Peter the Great St. Petersburg Polytechnic University
Institute of Computer Science and Cybersecurity

Final Project for Course

for the discipline "Seminar on Specialty"

Classification of Melanoma Cancer

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1 Problem Definition

Skin cancer is one of the most common types of cancer worldwide, and early detection is critical to improving survival rates. Among the various types of skin cancer, melanoma is the most aggressive and potentially life-threatening form. Detecting melanoma in its early stages can significantly improve treatment outcomes.

However, diagnosing melanoma is a challenging task, even for experienced dermatologists, as it requires careful examination of skin lesions and differentiation from benign conditions. To address this challenge, computer vision techniques and machine learning models have been increasingly employed to assist in the classification of skin lesions.

1.1 Contributions of the Study

The main contributions of this study can be summarized as follows:

- Development and implementation of a CNN model tailored for skin lesion classification.
- Fine-tuning and evaluation of the YOLOv8-cls-based model for the same task.
- A comprehensive comparison of the two models based on multiple performance metrics.
- Insights into the strengths and weaknesses of each model, providing guidance for their use in practical applications.

1.2 Objective

The primary objective of this project is to develop a computer vision-based model capable of classifying skin lesion images into two categories:

- **Melanoma:** Images that indicate the presence of melanoma.
- **Non-melanoma:** Images that do not indicate melanoma.

By leveraging advanced deep learning techniques, this project aims to create a robust and accurate classification system that can assist healthcare professionals in diagnosing melanoma more efficiently.

1.3 Dataset Description

To train and evaluate the proposed model, a high-quality dataset of skin lesion images has been utilized. The dataset includes the following characteristics:

- **Number of images:** 13,900
- **Image format:** JPEG (`.jpg`)
- **Image resolution:** 224x224 pixels
- **Classes:** Two categories:
  - Melanoma (positive cases)
  - Non-melanoma (negative cases)

The dataset has been preprocessed to ensure uniformity in image resolution and format, making it suitable for input into convolutional neural networks (CNNs). The balanced distribution of classes ensures that the model learns effectively without bias towards one category.

1.4 Significance of the Study

The successful implementation of this project can contribute to the field of medical imaging by providing an automated tool for early melanoma detection. This has the potential to:

- Reduce diagnostic errors caused by human limitations.
- Save time and resources in clinical settings.
- Improve patient outcomes by enabling timely interventions.

By combining the power of computer vision with medical expertise, this project aims to bridge the gap between technology and healthcare, paving the way for innovative solutions in dermatology.

2 Methods and Solutions

This chapter outlines the tools, infrastructure, and methodologies used to develop and evaluate the models for skin lesion classification. The chapter also describes the dataset and provides an overview of the two models implemented: a Convolutional Neural Network (CNN) and a YOLO-based model (YOLOv8-cls).

2.1 Tools and Technologies

The following tools and technologies were utilized during the development process:

- **HTML, CSS, jQuery:** Used for creating a user-friendly interface for visualizing results and interacting with the system.
- **PostgreSQL:** A relational database management system used for storing metadata about images and classification results.
- **Django:** A Python-based web framework used to build the backend of the application.
- **Python:** The primary programming language used for data preprocessing, model training, and evaluation.

2.2 Infrastructure

To facilitate model development, training, and evaluation, the following infrastructure was employed:

- **Jupyter Notebook:** Used for exploratory data analysis, preprocessing, and prototyping machine learning models.
- **Google Colab:** Leveraged for training deep learning models on GPUs provided by Google Colab's cloud environment.
- **Visual Studio Code:** Used as the primary integrated development environment (IDE) for writing and debugging Python and Django code.

2.3 Dataset Description

The dataset used for this project contains 13,900 images of skin lesions in JPEG format (`.jpg`). Each image has been resized to a resolution of 224 x 224 pixels to ensure compatibility with deep learning models. The dataset is divided into two classes:

- **Melanoma:** Images depicting melanoma cases.

