Tensorflow-Tiled-Image-Segmentation-Pre-Augmented-IDRiD-HardExudates (2025/01/28)

Sarah T. Arai
Software Laboratory antillia.com

This is the second experiment of Tiled Image Segmentation for IDRiD-HardExudates based on the latest Tensorflow-Image-Segmentation-API, and a **pre-augmented tiled dataset** Augmented-Tiled-IDRiD-HardExudates-ImageMask-Dataset.zip, which was derived by us from Segmentation dataset of **Indian Diabetic Retinopathy Image Dataset (IDRiD)**

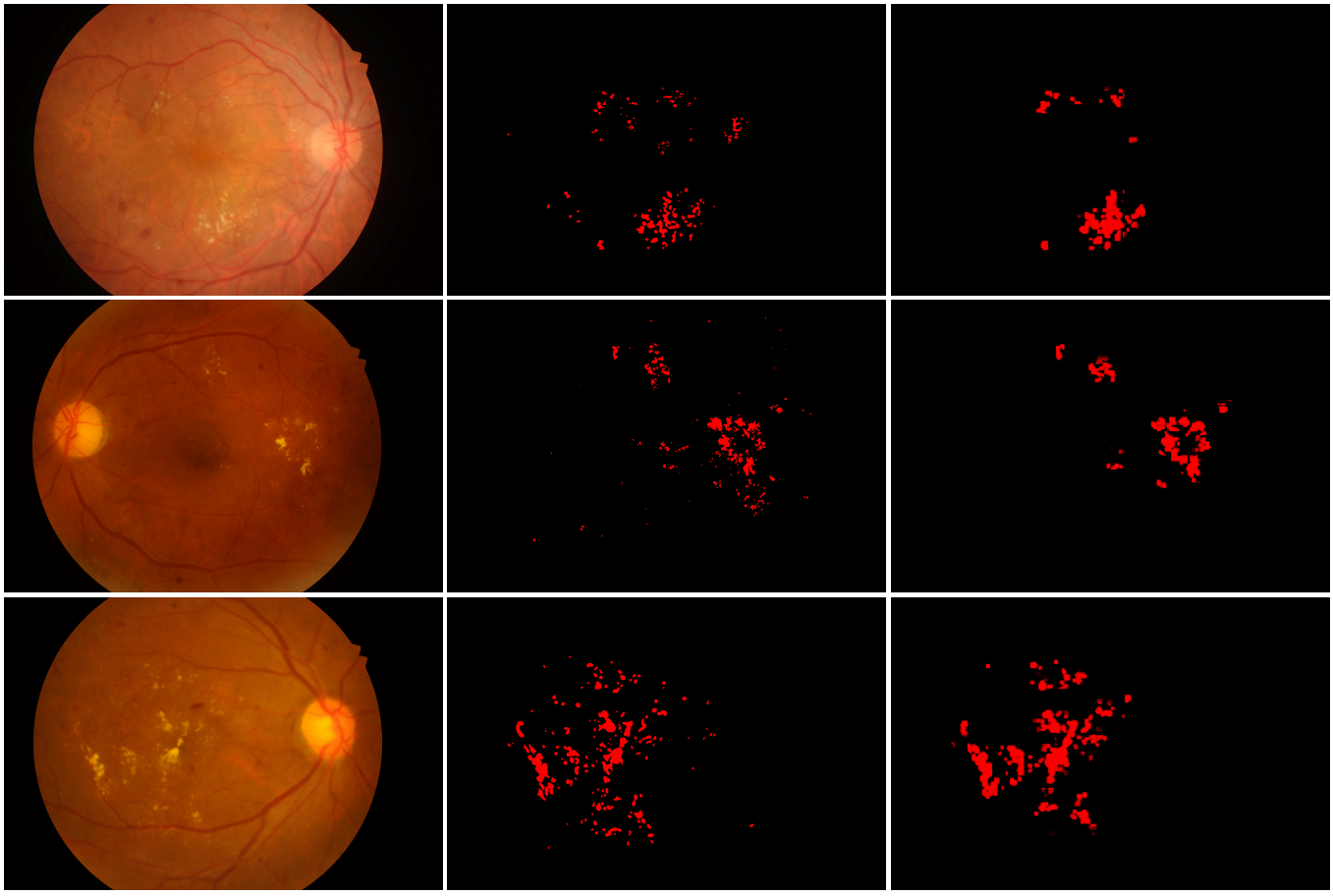
Please see also our first experiment **Tensorflow-Tiled-Image-Segmentation-IDRiD-HardExudates**

Experiment Strategies
In this experiment, we employed the following strategies.
1. Tiled ImageMask Dataset
We trained and validated a TensorFlow UNet model using the **Pre-Augmented-Tiled-IDRiD-HardExudates-ImageMask-Dataset**, which was tiledly-splitted to 512x512 pixels and reduced to 512x512 pixels image and mask dataset from the original 4288x2848 pixels images and mask files.

2. Tiled Image Segmentation
We applied our Tiled-Image Segmentation inference method to predict the HardExudates regions for the mini_test images with a resolution of 4288x2848 pixels.

Actual Tiled Image Segmentation for Images of 4288x2848 pixels
As shown below, the inferred masks look similar to the ground truth masks.

Input: image	Mask (ground_truth)	Prediction: inferred_mask



In this experiment, we used the simple UNet Model TensorflowSlightlyFlexibleUNet for this IDRiD-HardExudatesSegmentation Model.
As shown in Tensorflow-Image-Segmentation-API. you may try other Tensorflow UNet Models:

- TensorflowSwinUNet.py
- TensorflowMultiResUNet.py

- TensorflowAttentionUNet.py
- TensorflowEfficientUNet.py
- TensorflowUNet3Plus.py
- TensorflowDeepLabV3Plus.py

1. Dataset Citation

The dataset used here has been take from the following **IEEE DataPort** web site
Indian Diabetic Retinopathy Image Dataset (IDRiD)

Please see also **DIABETIC RETINOPATHY: SEGMENNTATION AND GRAND CHALLENGE**

Citation Author(s):
Prasanna Porwal, Samiksha Pachade, Ravi Kamble, Manesh Kokare, Girish Deshmukh,
Vivek Sahasrabuddhe, Fabrice Meriaudeau,
April 24, 2018, "Indian Diabetic Retinopathy Image Dataset (IDRiD)", IEEE Dataport,

DOI: https://dx.doi.org/10.21227/H25W98

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2 Augmented-Tiled-IDRiD-HardExudates ImageMask Dataset

If you would like to train this IDRiD-HardExudates Segmentation model by yourself, please download the pre-augmented dataset from the google drive Augmented-Tiled-IDRiD-HardExudates-ImageMask-Dataset.zip, expand the downloaded ImageMaskDataset and put it under **./dataset** folder to be

