# Melanoma Detection Model

**Computer Vision**
A.Y. 2023-2024

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# Task and goals

- **Melanoma:** skin cancer that develops in the cells that produce melanin
- Responsible for 75% of skin cancer deaths
- An early and accurate detection can make treatment more effective

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- **Task and motivation:**
  - Build a useful predictive model
  - Help people detect this problem in time
- **Related works:**
  - Various implementations (most of them uses pre-trained ConvNets)
- **Starting point:**
  - **Paper:** MSLANet - multi-scale long attention network for skin lesion classification, 2022
  - Trying to implement the same structure (by doing some modification)

# Dataset

- **ISIC-2018:** Collection of dermatoscopic images of common pigmented skin lesions (**~ 10k images**)
- Images splitted into **train**, **validation** and **test** sets
- Apply **z-score normalization** (stabilize training process)

Figure 1: ISIC-2018 example image

# Dataset

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Figure 1: ISIC-2018 example image

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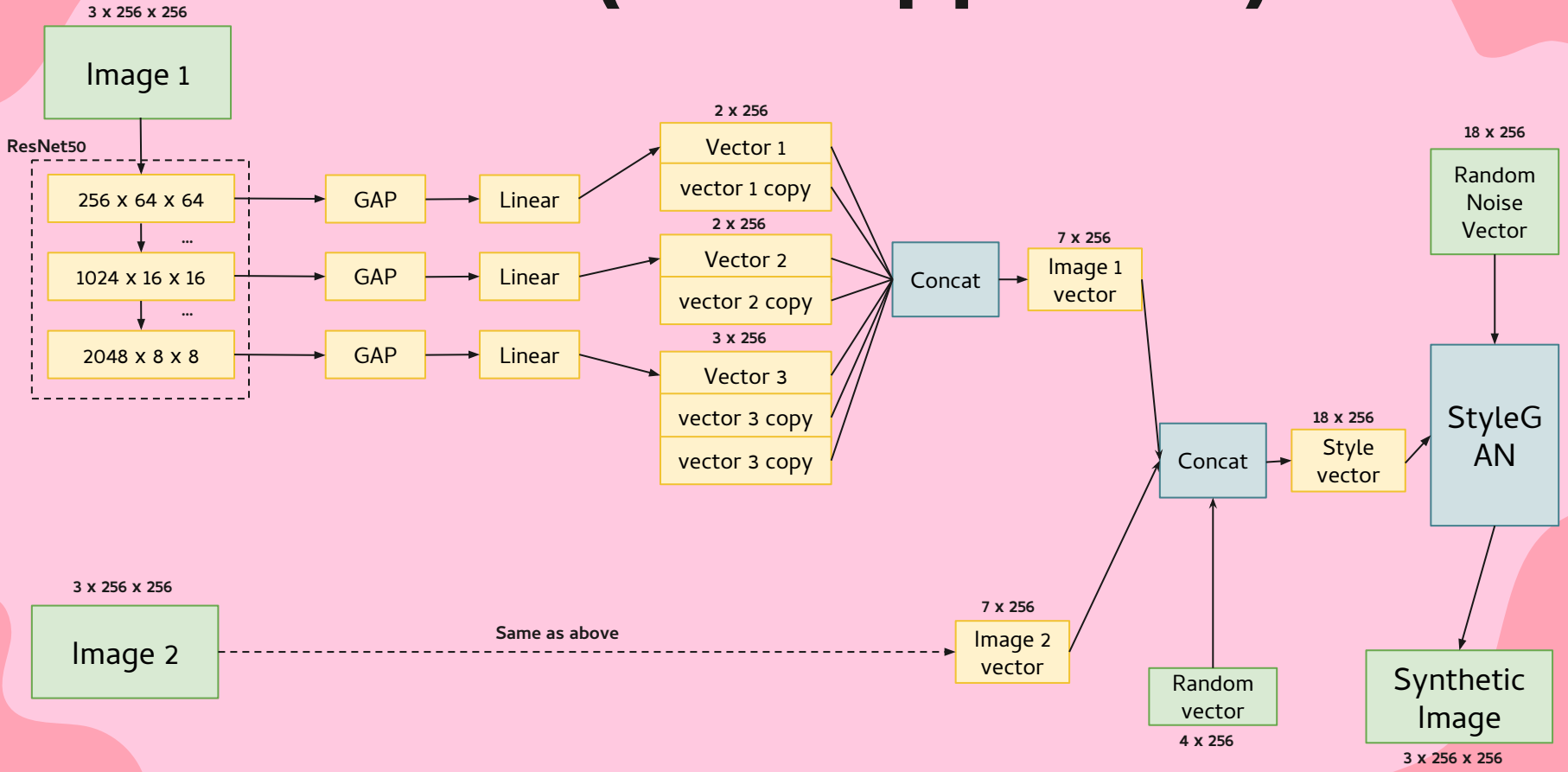
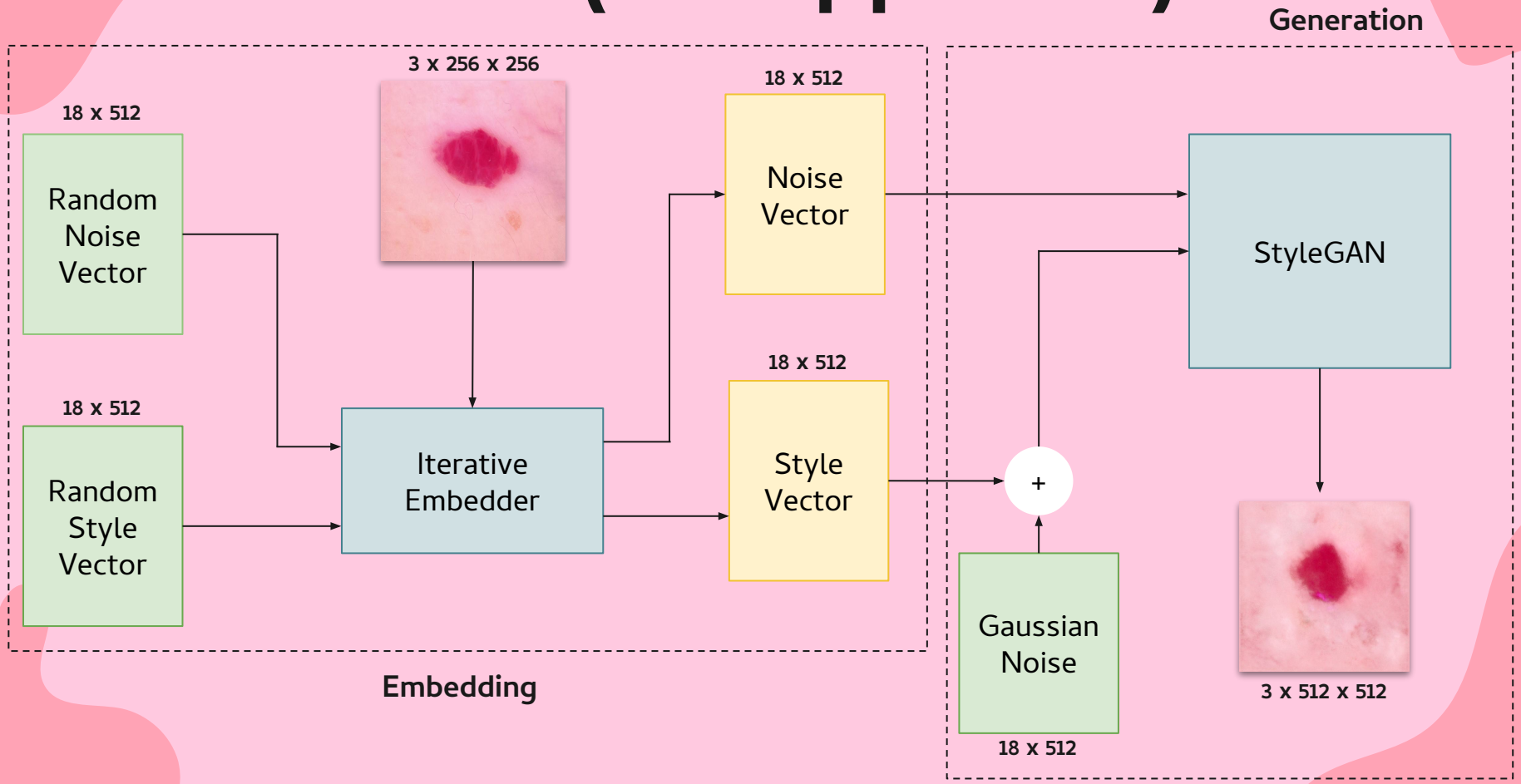
- **Class imbalance**
  - **7 classes** in total, with **4 benign** and **3 malignant**
  - Significant imbalance (particularly in malignant classes)
- **Resolution**
  - Applied various techniques from the referenced paper
  - Aiming at balancing classes and increasing model robustness
    - Included Transposition, Flipping, and CutOut

