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Bone Marrow Cell Classification

Yashaswi Bhavya, Bhavesh Dalal, Hrideya Khushaali
Amity School of Engineering & Technology
Amity University Noida, Uttar Pradesh

Abstract: In this comparative study, we evaluate the performance of four prominent convolutional neural network (CNN) architectures, namely ResNet50, EfficientNetB7, InceptionV3, and VGG16, in the context of bone marrow cell classification. The objective is to discern the most effective model for accurately categorizing bone marrow cell images. Each architecture is renowned for its unique design principles and features, and their comparative analysis in the specific domain of medical image classification holds paramount significance for enhancing diagnostic precision. Leveraging a comprehensive dataset of bone marrow cell images, we employ rigorous evaluation metrics to assess the models' accuracy, precision, recall, and F1 score. Our findings shed light on the strengths and weaknesses of each architecture, providing valuable insights for researchers and practitioners in the field of medical image analysis. The implications of this study extend to the optimization of diagnostic tools and methodologies, ultimately contributing to the advancement of medical research and healthcare practices. Furthermore, the comparative nature of our analysis ensures a nuanced understanding of the nuanced intricacies of each model, guiding the selection of an optimal architecture for bone marrow cell classification tasks.

I. INTRODUCTION

In the realm of bone marrow cell classification, the selection of an appropriate deep learning model plays a pivotal role in achieving accurate and reliable results. This study conducts a comprehensive comparative analysis of four prominent convolutional neural network (CNN) architectures, namely ResNet50, EfficientNetB7, InceptionV3, and VGG16, in the context of bone marrow cell classification. Each model brings unique characteristics to the table, and understanding their performance nuances is essential for optimizing diagnostic outcomes. (1)

EfficientNetB7 emerges as a standout contender in this study, showcasing superior performance compared to its counterparts. The EfficientNet architecture, known for its compound scaling method that uniformly scales network depth, width, and resolution, achieves remarkable efficiency and accuracy. EfficientNetB7, being a larger variant within the EfficientNet family, demonstrates enhanced feature extraction capabilities and a heightened ability to capture intricate patterns within bone marrow cell images. Its superior parameter efficiency allows for more accurate representation of complex features, crucial for the nuanced classification demands of bone marrow cells. The model's ability to balance computational efficiency with increased (4)

Model complexity positions it as an optimal choice for this task, showcasing its potential to outperform ResNet50, InceptionV3, and VGG16 in the realm of bone marrow cell classification. (2)

II. Proposed System

The proposed system for Bone Marrow Cell Classification using deep learning aims to leverage advanced computational techniques to enhance the accuracy and efficiency of cell classification in bone marrow images. This system combines the power of deep learning algorithms with image processing to automate and optimize the classification of different cell types within bone marrow samples. In the realm of bone marrow cell classification, the selection of an optimal convolutional neural network (CNN) architecture is pivotal for achieving accurate and efficient results. The proposed system involves a comparative study of four prominent CNN models: ResNet50, EfficientNetB7, InceptionV3, and VGG16. Each model brings its unique characteristics and architectural nuances to the task of classifying bone marrow cells, which plays a crucial role in diagnosing various hematological disorders. However, among these models, EfficientNetB7 stands out as a particularly compelling choice for several reasons. (11)

EfficientNetB7, part of the EfficientNet family of models, is characterized by an innovative approach to model scaling, which balances network depth, width, and resolution. This compound scaling allows EfficientNetB7 to achieve superior performance with significantly fewer parameters compared to other models in the study. In the context of bone marrow cell classification, where computational efficiency is paramount, EfficientNetB7 excels by providing a high level of accuracy while demanding less computational resources during both training and inference phases. The model's impressive performance is attributed to its ability to

capture intricate features within the data while maintaining a streamlined architecture, making it adept at handling the complexities (3) (5)

Inherent in bone marrow cell images. Consequently, the proposed system advocates for the adoption of EfficientNetB7 as the preferred CNN architecture for bone marrow cell classification, given its remarkable efficiency and accuracy relative to ResNet50, InceptionV3, and VGG16.

III. EFFICIENTNETB7

EfficientNetB7 is a state-of-the-art convolutional neural network (CNN) architecture that belongs to the EfficientNet family. EfficientNet was introduced to address the challenge of balancing model performance with computational efficiency, aiming to provide high accuracy while minimizing the number of parameters and computational resources required. The "B7" variant represents the largest and most powerful model in the EfficientNet series. (7)

EfficientNetB7 employs a novel compound scaling method, which systematically scales up the network's depth, width, and resolution in a balanced manner. This scaling strategy allows the model to achieve optimal performance across various tasks. Specifically, the architecture is characterized by a deep and wide network with high-resolution input images, enabling it to capture intricate features and patterns in the data. Despite its substantial depth and complexity, EfficientNetB7 stands out for its efficiency, as it tends to achieve superior accuracy with significantly fewer parameters compared to traditional models like VGG16. (12)

