Enhancing Skin Disease Classification with Depthwise Separable Inception Network

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Aim, objectives

Introduction-Aim

Problem

- The American Cancer Society estimates that in 2024, about 100,640 new melanoma cases will be diagnosed in the United States, and about 8,290 people will die from melanoma.[1]
- Traditional skin disease classification relies on medical experience by doctors. Through effective, this approach is time-consuming and dependent on varying skill levels.

Solution

- Deep learning with convolutional neural networks (CNN) has been widely used for image classification, including skin diseases.
- The use of inception model and depthwise separable convolution can improve the performance.

Introduction-Objectives

01 Dataset download and process

02 Model implementation

03 Model training

04 Model evaluation

05 Hyperparameter adjustment

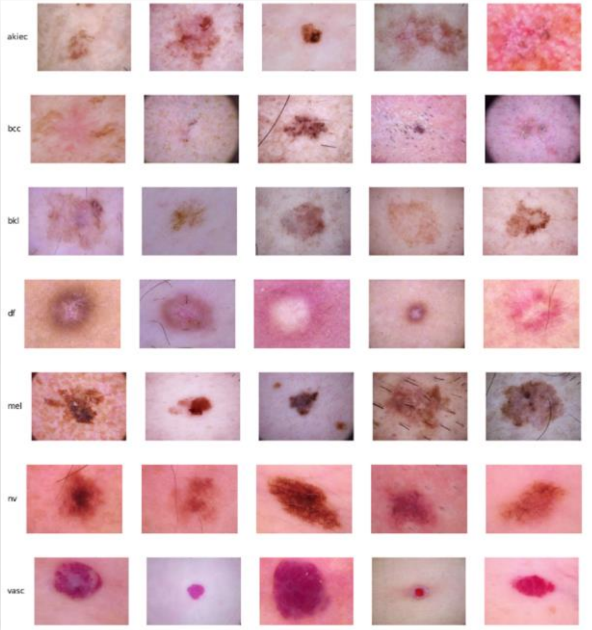
06 Build GUI of best model

Methodology

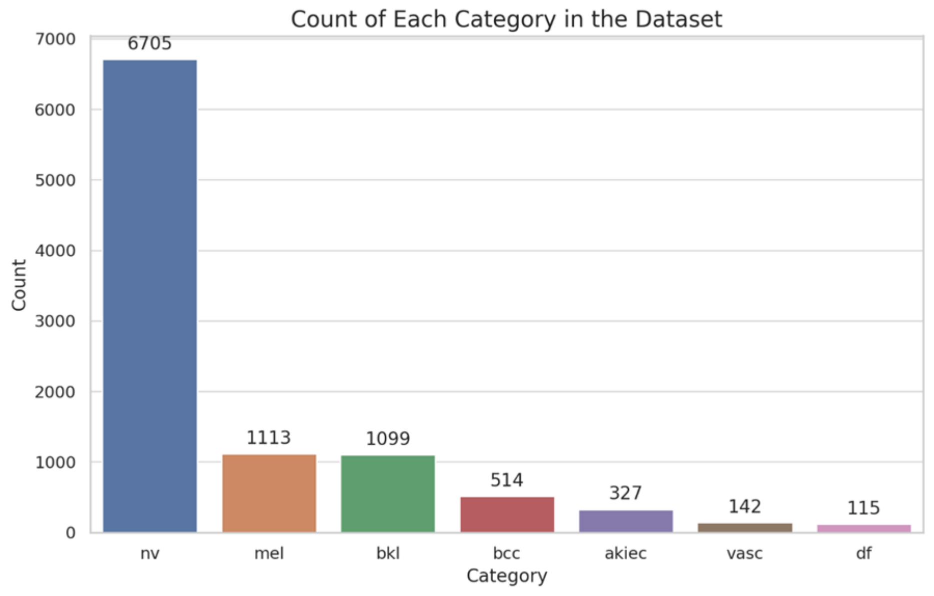
Dataset, model

Methodology-dataset

The HAM10000[2] "Human Against Machine with 10000 training images"dataset, is a large collection of 7 classes of skin disease images.



HAM10000



Number of each class

nv - Melanocytic Nevi
mel - Melanoma
bkl - Benign Keratosis-like Lesions
bcc - Basal Cell Carcinoma
vasc - Vascular Lesions
akiec - Actinic Keratoses and Intraepithelial Carcinoma
df - Dermatofibroma

