TensorFlow-FlexUNet-Image-Segmentation-BreastDM-DCE-MRI (2025/09/05)

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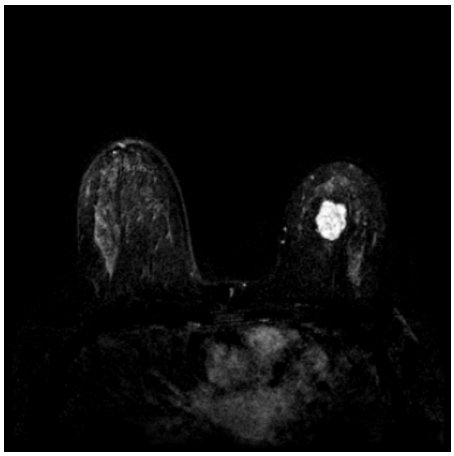
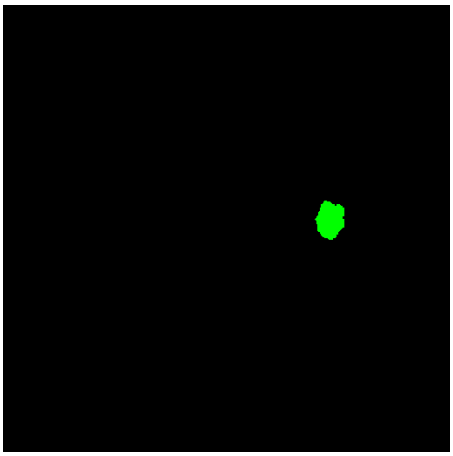
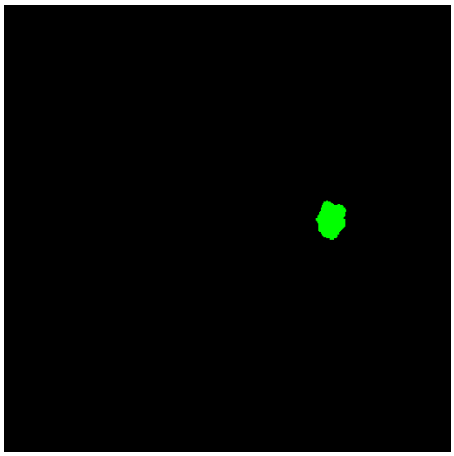
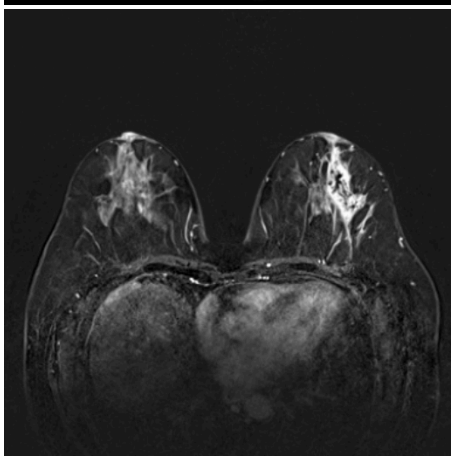
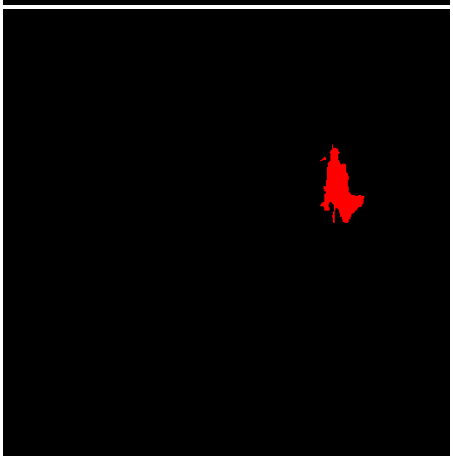
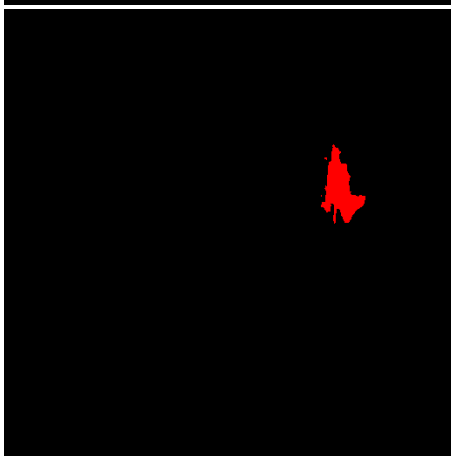
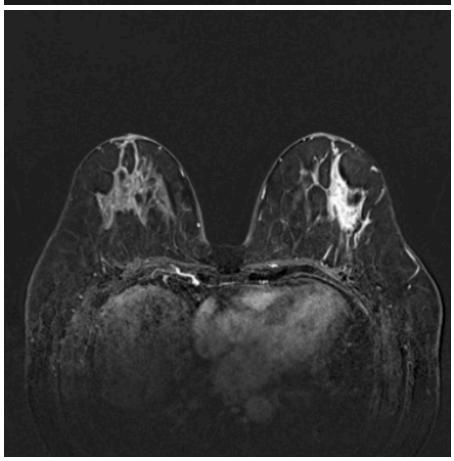
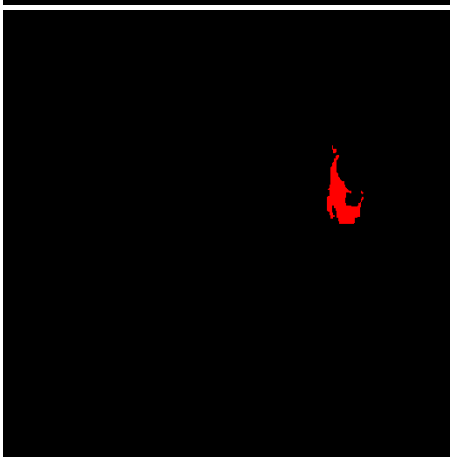
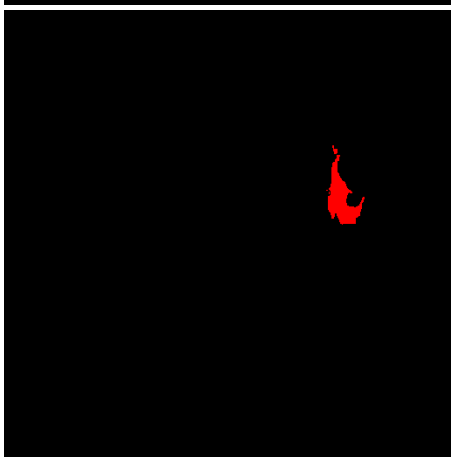
This is the first experiment of Image Segmentation for BreastDM-DCE(Dynamic Contrast-Enhanced)-MRI (Benign and Malignant) based on our TensorFlowFlexUNet (TensorFlow Flexible UNet Image Segmentation Model for Multiclass) and a 512x512 pixels BreastDM-ImageMask-Dataset.zip with colorized masks (benign:green, malignant:red), which was derived by us from the following dataset on the google drive BreaDM.zip specified in a repository Breast-cancer-dataset

