Maulana Azad National Institute of Technology Bhopal

PROJECT LAB 2

Medical Image Classification Using Deep CNN

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Contents

Introduction

Breast cancer is one of the most prevalent cancers worldwide. Early detection is crucial for improving survival rates. This presentation explores how **Deep Convolutional Neural Networks (CNNs)** can enhance medical image classification for better diagnosis and treatment outcomes.

Key goals of this project include:

- Applying **ResNet-50**, a state-of-the-art CNN architecture, to breast cancer image classification.
- Improving the accuracy and reliability of automated breast cancer detection using transfer learning techniques.
- Facilitating early diagnosis to assist healthcare professionals in clinical decision-making.

Overview of Breast Cancer and Its Detection

- **Uncontrolled Cell Growth:** Cancer causes cells to divide uncontrollably, leading to abnormal growth that invades healthy cells.
- **Potential Consequences:** This abnormal growth can form tumours, damage the immune system, and lead to life-threatening complications.
- **Breast Cancer Prevalence:** One of the most common cancers, particularly in women.
- **Global Impact:** According to the WHO, breast cancer is among the top 5 cause of cancer-related deaths worldwide.
- **Importance of Early Detection:** Early diagnosis is critical for successful treatment.
- **Demand for Detection Systems:** Developing effective Breast Cancer Detection (BCD) systems is essential and highly in demand.

Breast Cancer Detection

There are 2 different types of tumours:

1. Benign Tumours:

- Non-cancerous, grows slowly and remain localized.
- Do not spread to other parts of the body.
- Often less dangerous but may cause issues if large.

2. Malignant Tumours:

- Cancerous, grows rapidly and invade nearby tissues.
- Can spread to other body parts (metastasis).
- Potentially life-threatening and require treatment like surgery, chemotherapy, or radiation.