Methodology-dataset

80%

Train set

Used to train the model

10%

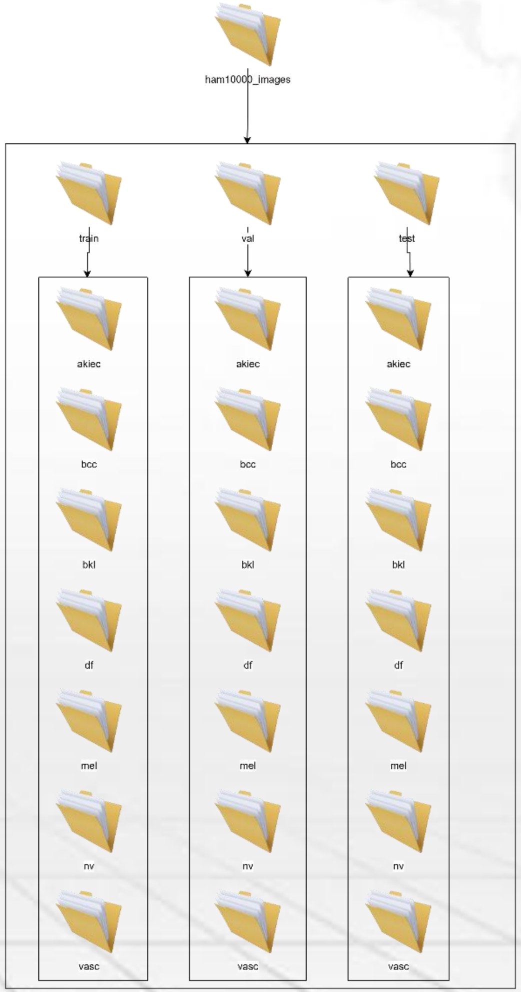
Validation set

Used to adjust model hyperparameters

10%

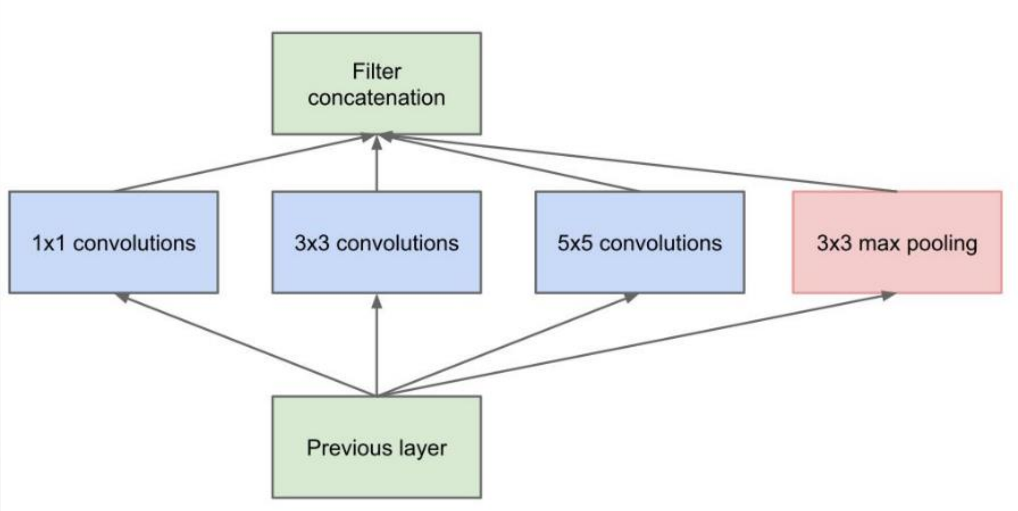
Test set

Used to evaluate models



Methodology-model

Inception



The inception[3]

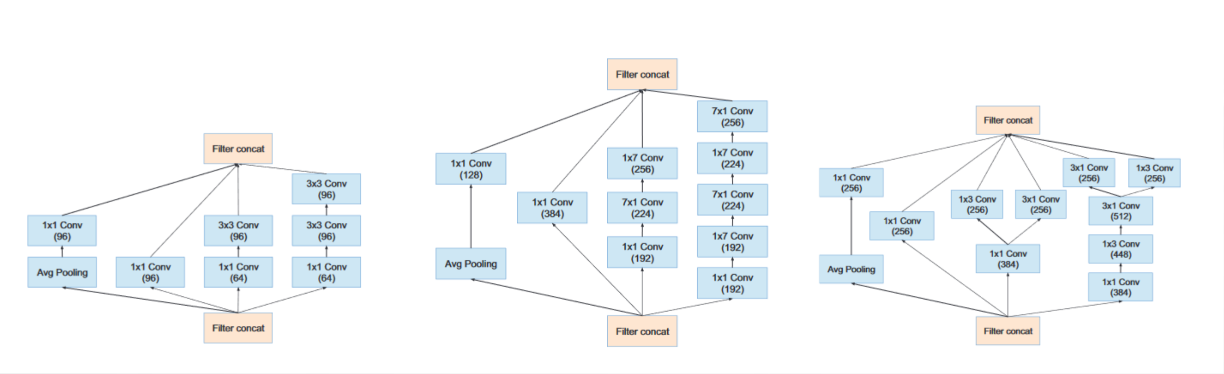
The core innovation of the Inception model is the Inception module, which extracts image features through parallel multi-scale convolution operations. Each Inception module includes convolutional filters of different sizes (1x1, 3x3, 5x5) and pooling operations, allowing it to capture features at multiple scales and combine them.

Benefits:
Multi-scale processing can retain the information in the image to the greatest extent, avoid information loss, and improve the overall performance of the model.