On BreaDM dataset, please refer to **BreastDM: A DCE-MRI dataset for breast tumor image segmentation and classification** , and Breast-cancer-dataset

.
Please see also our experiment for a singleclass segmentation model Tensorflow-Image-Segmentation-Malignant-BreastDM

Acutual Image Segmentation for 512x512 BreastDM images
As shown below, the inferred masks predicted by our segmentation model trained on the PNG dataset appear similar to the ground truth masks.
rgb_map = (benign:green, malignant:red)

Input: image	Mask (ground_truth)	Prediction: inferred_mask
		
		
		

1. Dataset Citation

The dataset used here has been obtained from the google drive BreaDM.zip specified in Breast-cancer-dataset

On BreastDM dataset, please refer to BreastDM: A DCE-MRI dataset for breast tumor image segmentation and classification
Xiaoming Zhao, Yuehui Liao, Jiahao Xie, Xiaxia He, Shiqing Zhang, Guoyu Wang
, Jiangxiong Fang , Hongsheng Lu, Jun Yu
https://doi.org/10.1016/j.compbiomed.2023.107255

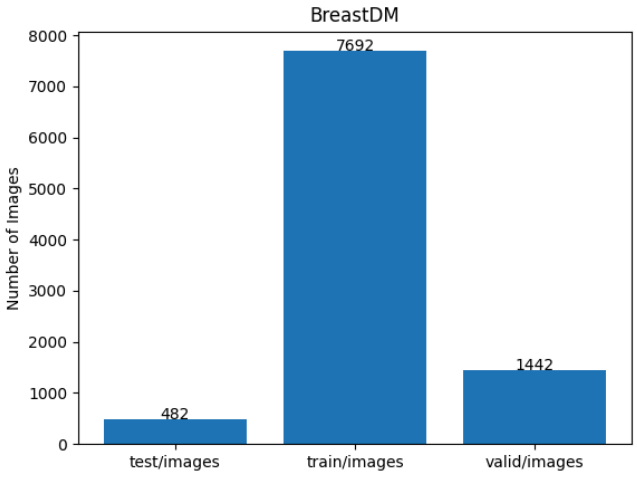
2 BreastDM ImageMask Dataset

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

```
./dataset
└─BreastDM
    ├─test
    │  ├─images
    │  └─masks
    ├─train
    │  ├─images
    │  └─masks
    └─valid
       ├─images
       └─masks
```

