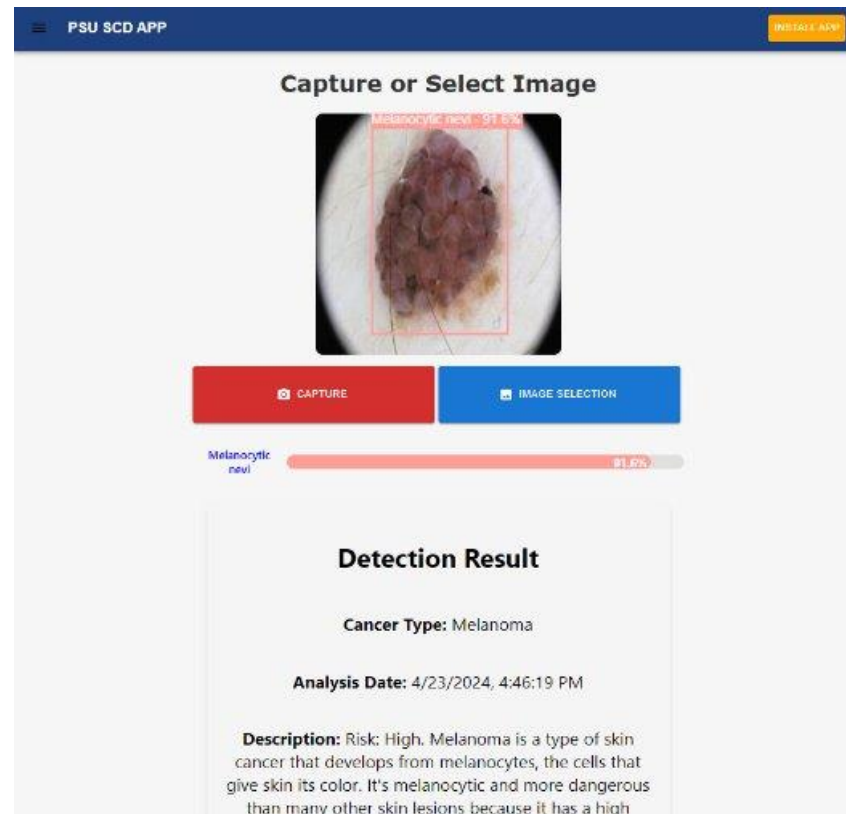


SKIN LESION DETECTION WEB APP PSU-SCD FINAL PRESENTATION

CMPSC 488
2024 SPRING

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Motivation



Create a web application that can detect skin lesion and classify



Combine available datasets (ISIC 2019 + ISIC 2020)



Adopt the state-of-the-art machine learning approach



Application is stable in various environments even without the internet connection.

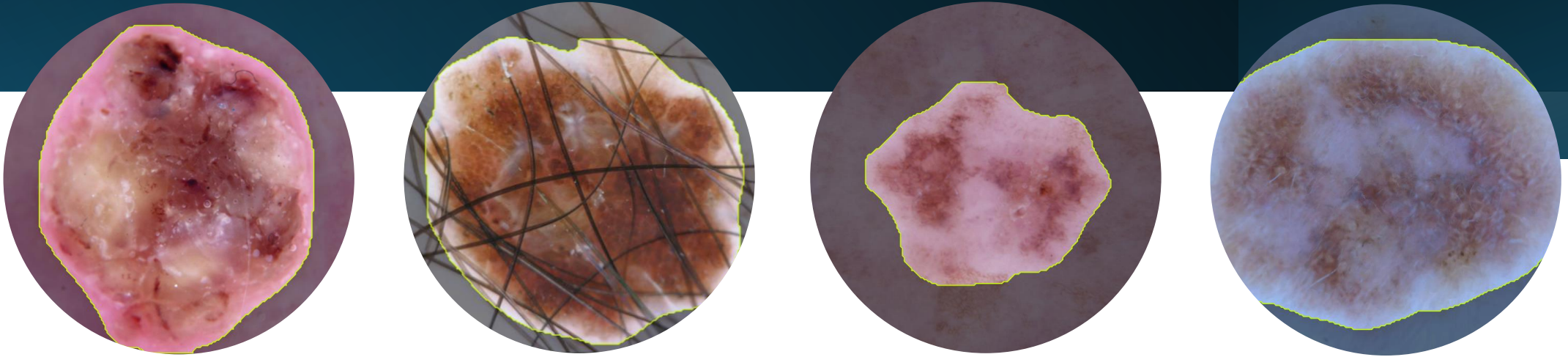


Develop the project into further research project that can improve the accurate detection of the architecture.

