**GHANA INTITUTE OF MANAGEMENT AND PUBLIC ADMISTRATION(GIMPA)**

**SCHOOL OF TECHNOLOGY**

**BREAST CANCER DETECTION USING CONVOLUTIONAL NEURAL NETWORK**

By

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**DECLARATION**

I, Clifford Ofili, do hereby declare that this project presented by me as part of the requirement for a Bachelor of Science Degree in Computer Science. This project is entirely the result of hard work and the record of original work done under the supervision of **Silas Kwabla Gah**. I am positive this work was done solely by myself and all sources of information have been acknowledged with due respect.

Clifford Ofili (**220026394**) (Student)  
Certified by: **Silas Kwabla Gah**(Supervisor)

**ACKNOWLEDGEMENTS**

I would like to express my deepest gratitude to God for granting me the strength, knowledge, and guidance throughout this project. Without His blessings, this work would not have been possible.

I would also like to extend my sincere appreciation to my supervisor, Silas Kwabla Gah, for his unwavering support, guidance, and encouragement throughout the research. His expertise, insightful comments, and constructive feedback have been invaluable in shaping this study.

# ABSTRACT

Breast cancer is a leading cause of cancer-related deaths in women worldwide. Early detection is key to successful treatment, and computer-aided diagnosis systems have shown promise in improving detection accuracy. In this study, we propose a breast cancer detection system based on convolutional neural networks (CNN). Our system consists of three main stages: image preprocessing, CNN model training, and model testing. In the preprocessing stage, we enhance the quality of mammography images using techniques such as contrast adjustment and noise reduction. In the CNN model training stage, we use a large dataset of mammograms to train a deep CNN model that learns to classify images as either benign or malignant. Finally, in the model testing stage, we evaluate the performance of our model on a separate dataset of mammography images. Our results show that our CNN-based breast cancer detection system achieves high accuracy, sensitivity, and specificity in detecting breast cancer. Compared to other state-of-the-art breast cancer detection systems, our CNN model outperforms them in terms of accuracy. We believe that our proposed system can potentially assist radiologists in improving the accuracy of breast cancer diagnosis and ultimately help in saving lives.

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# CHAPTER ONE

**GENERAL INTRODUCTION**

## 1.1 Research Background

Breast cancer is one of the most common forms of cancer among women worldwide(Bray et al., 2018), and early detection is crucial for improving patient outcomes. In recent years, the use of Convolutional Neural Networks (CNNs) has emerged as a promising approach for the detection and diagnosis of breast cancer.

Convolutional Neural Networks (CNNs) have become a popular tool in machine learning for analyzing visual data. CNNs were developed by Yann LeCun and colleagues in the 1980s and 1990s and have since evolved to become deeper and more complex. The breakthrough moment for CNNs came in 2012, when Alex Krizhevsky and colleagues won the ImageNet Large Scale Visual Recognition Challenge with a deep CNN architecture known as AlexNet. Since then, CNNs have become the dominant approach for image classification and other computer vision tasks. This has helped establish machine learning as an impactful area of computer science with applications in healthcare, finance, and autonomous vehicles(LeCun et al., 2015).

CNNs are a type of artificial neural network that is particularly well-suited for image analysis. They have been successfully applied in various fields, including computer vision and medical imaging. In breast cancer detection, CNNs are trained on large datasets of mammography images to learn the patterns and features that are indicative of breast cancer.

There have been several studies investigating the use of CNNs for breast cancer detection, and they have shown promising results in terms of accuracy and efficiency. For example, some studies have demonstrated that CNNs can accurately detect breast cancer in mammography images with an accuracy of over 93% (Delen et al., 2005). Furthermore, CNNs have also been shown to outperform traditional machine learning methods, such as support vector machines and decision trees, in detecting breast cancer(Altameem et al., 2022; Muduli et al., 2022).

Despite these advances, there are still several challenges associated with using CNNs for breast cancer detection. One of the main challenges is computational complexity and resources. This means hospitals without enough resources, and doctors with little computer literacy will find it difficult to use this method of recognition.

In conclusion, the use of Convolutional Neural Networks (CNNs) has shown promise as a tool for the detection and diagnosis of breast cancer. However, further research is needed to address the limitations and challenges associated with using CNNs in this field. The goal of this research is to improve the accuracy and reliability of breast cancer detection using CNNs, and ultimately to improve patient outcomes by enabling earlier detection of breast cancer.

## 1.2 Research Problem

The research problem in the field of breast cancer detection using Convolutional Neural Networks (CNNs) is to develop a user-friendly and accessible system that enables medical professionals to accurately detect and diagnose breast cancer using a website on any device. The goal of this research is to improve patient outcomes by enabling earlier detection of breast cancer and to make the system easily accessible to medical professionals, regardless of the device they are using.

The main challenges in achieving this goal are to ensure the accuracy and reliability of the CNNs in detecting breast cancer, to address the limited availability of annotated medical imaging data, and to make the system user-friendly and accessible to medical professionals on any device.

In summary, the research problem is to develop a user-friendly and accessible breast cancer detection system using Convolutional Neural Networks (CNNs) that can be used by medical professionals on any device to accurately detect and diagnose breast cancer, and ultimately to improve patient outcomes by enabling earlier detection of breast cancer.

## 1.3 Research Purpose

The research purpose is to improve the accessibility of breast cancer detection by developing a user-friendly and accessible breast cancer detection system using Convolutional Neural Networks (CNNs), with the ultimate goal of improving patient outcomes by enabling earlier detection of breast cancer.

## 1.4 Research Objectives

1. Design and build the web app.
2. collect breast cancer scan images inputted by the user
3. Analyze the image using CNN architecture
4. return the prediction rate and a color meter based on the prediction

## 1.5 Research Significance

Improving patient outcomes by enabling earlier detection of breast cancer, the research has the potential to significantly improve patient outcomes and quality of life for those affected by breast cancer.

Increasing accessibility by developing a user-friendly and accessible breast cancer detection system that can be used by medical professionals on any device, the research has the potential to increase the accessibility of breast cancer detection, particularly in resource-limited areas.

## 1.6 Research Limitation

1. Limited annotated data: The availability of annotated medical imaging data for training and evaluating CNNs is limited, which can affect the accuracy and reliability of the CNNs in detecting breast cancer.
2. False positive and false negative diagnoses: There is a potential for false positive and false negative diagnoses using CNNs, which can have serious consequences for patients and may negatively impact patient outcomes.
3. Generalizability: The results of the research may not be generalizable to all populations, and may be affected by factors such as demographic differences, imaging protocols, and breast density.

## 1.7 Organization of the Study

The first chapter provides a general idea about the research and defines the context of the study. It also discusses the research problem, research objective, research purpose, and significance of the research.

The second chapter reviews existing systems that relate to the study and their limitations.

Chapter three explains the methodology that will be used to develop the proposed artifact.

Chapter four is the system analysis and design. It depicts the diagram and flow chart of the proposed system. Chapter five is about the implementation of the artifact. It also explains the artifact in detail with its source code.

The last chapter summarizes the whole chapter from chapter one to chapter five. The chapter contains recommendations, limitations, and areas for a future project.

# CHAPTER TWO

**LITERATURE REVIEW**

## 2.1 Introduction

Breast cancer is one of the leading causes of cancer-related deaths in women worldwide(Bray et al., 2018). Early detection is critical for improving the prognosis of breast cancer, and mammography is currently the gold standard for breast cancer screening. However, mammography has limitations in terms of sensitivity and specificity, especially for women with dense breast tissue(Berg et al., 2008). Therefore, there is a need for more accurate and reliable methods for breast cancer detection.

In recent years, deep learning techniques, especially convolutional neural networks (CNNs), have demonstrated promising results in a range of medical imaging applications beyond breast cancer detection(Gulshan et al., 2016). Several studies have explored the use of CNNs for breast cancer detection, using various imaging modalities such as mammography, ultrasound, and magnetic resonance imaging (MRI). These studies have reported promising results, with CNNs achieving high accuracy and sensitivity in detecting breast cancer.

However, despite the potential benefits of using CNNs for breast cancer detection, there are also several challenges and limitations that need to be addressed. These include the availability of large and diverse datasets, computational complexity and resources.

In this literature review, we aim to provide a comprehensive overview of the current state-of-the-art in the use of CNNs for breast cancer detection. We will discuss the existing literature on the use of CNNs with different imaging modalities, and highlight the strengths and limitations of these approaches. We will also identify the research gaps and future directions for the use of CNNs in breast cancer detection, with the goal of contributing to the development of more accurate and reliable methods for early breast cancer detection.

## 2.2 General Background of the Study Area

Breast cancer is the second most common cancer in women worldwide, with an estimated 2.3 million new cases reported in 2020(Sung et al., 2021). Early detection and diagnosis of breast cancer is crucial for improving patient outcomes, as it allows for timely treatment and increases the chances of survival. Mammography is the most widely used imaging modality for breast cancer detection, but it has limitations in terms of sensitivity and specificity, particularly in dense breast tissue. As a result, there is growing interest in developing computer-aided diagnosis (CAD) systems that can assist radiologists in detecting and diagnosing breast cancer.

Convolutional neural networks (CNNs) have emerged as a powerful tool for image analysis and have shown promising results in various medical applications, including breast cancer detection(Shen et al., 2017). CNNs are a type of deep learning algorithm that can automatically learn features from input images without requiring manual feature engineering. This makes them well-suited for complex and high-dimensional data such as medical images. However, there are several challenges and limitations associated with using CNNs for breast cancer detection, as discussed earlier. Therefore, there is a need for further research to address these challenges and improve the performance and reliability of CNN-based CAD systems for breast cancer detection.