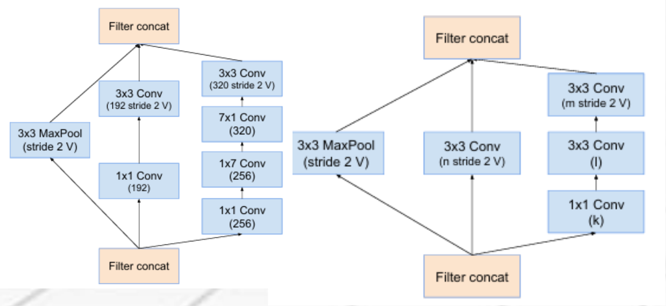
Methodology-model

Inception V4

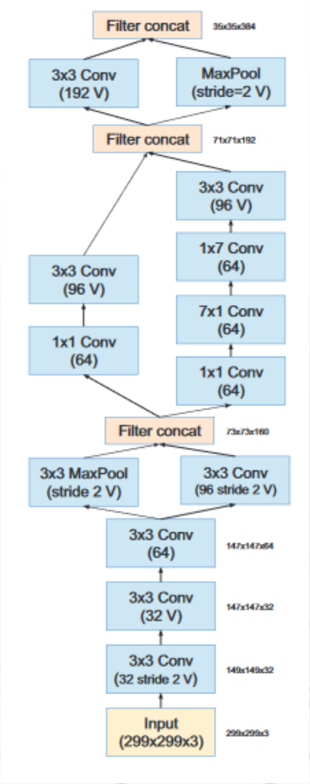
It is improved and optimized on the basis of Inception, mainly introducing more modules and structures to improve the accuracy and efficiency of the model.



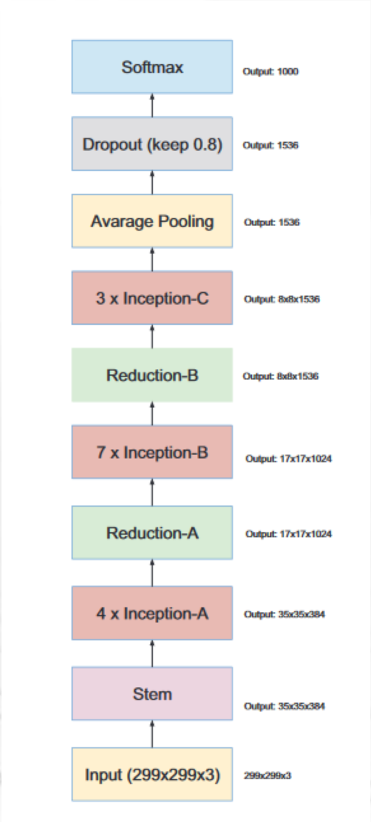
Inception block A,B,C in Inception V4[4]



Reduction A(left),B(right) in Inception V4[4]



Stem[4]



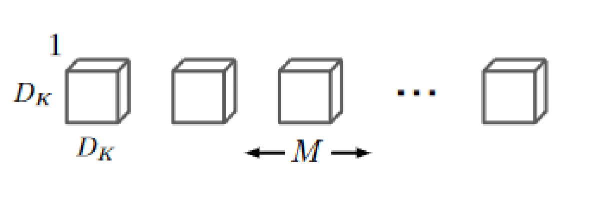
overall structure[4]

Methodology-model

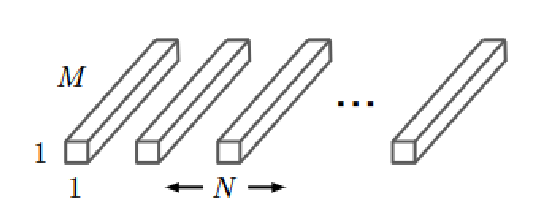
Depthwise separable convolution

Depthwise Convolution divide into two independent operations: Depthwise Convolution and Pointwise Convolution.

Depthwise convolution	Pointwise convolution	Depthwise separable convolution
Depthwise convolution applies one separate kernel for each input channel, rather than applying the same kernel to all channels as standard convolution does.	Point-by-point convolution uses the 1x1 convolution kernel to linearly combine the output of the depthwise convolution, a step that connects all channels.	Benefits: The combination of depthwise convolution and pointwise convolution significantly reduces the amount of computation and the number of parameters. On the situation of maintaining the performance of the model, the computational efficiency is improved



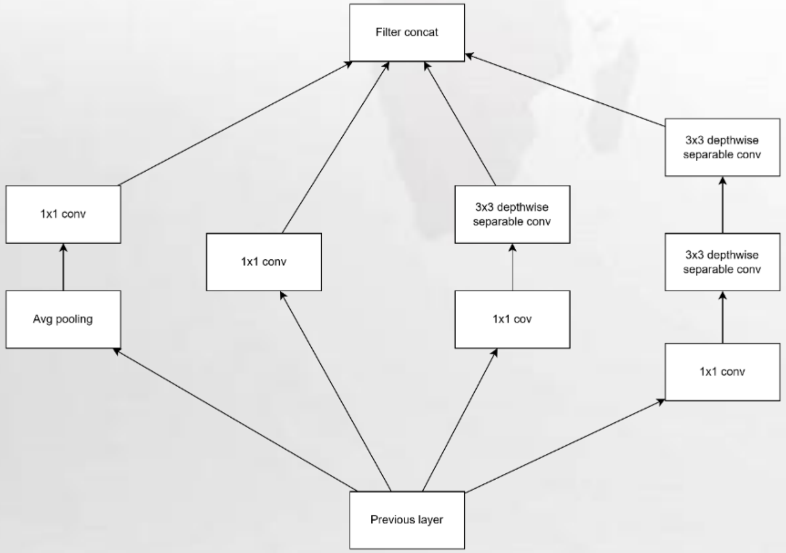
Depthwise convolution[5]