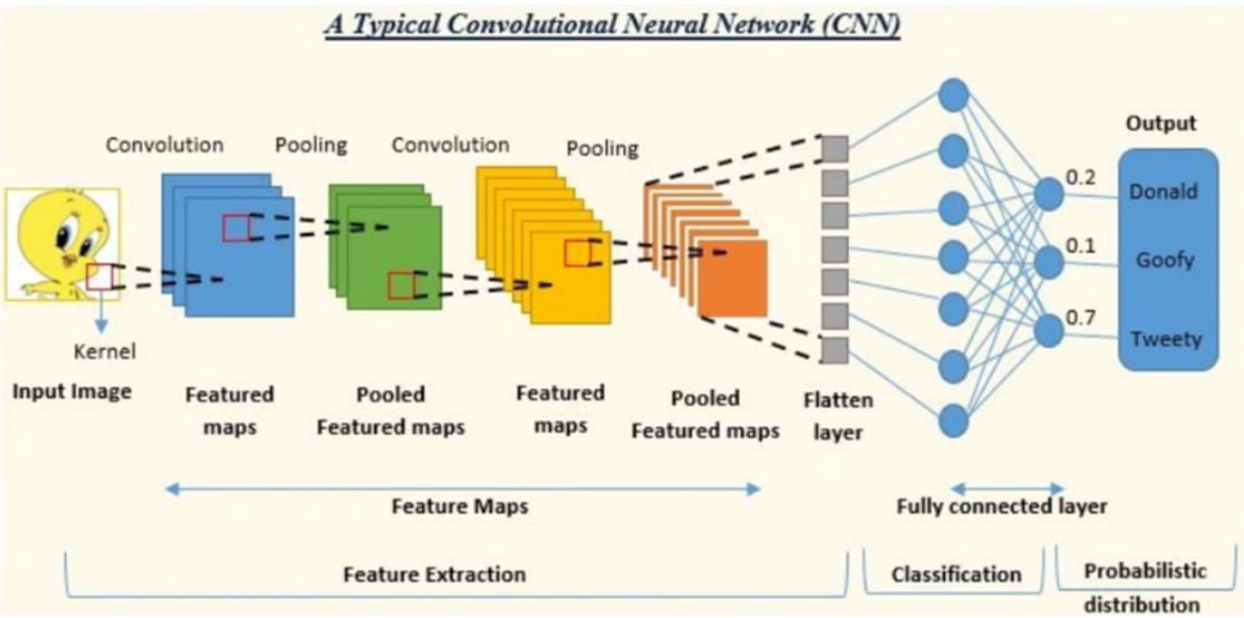
- **Non-melanoma:** Images depicting non-melanoma cases.

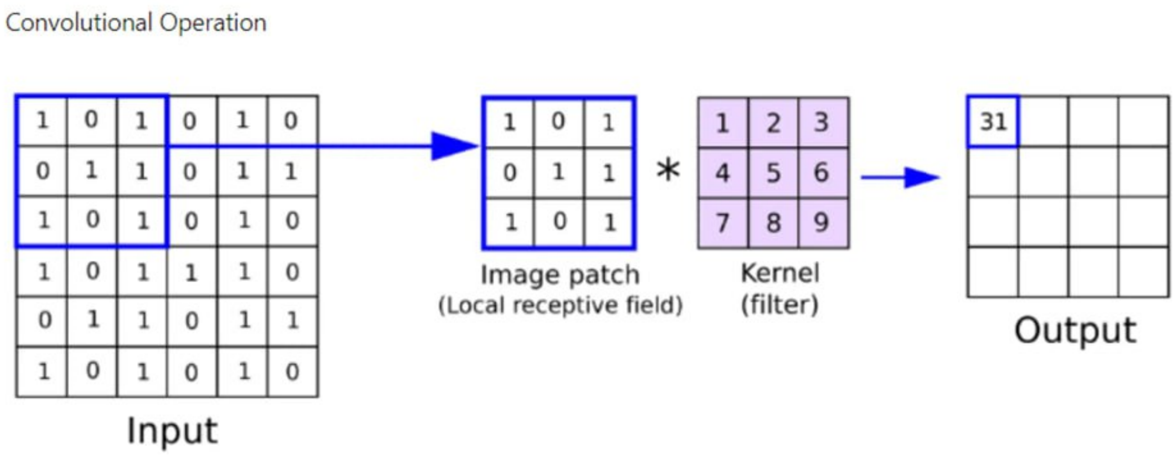
The dataset was preprocessed to normalize pixel values and augment data using techniques such as rotation, flipping, and scaling. This ensured that the models could generalize better to unseen data.