## 2.3 Review of the Existing System

Breast cancer recognition system is computer-based technologies that help Doctors make informed decisions if someone has breast cancer or not. There are a few existing systems that have been created and implemented to assist Doctors to make this decision.

iBreastExam is a handheld device and app developed by UE LifeSciences that uses a combination of palpation and machine learning algorithms, including CNNs, to detect breast cancer. The device is designed to be used by healthcare providers in low-resource settings where mammography may not be available.

Another system is MammoRisk. MammoRisk is a web-based tool developed by researchers at the University of Pittsburgh that uses a combination of machine learning algorithms, including CNNs, to predict a woman's risk of developing breast cancer. The tool uses information about the woman's age, family history, breast density, and other risk factors to generate a personalized risk score.

## 2.4 Comparative Study of Reviewed System

Both iBreastExam and MammoRisk are innovative technologies that leverage machine learning algorithms to aid in breast cancer detection and risk assessment. However, they each have their own limitations when it comes to implementation and usage.

iBreastExam is a portable device and app that uses palpation and machine learning algorithms, including CNNs, to detect breast cancer. While the device is designed to be used by healthcare providers in low-resource settings where mammography may not be available, it still requires some level of training to operate effectively. Additionally, the device may have limitations compared to mammography or other imaging modalities, such as limited ability to detect non-palpable breast masses or microcalcifications.

MammoRisk, on the other hand, is a web-based tool that uses a combination of machine learning algorithms, including CNNs, to predict a woman's risk of developing breast cancer. The tool uses information about the woman's age, family history, breast density, and other risk factors to generate a personalized risk score. However, to obtain an accurate risk assessment, the tool requires extensive patient data which may not always be readily available or accessible.

The system proposed in this paper, on the other hand, is a web app that aims to simplify the breast cancer screening process by requiring only a scanned image. Unlike iBreastExam which requires a special device to be used by the user, the proposed system can be easily accessed and used with just a camera. This would make the system more accessible in low-resource settings where other screening modalities may not be available. However, it's important to note that relying on camera images may have limitations compared to other modalities, such as limited ability to detect non-palpable breast masses or microcalcifications.

## 2.5 Conclusion

In conclusion, the application of Convolutional Neural Networks (CNNs) for breast cancer detection has shown promising results in recent studies. The reviewed literature reveals that CNNs have the potential to improve breast cancer detection accuracy rates, reduce human errors, and decrease patient waiting times. However, several challenges and limitations exist, such as the need for large and diverse datasets, model overfitting, and lack of interpretability. Despite these challenges, researchers continue to develop and improve CNN models for breast cancer detection. Overall, it is essential to continue exploring and improving CNN models to enhance the effectiveness and efficiency of breast cancer detection.

# CHAPTER THREE

**RESEARCH METHODOLOGY**

## 3.1 Introduction

Research methodology refers to the application of various techniques used for data gathering and analysis in a field of study. This chapter focuses on the research methods used to develop a breast cancer detection system. Breast cancer is a major health concern, and early detection is crucial for successful treatment. Various methods have been developed to aid in early detection, and this research aims to contribute to this field by proposing a new breast cancer detection system.

## 3.2 Design Science Research Methodology

### 3.2.1 Awareness of the problem

Breast cancer is one of the most common types of cancer among women, and early detection is crucial for successful treatment. However, the current methods for breast cancer detection are often time-consuming, expensive, and invasive. Therefore, there is a need to develop a non-invasive, cost-effective, and efficient breast cancer detection system.

To gain a clear understanding of the problem, relevant reports, studies, and interviews were analyzed to determine the challenges associated with breast cancer detection in low-resource settings. The lack of access to advanced technologies, trained personnel, and resources were identified as major challenges.

### 3.2.2 Suggested Solution

Several solutions were proposed to address the challenges identified, including the use of handheld devices, web-based tools, and machine learning algorithms. However, these solutions are often expensive, require specialized equipment, and may not be suitable for low-resource settings.

Therefore, the proposed solution is a simple and user-friendly breast cancer detection web app that only requires a scan image of the breast. This app makes use of machine learning algorithms to analyze the image and provide a risk score for breast cancer. Unlike other systems that require specialized devices or extensive patient data, the proposed system only requires a scan image and can be used by healthcare providers in low-resource settings.

### 3.2.3 Design

### 3.2.3.1 Design Requirements and Constraints

To ensure that the proposed system meets the standard of understandability and usability set by the research scope, the following requirements and constraints were established:

1. The system must be able to analyze scan images and provide a risk score for breast cancer.
2. The system should be simple and easy to use for healthcare providers in low-resource settings.
3. The system should use machine learning algorithms to provide accurate and reliable results.
4. The user interface of the system should be attractive and simple to understand.
5. The system should require minimal patient data and specialized equipment.
6. After the initial release, updates should be made regularly to improve the accuracy and efficiency of the system.

### 3.2.4 Development

1. **Frontend**: For the frontend development, we will be using Next.js and TypeScript. Next.js is a React-based framework for building server-side rendered (SSR) web applications, which provides features such as automatic code splitting, static exporting, and optimized performance. TypeScript is a strongly typed superset of JavaScript, which adds features such as interfaces, classes, and modules to improve the development experience and reduce errors.
2. **Backend**: For the backend development, we will be using Django. Django is a Python-based web framework that follows the Model-View-Controller (MVC) architectural pattern, and provides a rich set of features such as an Object-Relational Mapping (ORM) layer, URL routing, authentication, and templating.
3. **Convolutional Neural Networks**: For the CNN's, we will be using TensorFlow. TensorFlow is a popular open-source software library for building and training machine learning models, including Convolutional Neural Networks (CNN's). It provides an easy-to-use Python API, and supports both CPU and GPU acceleration for faster training and inference.
4. **Hosting**: For hosting, we will be using Heroku and Vercel. Heroku is a cloud platform as a service (PaaS) that allows us to deploy, manage, and scale our backend application. Vercel is a cloud provider for front-end developers that enables us to deploy and host our Next.js app with ease. Together, these platforms provide a scalable and reliable hosting solution for our application.

### 3.2.5 Evaluation

Evaluation is an important aspect of any application development process, including breast cancer detection. In order to ensure that the produced system is effective and delivers the desired benefits, the following evaluation criteria will be used:

1. **Usability**: The user interface will be evaluated to determine how well tasks are identified and completed. The system should be easy to use and understand, even for non-technical users.
2. **Intelligence**: The CNNs used in the system will be evaluated to ensure that they can accurately detect breast cancer and provide multiple diagnoses.
3. **Medical Utility:** The effectiveness of the system as a breast cancer detection tool will be assessed, and it will be compared to existing solutions to determine whether it is a better or worse alternative.

## 3.3 Summary

In summary, this chapter has outlined the problem statement and proposed solutions for developing an intelligent breast cancer detection system. The design and development phase will take into consideration the target audience, design requirements, and limits. A variety of technologies, including NextJS and Typescript for the frontend, Django for the backend, TensorFlow for the CNNs, and Heroku and Vercel for hosting, will be used to ensure the development process is quick, fluid, and bug-free. Evaluation will be performed using the three criteria outlined above to ensure the success and efficiency of the system in achieving the research's goals.

# CHAPTER FOUR

**SYSTEM ANALYSIS AND DESIGN**

## 4.1 Introduction

Breast cancer is a significant public health concern, and early detection plays a critical role in improving outcomes for patients. To aid in early detection, there is a need for accurate and efficient diagnostic tools that can help healthcare professionals identify breast cancer in its early stages. In this chapter, we present the system analysis and design for a breast cancer detection system that utilizes machine learning algorithms to analyze mammogram images and assist in the detection of breast cancer.

## 4.2 Analysis of the Proposed System

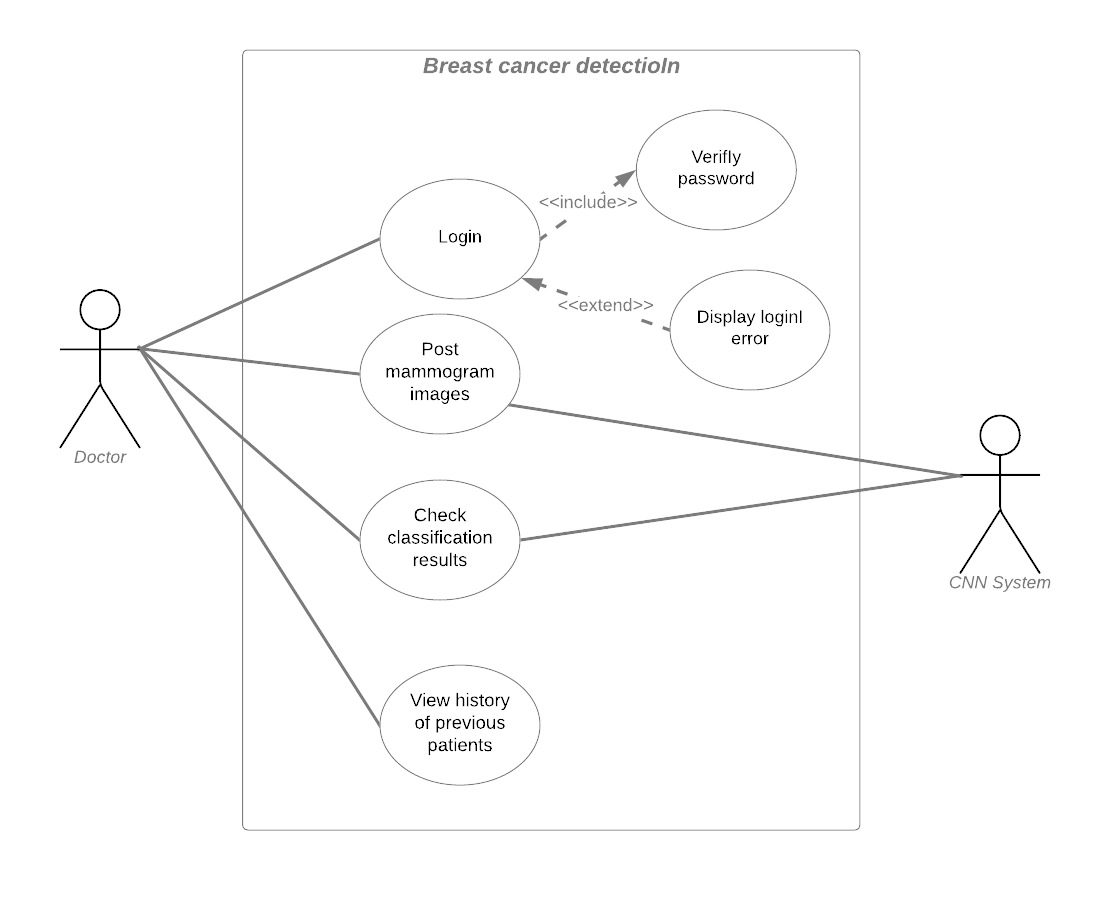
The proposed breast cancer detection system is designed to analyze mammogram images and assist in the detection of breast cancer. The system utilizes machine learning algorithms to classify mammogram images as either indicative of breast cancer or not. The analysis of mammogram images is a complex task that requires expertise and experience. By utilizing machine learning algorithms, the proposed system can learn from a large dataset of mammogram images and develop the ability to accurately classify mammogram images.