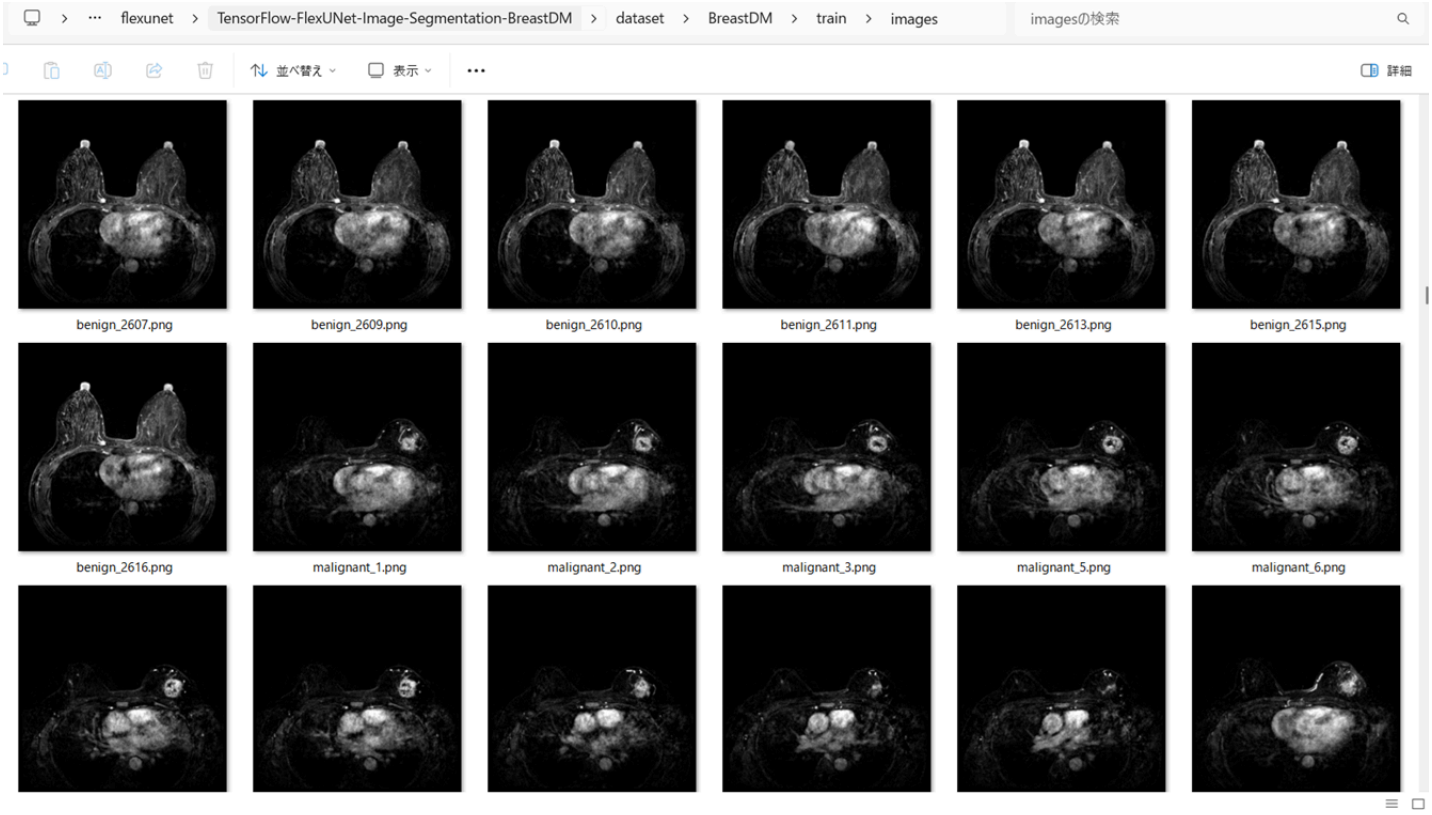
On the derivation of this dataset, please refer to TrainMalignantImageMaskDatasetGenerator.py in our repository Tensorflow-Image-Segmentation-Malignant-BreastDM