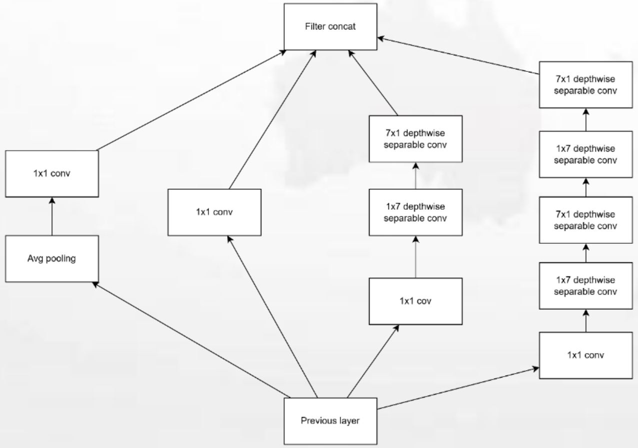
Pointwise convolution[5]

Methodology-model

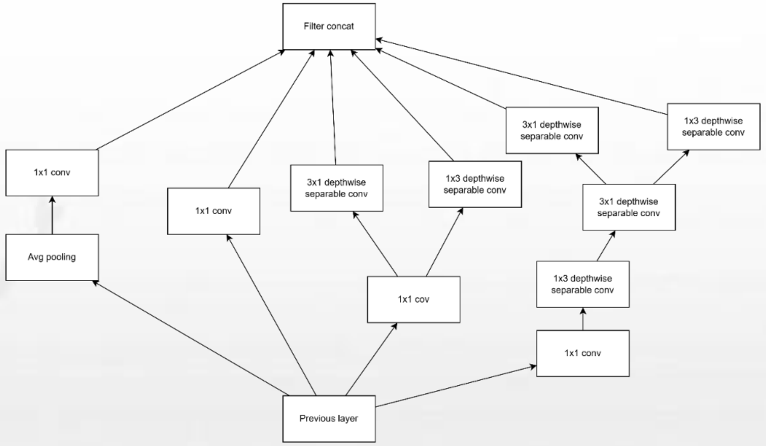
Combine of inceptionV4 and depthwise separable