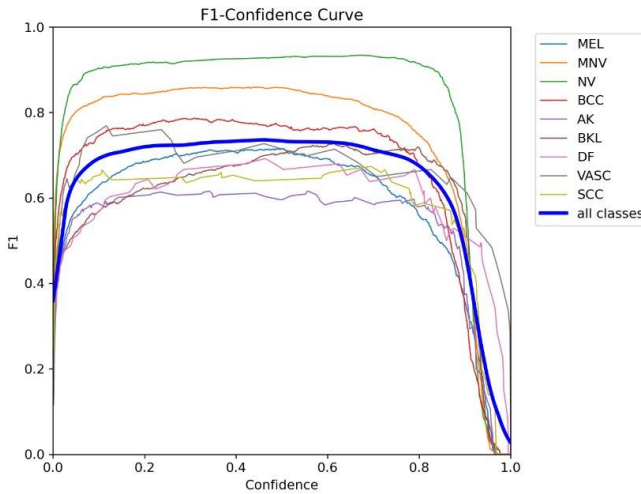


Utilize the interpretability framework to analyze whether the model accurately comprehend the features of the data for its decision.

Dataset Preprocessing



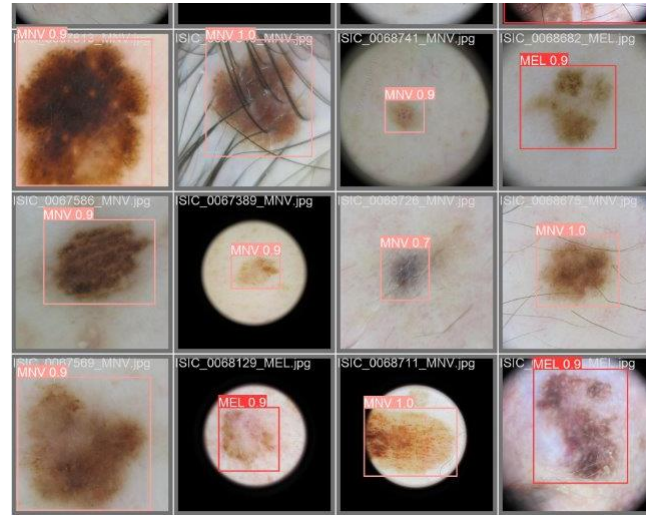
- **Combine dataset.** of **ISIC 2019** and **ISIC 2020** datasets
- **Instance segmentation.** is applied to the data annotation
- This is to identify each distinct object of interest in an image for the model training
- **HAM10000.** dataset is used to train a model that helps the segmentation annotation of the combined dataset.
- **Data augmentation.** Data augmentation is used with built-in systems, such as the mosaic augmentation in the Ultralytics system.



Normalized Confusion Matrix

	0	1	2	3	4	5	6	7	8	9
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.79	0.12	0.01	0.03	0.01	0.03	0.00	0.00	0.00
2	0.00	0.17	0.75	0.01	0.03	0.00	0.02	0.00	0.00	0.00
3	0.00	0.04	0.02	0.93	0.00	0.00	0.01	0.00	0.00	0.00
4	0.00	0.08	0.05	0.00	0.81	0.03	0.00	0.00	0.00	0.00
5	0.00	0.15	0.00	0.00	0.24	0.40	0.14	0.00	0.00	0.00
6	0.00	0.27	0.09	0.00	0.07	0.04	0.51	0.00	0.00	0.00
7	0.00	0.08	0.29	0.00	0.17	0.00	0.04	0.42	0.00	0.00
8	0.00	0.12	0.20	0.00	0.00	0.00	0.00	0.00	0.68	0.00
9	0.00	0.13	0.02	0.00	0.26	0.11	0.08	0.04	0.00	0.00

True Label (Y-axis), Predicted Label (X-axis)