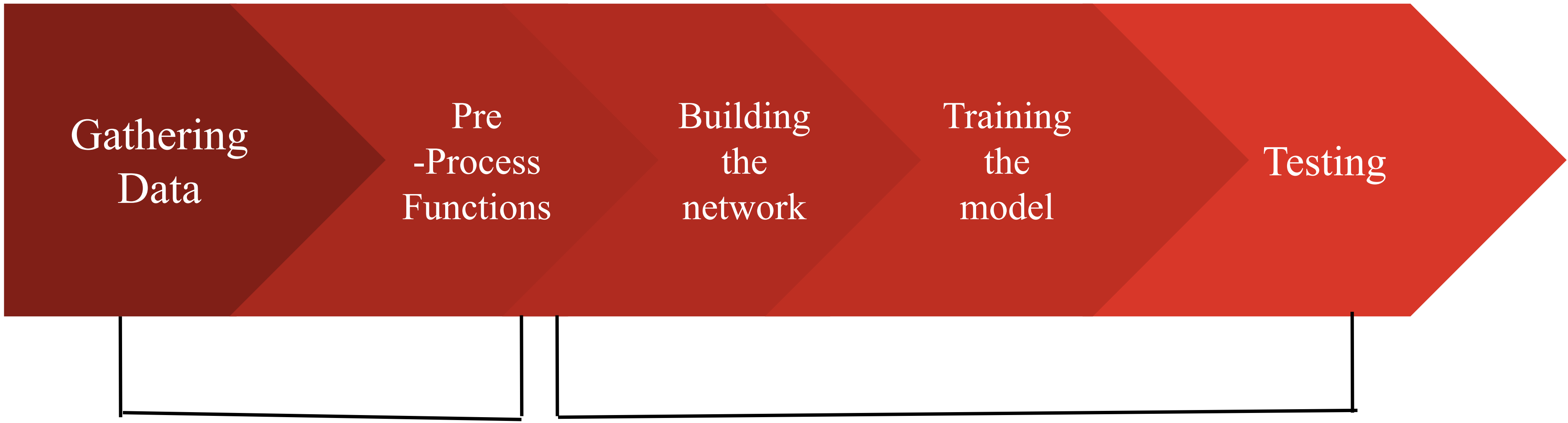
Literature Review

Ref No.	Author	Findings
1.	V. Asha, B. Saju, S. Mathew, A. M. V, Y. Swapna and S. P. Sreeja	This study address the critical need for early breast cancer detection, emphasizing the impact of limited awareness on mortality rates. In their study, they utilize machine learning techniques—including DNN, CNN, and ANN architectures—with Recursive Feature Elimination (RFE) for feature selection. This automated classification system is designed to distinguish between malignant and benign breast cancer cases. The results demonstrate that the DNN model achieved the highest accuracy of 97%, outperforming other models on the dataset, highlighting its effectiveness for reliable breast cancer classification.
2.	Tarek Khater, Abir Hussain, Soliman Mahmoud, Salwa Yasen	This study highlights AI's growing role in healthcare, particularly for breast cancer diagnosis, where high accuracy models are often opaque. It emphasizes the need for explainable AI technique like LIME, which help clarify model decisions by identifying influential features (e.g., Bare Nuclei, Clump Thickness) in predictions. These tools bridge the gap between predictive power and interpretability, supporting trustworthy, clinically relevant AI diagnostics.