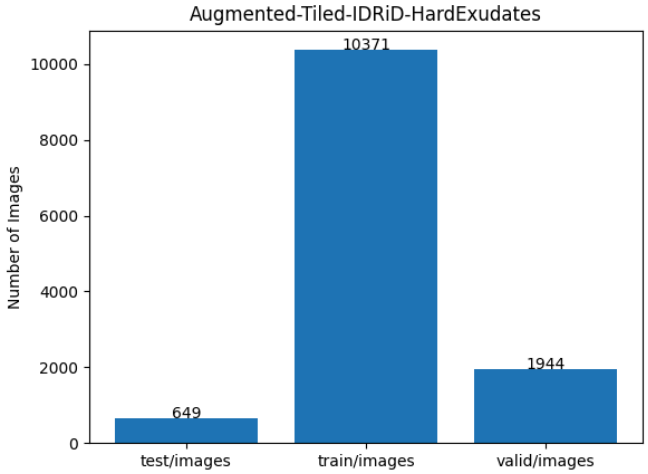
```
./dataset
└─Augmented-Tiled-IDRiD-HardExudates
    ├─test
    │  ├─images
    │  └─masks
    ├─train
    │  ├─images
    │  └─masks
    └─valid
       ├─images
       └─masks
```

This is a 512x512 pixels pre augmented tiles dataset generated from 4288x2848 pixels 54 **Original Images** and their corresponding **Hard Exudates GroundTruths** in Training Set.
.
We excluded all black (empty) masks and their corresponding images to generate our dataset from the original one.
The folder structure of the original Segmentation data is the following.

```
./A. Segmentation
├─1. Original Images
│  ├─a. Training Set
│  └─b. Testing Set
└─2. All Segmentation Groundtruths
   ├─a. Training Set
   │  ├─1. Microaneurysms
   │  ├─2. Haemorrhages
   │  ├─3. Hard Exudates
   │  ├─4. Soft Exudates
   │  └─5. Optic Disc
   └─b. Testing Set
      ├─1. Microaneurysms
      ├─2. Haemorrhages
      ├─3. Hard Exudates
      ├─4. Soft Exudates
      └─5. Optic Disc
```

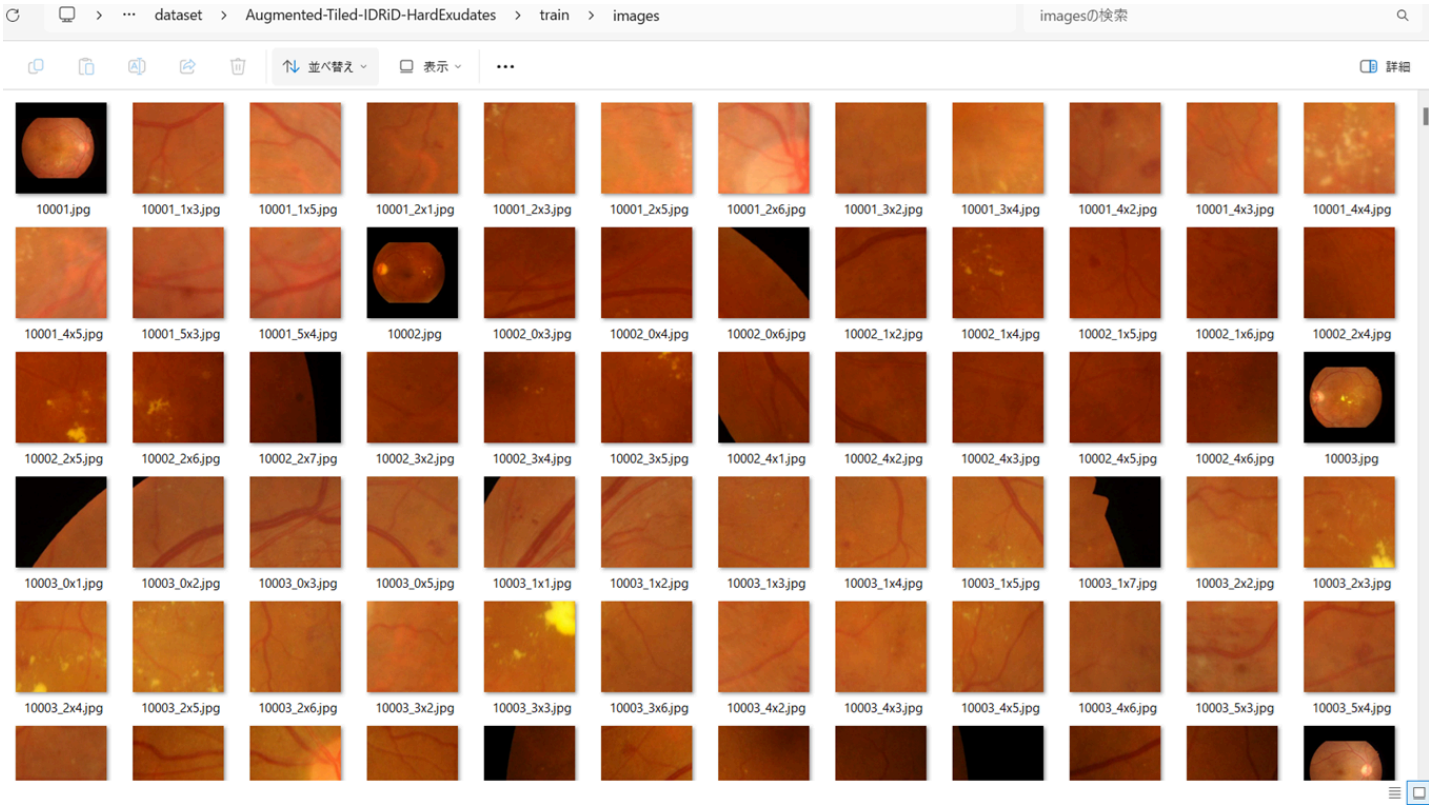
On the derivation of this tiled dataset, please refer to the following Python scripts.
- TiledImageMaskDatasetGenerator.py
- split_tiled_master.py

