Tensorflow-Tiled-Image-Segmentation-IDRiD-Retinal-Vessel (2025/03/09)

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This is the first experiment of Image Segmentation for **IDRiD Retinal Vessel** based on Pretrained HRF Retinal Vessel Model, which was trained by the latest Tensorflow-Image-Segmentation-API, and a **pre-augmented tiled dataset** Augmented-Tiled-HRF-ImageMask-Dataset.zip, which was derived by us from the following dataset:

Download the whole dataset (~73 Mb) in **High-Resolution Fundus (HRF) Image Database**.

Please see also our experiments:
- Tensorflow-Tiled-Image-Segmentation-Pre-Augmented-HRF-Retinal-Vessel based on High-Resolution Fundus (HRF) Image Database.
- Tensorflow-Tiled-Image-Segmentation-Pre-Augmented-DRIVE-Retinal-Vessel based on DRIVE: Digital Retinal Images for Vessel Extraction
- Tensorflow-Tiled-Image-Segmentation-Pre-Augmented-STARE-Retinal-Vessel based on STructured Analysis of the Retina.
- Tensorflow-Image-Segmentation-Retinal-Vessel based on CHASE_DB1 dataset.

Experiment Strategies

1. Masks (antillia ground truth) for IDRiD master Original Images
The IDRiD dataset contains no masks (ground truths) data for Retinal Vessel. Therefore, we created our own master masks (ground truths) from the IDRiD Original Images by using Tiled Image Segmentation method and Pretrained-HRF-Retinal-Vessel UNet Model which was trained by the latest Tensorflow-Image-Segmentation-API, and a **pre-augmented tiled dataset** Augmented-Tiled-HRF-ImageMask-Dataset.zip.

2. Augment IDRiD Dataset
We augmented the IDRiD-master images and masks by using ImageMaskDatasetGenerator.

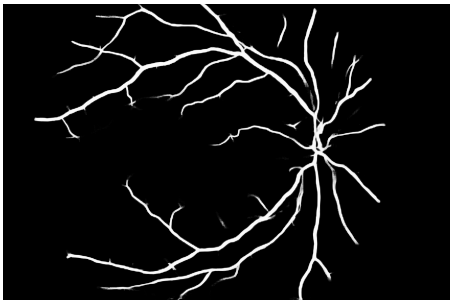
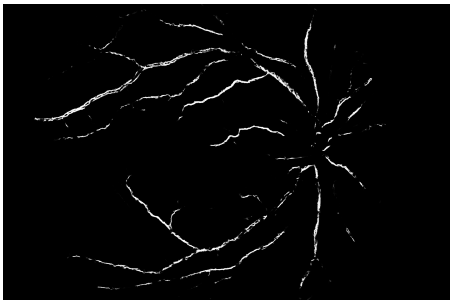
3. Split Augmented-IDRiD-master
We splitted the Augmented-IDRiD-master images and masks into test, train and valid subsets.

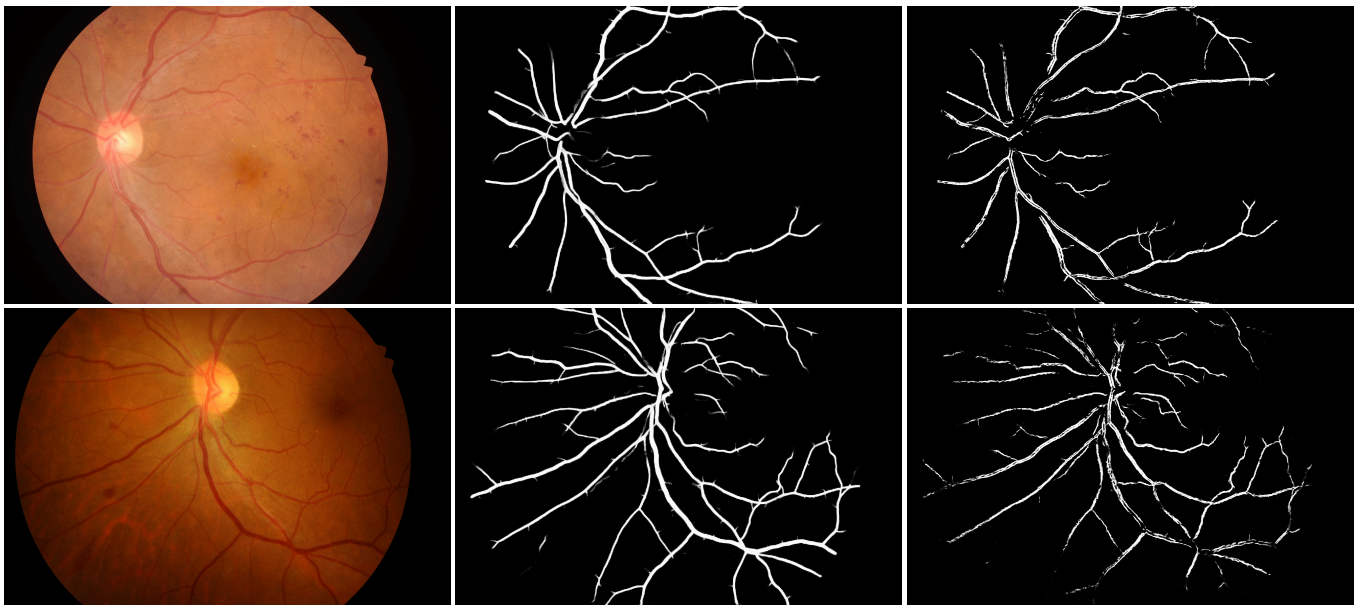
4. Train IDRiD Retinal Vessel Segmentation Model
We trained and validated a TensorFlow UNet model by using the **Augmented-IDRiD train and valid subsets**

5. Evaluate IDRiD Segmentation Model
We evaluated the performance of the trained UNet model by using the **Augmented-IDRiD test** dataset by computing the **bce_dice_loss** and **dice_coef**.