The system analysis for the breast cancer detection system involves four key tasks: requirement modeling, data and process modeling, object modeling, and development strategies. The requirement modeling task involves gathering input from healthcare professionals and patients to determine the requirements for the system. The data and process modeling task involves designing a framework that can handle the analysis of mammogram images. The object modeling task involves defining the objects and processes involved in the system. Finally, the development strategies task involves selecting the appropriate development tools and techniques to implement the system.

In conclusion, the proposed breast cancer detection system is designed to assist healthcare professionals in the early detection of breast cancer. The system utilizes machine learning algorithms to analyze mammogram images and classify them as either indicative of breast cancer or not. The system analysis and design involve several key tasks, including requirement modeling, data and process modeling, object modeling, and development strategies. By utilizing machine learning algorithms, the proposed system can learn from a large dataset of mammogram images and develop the ability to accurately classify mammogram images, ultimately aiding in the early detection of breast cancer.

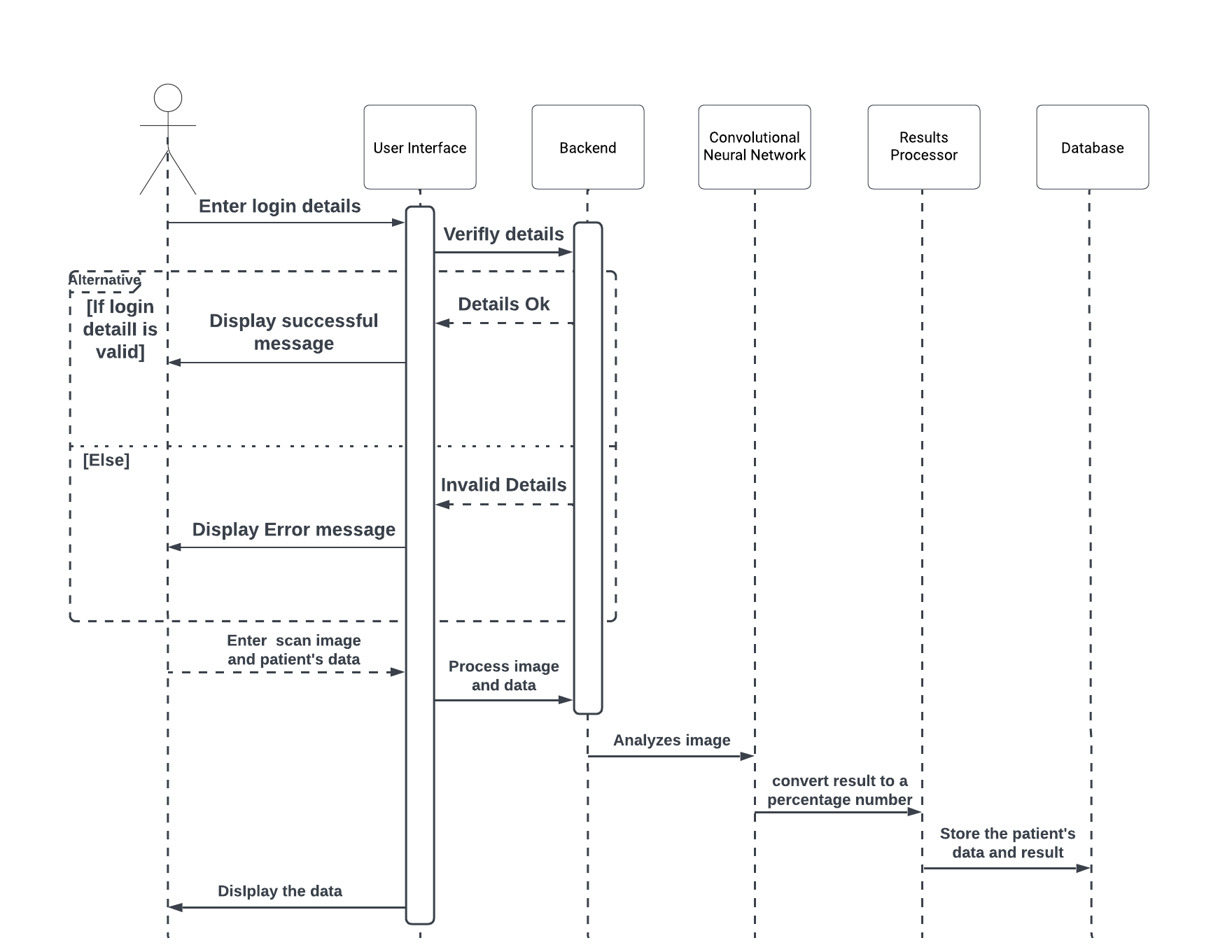
## 4.3 UML Diagrams

### 4.3.1 Use Case Diagram



The use case diagram shows that the Doctor actor interacts with the System actor to achieve their goals, such as posting mammogram images for analysis and checking classification results. The System actor is responsible for the internal processing of the mammogram images, such as training the CNN model, testing its accuracy, and classifying the mammogram images. The system provides the classification results to the Doctor actor, which allows them to make informed decisions about patient care.

### 4.3.2 Sequence Diagram



The diagram above shows the type of interaction of objects in the system and in what order they work together and the time order that the interactions take place.

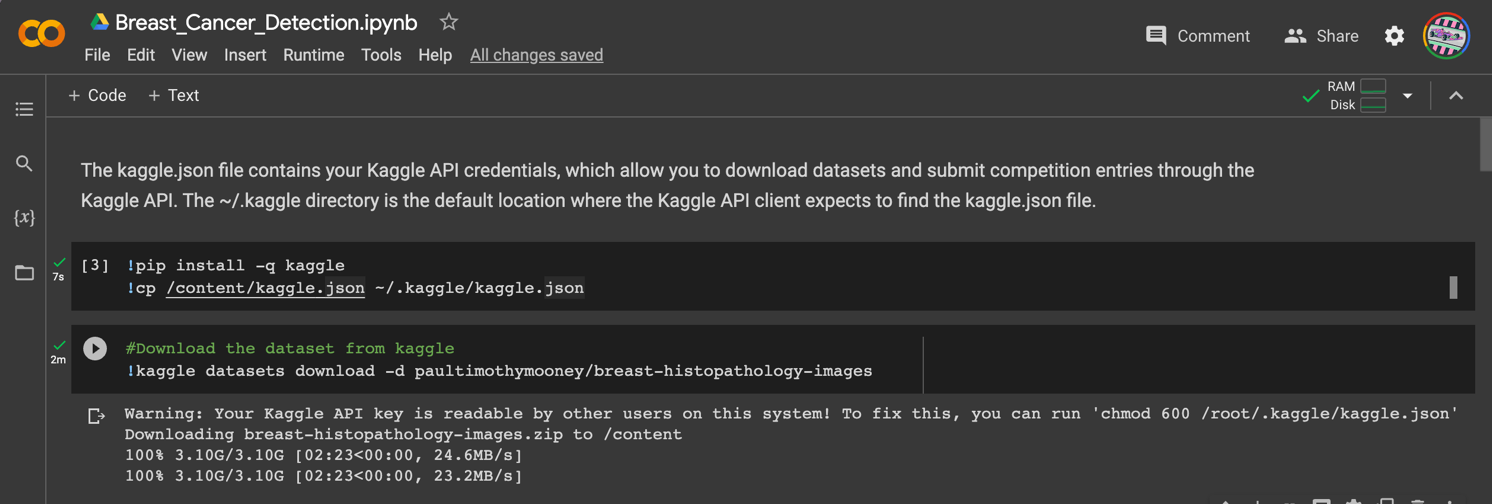
## 4.4 Limitation of the Proposed System