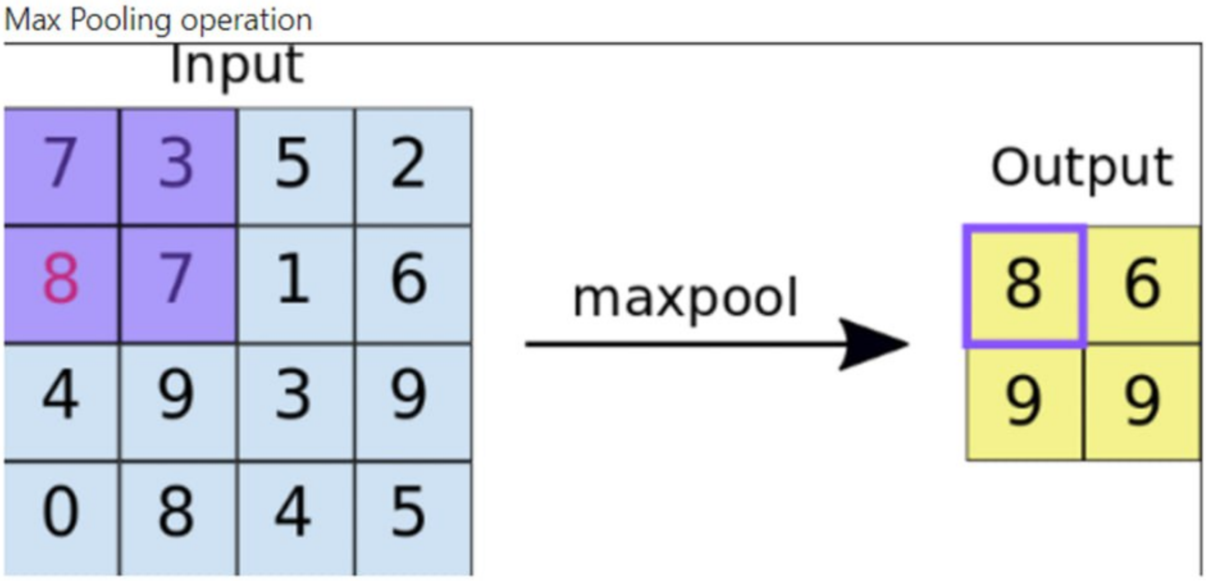
2.4 Model 1: Convolutional Neural Network (CNN)

The first model implemented is a standard Convolutional Neural Network (CNN), which is well-suited for image classification tasks. The architecture includes:

- Convolutional layers to extract spatial features from images.
- Pooling layers to reduce dimensionality and computational complexity.
- Fully connected layers to map extracted features to the output classes.