BreastDM Statistics

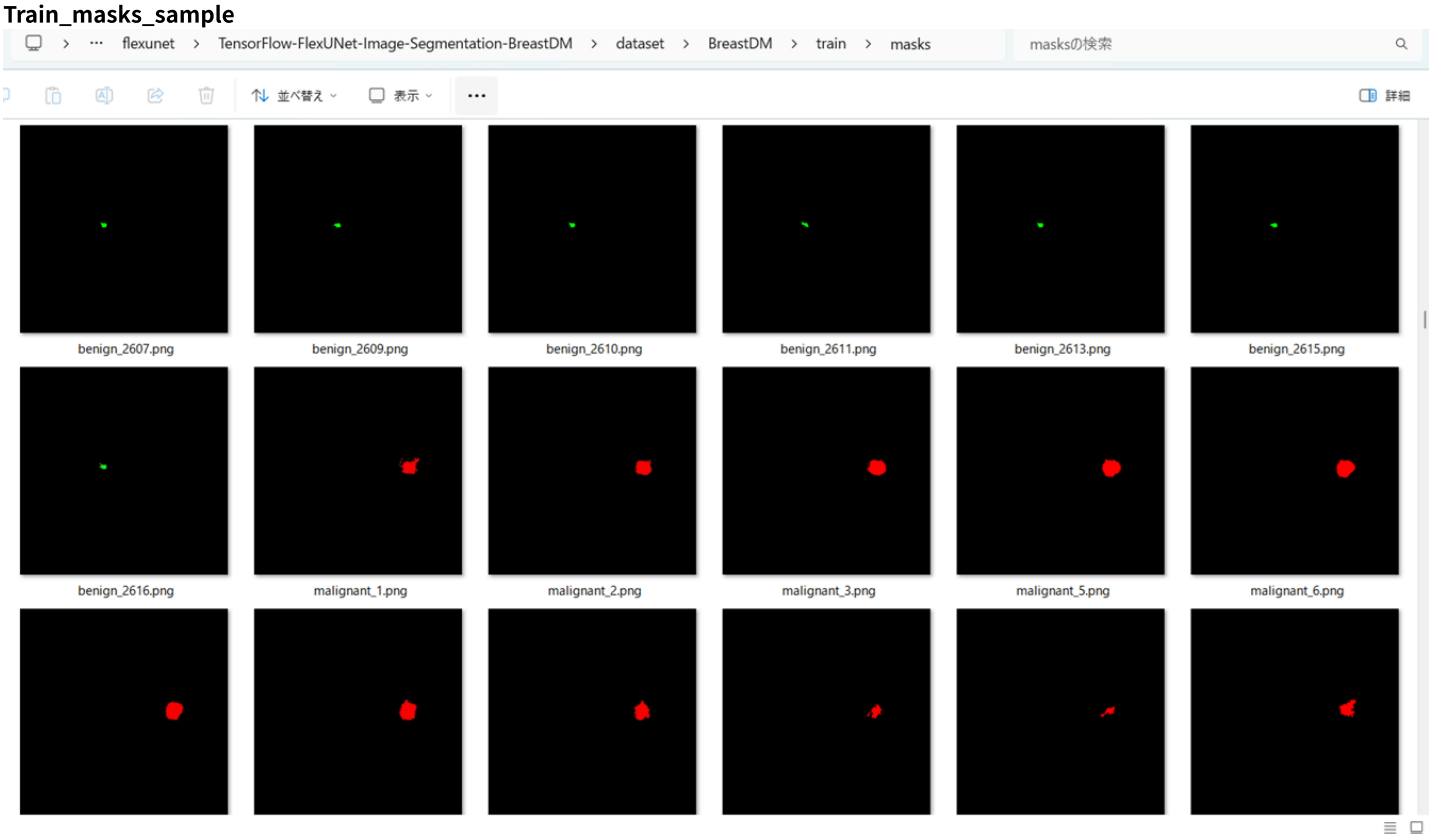


As shown above, the number of images of train and valid datasets is large enough to use for a training set of our segmentation model.

Train_images_sample



Train_masks_sample



3 Train TensorFlowFlexUNet Model

We trained BreastDM TensorFlowFlexUNet Model by using the following **train_eval_infer.config** file.
Please move to ./projects/TensorFlowFlexUNet/BreastDM and run the following bat file.

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

, which simply runs the following command.