5. Tiled Inference
We applied our Tiled Image Segmentation method to infer the Retinal Vessel for the mini_test images of the IDRiD images of 4288x2848 pixels.

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

Input: image	Mask (antillia ground_truth)	Prediction: tiled_inferred_mask
		



In this experiment, we used the simple UNet Model TensorflowSlightlyFlexibleUNet for this HRFSegmentation 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

1.1 High-Resolution Fundus (HRF) Image Database

The dataset used here has been taken from the dataset Download the whole dataset (~73 Mb) in **High-Resolution Fundus (HRF) Image Databaset**.

Introduction
This database has been established by a collaborative research group to support comparative studies on automatic segmentation algorithms on retinal fundus images. The database will be iteratively extended and the webpage will be improved.
We would like to help researchers in the evaluation of segmentation algorithms. We encourage anyone working with segmentation algorithms who found our database useful to send us their evaluation results with a reference to a paper where it is described. This way we can extend our database of algorithms with the given results to keep it always up-to-date.
The database can be used freely for research purposes. We release it under Creative Commons 4.0 Attribution License.

Citation
Robust Vessel Segmentation in Fundus Images
Budai, Attila; Bock, Rüdiger; Maier, Andreas; Hornegger, Joachim; Michelson, Georg.
International Journal of Biomedical Imaging, vol. 2013, 2013

1.2 IDRiD Dataset

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

License:

2. Create Masks for IDRiD Retinal Vessel Images

2.1 Download IDRiD IMAGES Dataset

Please download **Indian Diabetic Retinopathy Image Dataset (IDRiD)** 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
```

As shown above, this datatset contains no masks (ground truths) data for **IDRiD Retinal Vessel**. Therefore, we created our own mask files for the IDRiD Retinal Vessel.
At first, please copy all image files in **1. Original Images** under the following folder **images**.

```
./projects
    └──generator
        └──IDRiD-master
            └──images
```

2.2 Download Augmented-Tiled-HRF-Pretrained-Model

Please download our Augmented-Tiled-HRF-Pretrained-Model.zip, expand it and place **best_model.h5** under models folder as shown below.

```
./projects
    └──TensorflowSlightlyFlexibleUNet
        └──Augmented-Tiled-HRF
            └──models
                └──best_model.h5
```

2.3 Run Tiled Inference method

Please move the folder "./projects/TensorflowSlightlyFlexibleUNet/Augmented-Tiled-HRF". and run the following bat file.

```
5.tiled_infer-idrid.bat
```

This will generate our own masks (ground truths) for Retinal Vessel of IDRiD images by using the HRF-Pretrained-Model, without any human experts.

```
./projects
    └──generator
        └──IDRiD-master
            ├──images
            └──masks
```

The number of images and their corresponding masks in IDRiD-master is 81 respectively, which is too small to use for a training set of our Segmentation Model.

2.4 Augment IDRiD-master

Please move to "./projects/generator" folder and run the following Python script.

```
python ImageMaskDatasetGenerator.py
```

, by which the following Augmented-IDRiD-master will be generated.