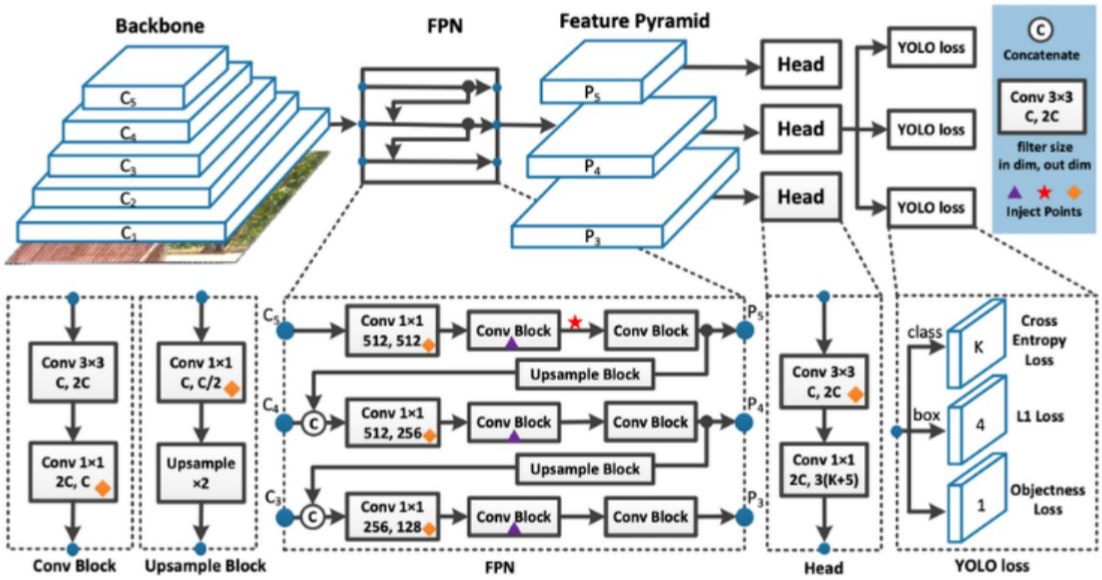
2.5 Model 2: YOLO-Based Model (YOLOv8-cls)

The second model is based on the YOLO (You Only Look Once) framework, specifically using the YOLOv8-cls variant. YOLOv8-cls is designed for classification tasks and leverages the efficiency and speed of YOLO architectures.

Overview of YOLOv8-cls

YOLOv8-cls is a state-of-the-art model for image classification. It inherits key features from previous YOLO versions while introducing improvements in accuracy and computational efficiency. Some notable characteristics of YOLOv8-cls include:

- Lightweight architecture optimized for real-time performance.
- Improved feature extraction using advanced convolutional techniques.
- Pretrained weights available on large datasets such as ImageNet, enabling transfer learning for specific tasks.



2.6 Summary

This chapter described the tools, infrastructure, dataset, and methodologies employed in this project. Two models were developed: a CNN and a YOLOv8-cls-based model. The next chapter will present the results obtained from these models and analyze their performance.

3 Results

This chapter presents the results of the two models developed for skin lesion classification: the Convolutional Neural Network (CNN) and the YOLO model. The performance of these models is compared based on key evaluation metrics, including accuracy, precision, recall, and F1-score.

