Chapter 1

Introduction

1.1 Background

1.1.1 Overview of Cancer and Acute Lymphocytic Leukemia

Cancer is a genetic disease where cells in the body grow uncontrollably or undergo mutation which can spread to other areas. This is due to changes in genes that regulate cell growth and division. This includes errors during cell division, damage to DNA from environmental factors or heredity issues. Cancerous tumors can invade nearby tissues and infect other body parts to create new tumors, a process known as metastasis. These tumors are often referred to as malignant. Tumors that stay in their primary location without invading other areas are known as benign. While many cancers form solid tumors, blood cancers like leukemia typically do not (NCI, 2021).

Acute Lymphocytic Leukemia (ALL) has a rate of 1.8 new cases per 100,000 people and a death rate of 0.4 per 100,000 annually, based on data from 2017-2021. The lifetime risk of developing ALL is about 0.1%. In 2021, 115,294 people in the U.S. were living with ALL. The 5-year relative survival rate is 72%. In 2024, around 6,550 new cases and 1,330 deaths are expected. ALL is most common in children and young adults, particularly among Hispanics and Whites, with the median age of diagnosis at 17. As for the age with the highest mortality rate, it appears highest among those aged 65-74, with the median age of death at 60 (Acute Lymphocytic Leukemia - Cancer Stat Facts, 2018).

1.1.2 Artificial Intelligence and Computer Vision

Artificial intelligence (AI) is one of the oldest fields of computer science, focusing on replicating human cognitive functions to solve real-world problems (Holzinger et al., 2019). The field takes inspiration from cognitive science and computer science, and due to success in machine learning AI has become popular. AI trains computers to perform human-like tasks like learning, judgment, and decision-making. It uses knowledge from multiple fields involving computer science, logic, biology, psychology, philosophy, etc, with the purpose to replicate human intellect (X. Du-Harpur et al., 2020). Common

concepts of AI include: machine learning, deep learning, natural language processing (NLP), computer vision, robotics, speech recognition, generative AI, and etc (Mintz et al., 2020). AI has also made significant progress in the medical field and its achievements can be seen throughout history. It has made an impact in medical image analysis, omics analysis, and also through the implementation of Natural Language Processing (NLP) it has helped with data analysis (Hamamoto, 2021). In medical analysis it mainly supports physicians in diagnosis of image data. One of the examples for AI implementation in image analysis is its high rate of determining cancer even when it is not visible to the physicians (Olivier Elemento et al., 2021).

Machine learning, a subset of AI and computer science, teaches computers to "learn" without having to program them beforehand. It involves creating models that predict outcomes from data or by identifying patterns. The goal is to replicate human pattern recognition using computational methods. Machine learning becomes useful when datasets are too large or complex for human analysis, or when automating data analysis is required for efficiency and consistency (Greener et al., 2021). Some concepts of machine learning include: supervised learning, unsupervised learning, semi-supervised learning, reinforcement learning, multi-task learning, ensemble learning, neural networks, instance-based learning, etc. To follow up on these concepts, some of the algorithm includes: decision tree, naive bayes, support vector machine, principal component analysis, k-means, generative models, self-training, transductive support vector machine, boosting, bagging, supervised neural networks, unsupervised neural network, reinforced neural network, k-nearest neighbor, etc (Mahesh, 2020).

Computer vision, a subset of AI and computer science as well, uses machine learning and neural networks to help computers interpret and extract information from image data including digital images, videos, and other visual inputs (Huang & Le, 2021). It allows computers to "see" and understand their environment, enabling them to take actions, create predictions, or provide recommendations accordingly. There are several applications, including video surveillance, facial

recognition, image retrieval, biometrics, and etc. The three core tasks are image classification, object detection, and image segmentation.

Supervised learning is a type of machine learning where the model is trained using labeled data. The objective is to learn the relationship and look for patterns between inputs and outputs, so it can predict the correct output for new, untrained data. It has two purposes: classification and prediction (Verma et al., 2021).

You Only Look Once (YOLO) is a real-time object detection system that divides the target detection task into two components: target region prediction and category prediction. Both rely on a single neural network to predict object boundaries and category probabilities. It is known for its advantages, including fast object detection, reduced background errors, and effective generalization of object characteristics. However, there are limitations, such as lower accuracy compared to other methods, susceptibility to object mispositioning, and difficulty in detecting small objects (Yang et al., 2021).

YOLOv5, by Ultralytics, is a PyTorch implementation of YOLO's architecture. It is composed of three parts: the backbone, neck, and head. Each parts have Convolution (Conv), Concatenation (Concat), Cross Stage Partial network (CSP), and Spatial Pyramid Pooling (SPP) layers (Lamane et al., 2022).

EfficientNet is a common classification tool can be utilized for detection and classification of cancer since it is important. It is a deep learning algorithm which can be trained on medical images of different types of cancer as well as its stages to learn specific features to help identify the cancer and its stage accordingly (Anwar, 2023).

1.2 Objective

This thesis intends to cover the study of comparing four EfficientNet models, B0, B1, B2, B3, in the analysis of Blood Cells of Acute Lymphocytic Leukemia to determine which model will be able to classify the data best.

1.3 Hypothesis

EfficientNet models are effective in the analysis of blood cell classification using Blood Cell of Acute Lymphocytic Leukemia.