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

Model parameters
Defined a small **base_filters = 16** and large **base_kernels = (7,7)** for the first Conv Layer of Encoder Block of TensorFlowFlexUNet.py and a large num_layers (including a bridge between Encoder and Decoder Blocks).

```
[model]
;You may specify your own UNet class derived from our TensorFlowFlexModel
model         = "TensorFlowFlexUNet"
generator     =  False
image_width    = 512
image_height   = 512
image_channels = 3
num_classes    = 3

base_filters   = 16
base_kernels   = (7,7)
num_layers     = 8
dropout_rate   = 0.05
dilation       = (1,1)
```

Learning rate

Defined a very small learning rate.

```
[model]
learning_rate  = 0.00007
```

Loss and metrics functions

Specified "categorical_crossentropy" and "dice_coef_multiclass".

```
[model]
loss           = "categorical_crossentropy"
metrics        = ["dice_coef_multiclass"]
```

Dataset class

Specifed ImageCategorizedMaskDataset class.

```
[dataset]
class_name    = "ImageCategorizedMaskDataset"
```

Learning rate reducer callback

Enabled learing_rate_reducer callback, and a small reducer_patience.

```
[train]
learning_rate_reducer = True
reducer_factor     = 0.5
reducer_patience   = 4
```

Early stopping callback

Enabled early stopping callback with patience parameter.

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

RGB Color map

rgb color map dict for BreastDM 1+2 classes.

```
[mask]
mask_file_format = ".png"

; RGB colors    benign:green, malignanat:red
rgb_map = {(0,0,0):0,(0,255,0):1,(255,0,0):2,}
```

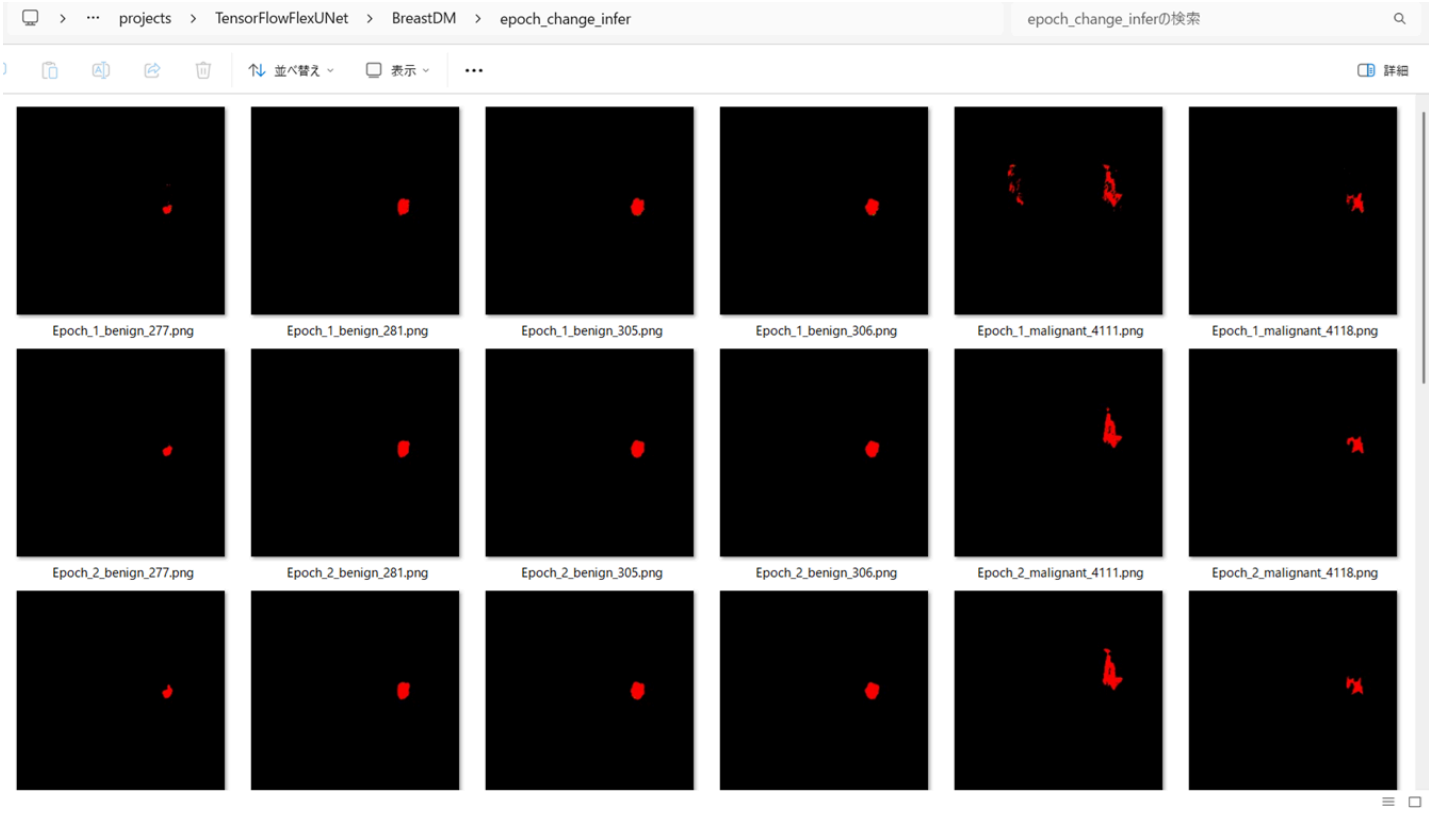
Epoch change inference callback

Enabled epoch_change_infer callback (EpochChangeInferencer.py).