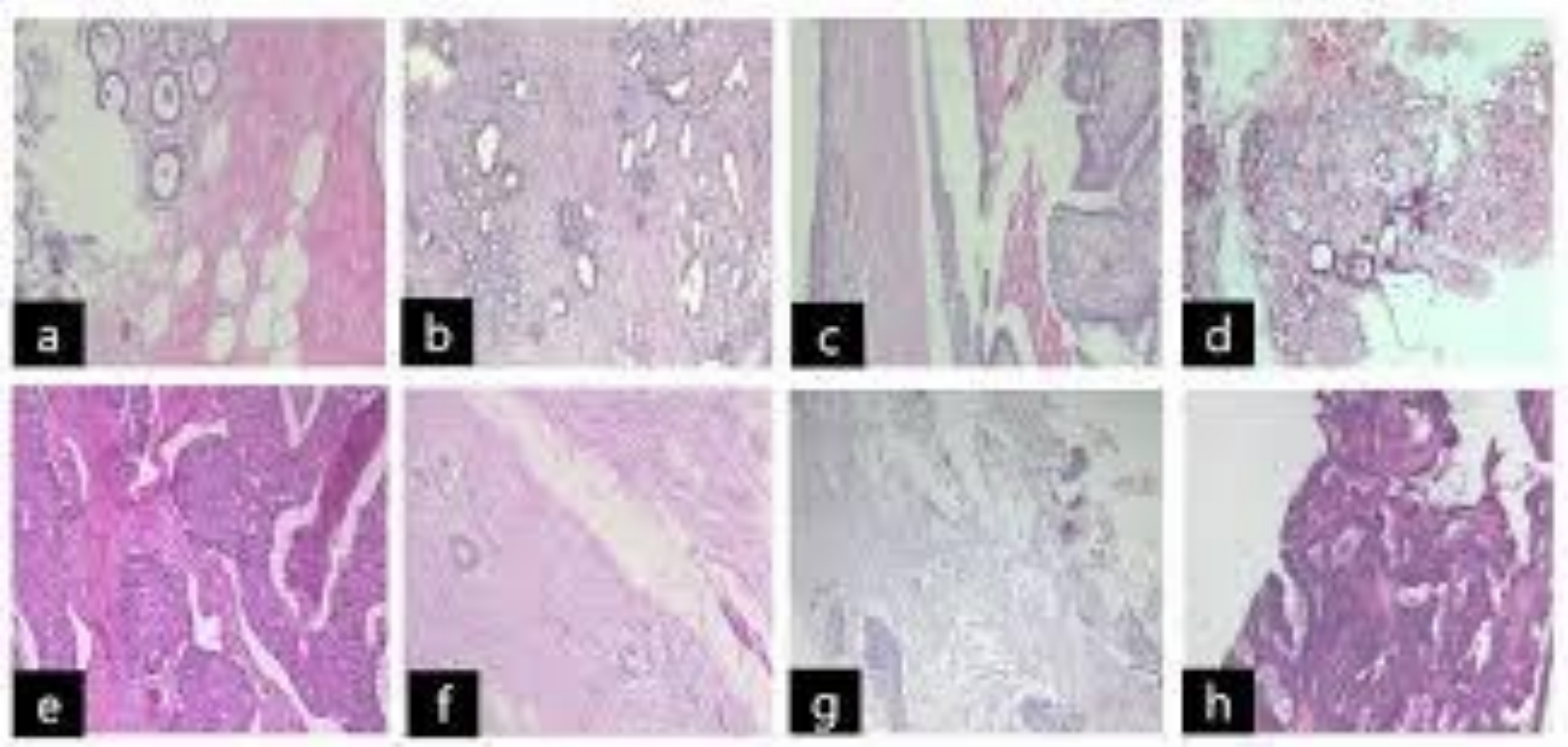
Deep Learning

- **Deep Learning (DL)**, a subset of artificial intelligence, is widely used for medical image detection and classification.
- DL uses **deep neural networks** with multiple layers between the input and output to perform tasks like image classification.
- In recent years, image classification using DL has gained significant attention due to its high accuracy and efficiency.
- In 2010, **GPUs** and optimized 2D convolution were shown to be powerful tools for training large **Convolutional Neural Networks (CNNs)**.

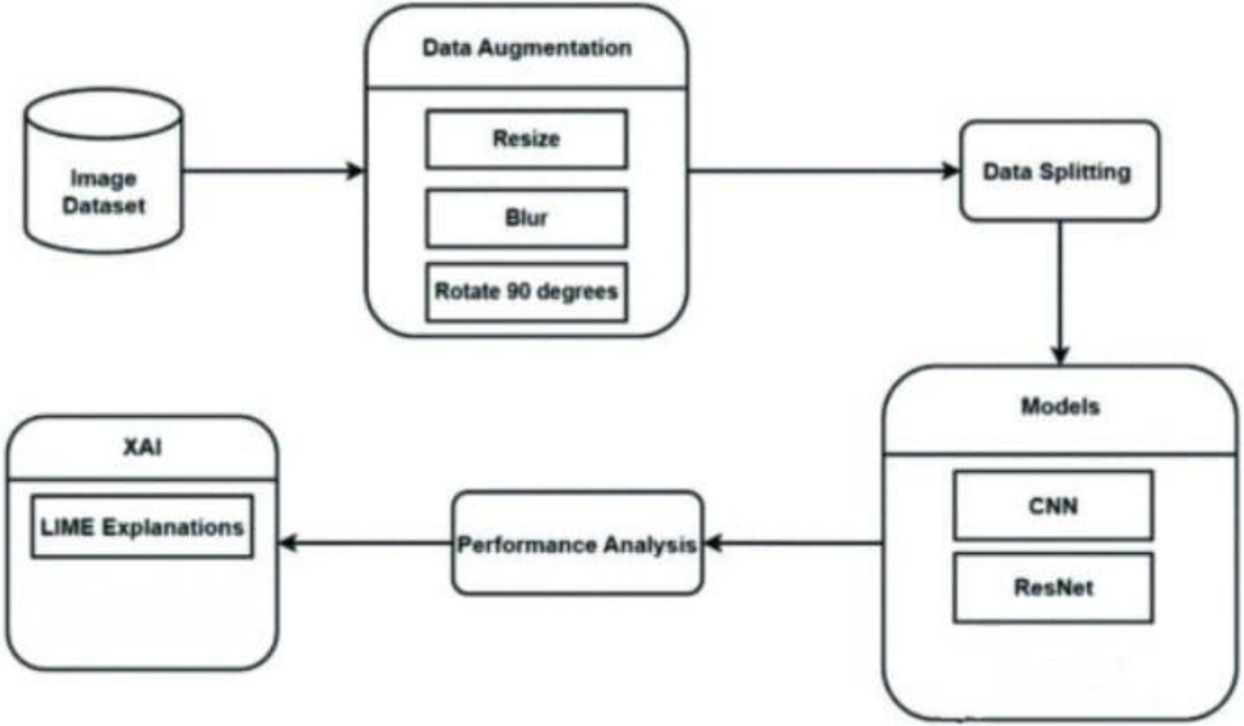
Phases


Gathering Data
Pre -Process Functions
Building the network
Training the model
Testing