```
./projects
    └──generator
        └──Augmented-IDRiD-master
            ├──images
            └──mask
```

2.5 Split Augmented-IDRiD-master

Please move to "./projects/generator" folder and run the following Python script.

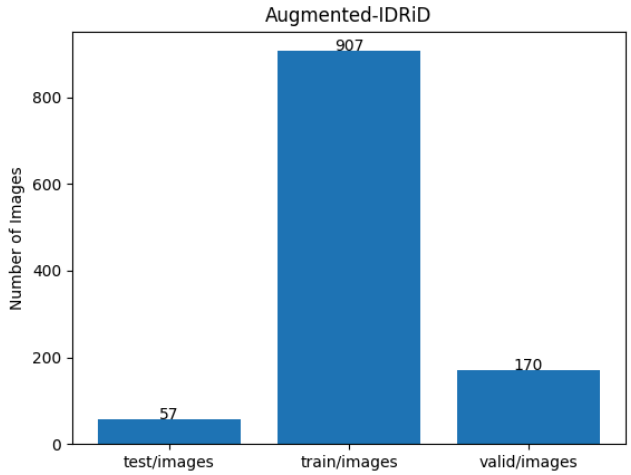
```
python spit_augmented_master.py
```

, by which the following Augmented-IDRiD dataset will be created.

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

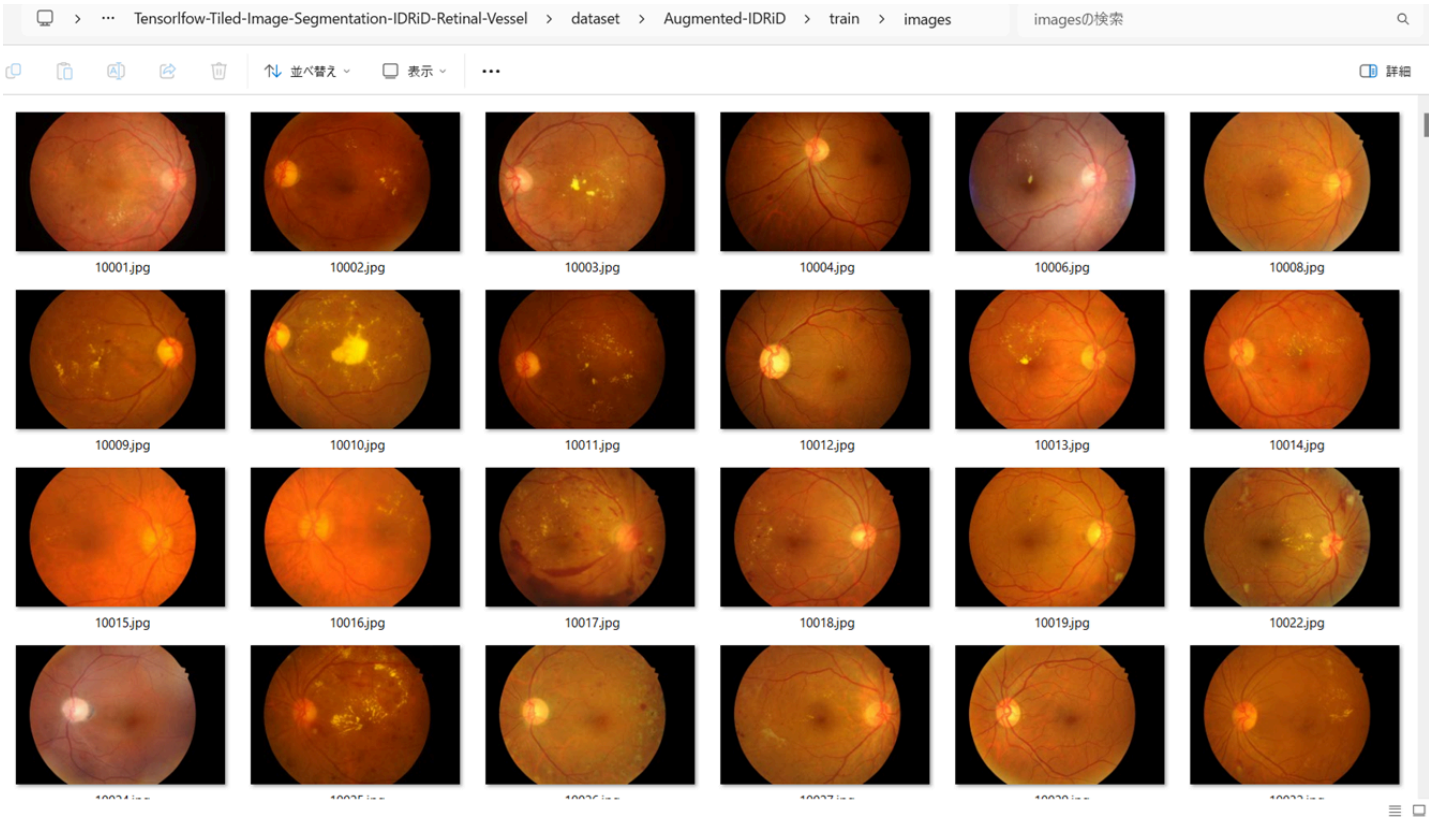
This is a Non-Tiled 4288x2848 pixels images and their corresponding masks dataset for IDRiD Retinal Vessel.
You may also download this dataset from the google drive [Antillia-Augmented-IDRiD-Dataset.zip (2.06G)]