Detection Model

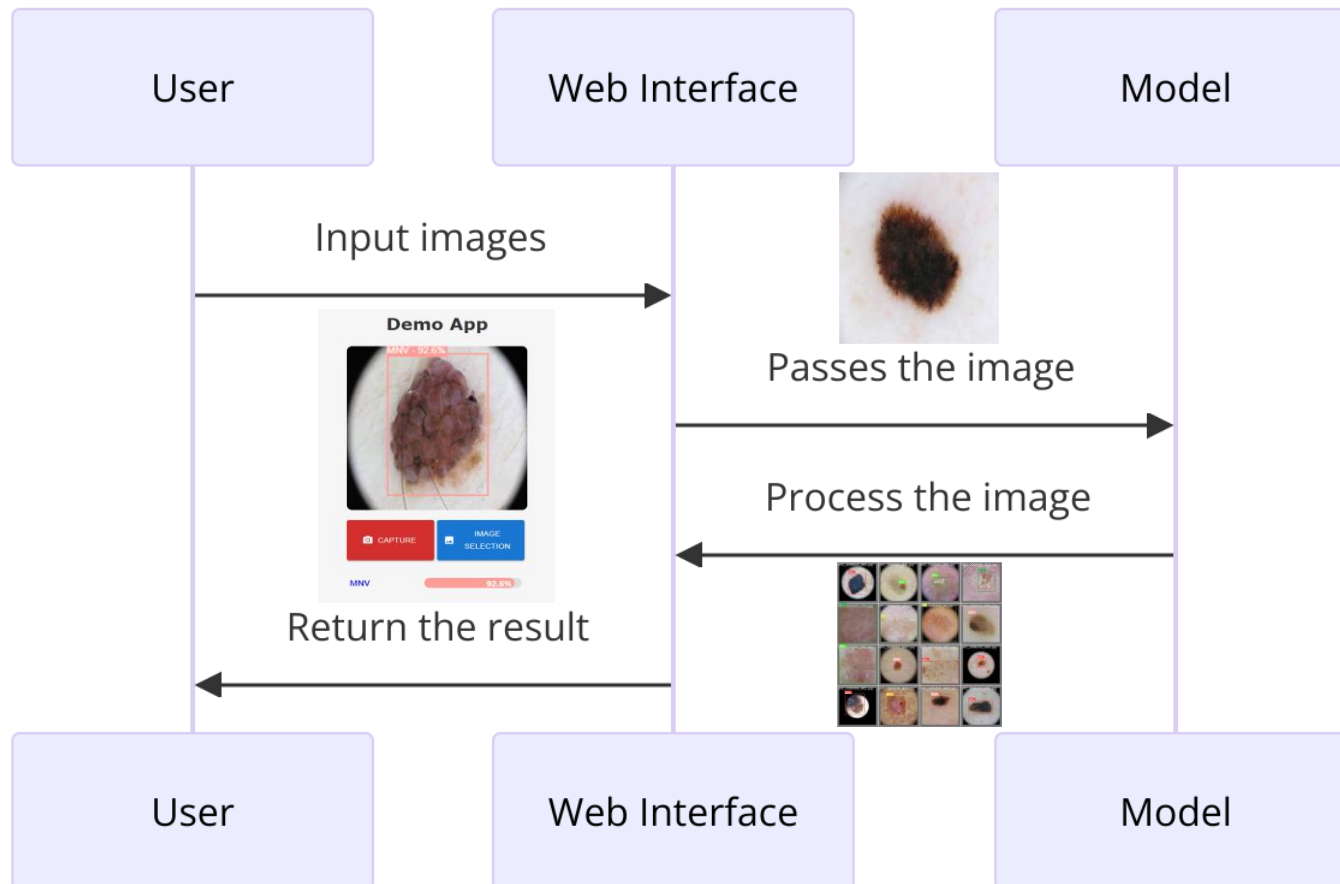
Model Type: YOLOv8

- **Tested Models:** Mask2Former, OneFormer, SwinV2, YOLOv8
- **Decision:** Adopted YOLOv8 as the baseline
- **Reason:** Demonstrated the highest accuracy and speed

Evaluation Metrics

- **Metrics Used:** Confusion matrix, F1 scores
- **Performance:** YOLOv8 showed the best performance

Web Interface (React)



User passes image to web interface



Web interface passes image to the uploaded model



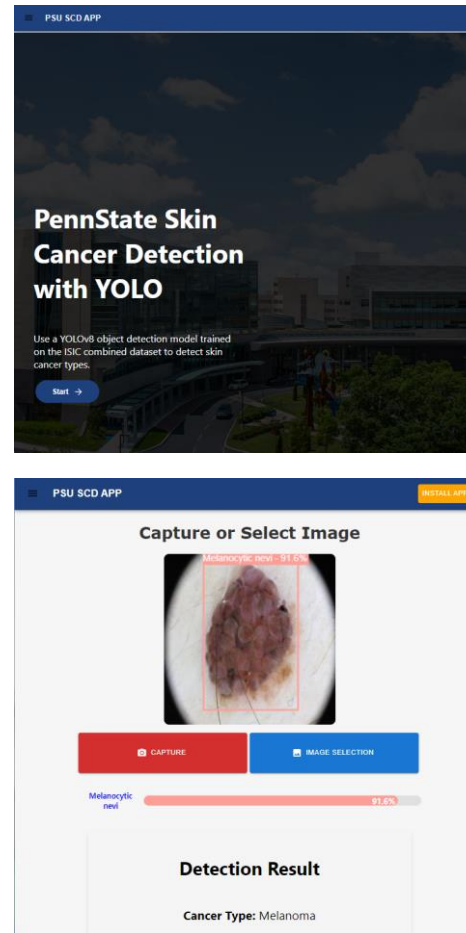
Trained model outputs the result through the web interface



Analysis can be saved to the device

Web Application Online

- **Link:** <https://psu-scd.netlify.app> or QR code scan
- **Responsiveness:** Using a Progressive Web Application (PWA), the application is responsive across various OS and device environments.
- **Accessibility:** Since the model is downloaded within the application, it can operate even in offline environments.
- **Landing Page and Main Page:** The Landing Page introduces the application and provides a link to the repository. The Main Page processes and displays the results of the user's input image.