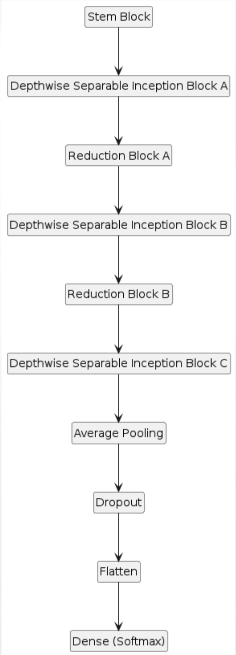
Depthwise separable inception block A



Depthwise separable inception block B



Depthwise separable inception block C



Overall structure of depthwise separable inception model

Combine of benefit of two of them, improve the accuracy and efficiency

Implementation & Results

Implementation & Results

Software and hardware for build the model

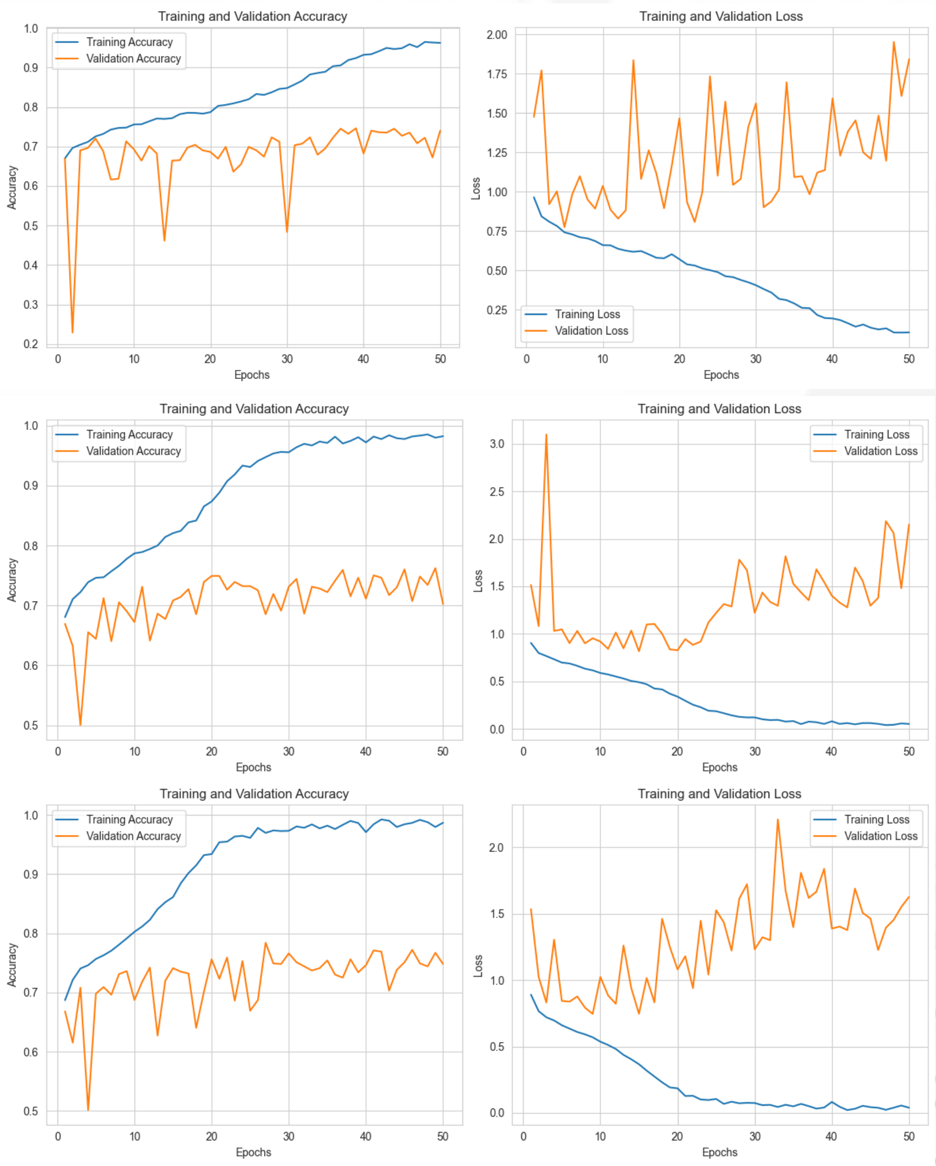
Software	Framework	TensorFlow
	Language	Python
	Libraries	Numpy, Pandas, Matplotlib, sklearn
	Version management plan	Git repository
Hardware	Central processing unit(CPU)	Intel(R) Core(TM) i7-13700KF CPU @ 3.40GHz
	Graphic Processing Unit(GPU)	NVIDIA GeForce RTX 4090

Implementation & Results

For optimization and training control, the model utilizes an Adam optimizer at the learning rate of 0.001, categorical crossentropy as the loss function.

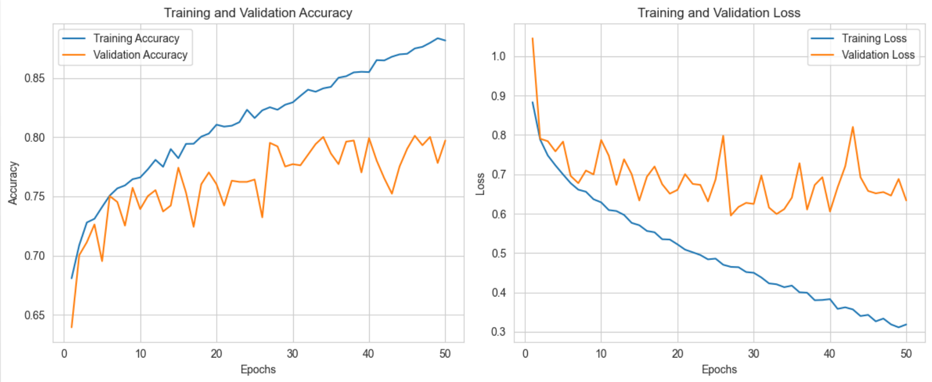
Compare of different number of inception block

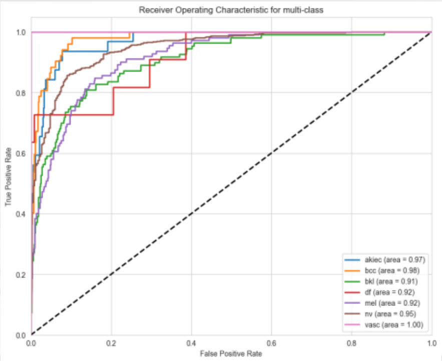
Depthwise Separable Inception Block A	Depthwise Separable Inception Block B	Depthwise Separable Inception Block C	Test Accuracy (%)
4	7	3	72%
2	4	1	73%
1	1	1	75%