Augmented-IDRiD Statistics

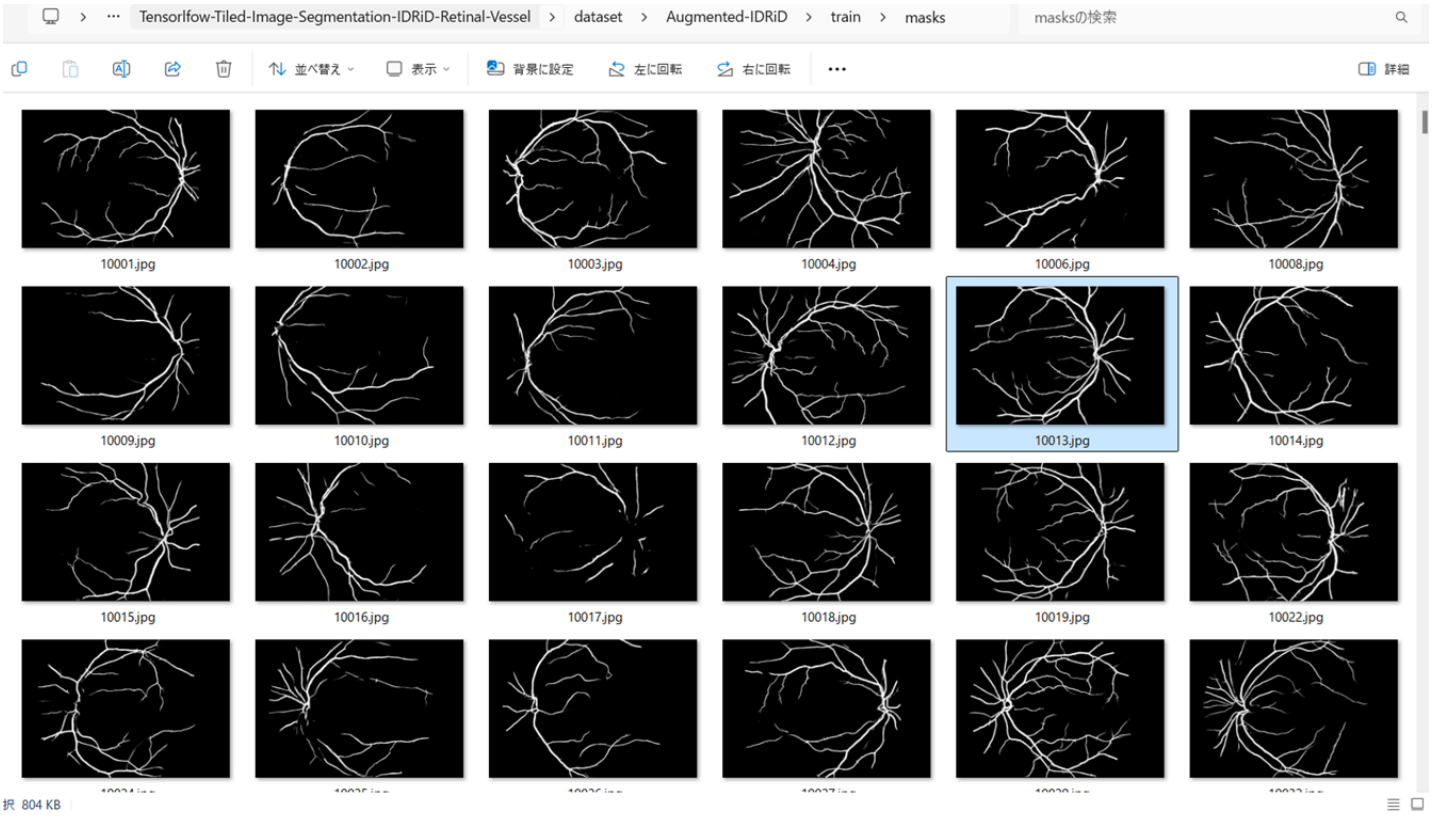


As shown above, the number of images of train and valid datasets is not so large, but enough to use for a training set of our segmentation model.

Train_images_sample



Train_masks_sample



3 Train TensorflowUNet Model

We have trained HRF TensorflowUNet Model by using the following **train_eval_infer.config** file.
Please move to ./projects/TensorflowSlightlyFlexibleUNet/IDRiD and 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=(11,11)** 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   = (11,11)
num_layers     = 8
dilation       = (1,1)
```