3.1 Performance of CNN

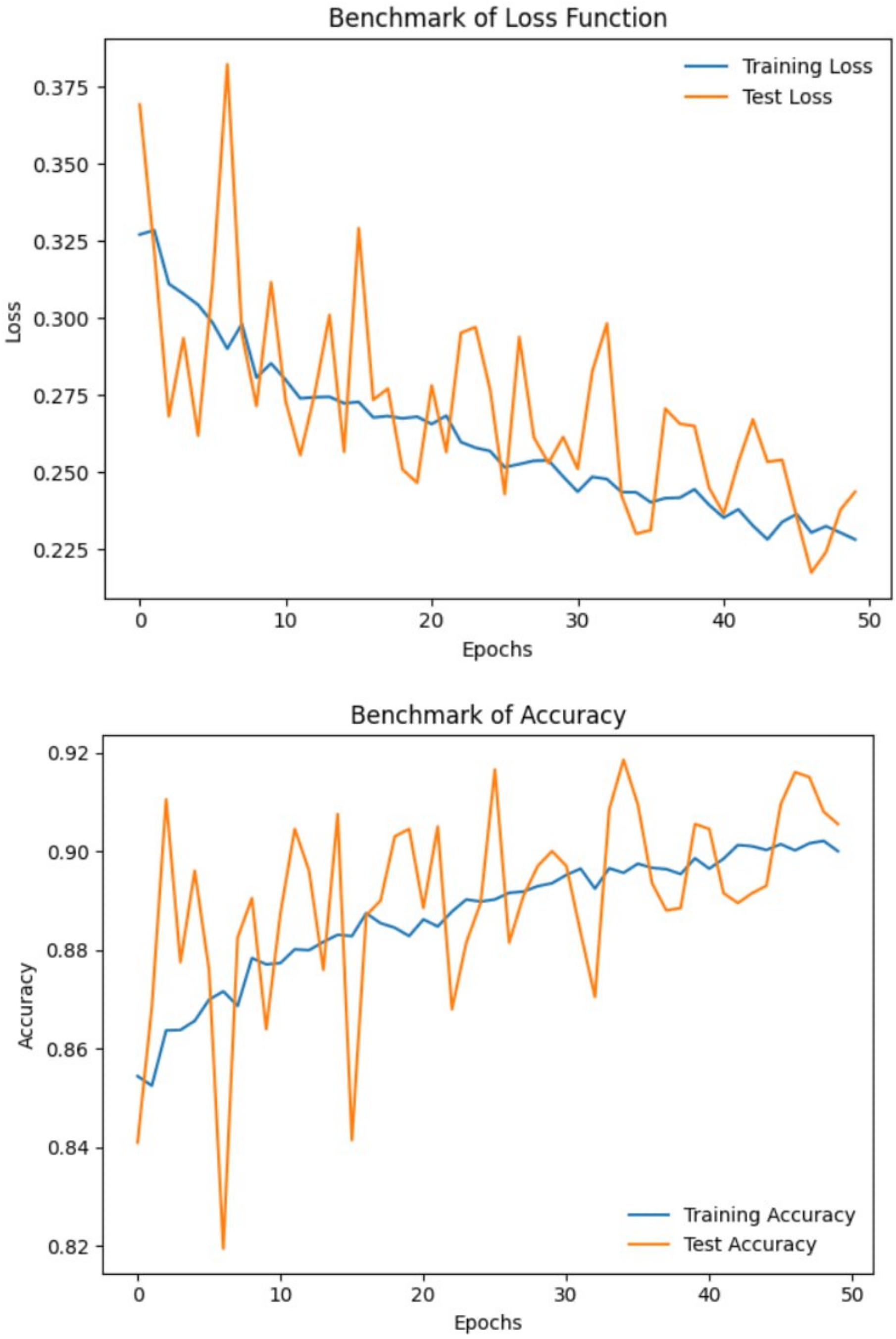


Figure 1: Monitoring results in CNN model

```
print(testing_results)
```

	accuracy	precision	recall	f1_score
0	0.9185	0.919205	0.9185	0.918466

Figure 2: Test characteristics for CNN

```
[43] image, label, prob_dist = inference(model_path = best_model_path,
                                          data_loader = test_loader,
                                          device = device,
                                          sample_pos = 12)
     print(f"True label: {label}")
     print(f"Prob distribution: {prob_dist}")
```

```
True label: 0
Prob distribution: [[7.9139358e-01 2.0826496e-01]]
```

Figure 3: Inference for CNN

3.2 Performance of YOLO

```
# Run prediction
results = model.predict('/content/drive/MyDrive/dataset/test/Benign/6299.jpg')

# Access the first result
result = results[0]  # Assuming a single image was processed

# Extract probabilities (the classification outputs)
probs = result.probs

# Print the probabilities
print(probs.data)
```

```
image 1/1 /content/drive/MyDrive/dataset/test/Benign/6299.jpg: 224x224 Benign 0.58, Malignant 0.42, 29.6ms
Speed: 3.2ms preprocess, 29.6ms inference, 0.1ms postprocess per image at shape (1, 3, 224, 224)
tensor([0.5846, 0.4154])
```