Implementation & Results

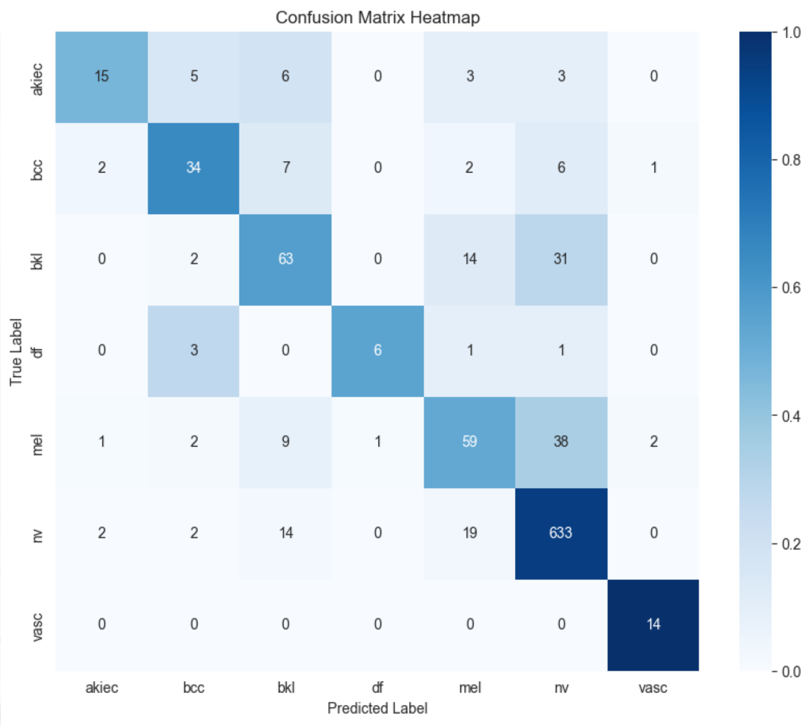
The best model of after adjust hyperparameter:
Accuracy is up to 82%:





Classification Report:

	precision	recall	f1-score	support
akiec	0.75	0.47	0.58	32
bcc	0.71	0.65	0.68	52
bkl	0.64	0.57	0.60	110
df	0.86	0.55	0.67	11
mel	0.60	0.53	0.56	112
nv	0.89	0.94	0.92	670
vasc	0.82	1.00	0.90	14
accuracy			0.82	1001
macro avg	0.75	0.67	0.70	1001
weighted avg	0.81	0.82	0.82	1001



Implementation & Results

GUI web:

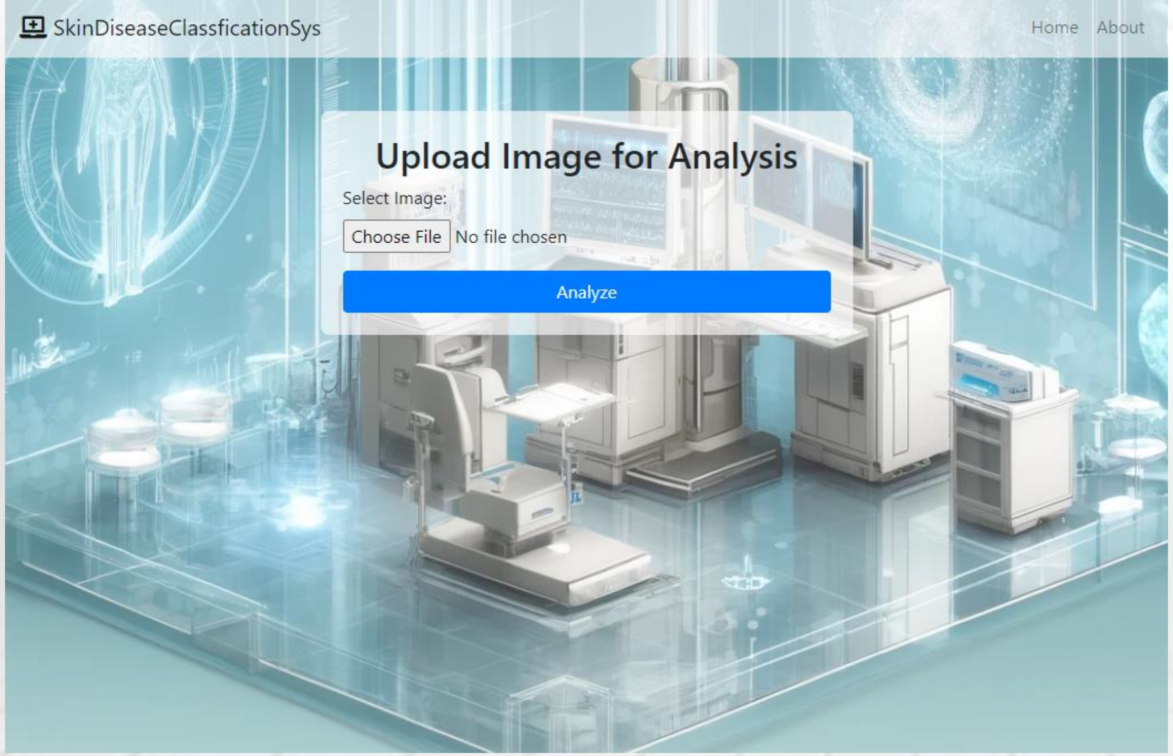
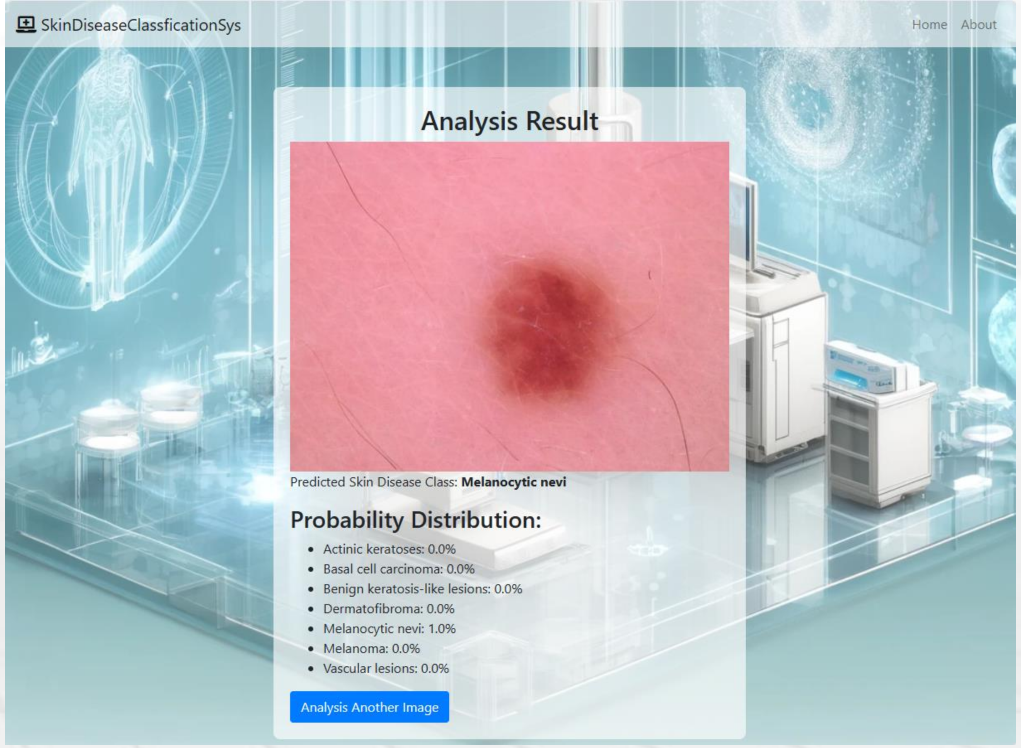