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_LINEAR"
```

Early stopping callback

Enabled early stopping callback with patience parameter.

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

Tiled Inference

Used the original IDRiD IMAGES as a mini_test dataset for our inference images.

```
[tiledinfer]
images_dir    = "./mini_test/images"
output_dir    = "./mini_test_output_tiled"
```

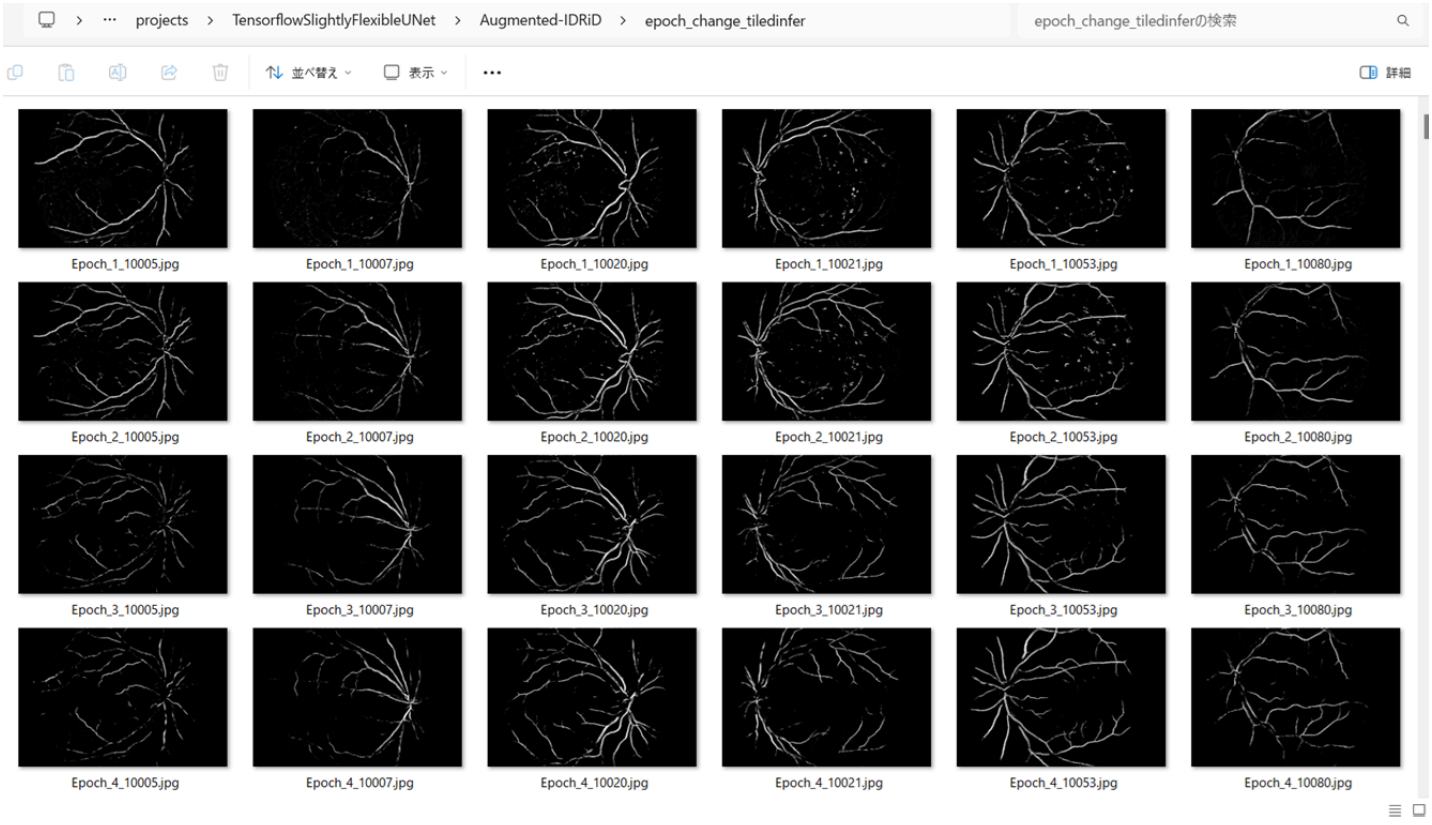
Epoch change inference callbacks

Enabled epoch_change_infer callback.

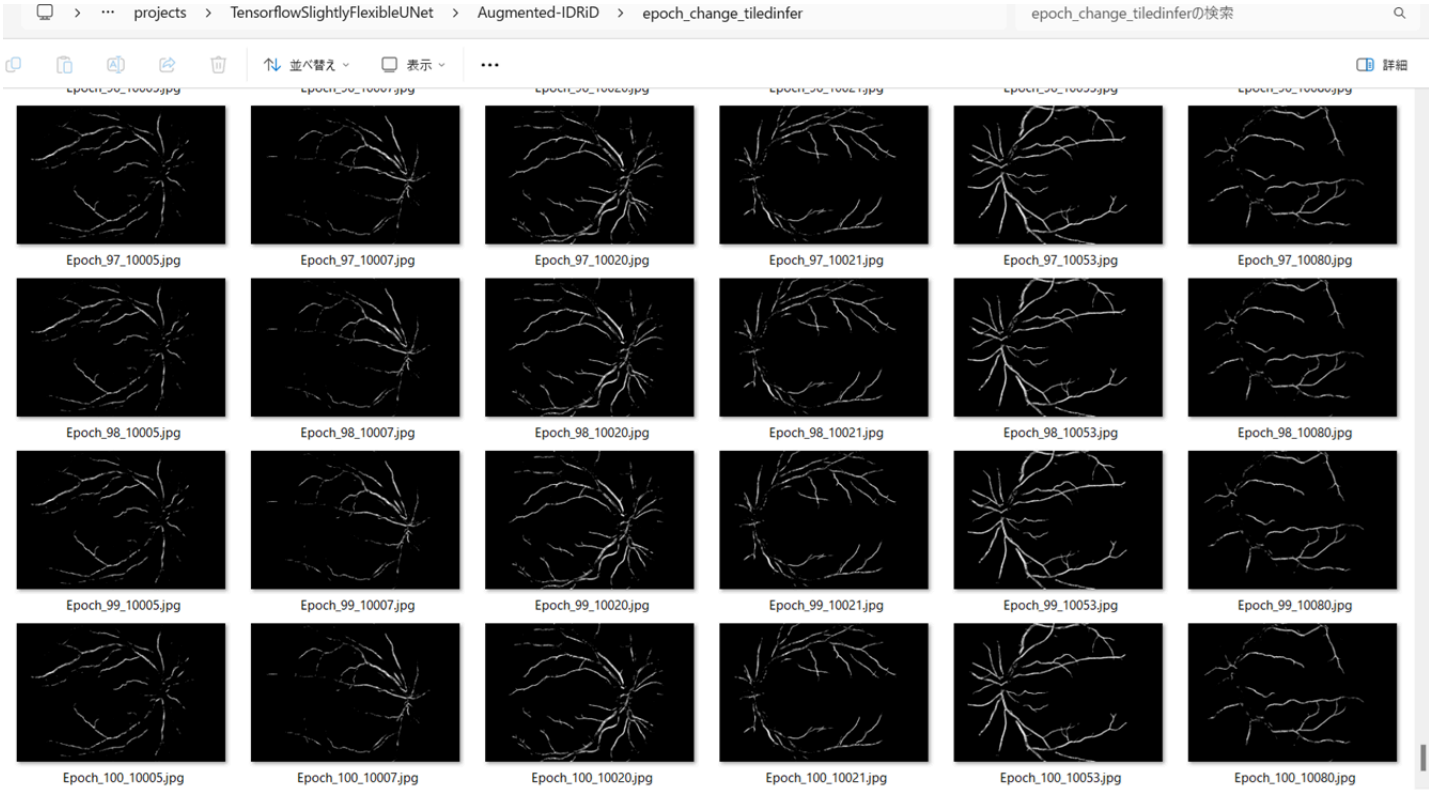
```
[train]
epoch_change_infer      = False
epoch_change_infer_dir  = "./epoch_change_infer"
epoch_change_tiledinfer = True
epoch_change_tiledinfer_dir = "./epoch_change_tiledinfer"
num_infer_images        = 6
```

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

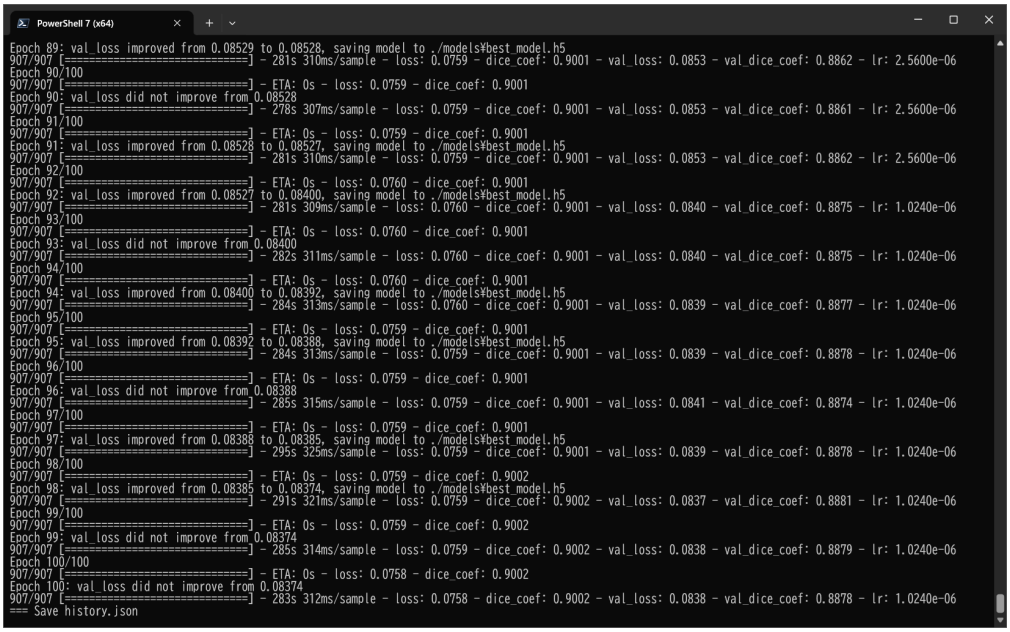