Augmented-Tiled-IDRiD-HardExudates Statistics

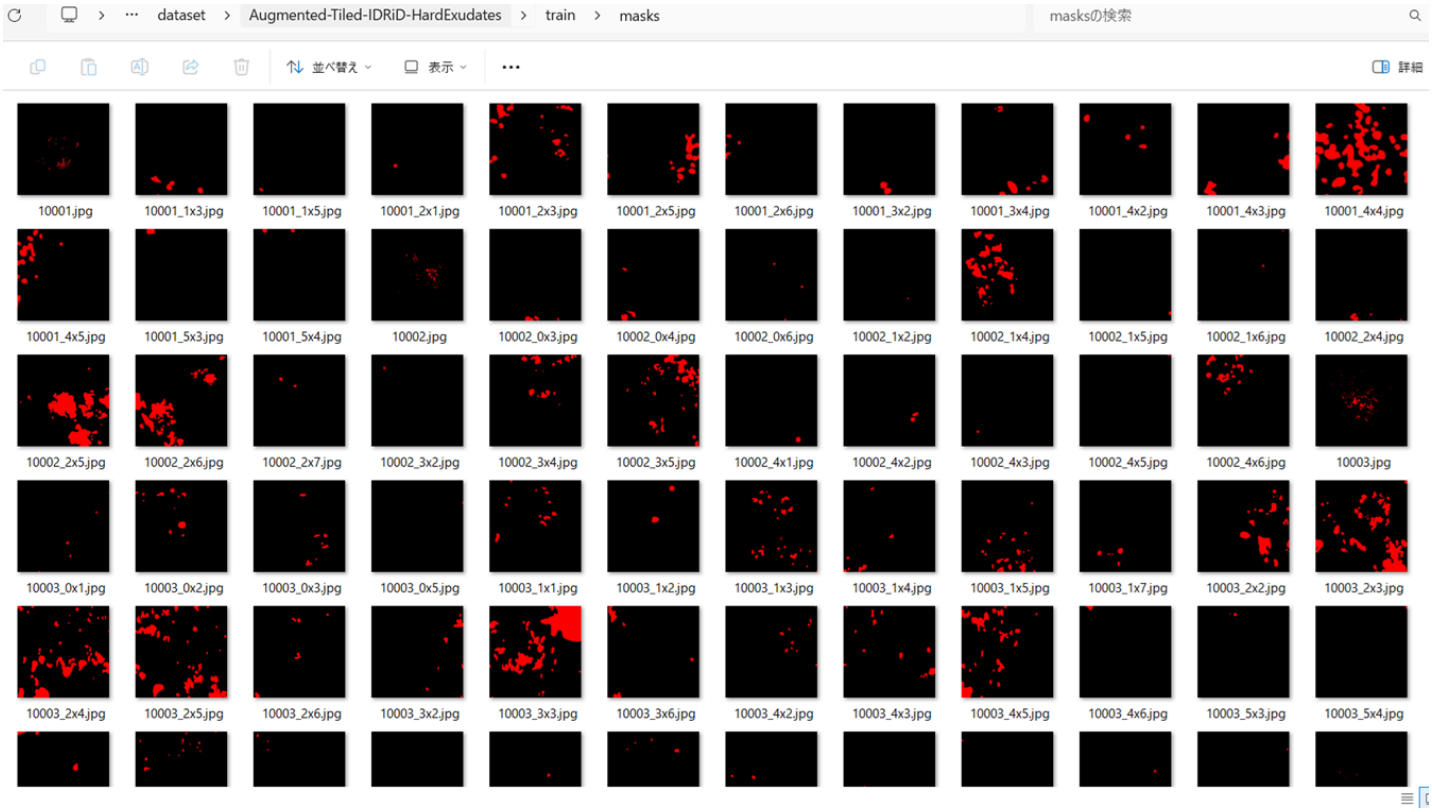


As shown above, the number of images of train and valid datasets is enough to use for a training set of our segmentation model.

Train_images_sample



Train_masks_sample



3 Train TensorflowUNet Model

We have trained IDRiD-HardExudates TensorflowUNet Model by using the following **train_eval_infer.config** file.
Please move to ./projects/TensorflowSlightlyFlexibleUNet/IDRiD-HardExudatesand run the following bat file.

```
>1.train.bat
```

, which simply runs the following command.

```
>python ../../../src/TensorflowUNetTrainer.py ./train_eval_infer.config
```

Model parameters
Enabled Batch Normalization.
Defined a small **base_filters=16** and large **base_kernels=(9,9)** for the first Conv Layer of Encoder Block of TensorflowUNet.py and a large num_layers (including a bridge between Encoder and Decoder Blocks).

```
[model]
base_filters   = 16
base_kernels   = (9,9)
num_layers     = 8
dilation       = (3,3)
```

Learning rate
Defined a small learning rate.

```
[model]
learning_rate  = 0.0001
```

Online augmentation
Disabled our online augmentation tool.

```
[model]
model          = "TensorflowUNet"
generator      = False
```

Loss and metrics functions
Specified "bce_dice_loss" and "dice_coef".

```
[model]
loss           = "bce_dice_loss"
metrics        = ["dice_coef"]
```

Learning rate reducer callback
Enabled learing_rate_reducer callback, and a small reducer_patience.

```
[train]
learning_rate_reducer = True
reducer_factor     = 0.4
reducer_patience   = 4
```

Dataset class

Specified ImageMaskDataset class.

```
[dataset]
datasetclass  = "ImageMaskDataset"
resize_interpolation = "cv2.INTER_CUBIC"
```

Early stopping callback

Enabled early stopping callback with patience parameter.

```
[train]
patience      = 10
```