Image upload page



Result page

Use flask to make the model in the backend interact with the frontend

Conclusion

Achievement ,Limitation, Future work

Achievement

This project successfully fusion depthwise separable convolutions in the Inception model, improved the classfication of skin disease. The depthwise separable model finally get 82% accuracy.

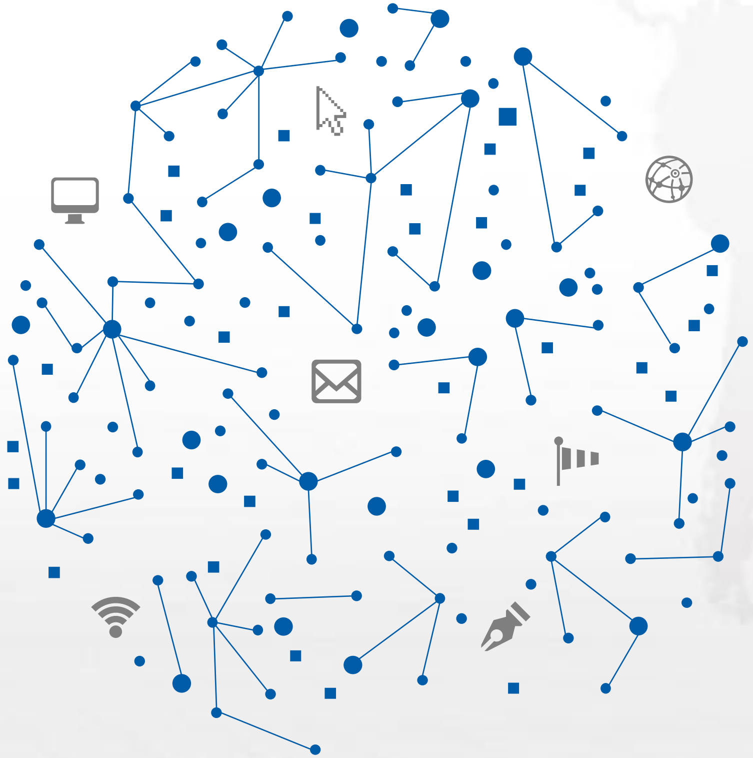
Limitation

- Limitation of dataset
- Overfitting risk
- Limitation of generalization

Future work

- Extend dataset
- Combine multimodal data
- Using the latest deep learning techniques

Thanks for listening



Reference

[1]"Key able: Statistics for Melanoma." [Online]. Available: https://www.cancer.org/cancer/types/melanoma-skin-cancer/about/key-statistics.html