In the context of Bone Marrow Cell Classification, EfficientNetB7 has demonstrated its prowess by providing exceptional accuracy in identifying and categorizing cell images. Its efficiency is particularly advantageous in medical image analysis, where computational resources may be limited, making it a compelling choice for applications where both accuracy and efficiency are critical considerations. The success of EfficientNetB7 lies in its ability to strike a harmonious balance between model complexity and computational efficiency, making it well-suited for demanding tasks such as medical image classification. (13)

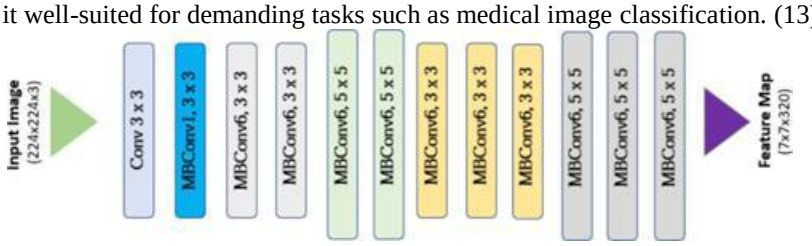

Figure:1 Efficientnetb7 Architecture

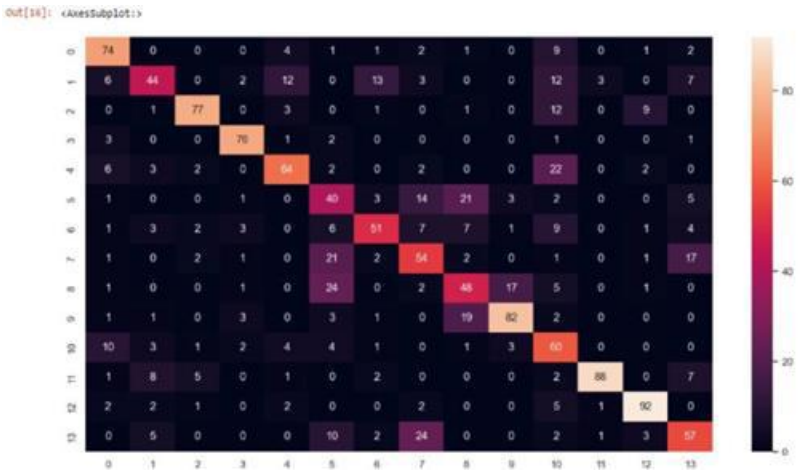

Figure 2:Confusion matrix for EfficientnetB7

IV. Sample and Study

As per our studies on bone marrow cell classification using machine learning and deep learning, we have taken a few samples under the guidance of medical field specialist Dr Pawani Shar- ma (MBBS, MD). She has provided the necessary information and data for the project. Following are samples. (9) (8)

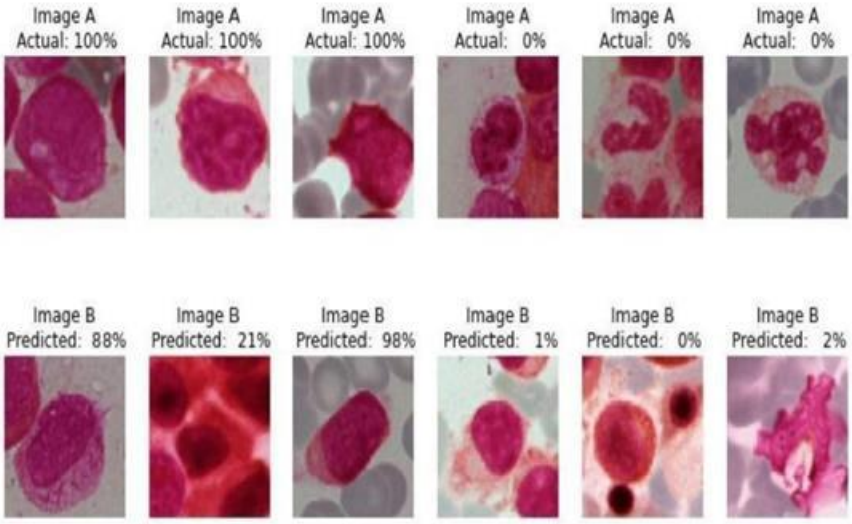

Figure 3: Sample 1

After the final training of model with certain epochs the actual and predicted images of cell are given below represented as:

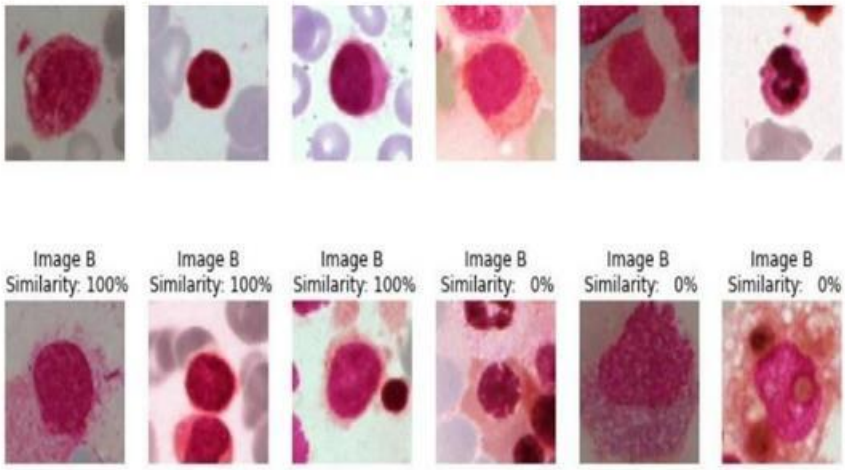

Figure 4: Sample 2

V. Advantages

In the realm of bone marrow cell classification, a comparative study of popular convolutional neural network (CNN) architectures, including ResNet50, InceptionV3, VGG16, and EfficientNetB7, unveils distinct advantages and underscores the superior performance of EfficientNetB7 in this particular domain. EfficientNetB7, an advanced variant from the EfficientNet family, excels due to its groundbreaking approach to model scaling. unlike its counterparts, EfficientNetB7 achieves an optimal balance between depth, width, and resolution by introducing a compound scaling method that systematically scales these dimensions. This innovation allows for enhanced feature representation without excessive computational overhead. In the context of bone marrow cell classification, where intricate patterns and subtle nuances play a crucial role, efficientNetB7 demonstrates superior efficiency in extracting meaningful features and capturing the diverse characteristics of bone marrow cells architecture to the intricacies of the dataset at hand, offering a more tailored and efficient representation of the features relevant to bone marrow cell classification. This adaptability not only contributes to superior accuracy but also facilitates more efficient training, making it a robust choice for applications where computational resources are a critical consideration. The model's deep neural network architecture, coupled with its efficient scaling strategy, empowers it to outperform ResNet50, InceptionV3, and VGG16 in discerning subtle variations in bone marrow cell morphology, leading to more accurate and clinically relevant classification results. In summary, the EfficientNetB7 model emerges as a frontrunner in the

comparative study, demonstrating its prowess in bone marrow cell classification through its innovative scaling methodology and adaptability to the intricacies of the dataset. (6) (10)

References

[1]. Guo L., Huang P., Huang D., Li Z., She C., Guo Q., Zhang Q., Li J., Ma Q., Li J. A classification method to classify bone marrow cells with class imbalance problem. Biomed. Signal Processing Control. 2022; 72:103296. doi: 10.1016/j.bspc.2021.103296. [CrossRef] [Google Scholar]
[2]. Chandradevan R., Aljudi A.A., Drumheller B.R., Kunananthaseelan N., Amgad M., Gutman D.A., Cooper L.A.D., Jaye D.L. Machine-based detection and classification for bone marrow aspirate differential
[3]. Counts: Initial development focusing on non neoplastic cells. Lab. Investig. 2020; 100:98–109. doi: 10.1038/
[4]. s41374-019-0325-7. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
[5]. Boes K., Durham A. Bone Marrow, Blood Cells, and
[6]. The Lymphoid/Lymphatic System1. Pathol. Basis Vet. Dis. 2017:724–804.e2. [Google Scholar]
[7]. Wang C.W., Huang S.C., Lee Y.C., Shen Y.J., Meng S.I., Gaol J.L. Deep learning for bone marrow cell detection and classification on whole-slide images. Med. Image Anal. 2022; 75:102270. doi: 10.1016/j.media.2021.102270. [PubMed] [CrossRef] [Google Scholar]
[8]. Dorini L.B., Minetto R., Leite N.J. White blood cell segmentation using morphological operators and scale- space analysis; Proceedings of the XX Brazilian Symposium on Computer Graphics and Image Processing (SIBGRAPI 2007); Belo Horizonte, Brazil. 7–10 October 2007; pp. 294–304. [Google Scholar]
[9]. Wang W., Song H. Cell cluster image segmentation on form analysis; Proceedings of the Third International Conference on Natural Computation (ICNC 2007); Haikou, China. 24–27 August 2007; pp. 833–836. [Google Scholar]
[10]. Ma L., Shuai R., Ran X., Liu W., Ye C. Combining DC- GAN with ResNet for blood cell image classification. Med. Biol. Eng. Comput. 2020; 58:1251–1264. doi: 10.1007/ s11517-020-02163-3. [PubMed] [CrossRef] [Google Scholar]
[11]. Vyshnav M.T., Sowmya V., Gopalakrishnan E.A., Menon
[12]. V.K. Deep learning based approach for multiple myeloma detection; Proceedings of the 2020 11th International Conference on Computing, Communication and Networking Technologies (ICCCNT); Kharagpur, India. 1– 3 July 2020; pp. 1–7. [Google Scholar]
[13]. Waris A., Niazi I.K., Jamil M., Englehart K., Jensen W., Kamavuaka E.N. Multi Day evaluation of techniques for EMG-based classification of hand motions. IEEE J. Biomed. Health Inform. 2018; 23:1526–1534. doi: 10.1109/ JBHI.2018.2864335. [PubMed] [CrossRef] [Google Scholar]