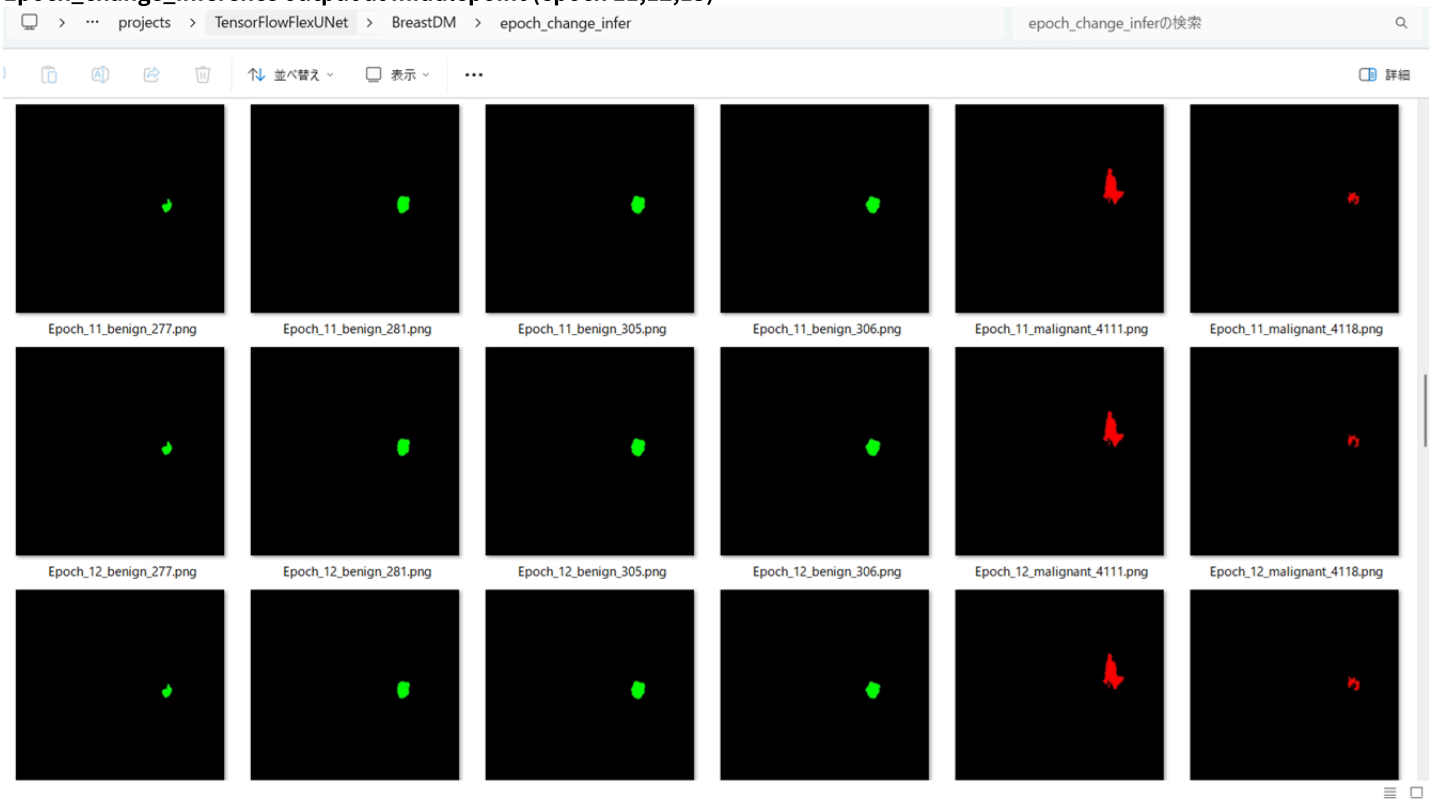
```
[train]
epoch_change_infer       = True
epoch_change_infer_dir   = "./epoch_change_infer"
num_infer_images         = 6
```

By using this callback, on every epoch_change, the 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.