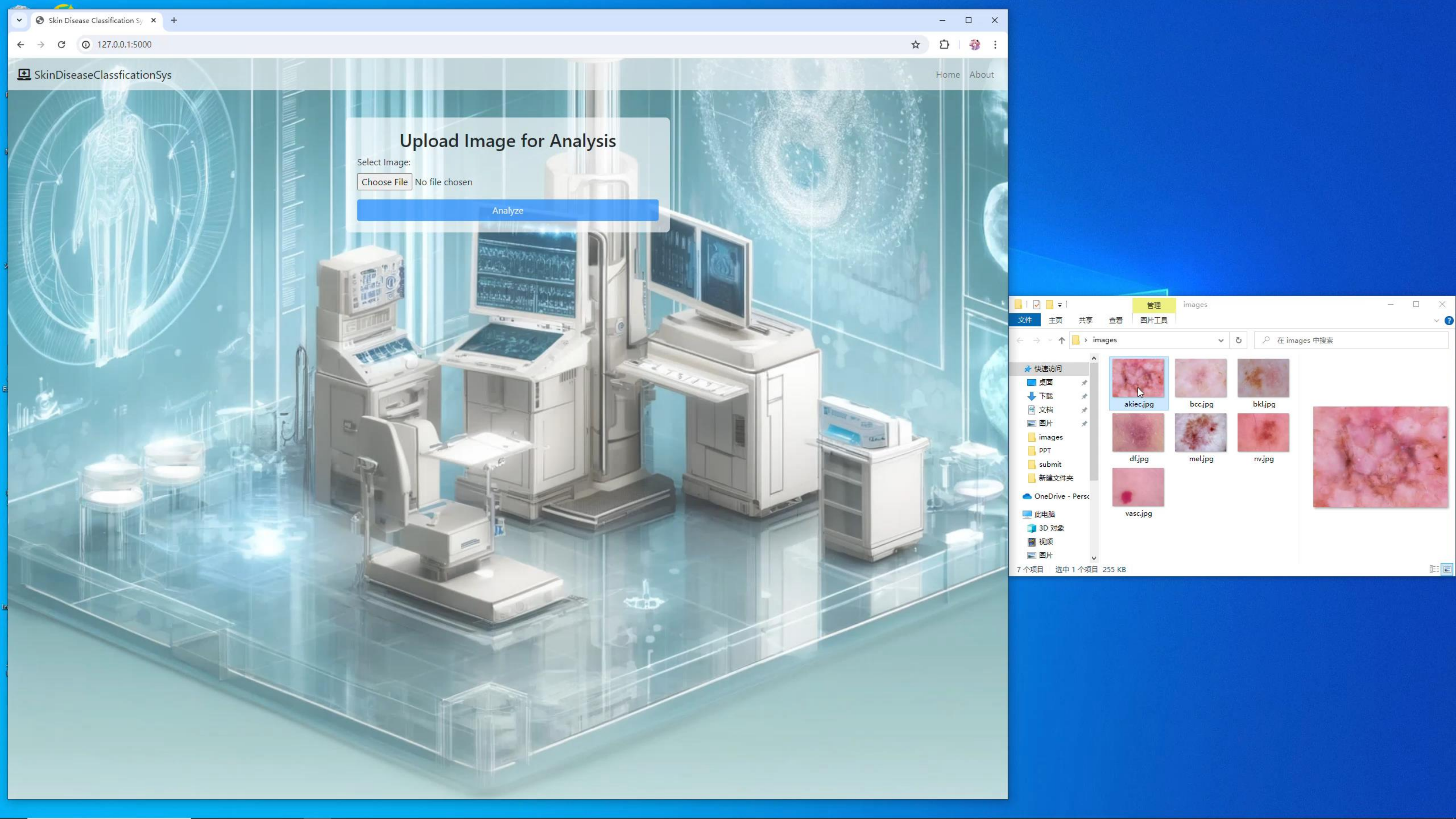
[2] P. Tschandl, C. Rosendahl, and H. Kittler, 'The HAM10000 dataset, a large collection of multi-source dermatoscopic images of common pigmented skin lesions', *Sci Data*, vol. 5, no. 1, p. 180161, Aug. 2018, doi: 10.1038/sdata.2018.161.

[3] C. Szegedy *et al.*, 'Going deeper with convolutions', in *2015 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, Boston, MA, USA: IEEE, Jun. 2015, pp. 1–9. doi: 10.1109/CVPR.2015.7298594.

[4] C. Szegedy, S. Ioffe, V. Vanhoucke, and A. Alemi, 'Inception-v4, Inception-ResNet and the Impact of Residual Connections on Learning', *AAAI*, vol. 31, no. 1, Feb. 2017, doi: 10.1609/aaai.v31i1.11231.

[5] A. G. Howard *et al.*, 'MobileNets: Efficient Convolutional Neural Networks for Mobile Vision Applications'. arXiv, Apr. 16, 2017. Accessed: Oct. 27, 2023. [Online]. Available: http://arxiv.org/abs/1704.04861

Demo


Skin Disease Classification Sy
127.0.0.1:5000
SkinDiseaseClassficationSys
Home
About
Upload Image for Analysis
Select Image:
Choose File
No file chosen
Analyze
管理
images
文件
主页
共享
查看
图片工具
images
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akiec.jpg
bcc.jpg
bkl.jpg
df.jpg
mel.jpg
nv.jpg
vasc.jpg
7 个项目
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Q&A