<https://psu-scd.netlify.app/>



MEL



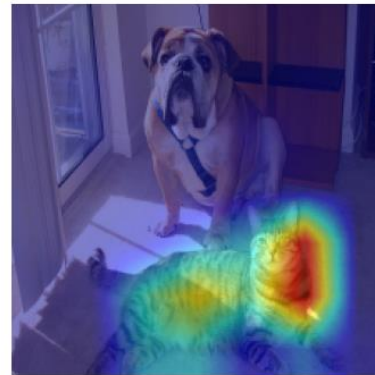
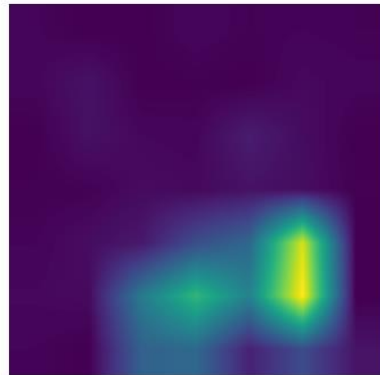
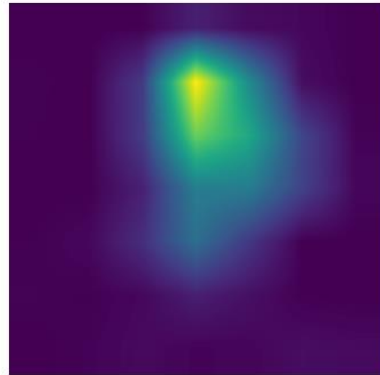
MNV

Further Development into Research

- **Limitations.** Medical decisions based on machine learning cannot solely rely on simple image detection due to legal reasons.
- **Changed Research Goal.** Enhance the accuracy of the detection process.
- **Phase 1:** Reinforced image preprocessing.
- **Phase 2:** Modify the model directly.



Functional Requirements - Explainability



- **Regulatory requirement:** Comply with emerging regulations on AI/ML
- **Model validation:** Identify and eliminating biases
- **User friendliness:** Explain results to people without domain knowledge
- **Mitigation of risks:** Cybersecurity, fraudulent detection, etc.