Epoch_change_tiled_inference output at starting (1,2,3,4)



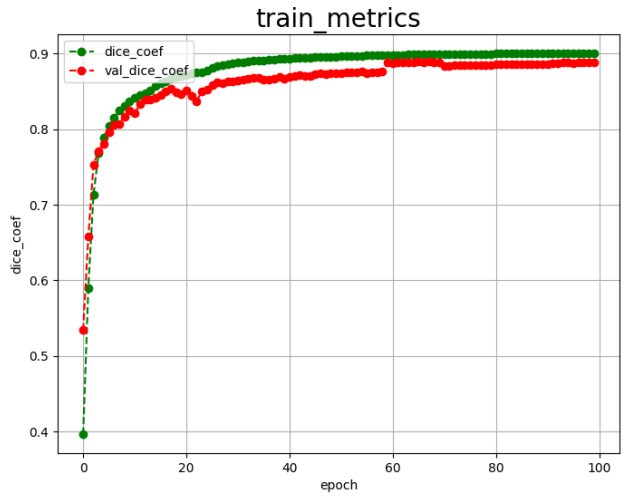
Epoch_change_tiled_inference output at ending (75,76,77,78)



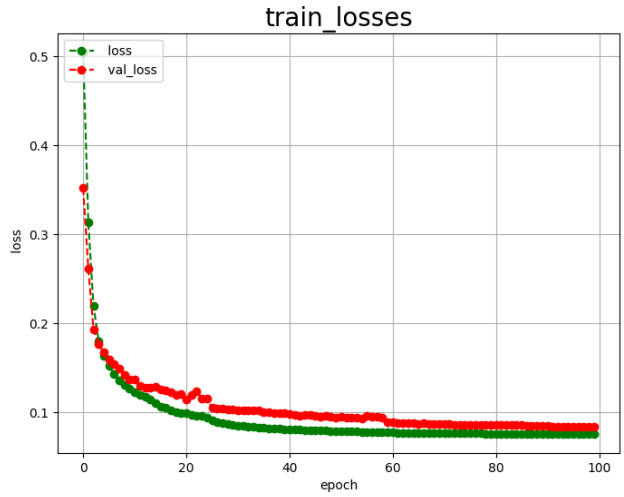
In this experiment, the training process was terminated at epoch 100.



train_metrics.csv



[train_losses.csv](#)



4 Evaluation

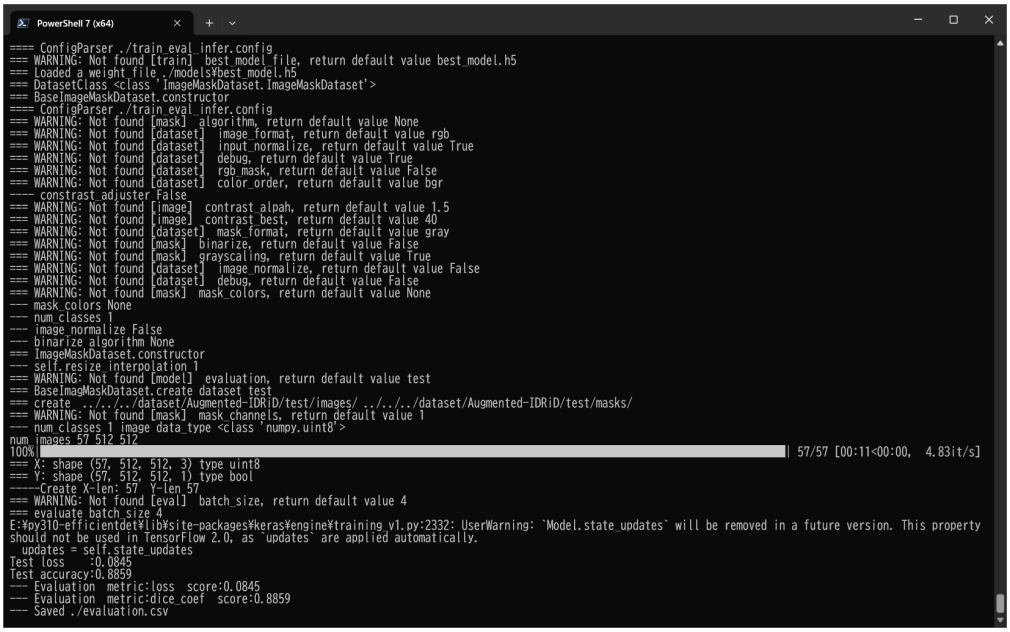
Please move to a **./projects/TensorflowSlightlyFlexibleUNet/IDRiD** folder,
and run the following bat file to evaluate TensorflowUNet model for IDRiD/test.

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

This bat file simply runs the following command.

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

Evaluation console output:



evaluation.csv

The loss (bce_dice_loss) to this IDRiD/test was low, and dice_coef high as shown below.