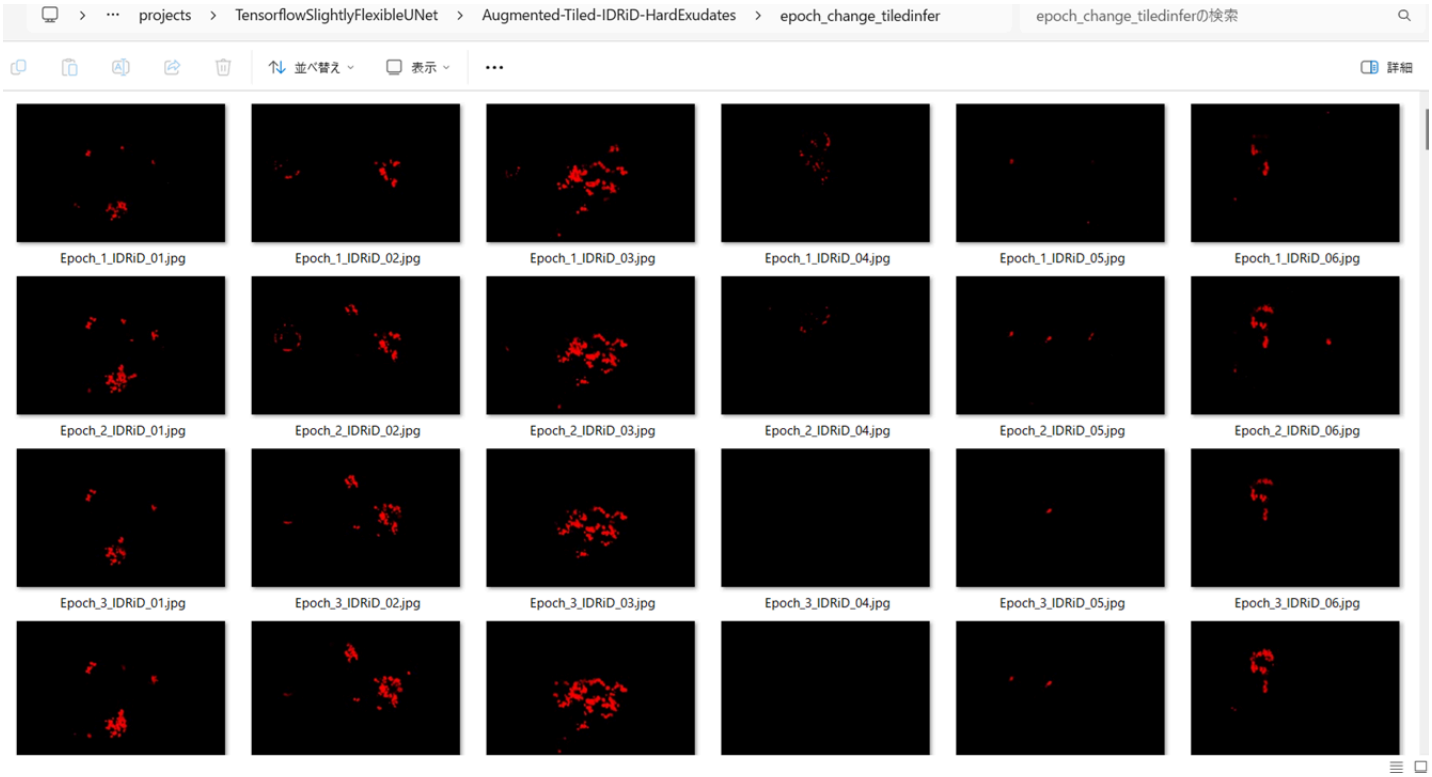
Epoch change inference callbacks

Enabled epoch_change_infer callback.

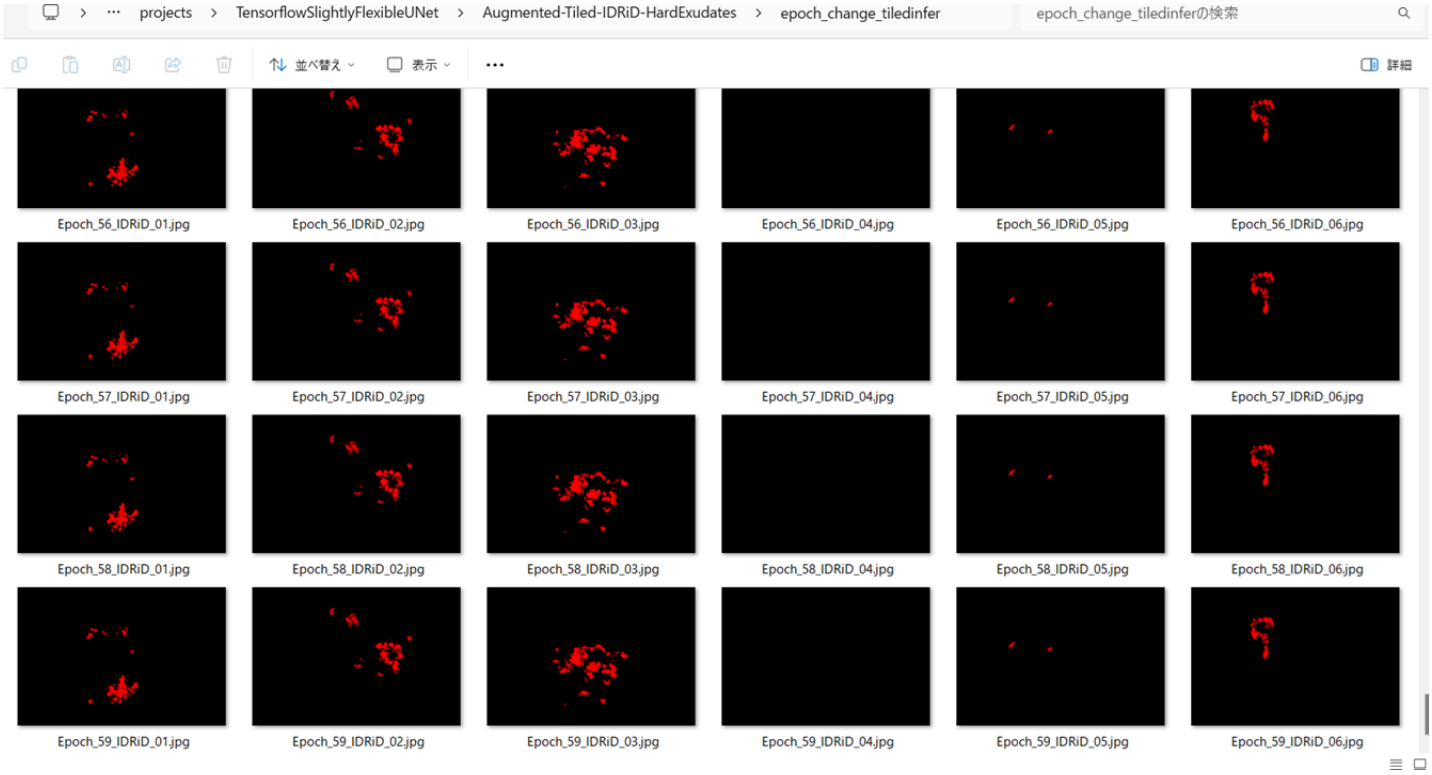
```
[train]

epoch_change_infer      = False
epoch_change_infer_dir  = "./epoch_change_infer"
epoch_change_tiledinfer = True
epoch_change_tiledinfer_dir = "./epoch_change_tiledinfer"
num_infer_images        = 6
```

By using this callback, on every epoch_change, the epoch change tiledinfer procedure can be called for 6 image in **mini_test** folder. This will help you confirm how the predicted mask changes at each epoch during your training process.