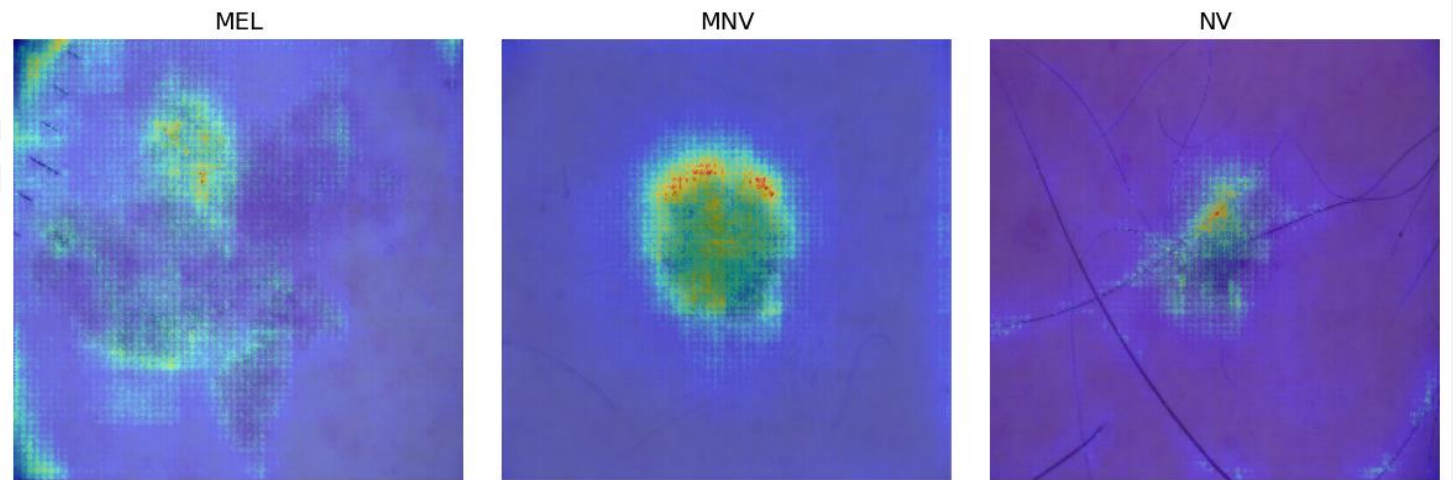
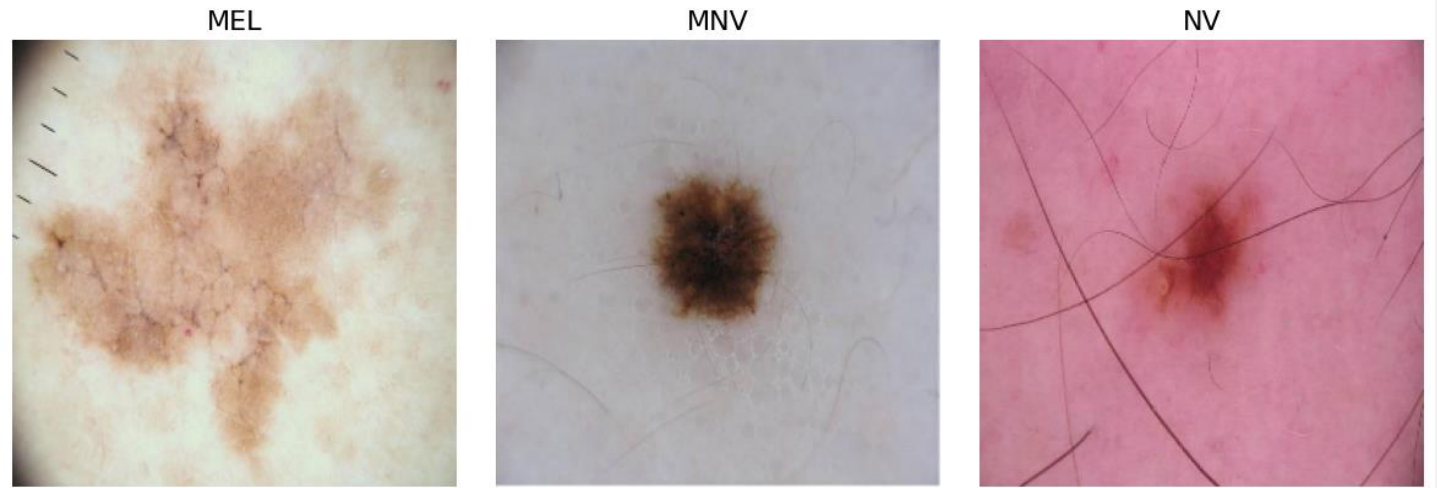
How was explainability used in this project?

- **Model validation**

- Current model will treat artifacts such as hair and dark corners as features.
- This motivated us to develop methods to remove such artifacts.

- **Feature Identification**

- People without domain knowledge will find explanations generated by pixel attribution-based methods difficult to understand.
- Addressing this issue will be one of our future research directions.