Dataset Overview



Model Flow Chart

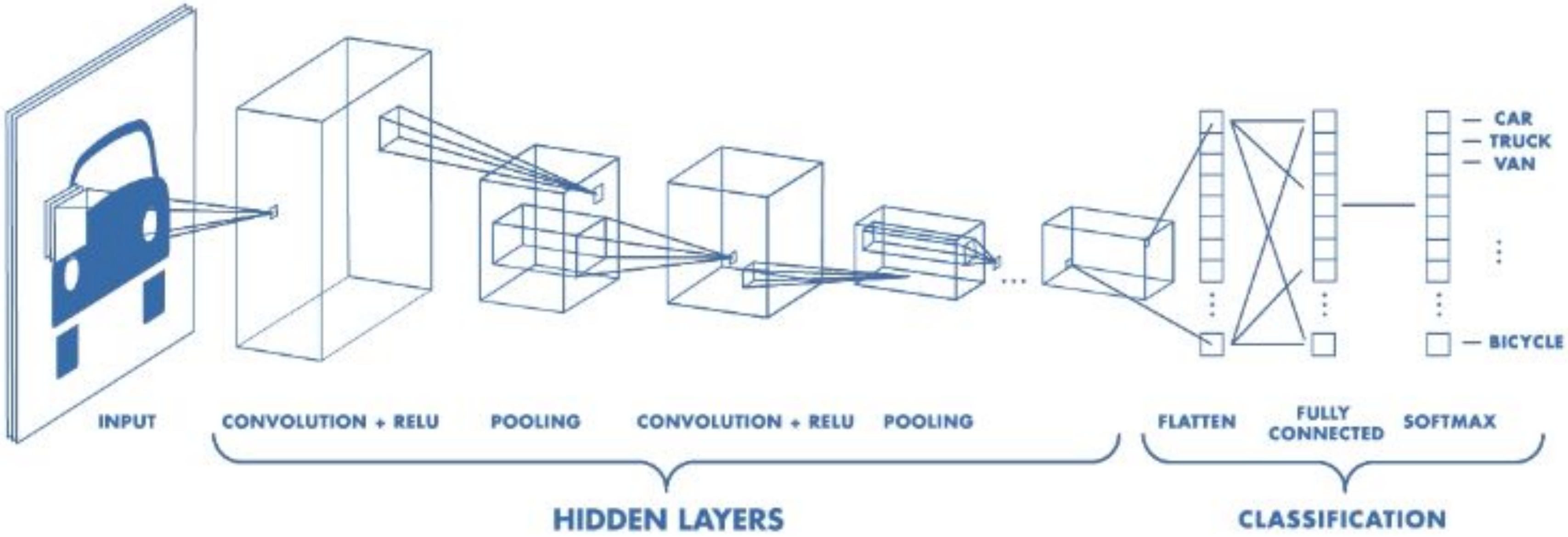


How CNN works?

In Machine Learning, a convolutional neural network is a class of deep, feed-forward artificial neural networks that has successfully been applied to analysing visual imagery.

CNNs use a variation of multilayer perceptron designed to require minimal preprocessing. They are also known as shift invariant or space invariant artificial neural networks (SIANN), based on their shared-weights architecture and translation invariance characteristics.