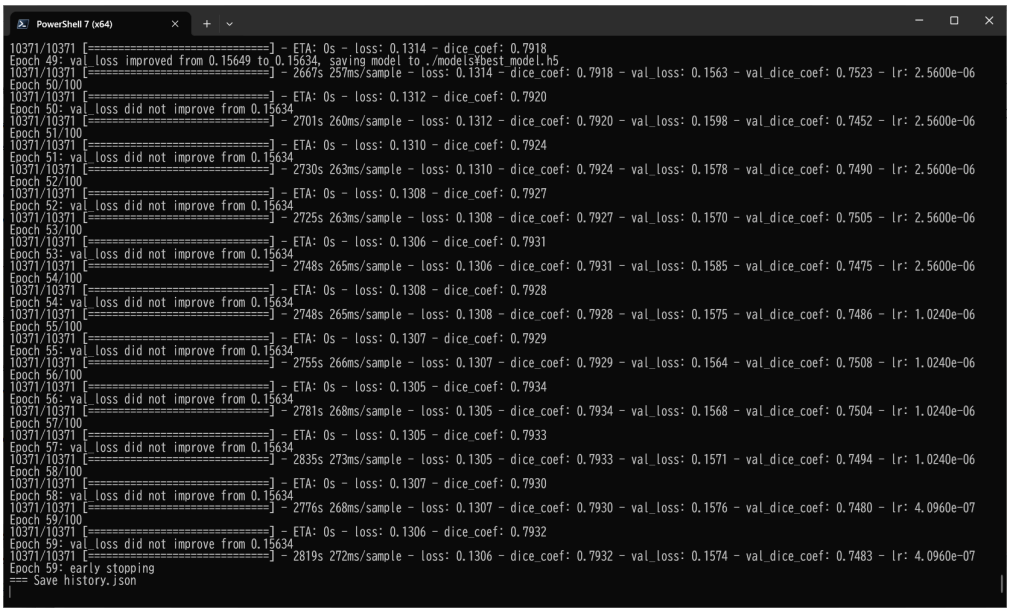
Epoch_change_inference output at starting (1,2,3,4)



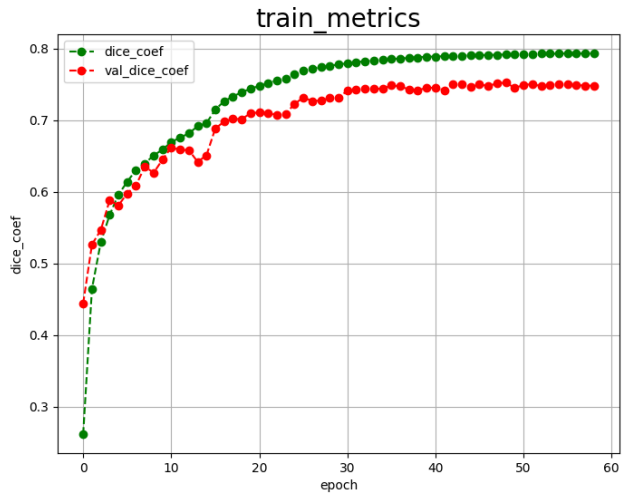
Epoch_change_inference output at ending (56,57,58,59)



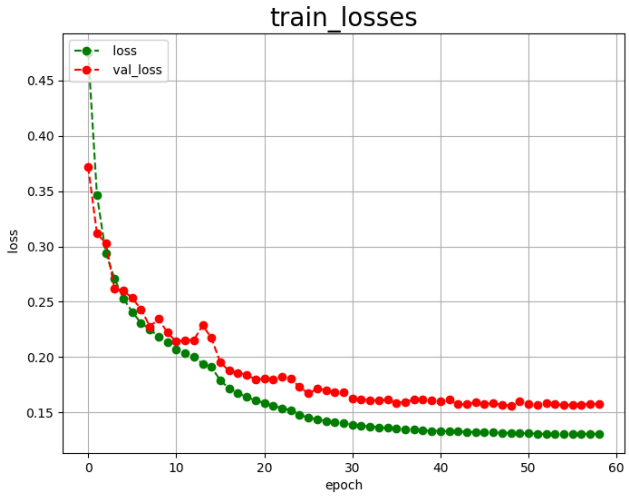
In this experiment, the training process was stopped at epoch 59 by EarlyStopping Callback.



train_metrics.csv



train_losses.csv



4 Evaluation

Please move to a **./projects/TensorflowSlightlyFlexibleUNet/IDRiD-HardExudates** folder,
and run the following bat file to evaluate TensorflowUNet model for IDRiD-HardExudates.

```
./2.evaluate.bat
```

This bat file simply runs the following command.

```
python ../../../src/TensorflowUNetEvaluator.py ./train_eval_infer_aug.config
```

Evaluation console output:

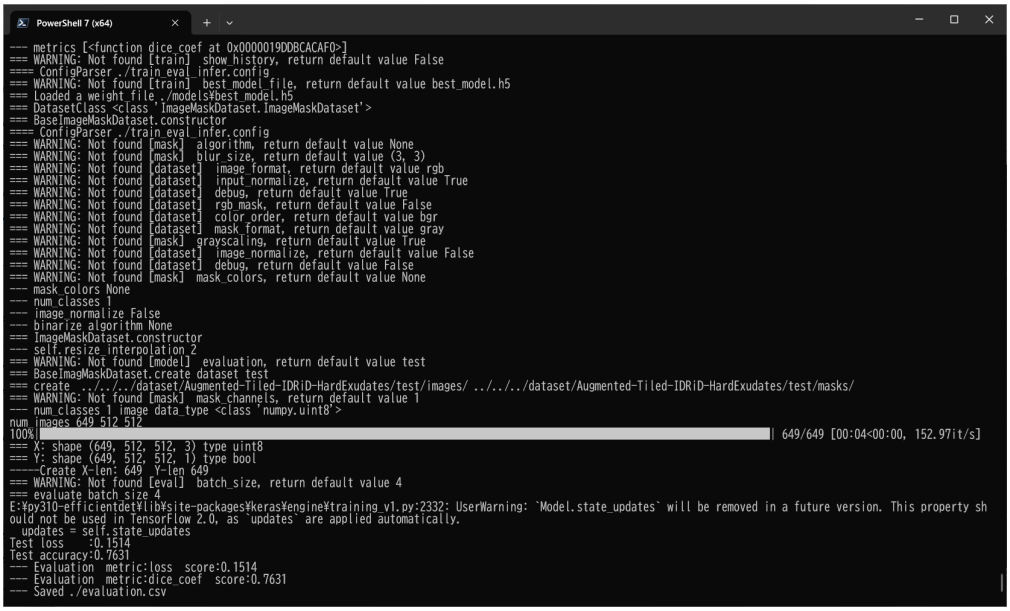


Image-Segmentation-IDRiD-HardExudates evaluation.csv
The loss (bce_dice_loss) to this IDRiD-HardExudates/test was not low, and dice_coef not high as shown below.

```
loss,0.1514
dice_coef,0.7631
```

But these are better than those of the first experiment **Tensorflow-Tiled-Image-Segmentation-IDRiD-HardExudates**

```
loss,0.2541
dice_coef,0.6416
```

5 Tiled inference

Please move to a **./projects/TensorflowSlightlyFlexibleUNet/IDRiD-HardExudates** folder
,and run the following bat file to infer segmentation regions for images by the Trained-TensorflowUNet model for IDRiD-HardExudates.