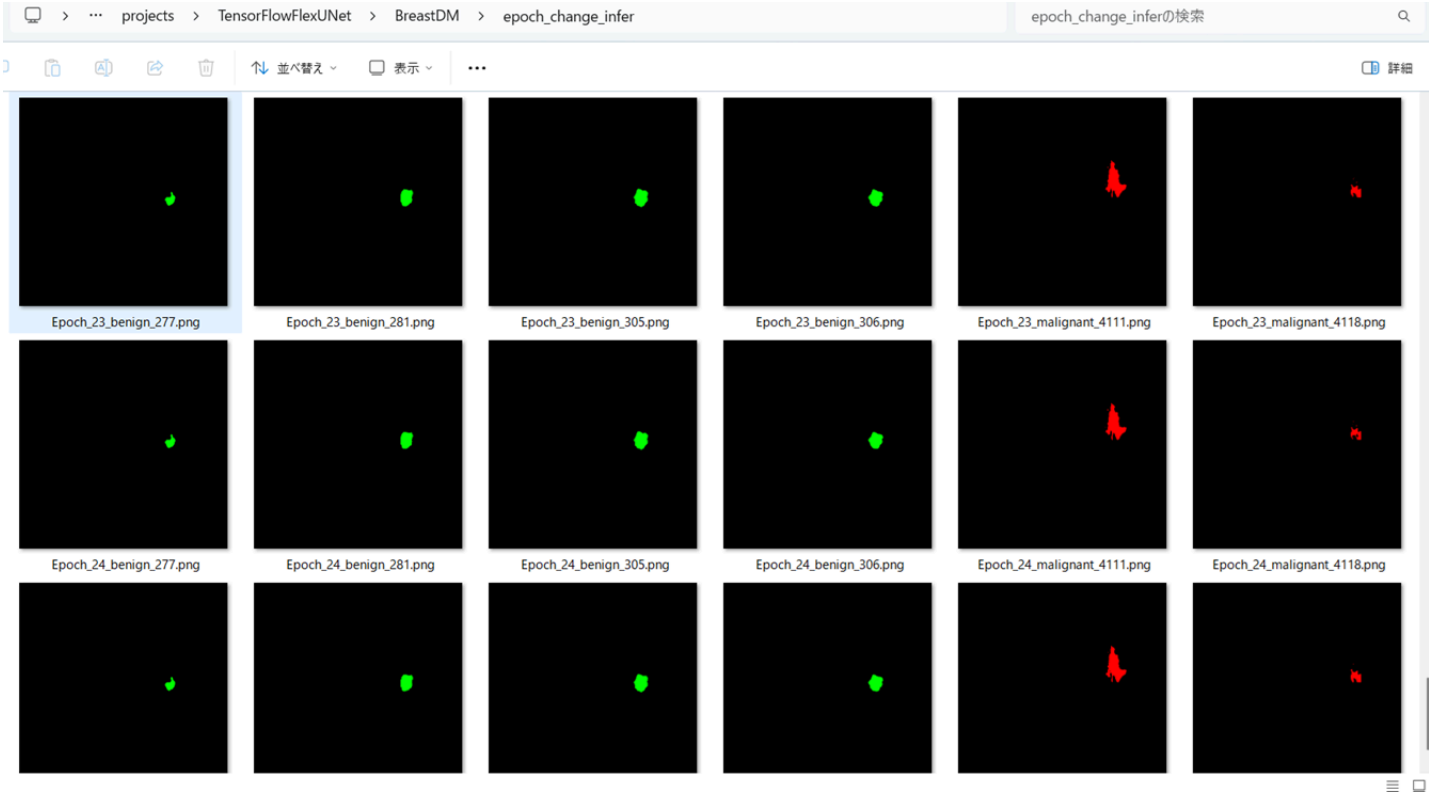
Epoch_change_inference output at starting (epoch 1,2,3)