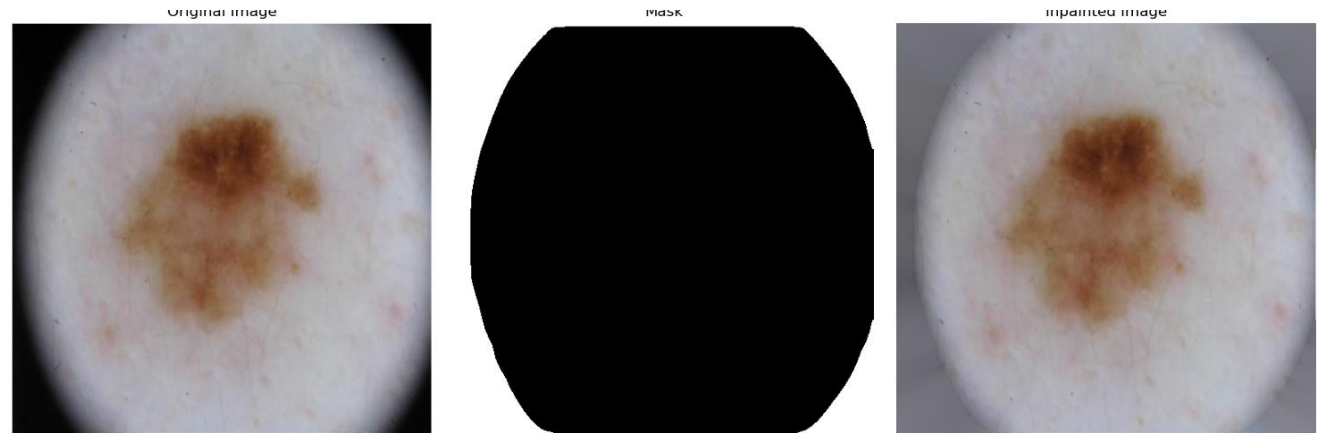


Phase 1

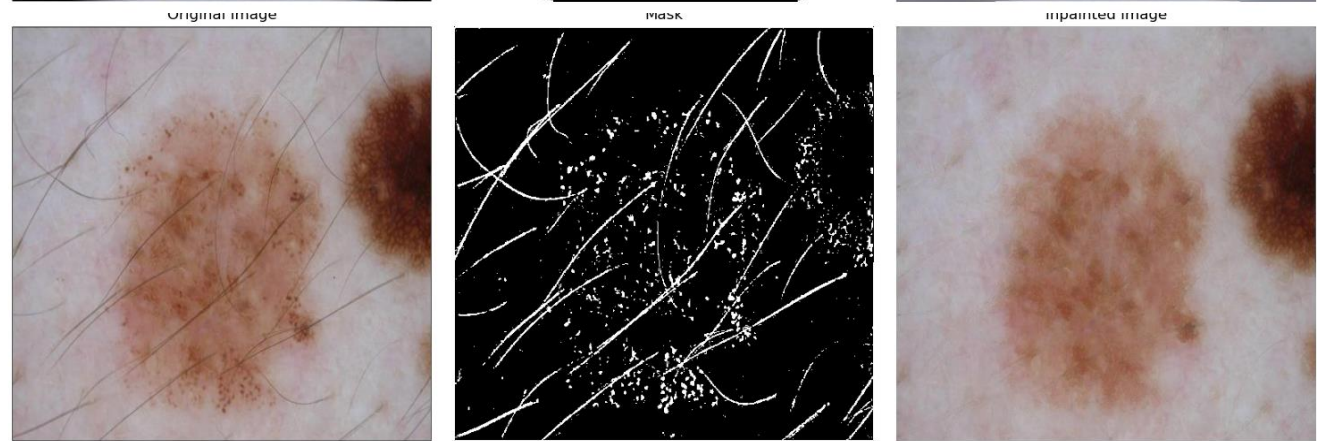
Image Preprocessing for Confounding Factors

- **DCA Removal (1):** Dark Corner Artifacts (DCA) have been identified as confounding factors in prior research on machine learning detection.
- **2 Hair Removal (2):** Hair can also be a confounding factor.
- **3 DCA + Hair Removal (3):** Consider scenarios where both factors exist in the same image.