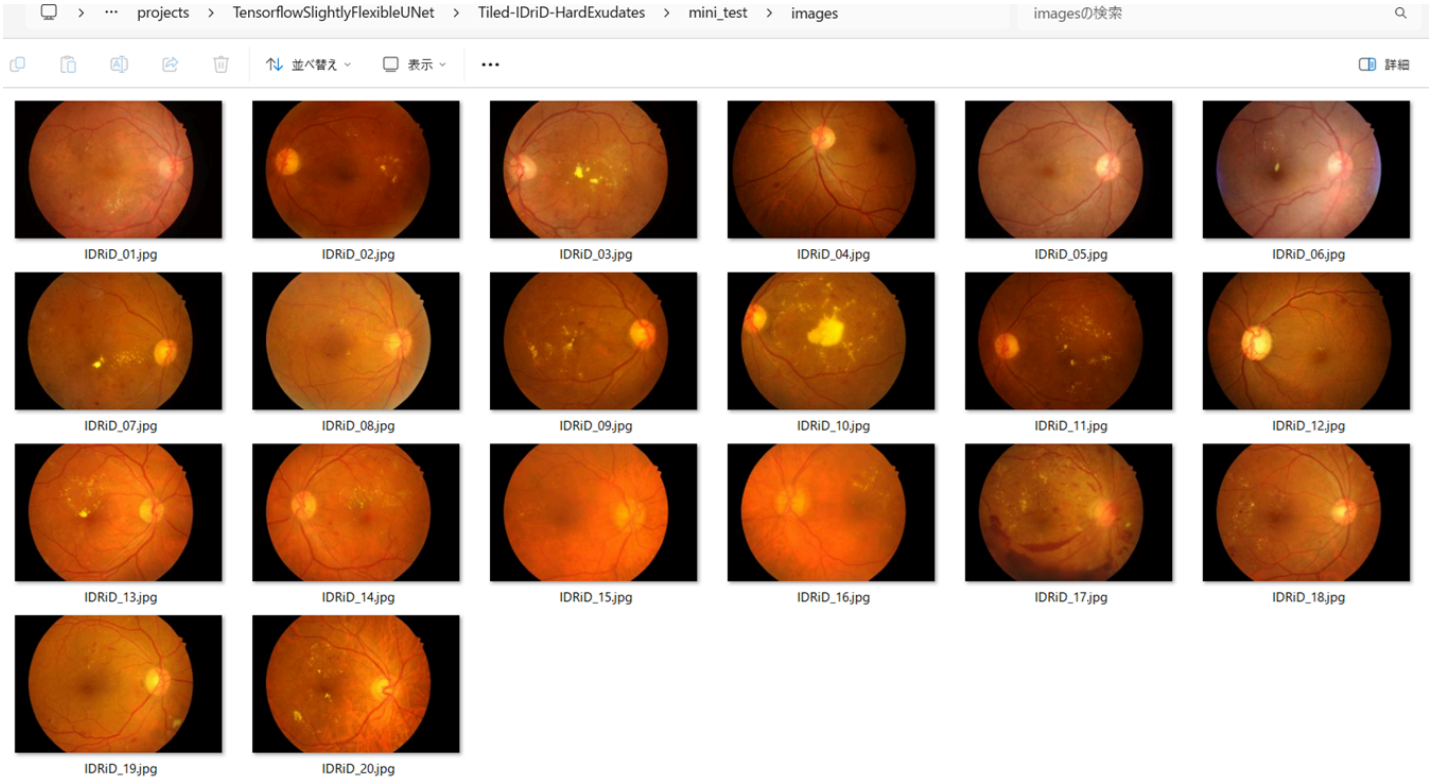
```
./4.tiled_infer.bat
```

This simply runs the following command.

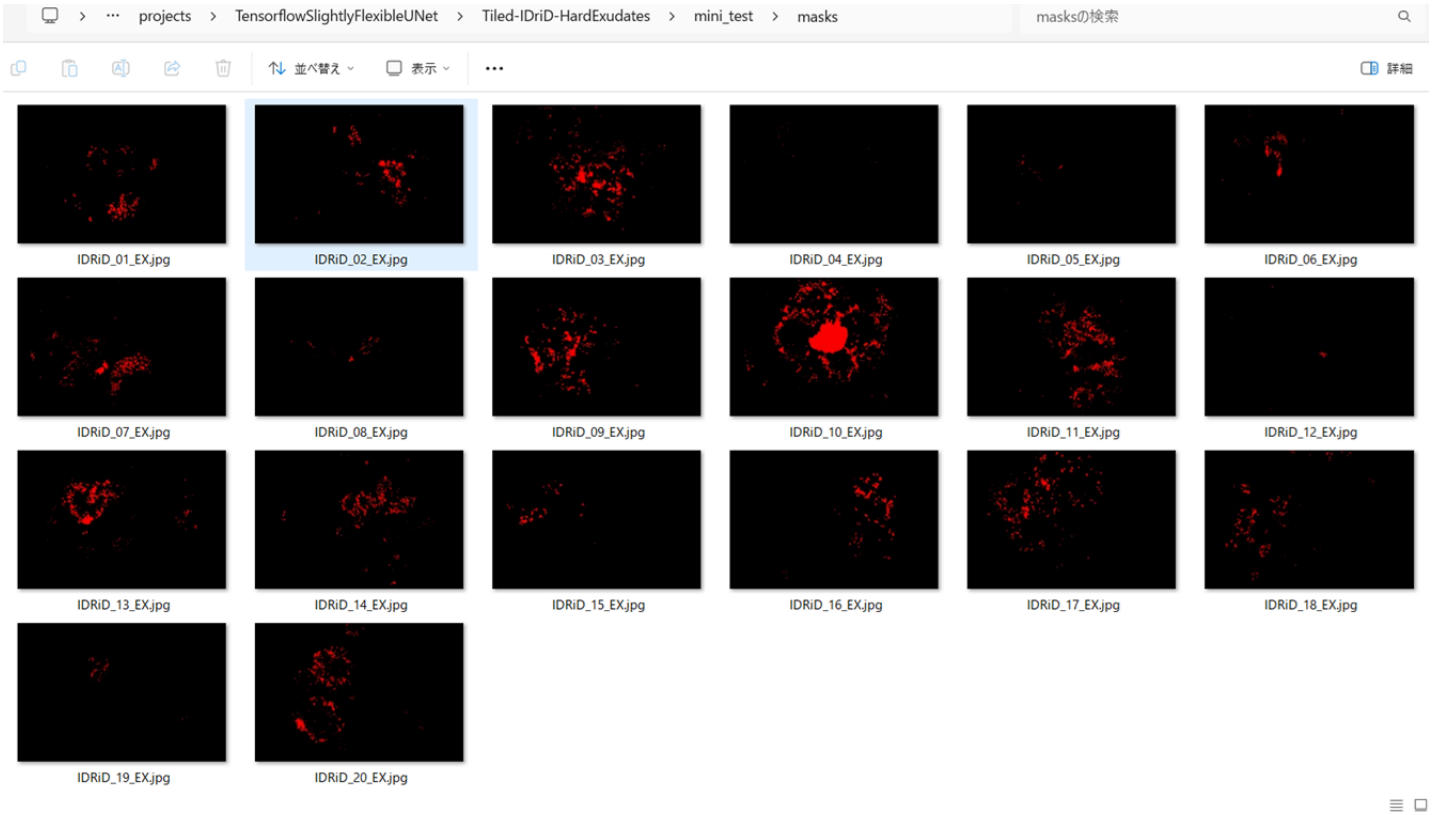
```
python ../../../src/TensorflowUNetTiledInferencer.py ./train_eval_infer.config
```