CNN Building Blocks

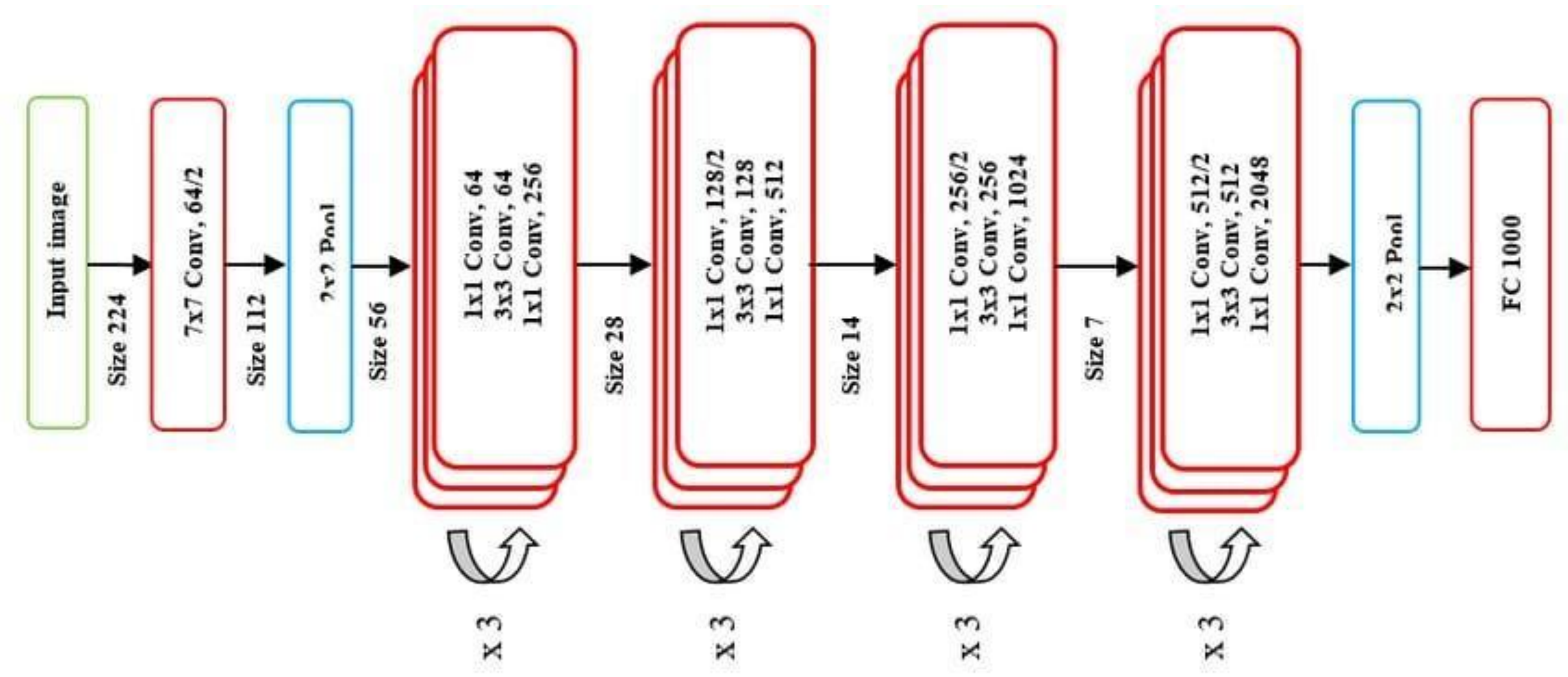


Resnet 50 Model

- **Architecture:** A deep **50-layer convolutional neural network** designed for image classification tasks.
- **Residual Learning**: Introduces **skip connections** to solve the vanishing gradient problem, allowing deeper networks to train effectively.
- **Pretrained** Model: Utilizes a model **pre trained on ImageNet** for transfer learning, enabling faster and more accurate training on new datasets.
- **Final Layer Modification:** Adjust the final layer to match the number of target classes (benign, malignant).
- **Key Benefits:**

- High accuracy for complex image classification tasks.
- Efficient training with reduced risk of overfitting through transfer learning and residual connections.