Figure 4: Inference for YOLO

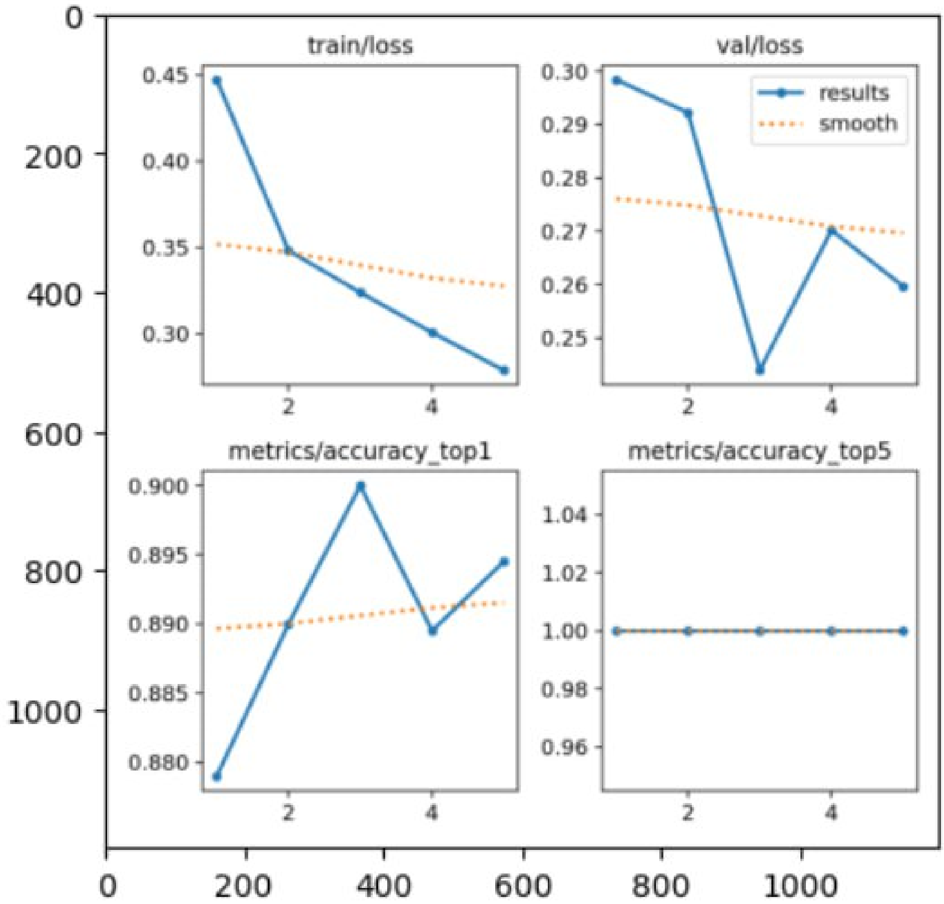


Figure 5: Monitoring results in YOLO model

3.3 Summary

This chapter presented the results of the two models developed for skin lesion classification. The YOLO model did not perform as expected because the data preprocessing step was skipped. In the next chapter, we will discuss the conclusions drawn from this study.

4 Conclusion

4.1 Summary of Findings

This study focused on the development and evaluation of two machine learning models, a Convolutional Neural Network (CNN) and a YOLOv8-cls-based model, for the classification of skin lesions into melanoma and non-melanoma categories. The primary goal was to compare the performance of these models using key evaluation metrics, including accuracy, precision, recall, and F1-score.

The results demonstrated that both models were capable of performing the classification task effectively. However, the CNN model showed the best result, since it has a better probability distribution in inference. We will choose her.

4.2 Limitations

While this study achieved promising results, it is not without limitations:

- **Dataset Size:** The dataset used in this study was relatively small compared to large-scale datasets typically used in deep learning research. A larger dataset could improve model performance and generalization.
- **Computational Resources:** Training the YOLOv8-cls model required significant computational resources, which may limit its accessibility for researchers with limited hardware capabilities.

4.3 Final Remarks

In conclusion, this study demonstrated that deep learning models hold promise for improving the accuracy and reliability of skin lesion classification.

Despite the limited amount of time, resources, and challenges and limitations encountered, the work was successful and provides a basis for future research.