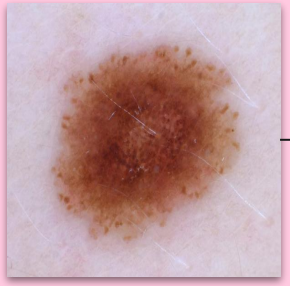
# GAN (their approach)



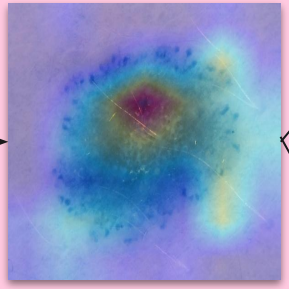
# GAN (our approach)



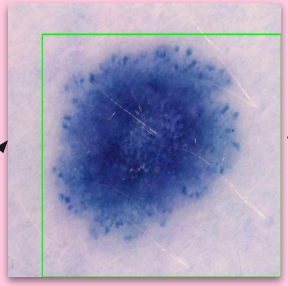
# GradCAM



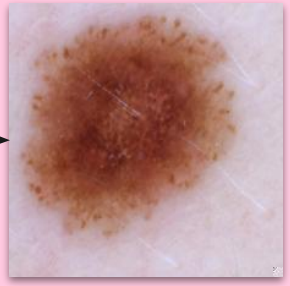
Original Image



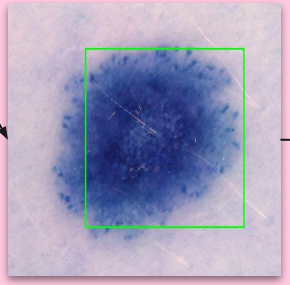
GradCAM Image



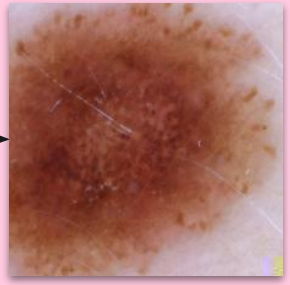
Low Threshold
Bounding Box



Low Threshold
Cropped Image

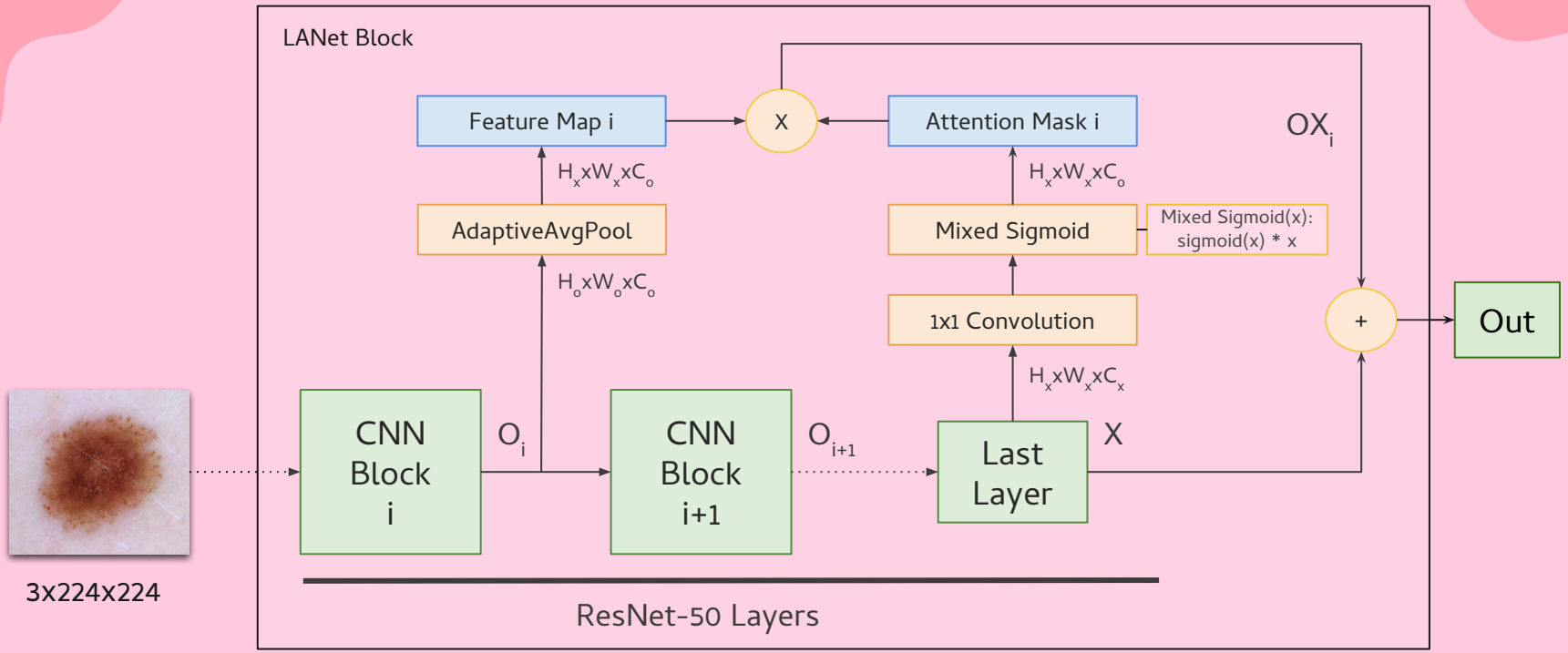


High Threshold
Bounding Box



High Threshold
Cropped Image

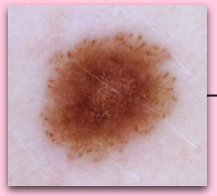
# LANet Block



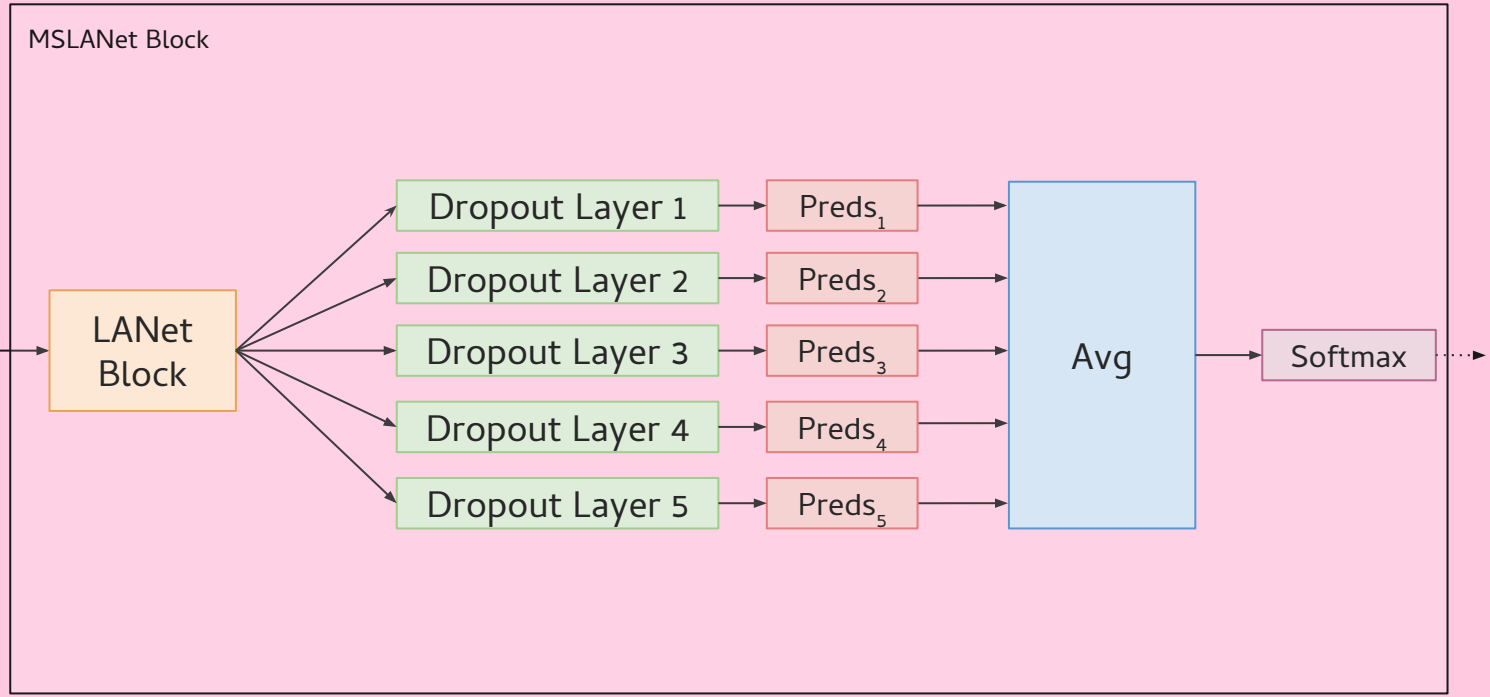

**Long Attention Mechanism** repeated for **each ResNet-50 layer**. The output is a concatenation of each $OX_i$ and the feature map X of the last layer:

**Out = [X, $OX_1$, $OX_2$, .., $OX_{L-1}$] ∀i∈[1, L], L: Number of ResNet50 layers**

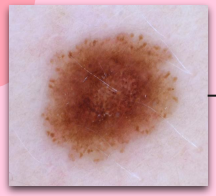
# MSLANet Block



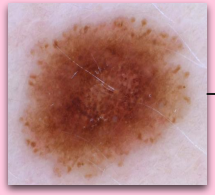
3x224x224



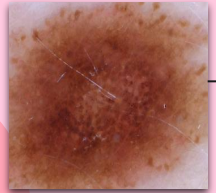
# MSLANet



Original Image
3x224x224



GradCAM low threshold
3x224x224



GradCAM high threshold
3x224x224

MSLANet Block

MSLANet Block

MSLANet Block

Avg

Final Prediction

# Model Evaluation

| | MSLANet (Ours) | | | | MSLANet (Theirs) | | | |
|---|---|---|---|---|---|---|---|---|
| **Class** | **ACC** | **AUC** | **SE** | **SP** | **ACC** | **AUC** | **SE** | **SP** |
| Melanocytic nevi | 66.16 | 76.59 | 96.93 | 35.40 | - | - | - | - |
| Seborrheic keratosis | 89.40 | 60.18 | 22.72 | 97.63 | 93.50 | 97.10 | 82.20 | 95.50 |
| Melanoma | 89.46 | 59.50 | 21.02 | 98.04 | 85.80 | 90.30 | 55.60 | 93.20 |
| Invasive carcinoma | 96.83 | 58.24 | 16.94 | 99.54 | - | - | - | - |
| Basal cell carcinoma | 95.78 | 66.76 | 34.40 | 99.12 | - | - | - | - |
| Dermatofibroma | 98.83 | 55.38 | 15.05 | 99.77 | - | - | - | - |
| Vascular lesions | 98.94 | 74.83 | 50.12 | 99.66 | - | - | - | - |
| | Avg. AUC: 59.84% (All classes: 64.49%) | | | | Avg. AUC: 93.70% | | | |

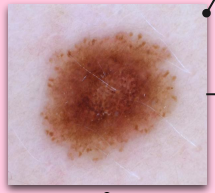
*Results are expressed in percentages (%). We consider Accuracy, AUC (Area under the curve), Sensitivity (Recall) and Specificity.

# MSLANet v2

**Original images** and **GAN generated images** used for training. **Oversampling** with **data augmentation** to solve class imbalances.