1



2

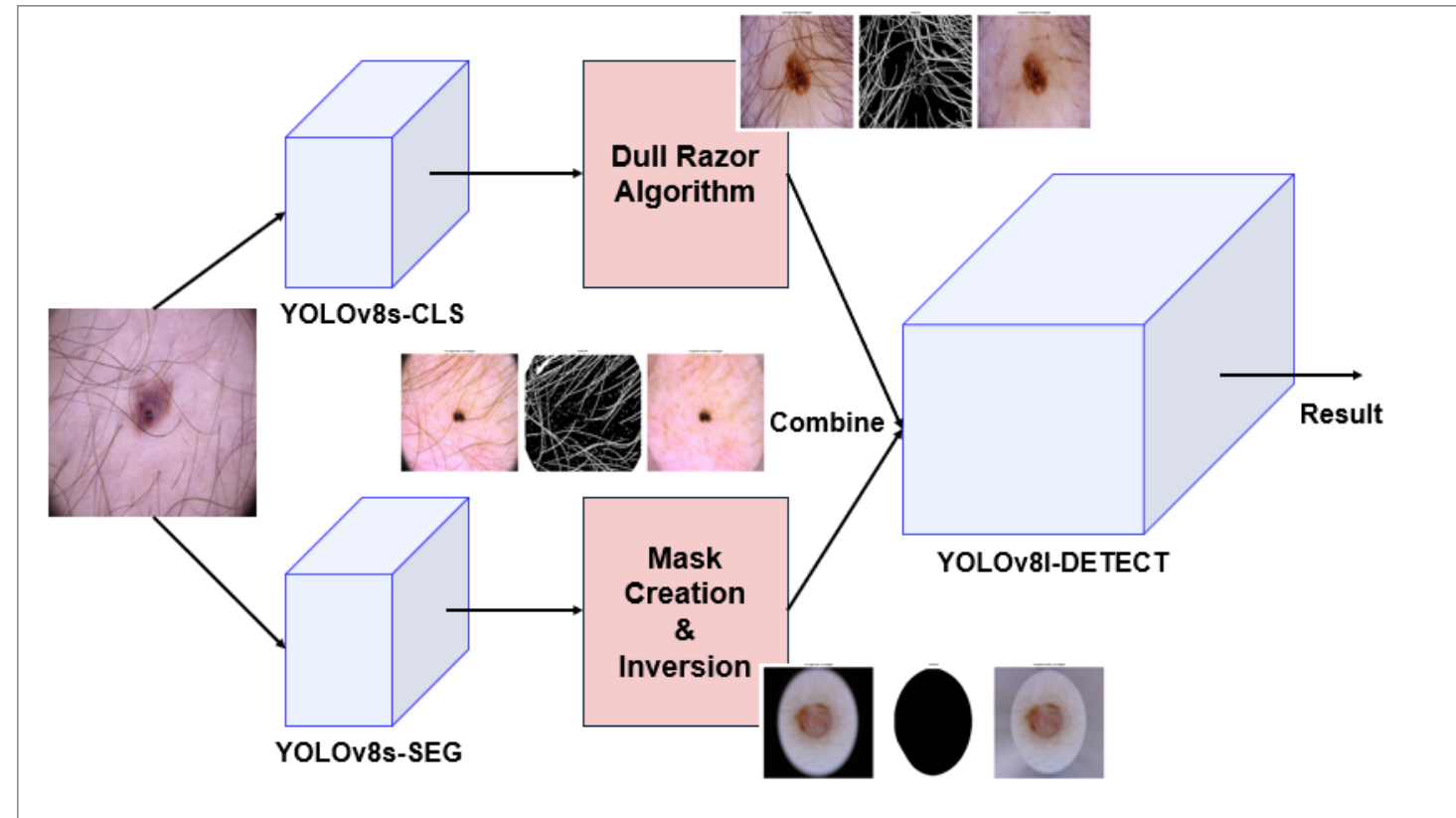


3



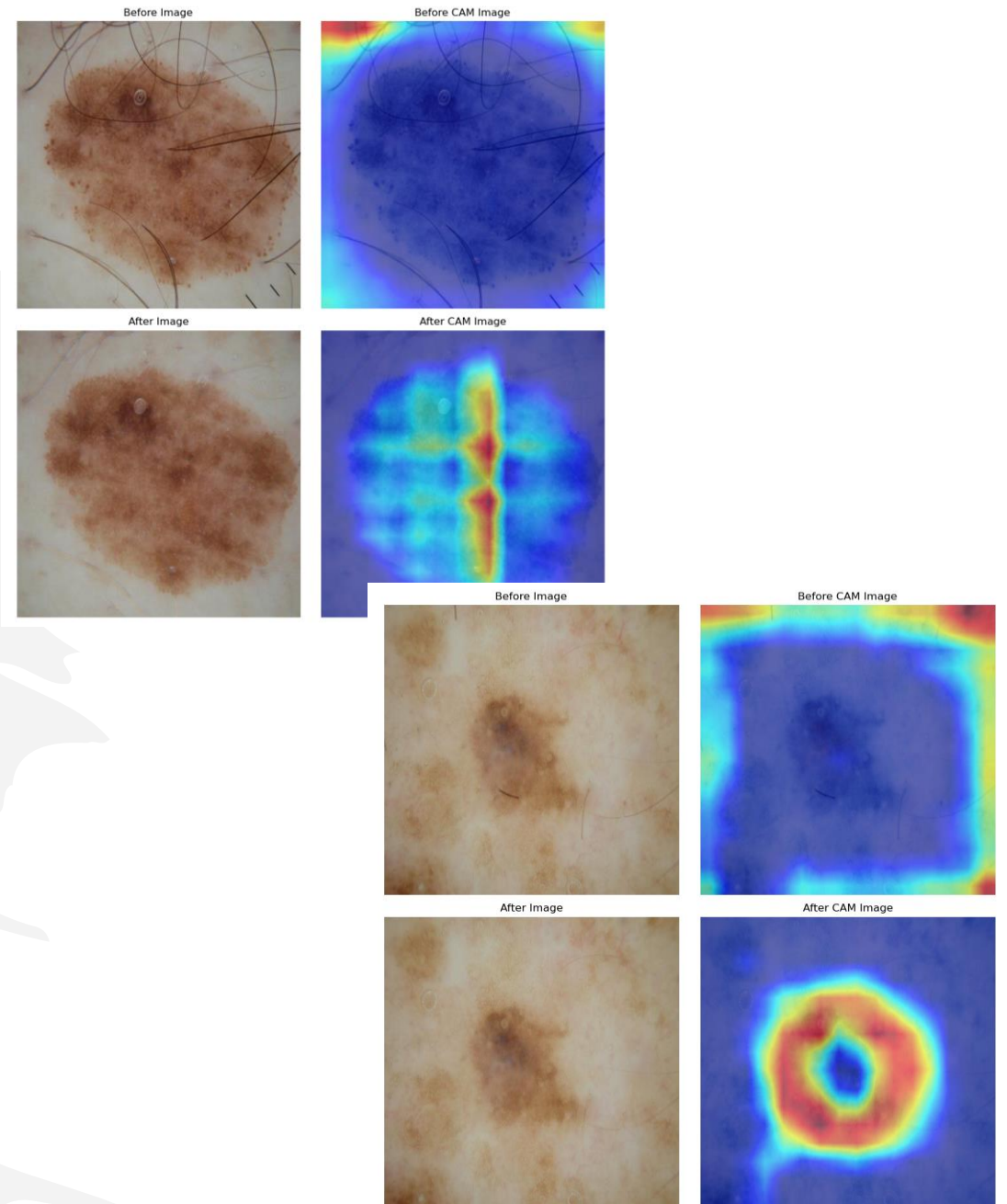
Phase 1 – Image Processing Structure

- **Pipeline.** Developed pipelines to process images and remove confounding factors.
- **Detection/Classification.** Use variations of the YOLOv8 model to identify images with confounding factors.
- **Post-Detection Processing.** Apply algorithms such as Dullrazor to create masks, then use inpainting algorithms to refine the masked sections.



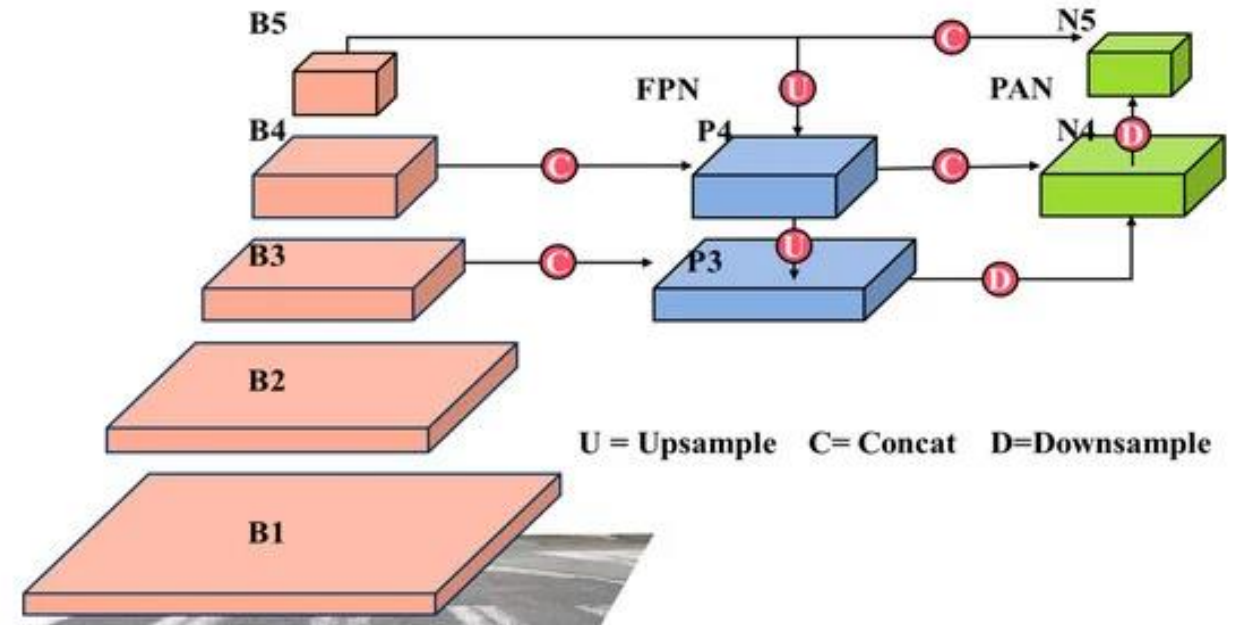
Results

- **Interpretability Analysis.** Temporary EigenCAM to assess changes in the model's understanding of processed images.
- Some samples showed improvement, with focus shifting from unrelated parts to the center, while few deteriorated.
- **Accuracy Results.** Improvements in accuracy were modest, with only a 0.05 increase in the mAP@50 score. This indicates that **further improvements or replacements with better algorithms** are necessary for future enhancements.



Phase 2 – Model Modification

- On progress for the final publication
- **Integration of modules** that improve generalization and accuracy is expected in the second stage of the research
- Such as the **Bidirectional Feature Pyramid Network (BiFPN)** module. This module enhances feature integration across different scales.



Technical Platforms



roboflow



Hugging

- Framework: **Pytorch**
- Model: **Ultralytics**, **HuggingFace**
- Explanation: **EigenCAM**
- Human intervention data annotation tool: **Roboflow**

PyTo

Future Plans

- **Complete the Second Stage of the Research.** Finish the ongoing second phase of the research project.
- **Reinforce the First Stage.** Enhance the effectiveness of the initial stage to improve the model's comprehension.
- **Expand into Related Research.** Develop additional research focused on enhancing model interpretability.





Thank you!