---

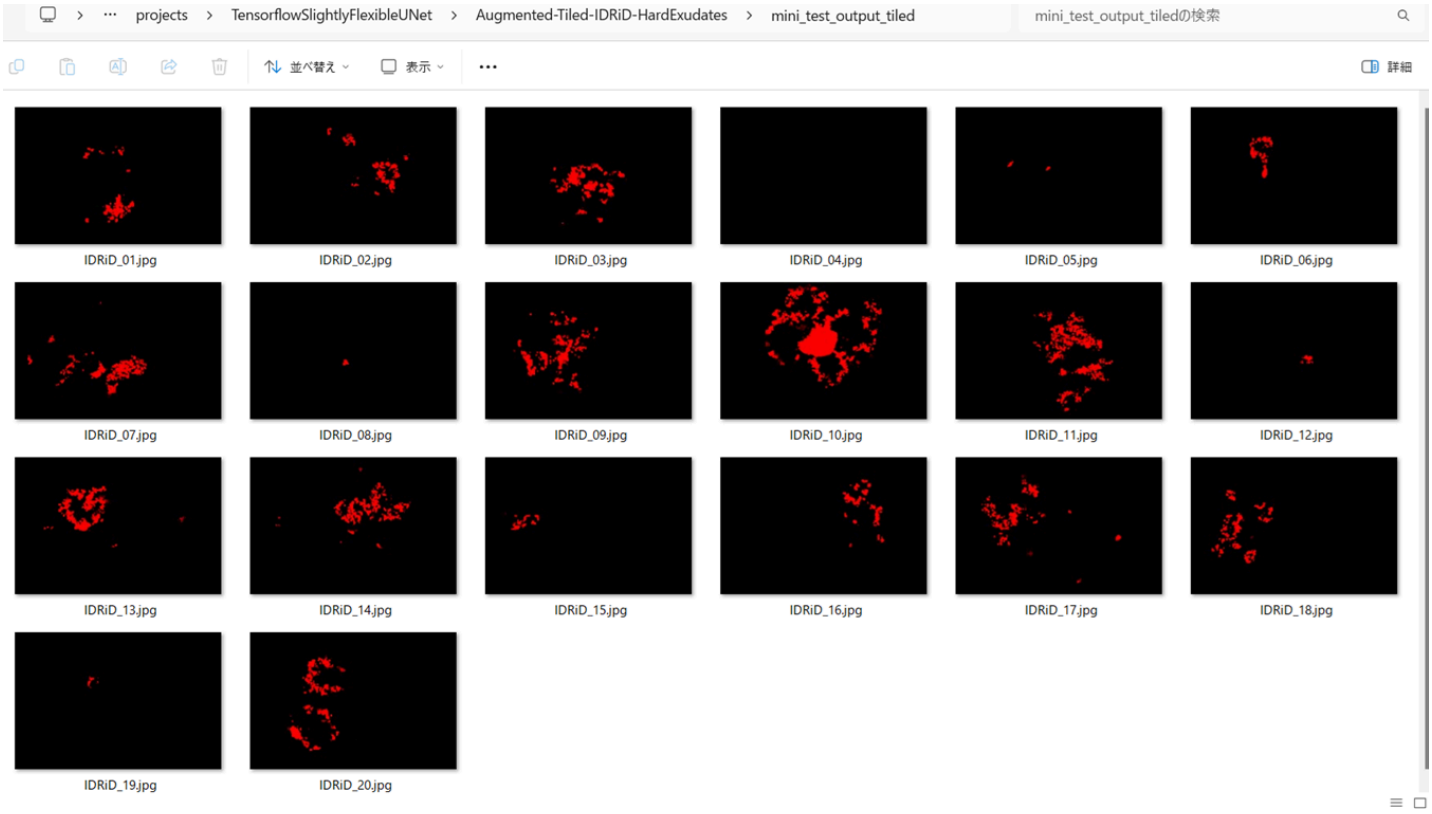
mini_test_images (4288x2848 pixels)