Resnet 50 Model



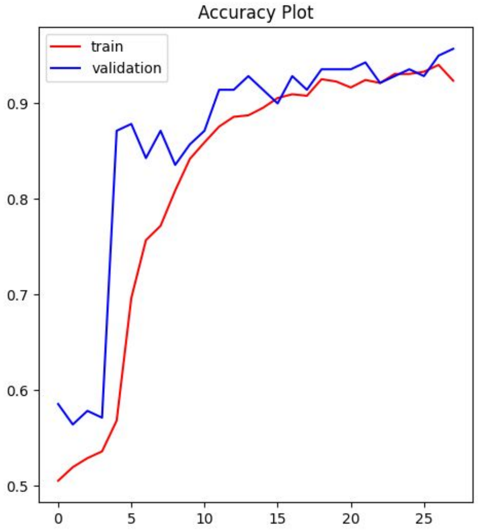
Data Preprocessing

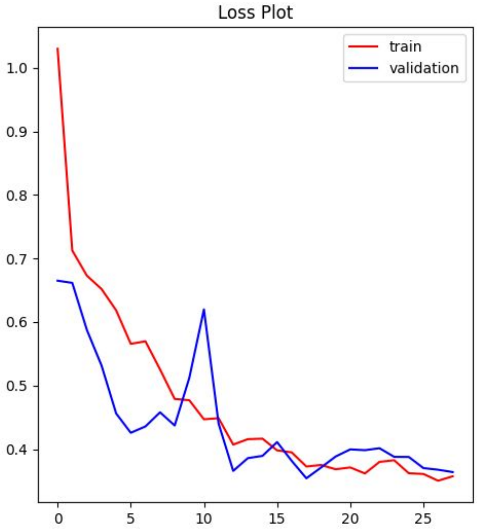
- **Image Resizing**: Resize all images to a uniform size (e.g. 150x150x3 pixels) for consistent input to the model.
- **Normalization:** Scale pixel values (0-255) to a range (e.g., 0-1) for better model convergence.
- **Augmentation**: Randomly rotating, translating, zooming to create multiple versions of same image to improve generalization.
- **Label Encoding:** Convert labels(benign, malignant)into numerical format.
- **Train-Test Split:** Split the dataset into training, validation, and test sets to evaluate model performance.

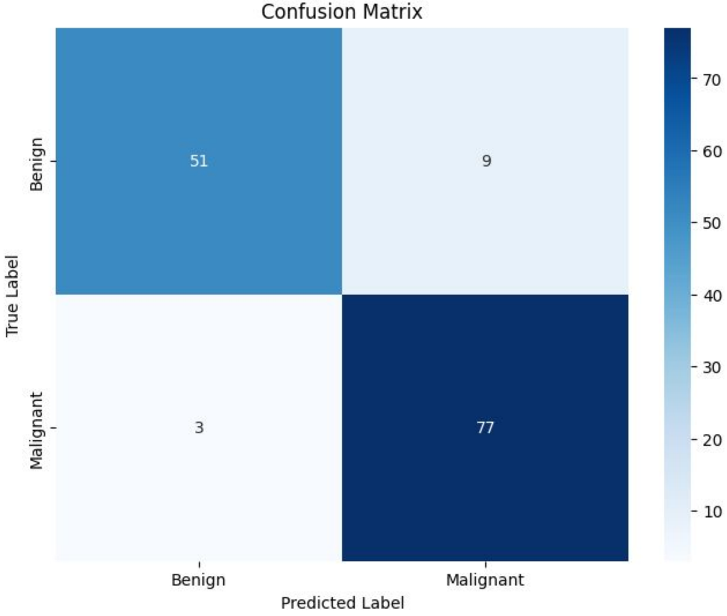
Training Model

- **Load Pretrained ResNet-50**: Start with a ResNet-50 model pre trained on ImageNet for transfer learning.
- **Replace Final Layer**: Modify the final fully connected layer to match the number of classes (benign, malignant).
- **Compile the Model**: Use a suitable optimizer (e.g., Adam), loss function (e.g., binary cross-entropy), and evaluation metrics. (e.g., accuracy).
- **Training the Model**: Feed the pre-processed images into the model with a set number of epochs and batch size.
- **Validation**: Monitor model performance using validation data to avoid overfitting.
- **Fine-Tuning**: Optionally, fine-tune the deeper layers of ResNet-50 for improved accuracy on the specific dataset.