```
loss,0.0845
dice_coef,0.8859
```

5 Tiled Inference

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

```
./4.tiledinfer.bat
```

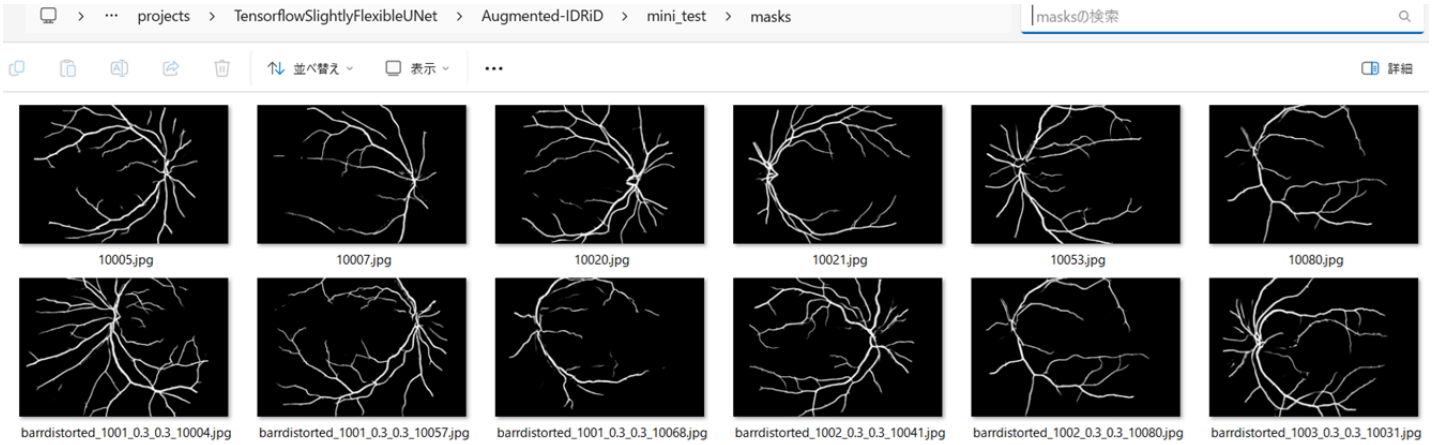
This simply runs the following command.

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

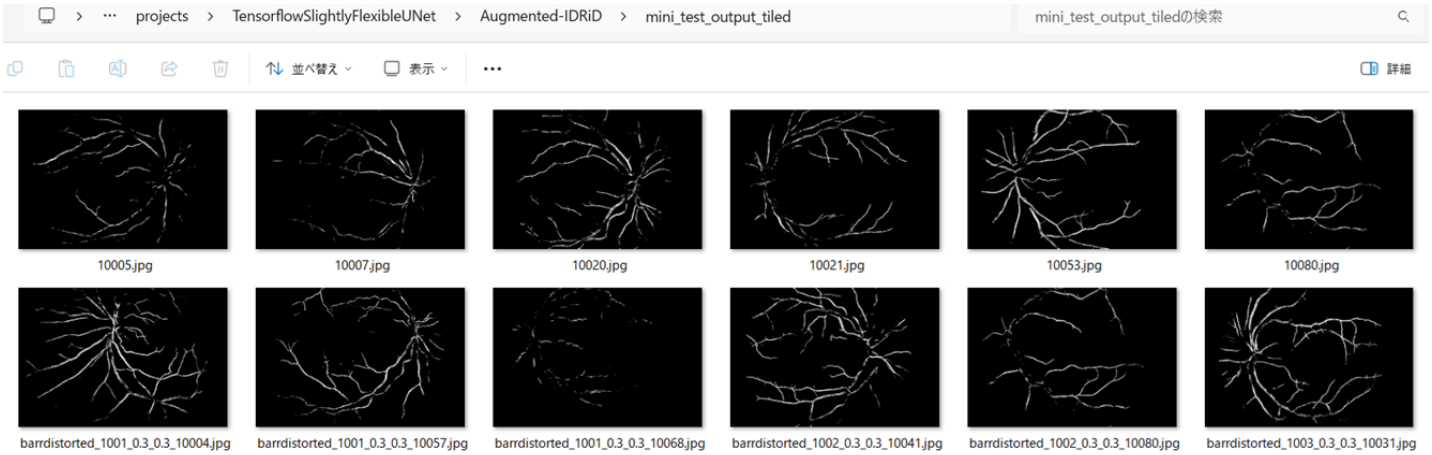
---

mini_test_images (4288x2848 pixels)

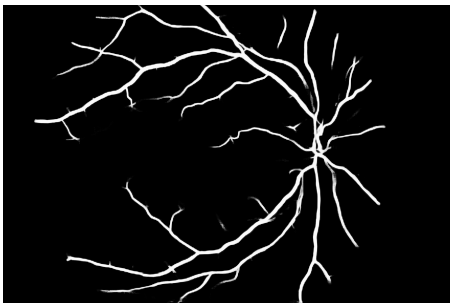
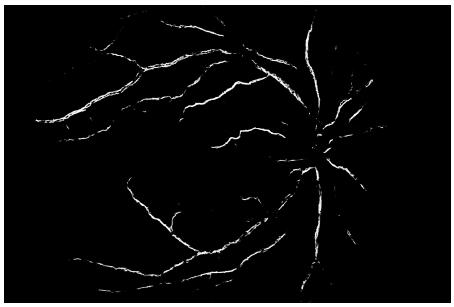