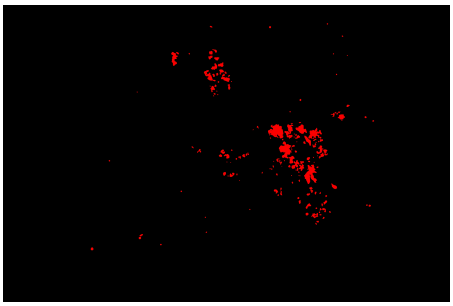
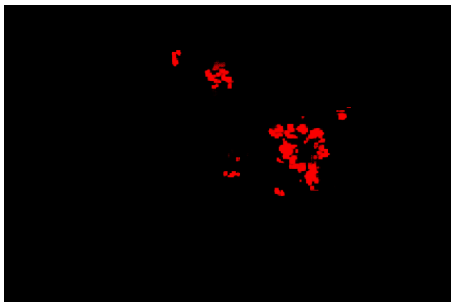
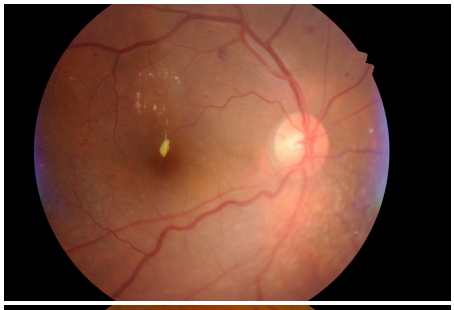
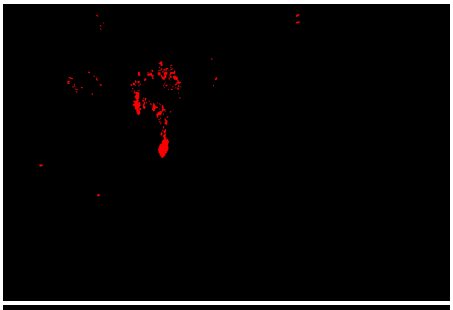
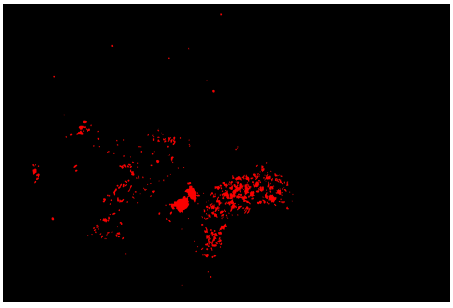
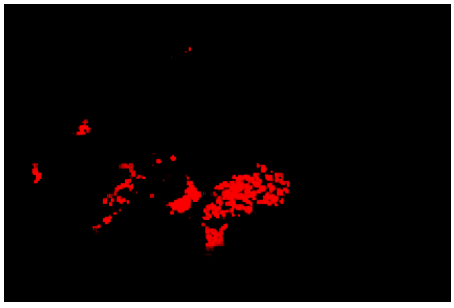
mini_test_mask(ground_truth)

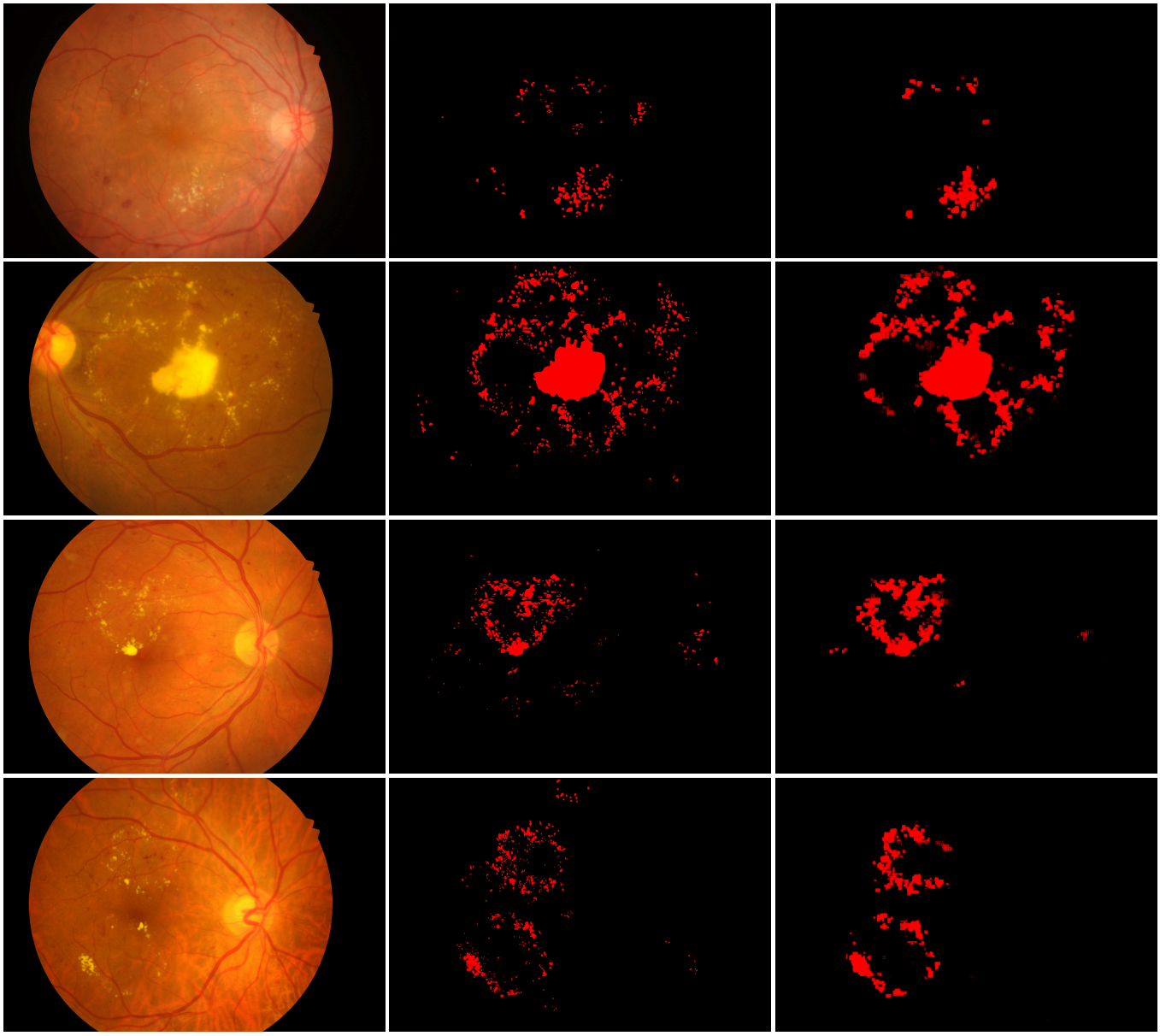


Tiled inferred test masks (4288x2848 pixels)



Enlarged images and masks of 4288x2848 pixels

Image	Mask (ground_truth)	Tiled-inferred-mask
		
		
		



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Yinghua Fu, Ge Zhang, Xin Lu, Honghan Wu, Dawei Zhang
https://doi.org/10.1016/j.eswa.2023.120987
https://www.sciencedirect.com/science/article/abs/pii/S0957417423014896

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Toshiyuki Arai @antillia.com
https://github.com/sarah-antillia/Tensorflow-Tiled-Image-Segmentation-IDRiD-HardExudates

4. Tensorflow-Tiled-Image-Segmentation-Augmented-Skin-Cancer
Toshiyuki Arai @antillia.com
https://github.com/sarah-antillia/Tensorflow-Tiled-Image-Segmentation-Augmented-Skin-Cancer

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Toshiyuki Arai @antillia.com
https://github.com/sarah-antillia/Tensorflow-Tiled-Image-Segmentation-Augmented-MultipleMyeloma

6. Tiled-ImageMask-Dataset-Breast-Cancer
Toshiyuki Arai @antillia.com
https://github.com/sarah-antillia/Tiled-ImageMask-Dataset-Breast-Cancer