Evaluation Metrics

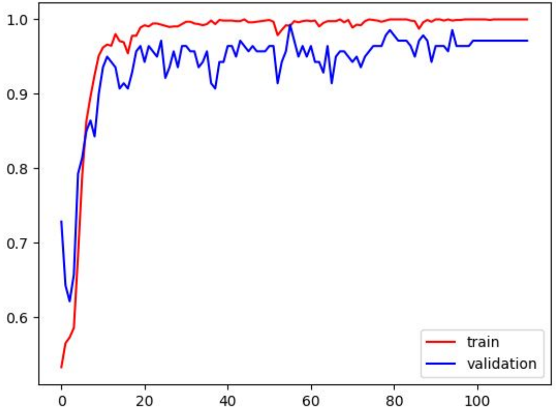


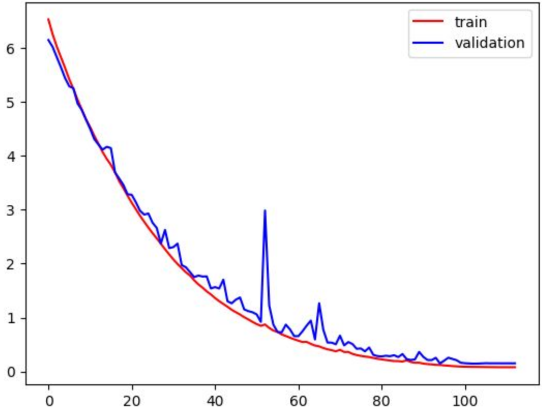


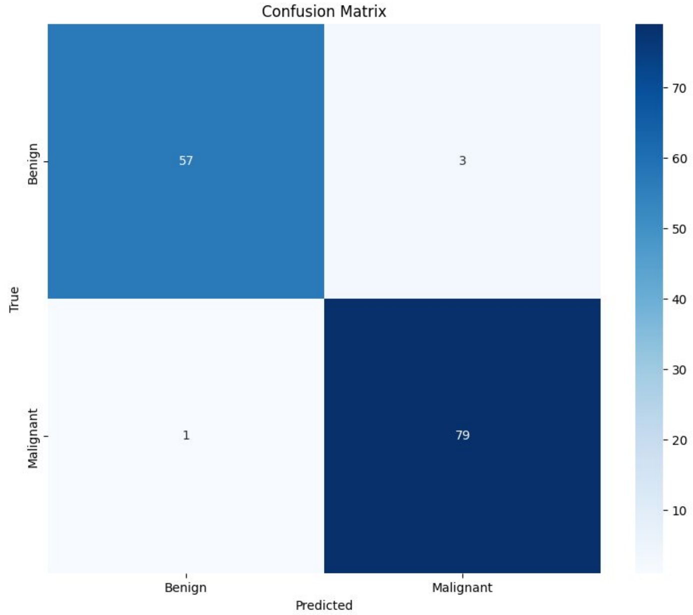


	precision	recall	f1-score	support
Benign	0.94	0.85	0.89	60
Malignant	0.90	0.96	0.93	80
accuracy			0.91	140
macro avg	0.92	0.91	0.91	140
weighted avg	0.92	0.91	0.91	140

Evaluation Metrics (updated)



