3075	0.8926	0.0806	1.0000
5	0.1785	0.9300	0.1288	1.0000
6	0.2325	0.9276	6.0869e-04	1.0000
7	0.1344	0.9600	9.8295e-04	1.0000
8	0.1374	0.9476	0.0037	1.0000
9	0.0950	0.9727	0.0010	1.0000
10	0.0818	0.9850	4.5572e-04	1.0000

Loading Time: 12 seconds
Avg. Initial Acc.: 85.034%

CONCLUSIONS

The study used transfer learning for its RAM-type classification. Pretrained models were utilized such as VGG16, VGG19, Inception, and Xception. The RAM-type images come from open-access repositories such as the internet, these include DDR1, DDR2, DDR3, and DDR4 RAM types. Based on the Results and Discussion, it was found that the most accurate model was Inception with the lowest accuracy being VGG19. The results also show that the best classifier is Xception with an initial accuracy of 85.034% with a 100% Val_Accuracy even though it has the longest loading time of 12 seconds.

REFERENCES

- [1] Adam Milton Barker. 2019. Inception V3 Deep Convolutional Architecture For Classifying Acute Myeloid/Lymphoblastic Leukemia. Intel® Software, 20-Feb-2019. [Online]. Available: <https://software.intel.com/en-us/articles/inception-v3-deep-convolutional-architecture-for-classifying-acute-myeloidlymphoblastic>. [Accessed: 18-Dec-2019].
- [2] "alexnet," Pretrained VGG-19 convolutional neural network-MATLAB. [Online]. Available: <https://www.mathworks.com/help/deeplearning/ref/vgg19.html>. [Accessed: 18-Dec-2019].
- [3] J. Brownlee. 2019. Introduction to Python Deep Learning with Keras. Machine Learning Mastery, 13-Sep-2019. [Online]. Available: <https://machinelearningmastery.com/introduction-python-deep-learning-library-keras/>. [Accessed: 18-Dec-2019].
- [4] Chollet and François. 2017. Xception: Deep Learning with Depthwise Separable Convolutions. arXiv.org,



- 04-Apr- 2017. [Online]. Available: <https://arxiv.org/abs/1610.02357>. [Accessed: 18-Dec-2019].
- [5] B. Curry. 2019. An Introduction to Transfer Learning in Machine Learning. Medium, 26 Jul 2018. [Online]. Available: <https://medium.com/kansas-city-machine-learning-artificial-intelligen/an-introduction-to-transfer-learning-in-machine-learning-7efd104b6026>. [Accessed: 18-Dec-2019].
- [6] Data Mining - (Classifier: Classification Function). Nickeau WebSite. [Online]. Available: https://gerardnico.com/data_mining/classification. [Accessed: 18-Dec-2019].
- [7] Krishnakumar. 2019. What is PyCharm and Why it is Recommended For Python Users? Eduonix Blog, 11-Jun-. [Online]. Available: <https://blog.eduonix.com/software-development/pycharm-and-why-is-it-recommended/>. [Accessed: 18-Dec-2019].
- [8] M. Mateen, J. Wen, Nasrullah, S. Song and Z. Huang. 2018. Fundus Image Classification Using VGG-19 Architecture with PCA and SVD. Symmetry. 11(1): 1.
- [9] Python Introduction. Introduction to Python. [Online]. Available: https://www.w3schools.com/python/python_intro.asp. [Accessed: 18-Dec-2019].
- [10] P. Radhakrishnan. 2019. What is Transfer Learning? Medium, 26-Oct-2019. [Online]. Available: <https://towardsdatascience.com/what-is-transfer-learning-8b1a0fa42b4>. [Accessed: 18-Dec-2019].
- [11] N. Ravikumar, A. A. Davari, S. Ellmann, and A. Maier. 2018. Classification of Breast Cancer Histology Images Using Transfer Learning. Springer Link, 27-Jun-2018. [Online]. Available: https://link.springer.com/chapter/10.1007/978-3-319-93000-8_92#citeas. [Accessed: 18-Dec-2019].
- [12] M. Rouse, K. Ferguson, M. Rouse, and M. Rouse. 2019. What is RAM (Random Access Memory)? - Definition from WhatIs.com. 2019. SearchStorage. [Online]. Available: [https://searchstorage.techtarget.com/definition/RAM-random-access-memory#:~:targetText=RAM\(Random Access Memory\) is, reached by the device's processor.&targetText=When the computer is](https://searchstorage.techtarget.com/definition/RAM-random-access-memory#:~:targetText=RAM(Random Access Memory) is, reached by the device's processor.&targetText=When the computer is) rebooted, from an HDD or SSD. [Accessed: 18-Dec-2019].
- [13] M. Togacar, B. Ergen and M. E. Sertkaya. 2019. Subclass Separation of White Blood Cell Images Using Convolutional Neural Network Models. Elektronika ir Elektrotechnika. [Online]. Available: <http://www.eejournal.ktu.lt/index.php/elt/article/view/24358>. [Accessed: 18-Dec-2019].
- [14] VGG16 - Convolutional Network for Classification and Detection. VGG16 - Convolutional Network for Classification and Detection, 21-Nov-2018. [Online]. Available: <https://neurohive.io/en/popular-networks/vgg16/>. [Accessed: 18-Dec-2019].
- [15] What are the advantages of using a computer? Computer Hope, 03-Sep-2019. [Online]. Available: <https://www.computerhope.com/issues/ch001798.htm>. [Accessed: 18-Dec-2019].
- [16] What is a Computer? Computer Basics: What is a Computer? [Online]. Available: <https://edu.gcfglobal.org/en/computerbasics/what-is-a-computer/1/>. [Accessed: 18-Dec-2019].
- [17] What is Python? Python for Beginners. [Online]. Available: <https://www.pythonforbeginners.com/learn-python/what-is-python/>. [Accessed: 18-Dec-2019].
- [18] [18-21] Jain, V. (2019, December 30). Everything you need to know about "Activation Functions in Deep Learning Models. Medium. <https://towardsdatascience.com/everything-you-need-to-know-about-activation-functions-in-deep-learning-models>.
- [19] S. Albawi, T. A. Mohammed and S. Al-Zawi. 2017. Understanding of a convolutional neural network. 2017 International Conference on Engineering and Technology (ICET), pp. 1-6, doi:10.1109/ICEngTechnol.20178308186.