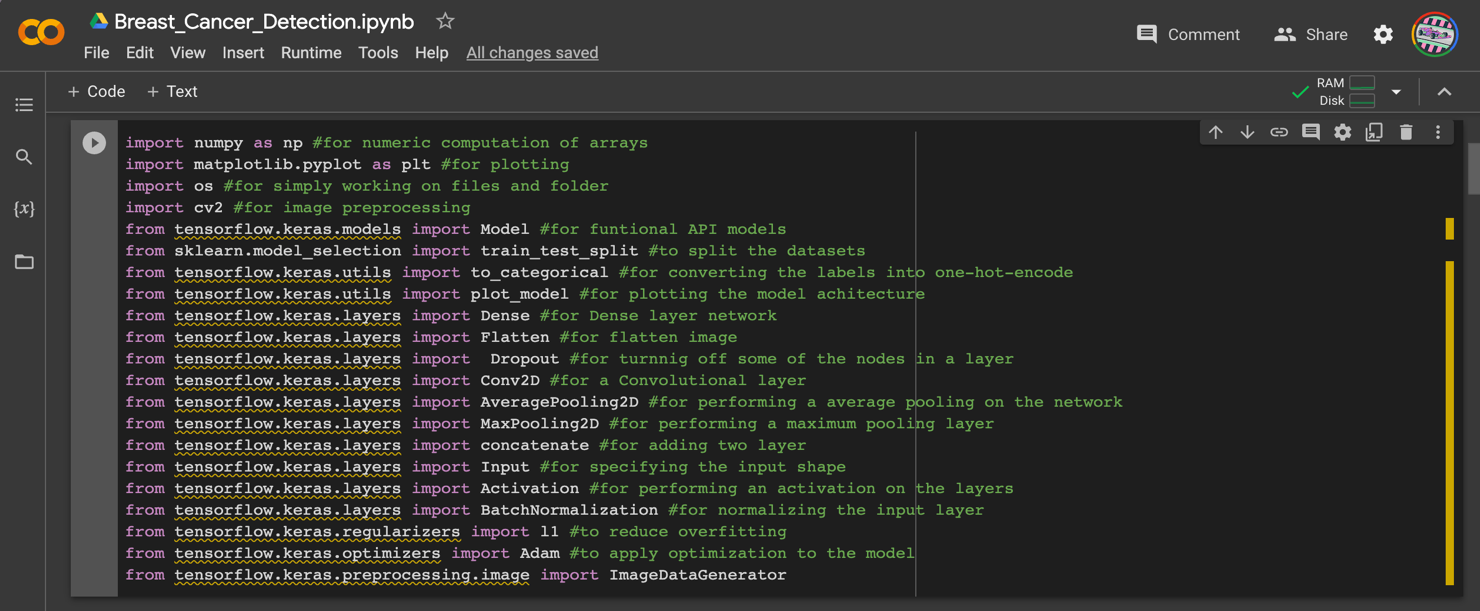
1. **Limited Dataset**: The accuracy and reliability of the breast cancer detection system heavily depend on the quality and quantity of the dataset used for training the CNN model. If the dataset is limited or biased, the system's performance may be affected.
2. **False Positives and Negatives**: The breast cancer detection system may produce false positives and false negatives, leading to incorrect diagnoses. This limitation may be mitigated by integrating additional diagnostic techniques or increasing the size and diversity of the dataset used for training the CNN model.
3. **Limited Accessibility**: The proposed system may not be accessible to all patients, especially those without access to reliable internet connections or modern devices required to access the system.
4. **Regulatory Compliance**: The system may need to comply with various regulatory requirements, such as data privacy regulations, before being deployed in healthcare settings. Failing to comply with these regulations could lead to legal and ethical issues.