**Data augmentation** methods: Random rotation, horizontal and vertical flipping, random cropping and cut out

Image 3x224x224



LANet Block

ResNet-50 with attention mechanism

Dropout Layer 1 → $Preds_1$

Dropout Layer 2 → $Preds_2$

Dropout Layer 3 → $Preds_3$

Dropout Layer 4 → $Preds_4$

Dropout Layer 5 → $Preds_5$

Avg

Softmax

Final Prediction

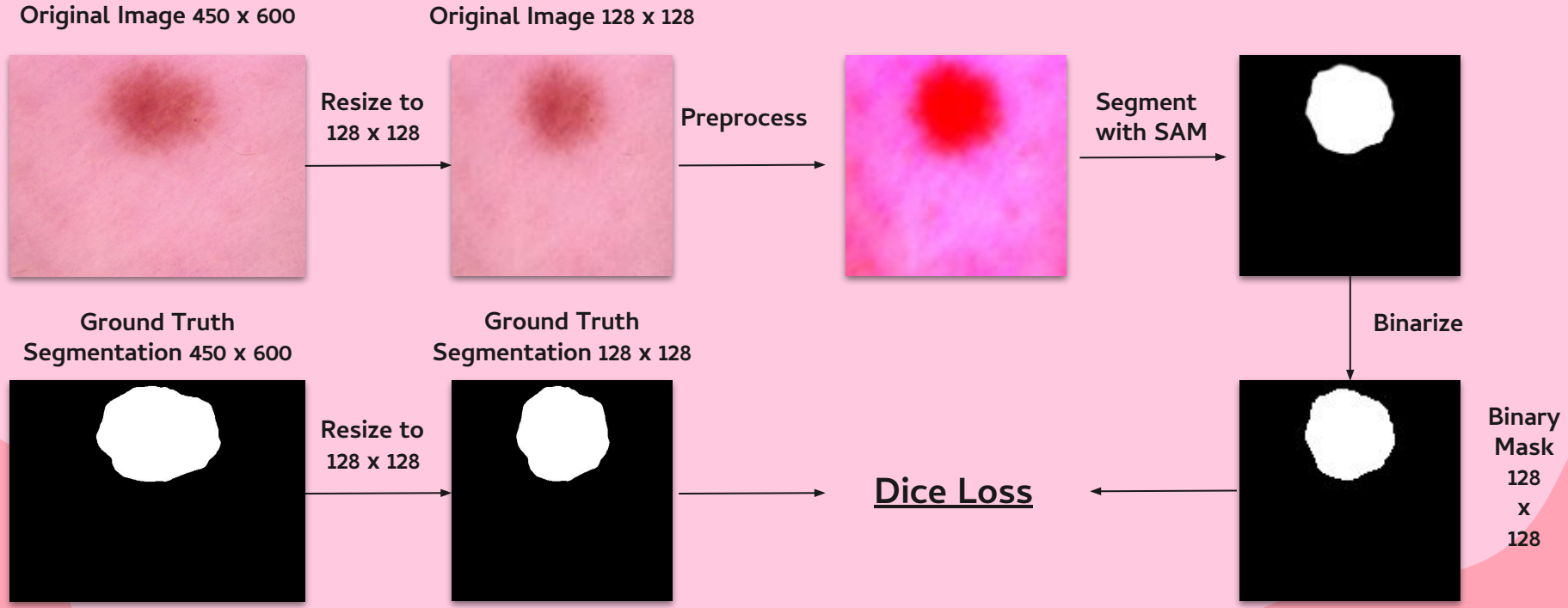
Moles segmented during inference using a **Segment Anything Model (SAM)**