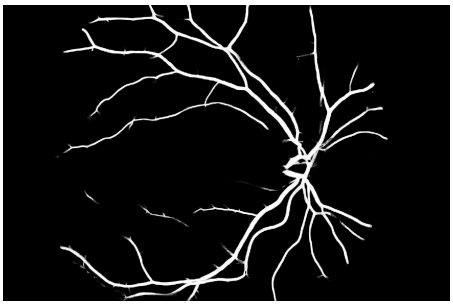
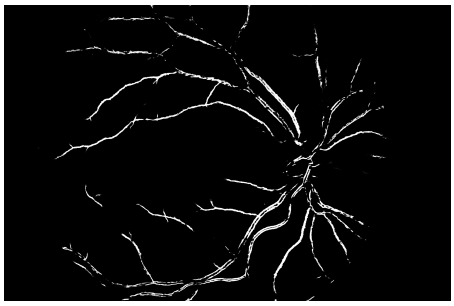
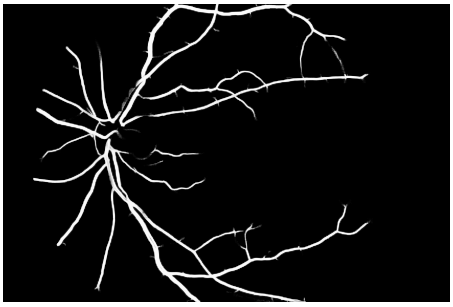
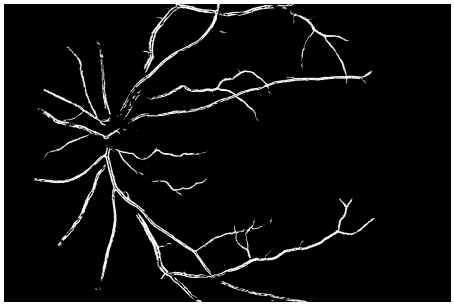
mini_test_mask(antillia ground_truth)

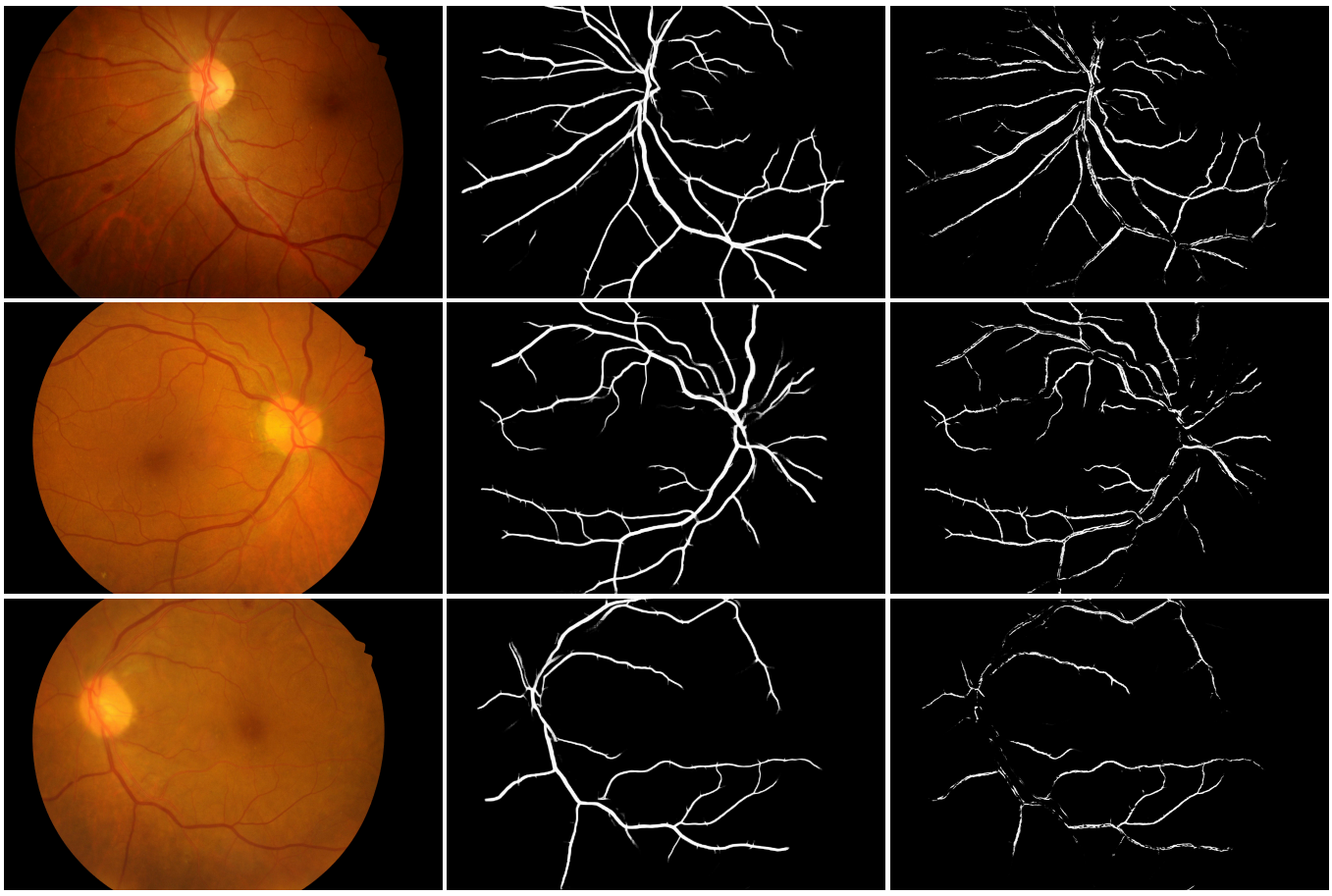


Tiled inferred test masks (4288x2848 pixels)



Enlarged images and masks of 4288x2848 pixels

Image	Mask (antillia ground_truth)	Tiled-inferred-mask
		
		
		



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