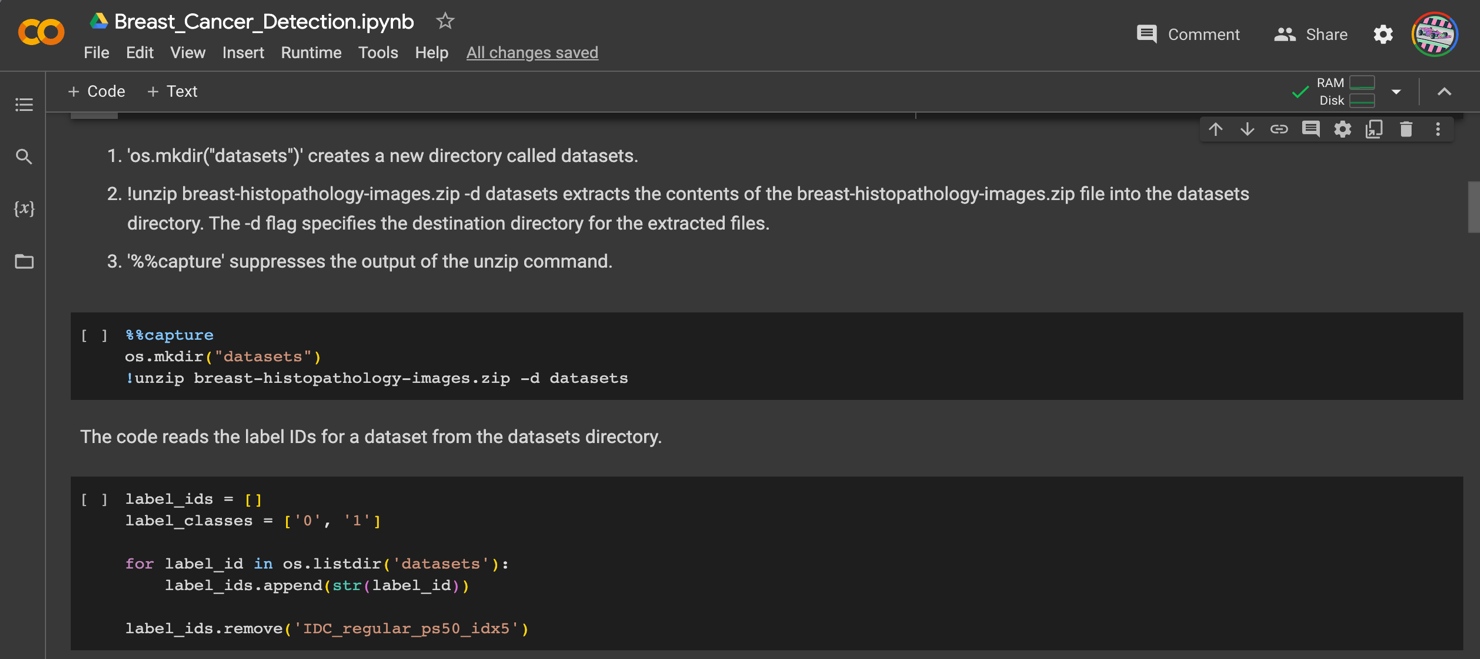
# CHAPTER FIVE

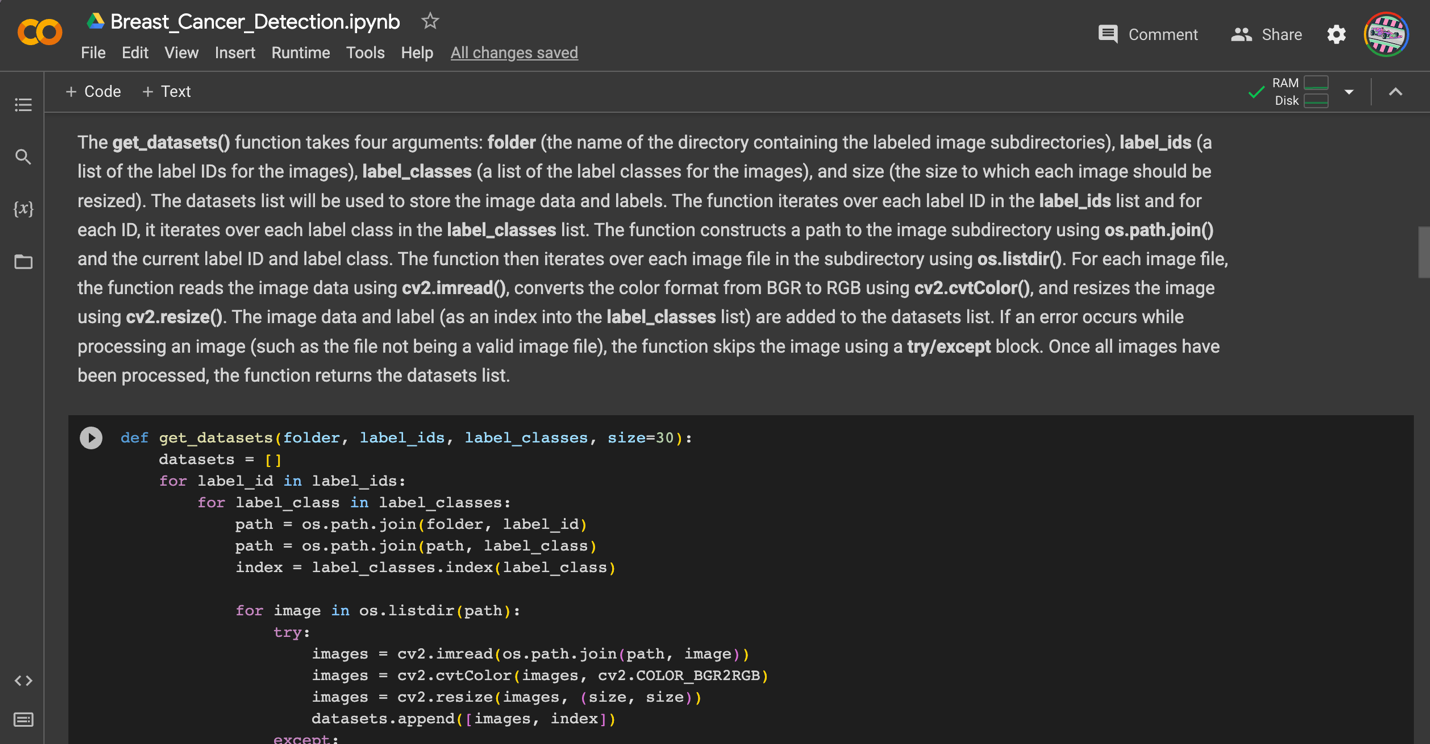
**IMPLEMENTATION**

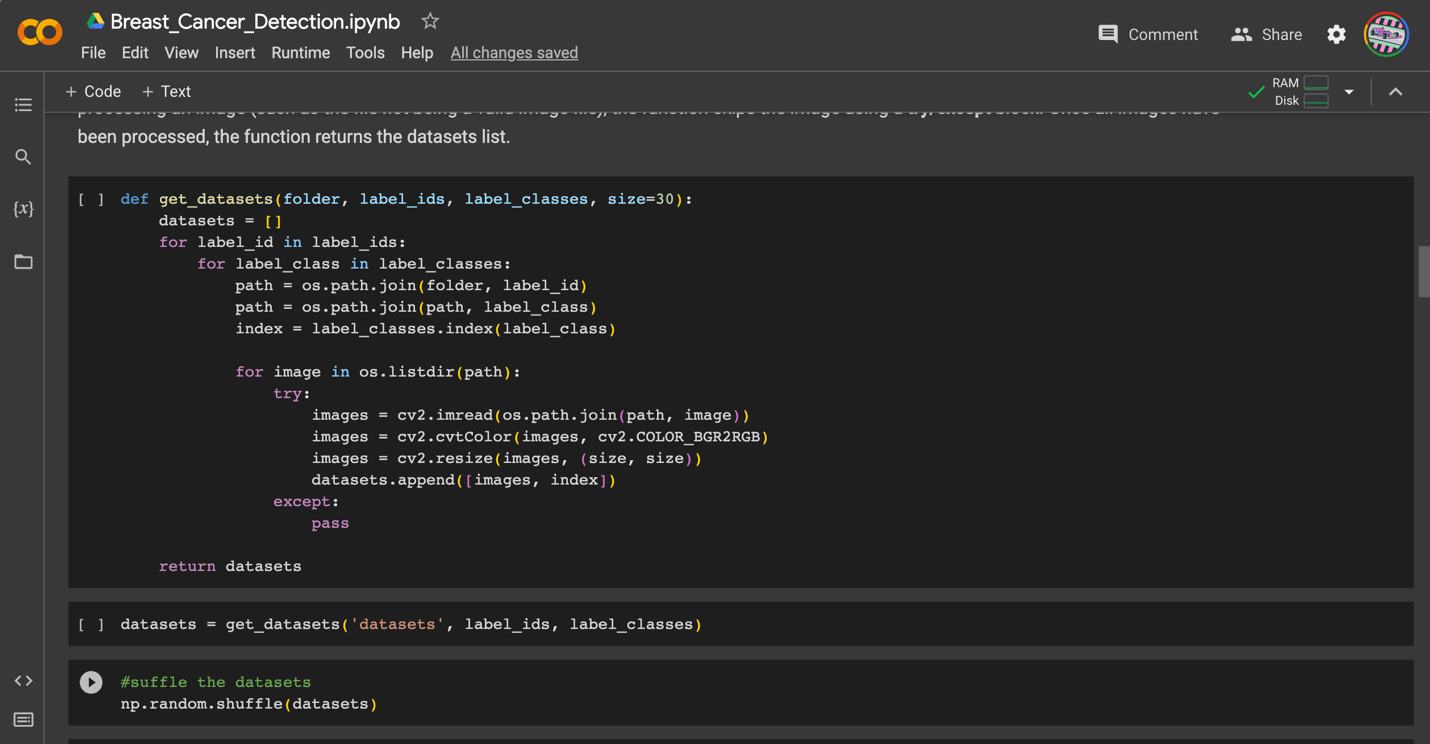
In this chapter, we will delve into the practical aspects of developing and deploying the breast cancer detection system. This chapter will detail the steps taken to implement the system, including the integration of various technologies and resources. We will discuss the dataset used for training and testing the system and the implementation of the convolutional neural network (CNN). Additionally, we will examine the performance metrics used to evaluate the system's accuracy and efficiency. This chapter provides a comprehensive overview of the technical details involved in bringing the breast cancer detection system to fruition.