**SAM** used for segmenting moles and add scale and position invariances. Much lighter than GradCAM.

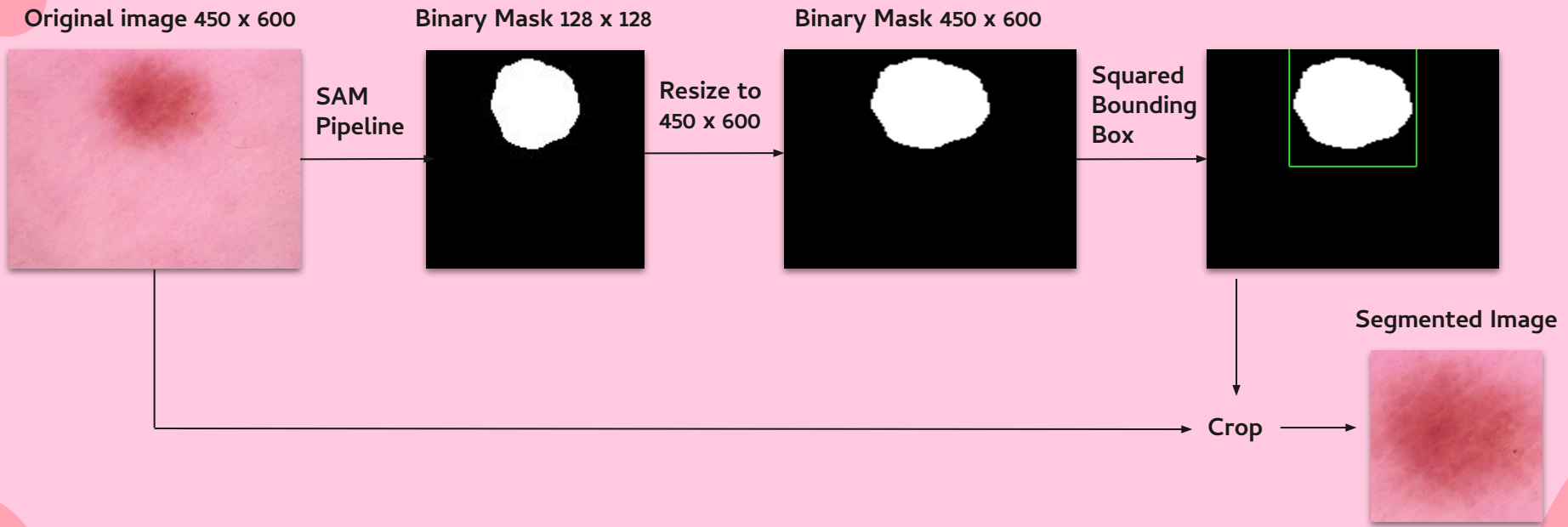
# Training Segmentation Pipeline

Fine-tuning **Segment Anything Model** (SAM) to obtain segmentation masks

After Fine Tuning: Mean **Intersection Over Union** of 88%



# Inference Segmentation Pipeline



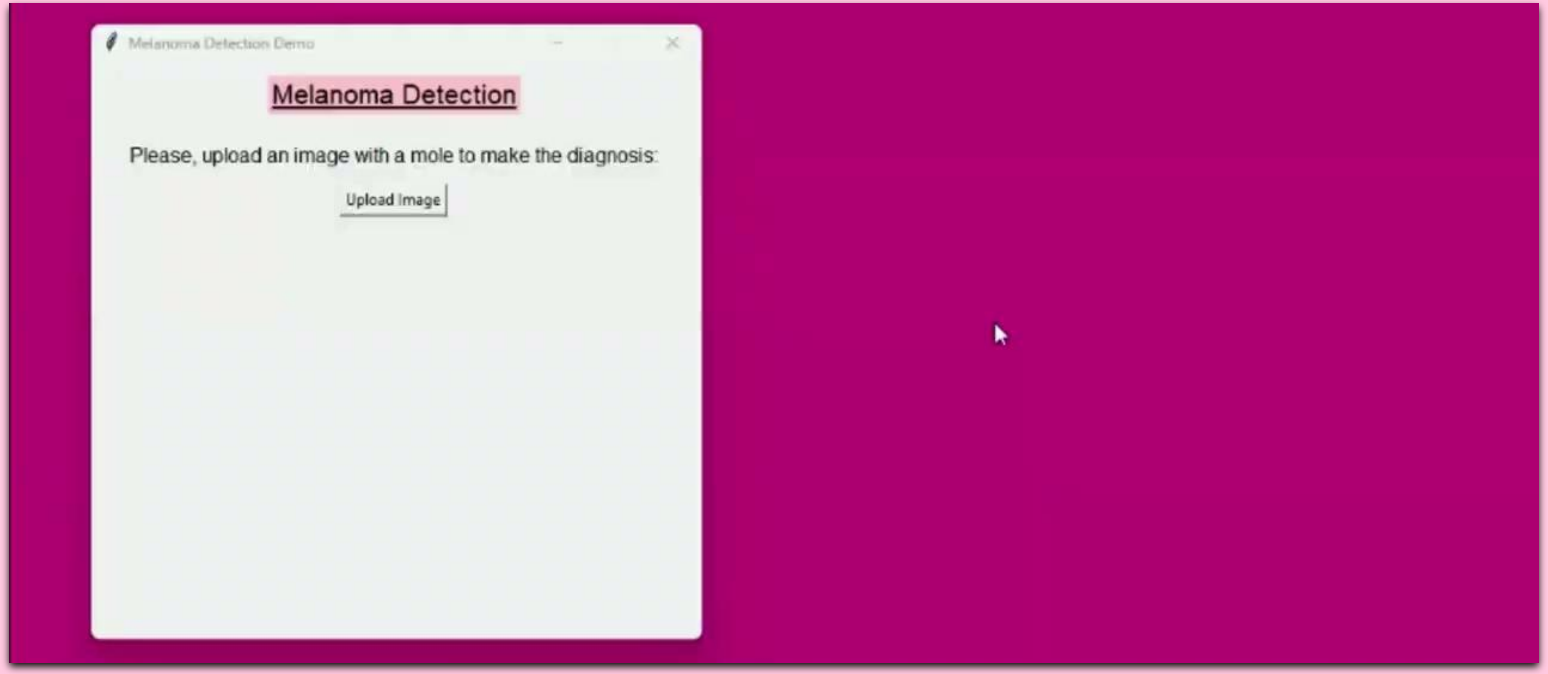
# Model Evaluation 2

| | **MSLANet v2** (Ours) | | | | MSLANet (Theirs) | | | |
|---|---|---|---|---|---|---|---|---|
| **Class** | **ACC** | **AUC** | **SE** | **SP** | **ACC** | **AUC** | **SE** | **SP** |
| Melanocytic nevi | 84.08 | 89.33 | 86.82 | 78.52 | - | - | - | - |
| Seborrheic keratosis | 91.01 | 87.54 | 51.01 | 95.95 | 93.50 | 97.10 | 82.20 | 95.50 |
| Melanoma | 86.80 | 85.49 | 52.02 | 91.14 | 85.80 | 90.30 | 55.60 | 93.20 |
| Invasive carcinoma | 97.28 | 91.51 | 52.54 | 98.79 | - | - | - | - |
| Basal cell carcinoma | 95.08 | 93.76 | 63.44 | 96.60 | - | - | - | - |
| Dermatofibroma | 98.61 | 87.80 | 15.05 | 99.55 | - | - | - | - |
| Vascular lesions | 99.05 | 98.32 | 80.76 | 99.38 | - | - | - | - |

Avg. AUC: 86.51% (All classes: 90.53%) Avg. AUC: 93.70%

*Results are expressed in percentages (%). We consider Accuracy, AUC (Area under the curve), Sensitivity (Recall) and Specificity.

# Demo


Melanoma Detection Demo
Melanoma Detection
Please, upload an image with a mole to make the diagnosis:
Upload Image

# Conclusions

- **Data transformation + Data augmentation + Synthetic Image Generation (GAN):** solve class imbalances
- **Normalization:** stabilize the learning process
- **GradCAM approach:** find the most important areas (too heavy)
- **SAM model:** exploits the segmentations of the dataset (more lightweight)

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- **Configuration tested**
  - **Data transformation + GradCAM** + **MSLANet** (theirs)
  - **GAN + Data augmentation** + **SAM** + **MSLANet v2** (ours)
- **Final results**
  - **Avg. AUC: 93.70%** (theirs)
  - **Avg. AUC: 86.51% (All classes: 90.53%)** (ours) → + Lighter + Faster to train

# References


1. **MSLANet: multi-scale long attention network for skin lesion classification (Yecong Wan, Yuanshuo Cheng & Mingwen Shao, 2022)**
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4. https://www.nature.com/articles/sdata2018161
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8. **Cancer Stat Facts, Melanoma of the Skin:**
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9. **Image2StyleGAN++- How to Edit the Embedded Images? (Abdal Et Al.)**
   https://arxiv.org/abs/1911.11544

# Thank you