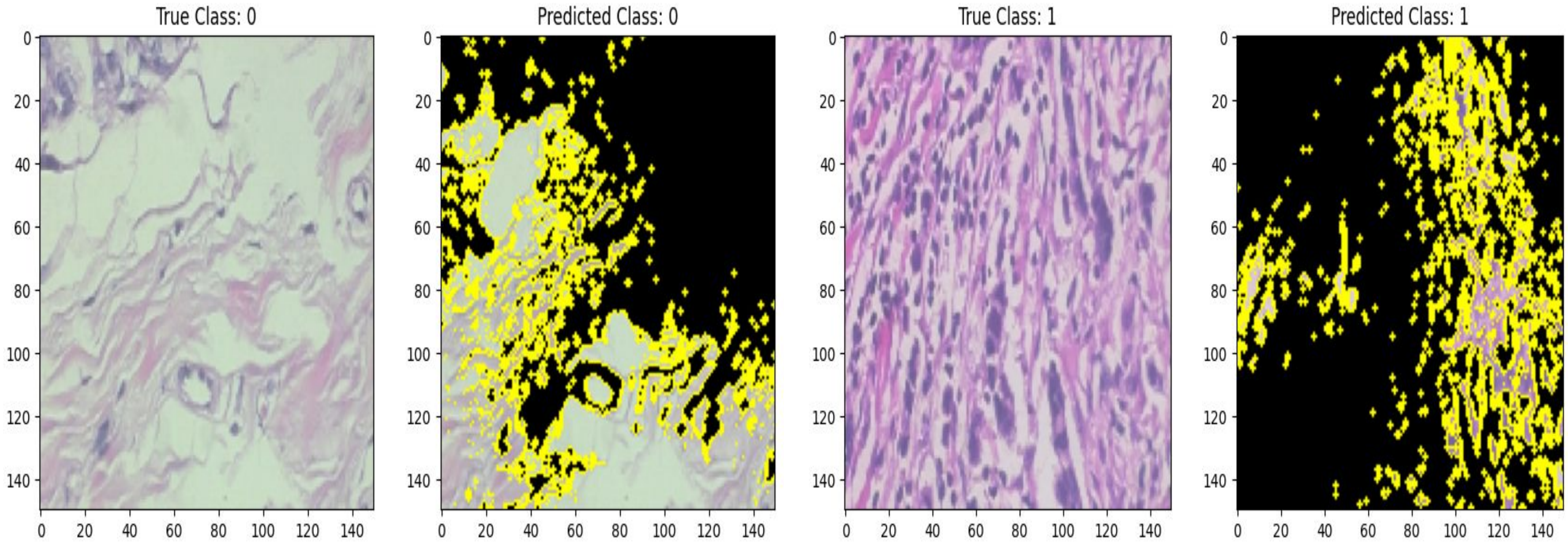




	precision	recall	f1-score	support
Benign	0.98	0.95	0.97	60
Malignant	0.96	0.99	0.98	80
accuracy			0.97	140
macro avg	0.97	0.97	0.97	140
weighted avg	0.97	0.97	0.97	140

	Class	TP	TN	FP	FN
0	Benign	57	79	1	3
1	Malignant	79	57	3	1

Lime AI Explanation



Benign **Malignant**

Applications

1. **Medical Diagnosis**:
   - **Assistance in Pathology**: The developed DCNN model can assist pathologists in accurately diagnosing breast cancer from histopathological images, potentially reducing human error and improving diagnostic efficiency.
2. **Early Detection**:
   - **Proactive Screening**: By utilizing advanced image classification techniques, the model can facilitate early detection of breast tumors, allowing for timely intervention and treatment, which is crucial for improving patient outcomes.
3. **Telemedicine**:
   - **Remote Consultations**: The application of this technology can enhance telemedicine services by enabling remote analysis of breast cancer images, allowing patients in underserved areas to receive expert opinions without needing to travel.
4. **Research and Development**:
   - **Data Analysis**: The model can serve as a foundational tool for researchers exploring the correlations between histopathological features and breast cancer prognosis, aiding in the development of personalized treatment plans.

Future Scope

- **Model Ensembling**: Ensemble ResNet50 with DenseNet, InceptionV3 for better generalization; combine different image resolutions.
- **Transfer Learning**: Fine-tune on medical datasets like primary datasets for better domain-specific performance.
- **Clinical Deployment**: Deploy on edge devices for real-time diagnosis and use human-in-the-loop systems for clinician collaboration.

THANK YOU.