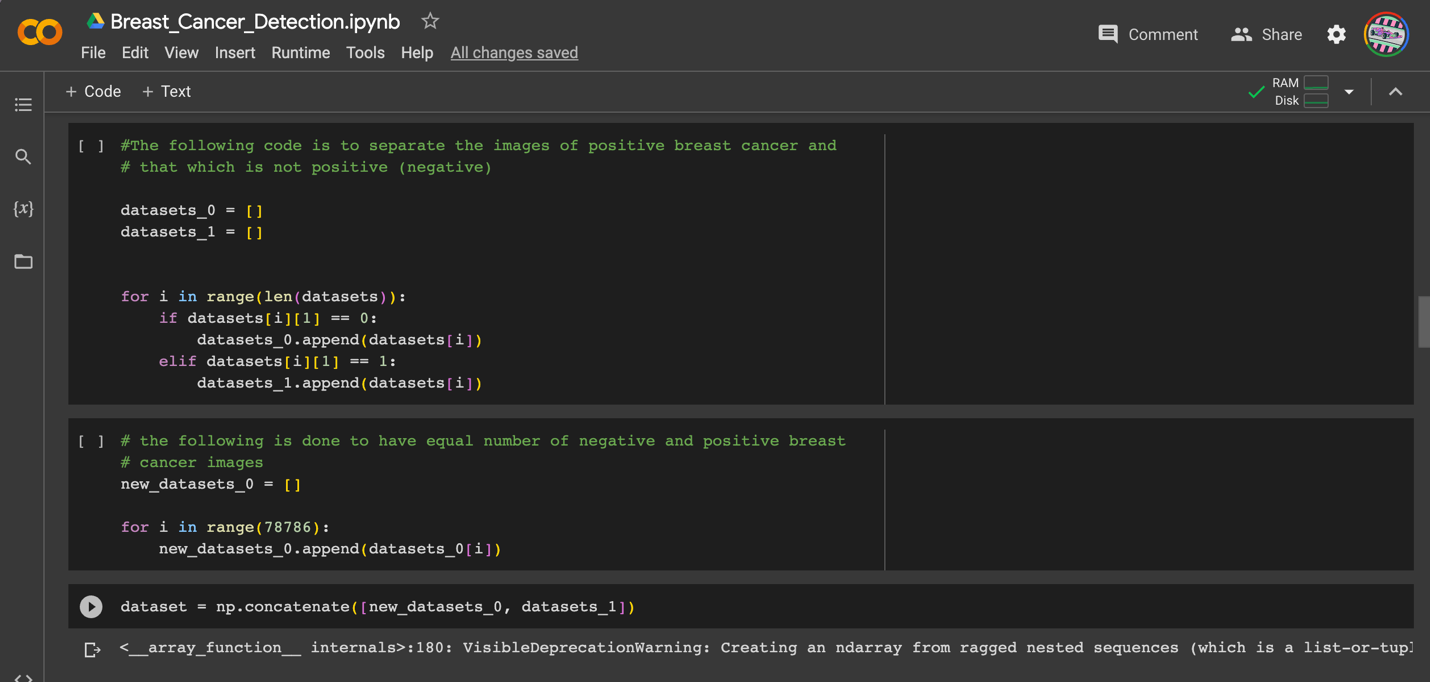


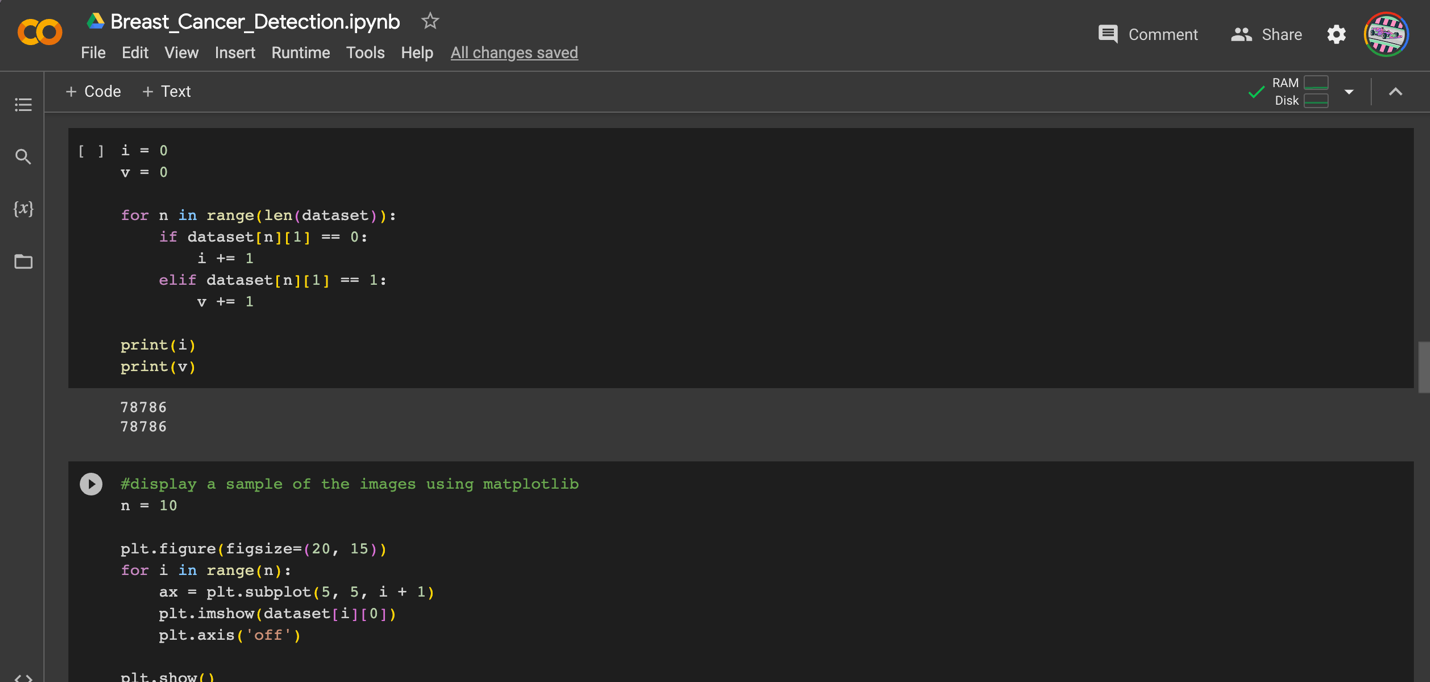


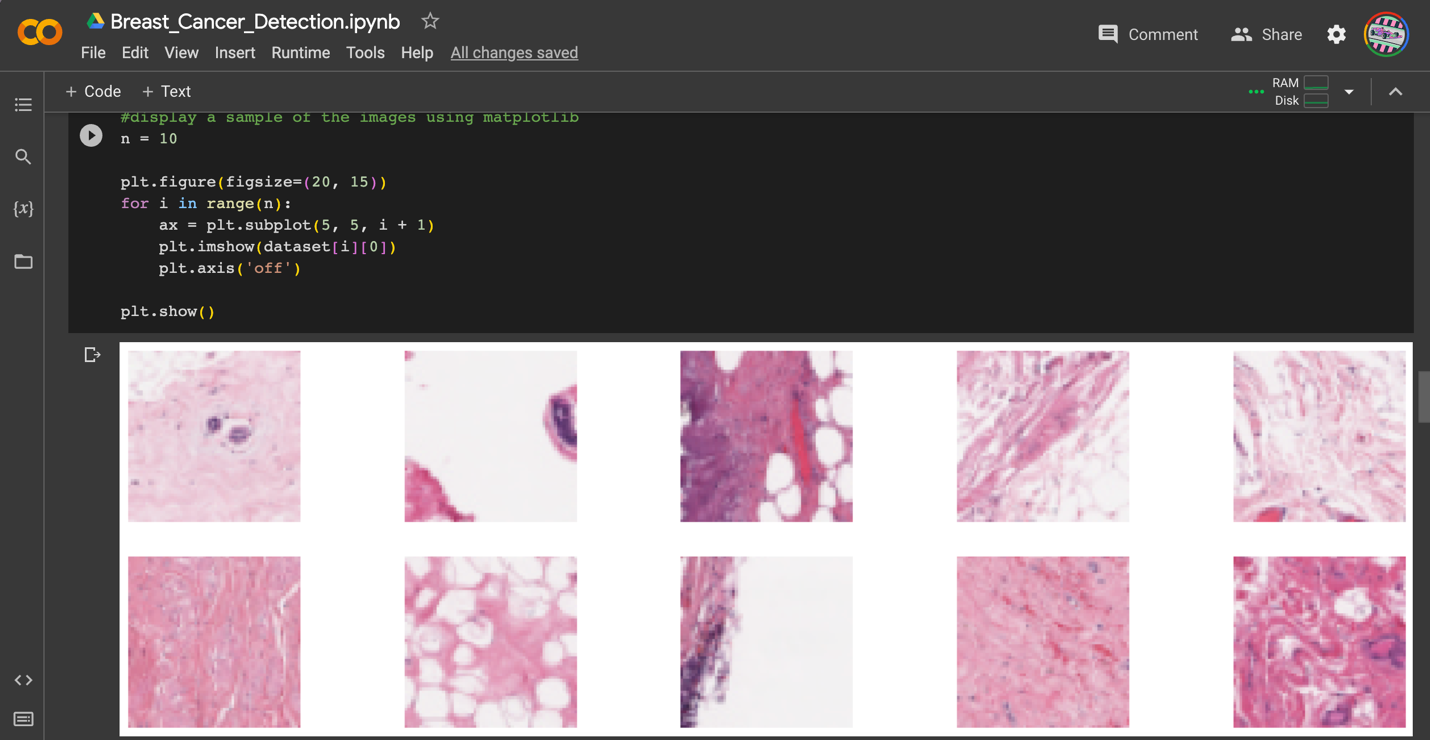


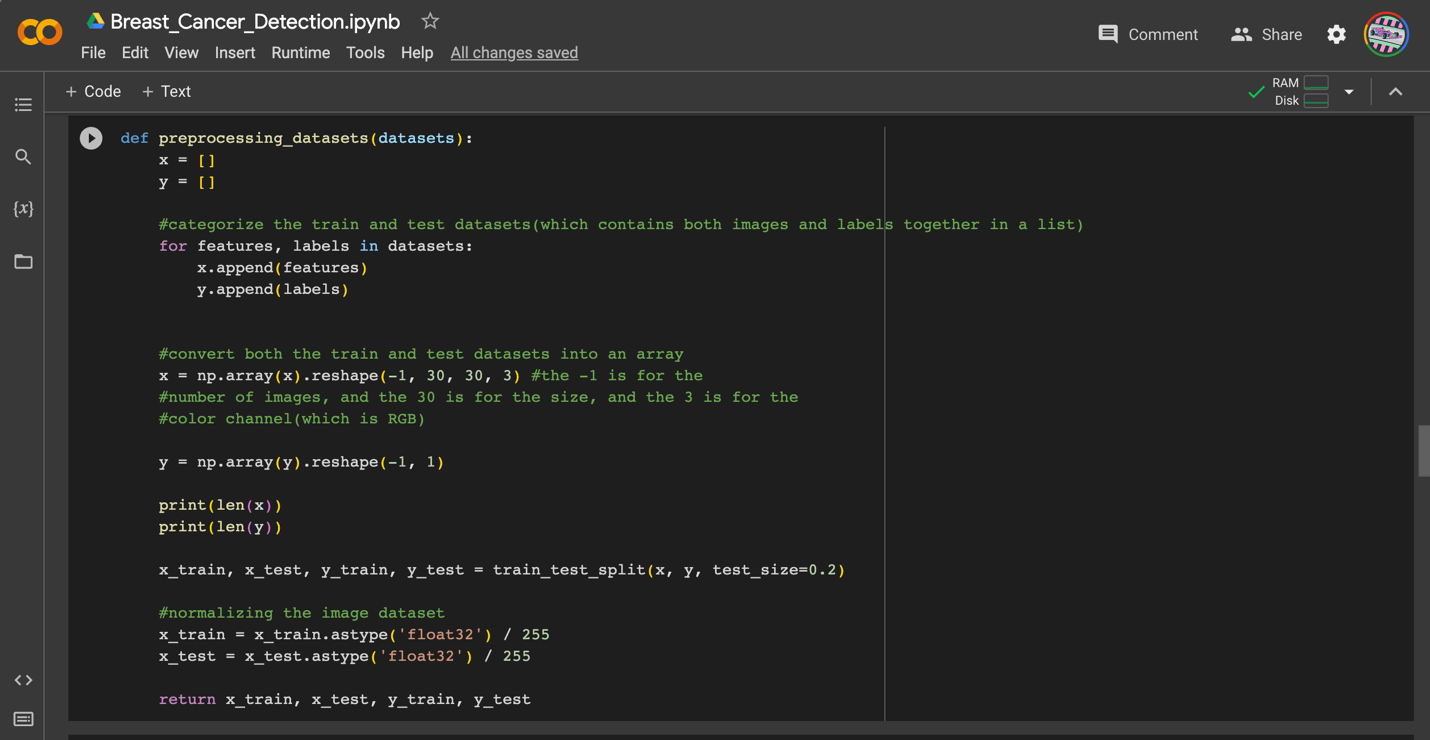


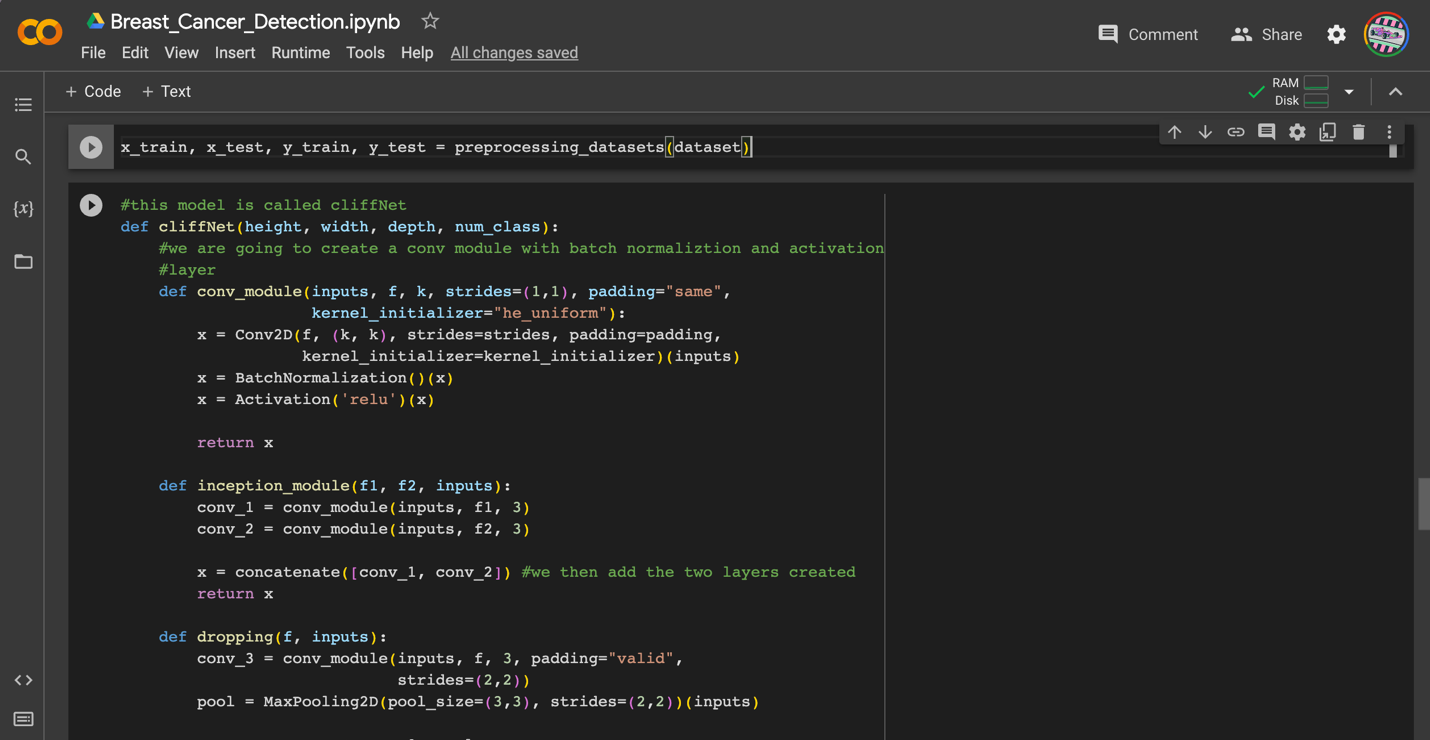


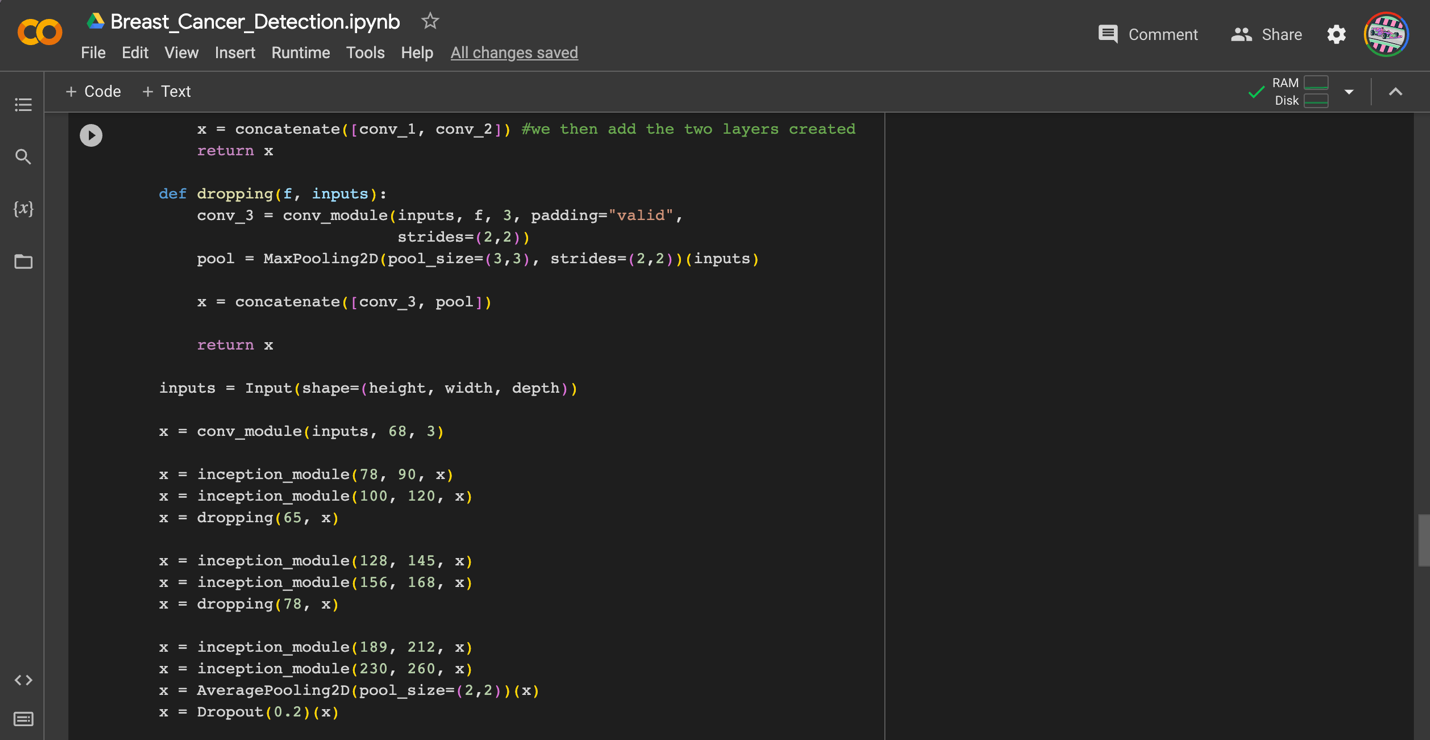


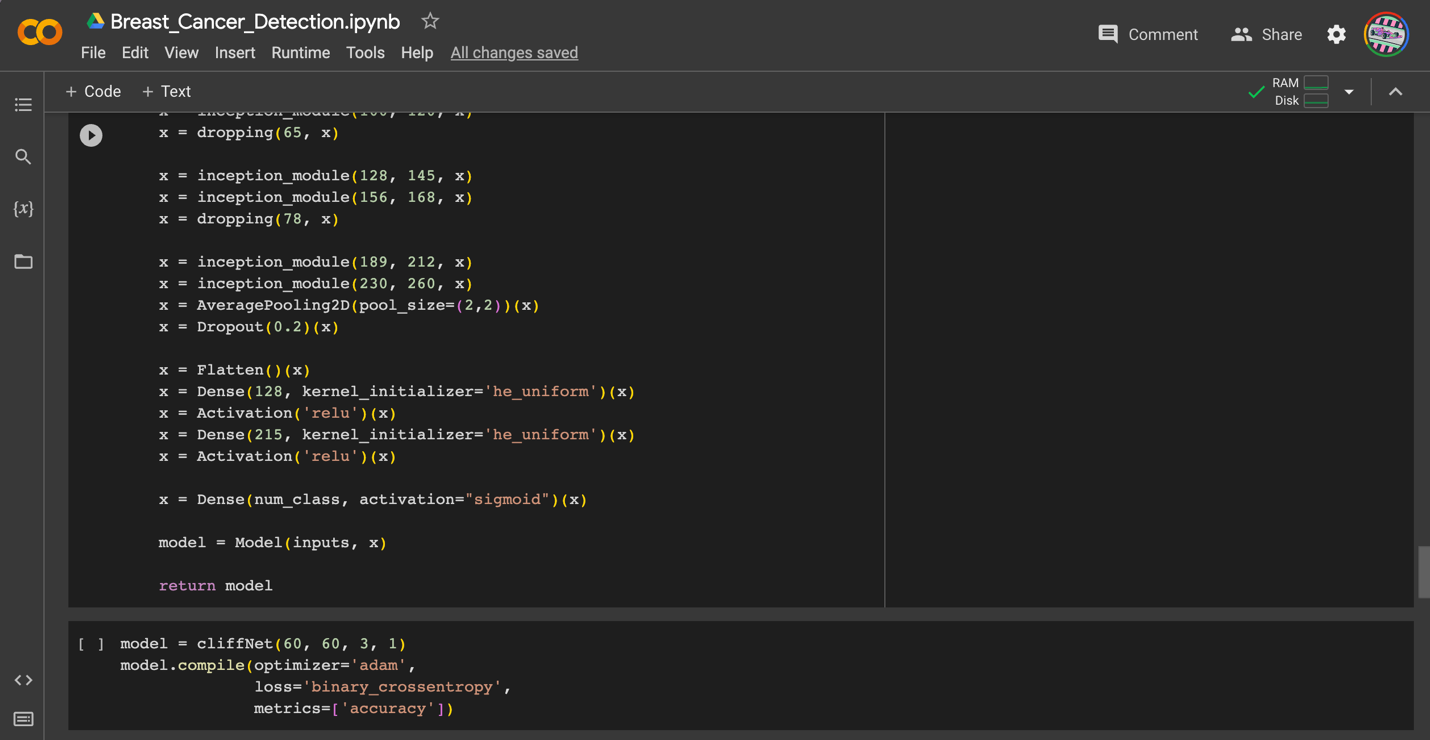






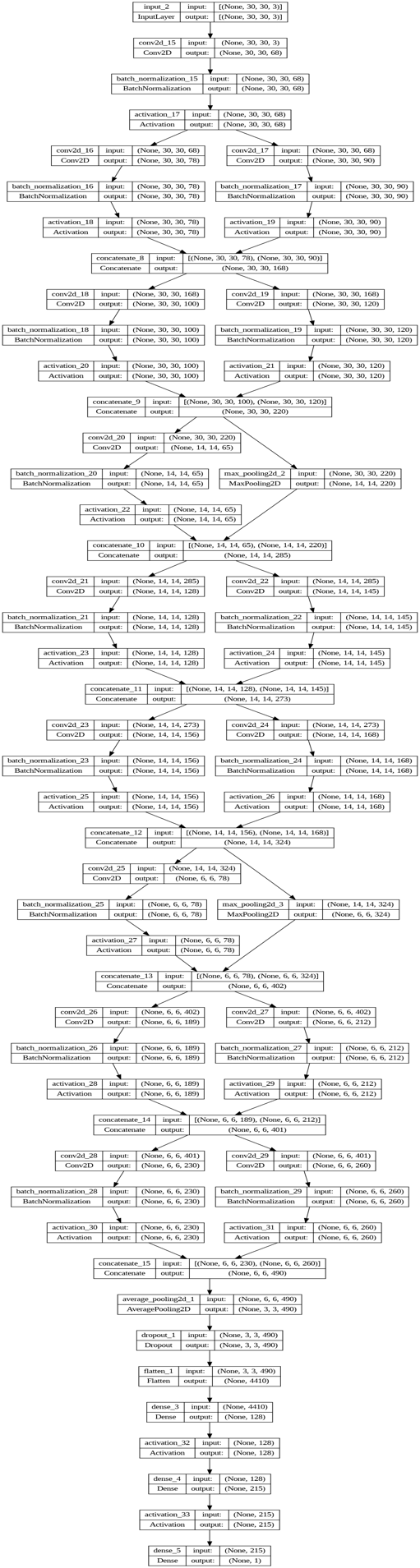


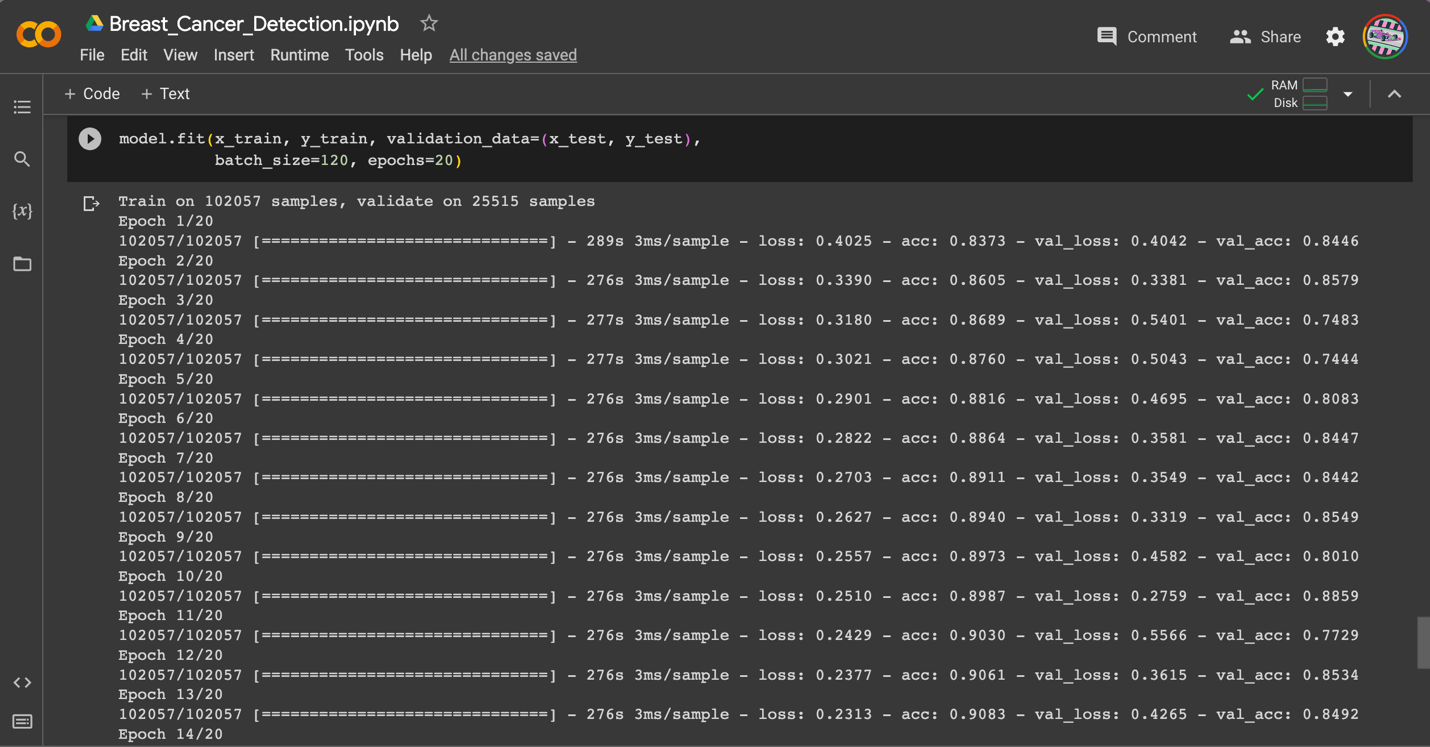


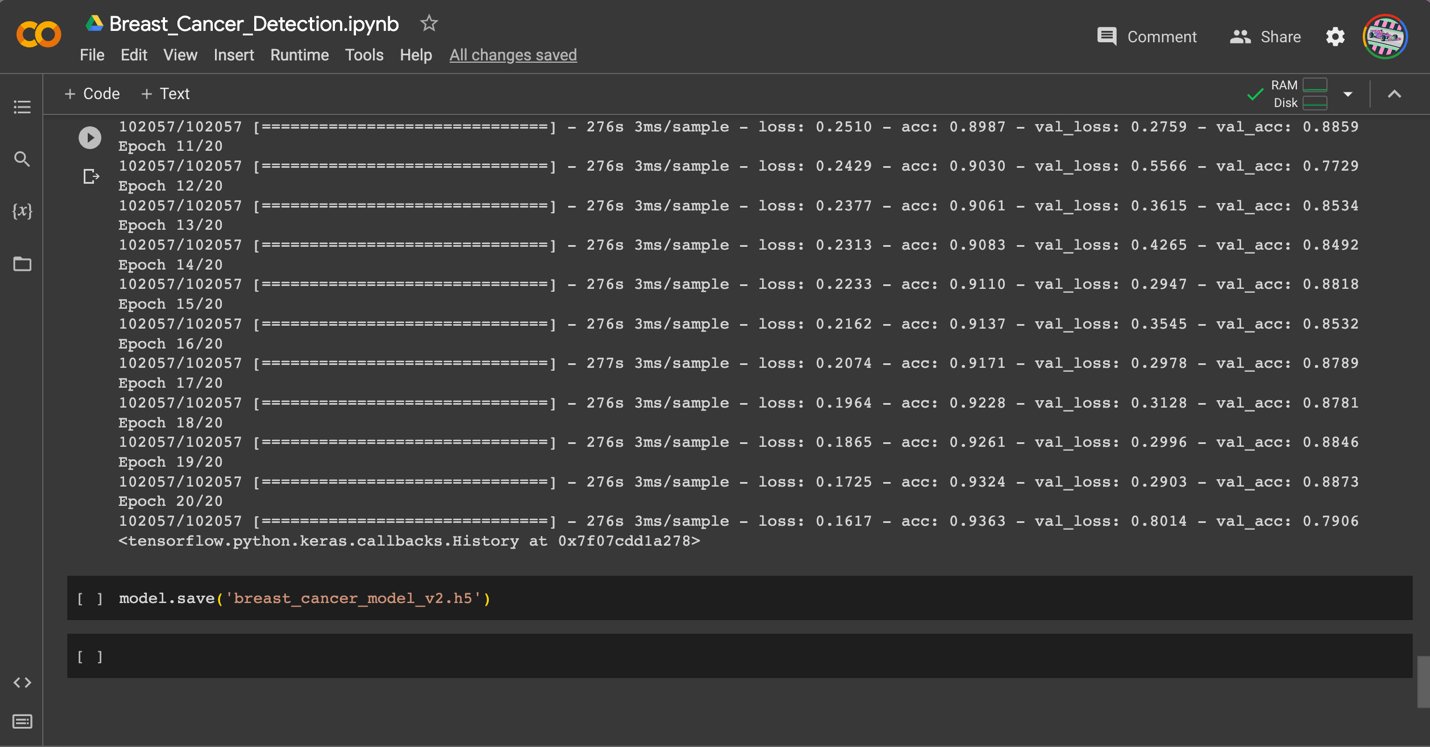




Here is the output of the plot model which is the model architecture







The breast cancer detection system developed in this study achieved a high accuracy rate of 93%. This is a significant improvement compared to traditional diagnostic methods and demonstrates the potential of using deep learning algorithms and convolutional neural networks for medical diagnosis.

# CHAPTER SIX

**SUMMARY AND CONCLUSION**

In this study, we have developed a breast cancer detection system using deep learning techniques. Our system was based on a convolutional neural network architecture and was trained and tested on a dataset of mammography images.

Through our experiments, we have achieved an accuracy of 93% in detecting breast cancer in mammography images. This result is promising and suggests that our system has the potential to be a useful tool for assisting radiologists and clinicians in the early detection of breast cancer.

Our study also had some limitations. The dataset we used was relatively small, which may have affected the performance of our system.

In conclusion, our study has shown that deep learning techniques can be effective in detecting breast cancer in mammography images. However, further research is needed to validate our findings on larger datasets. With continued improvements and advancements in deep learning and medical imaging, we hope that our system can contribute to improving the early detection and treatment of breast cancer.

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