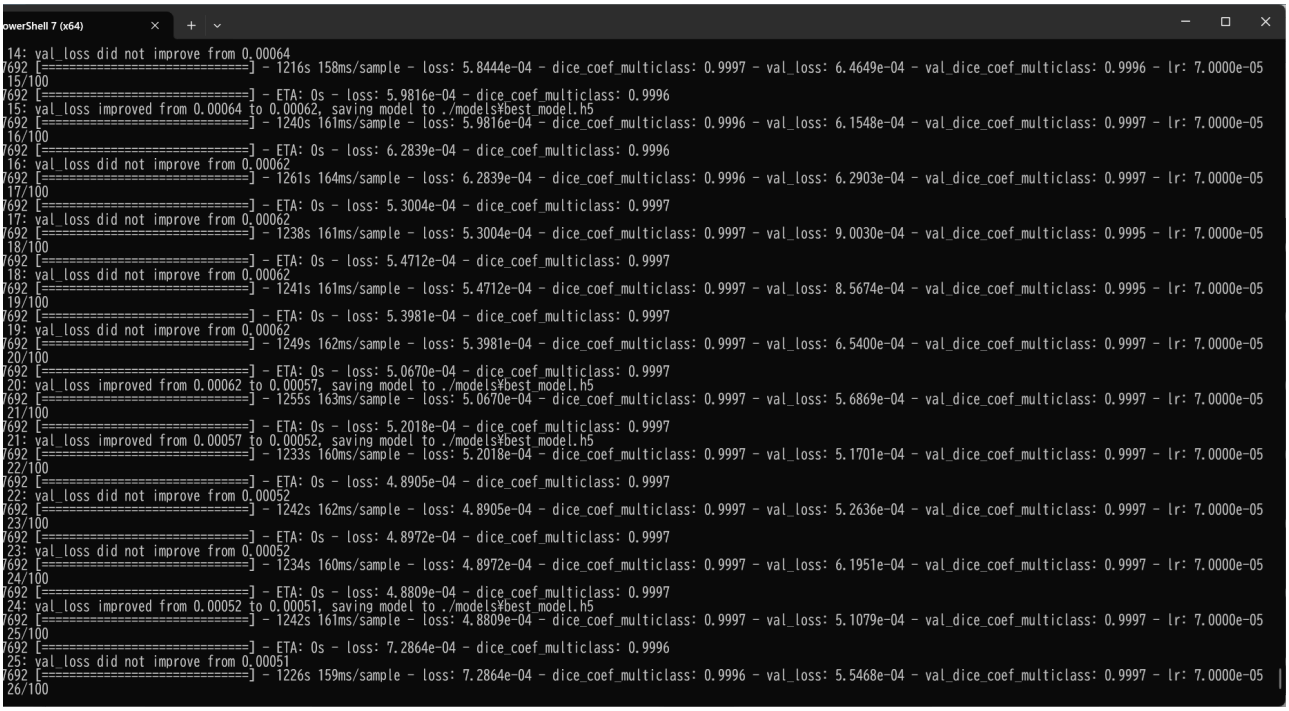
Epoch_change_inference output at middlepoint (epoch 11,12,13)



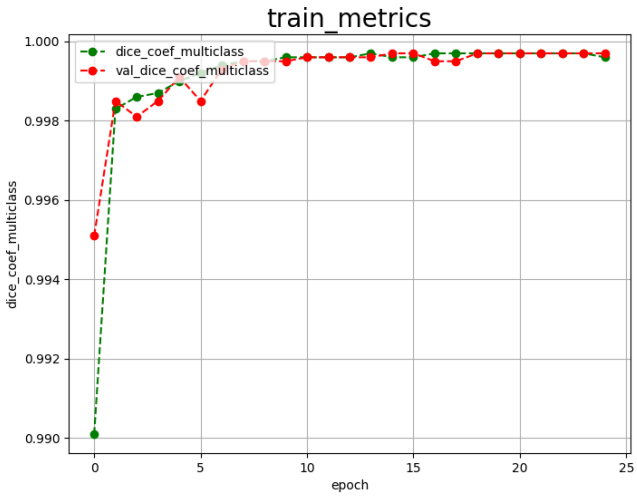
Epoch_change_inference output at ending (epoch 23,24,25)



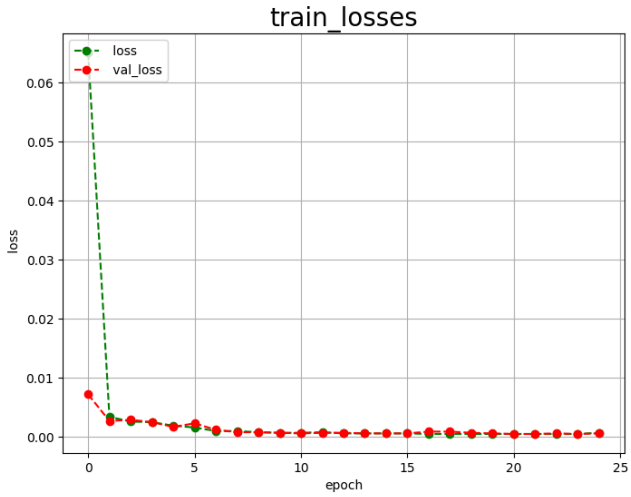
In this experiment, the training process was terminated at epoch 25.



[train_metrics.csv](#)



train_losses.csv



4 Evaluation

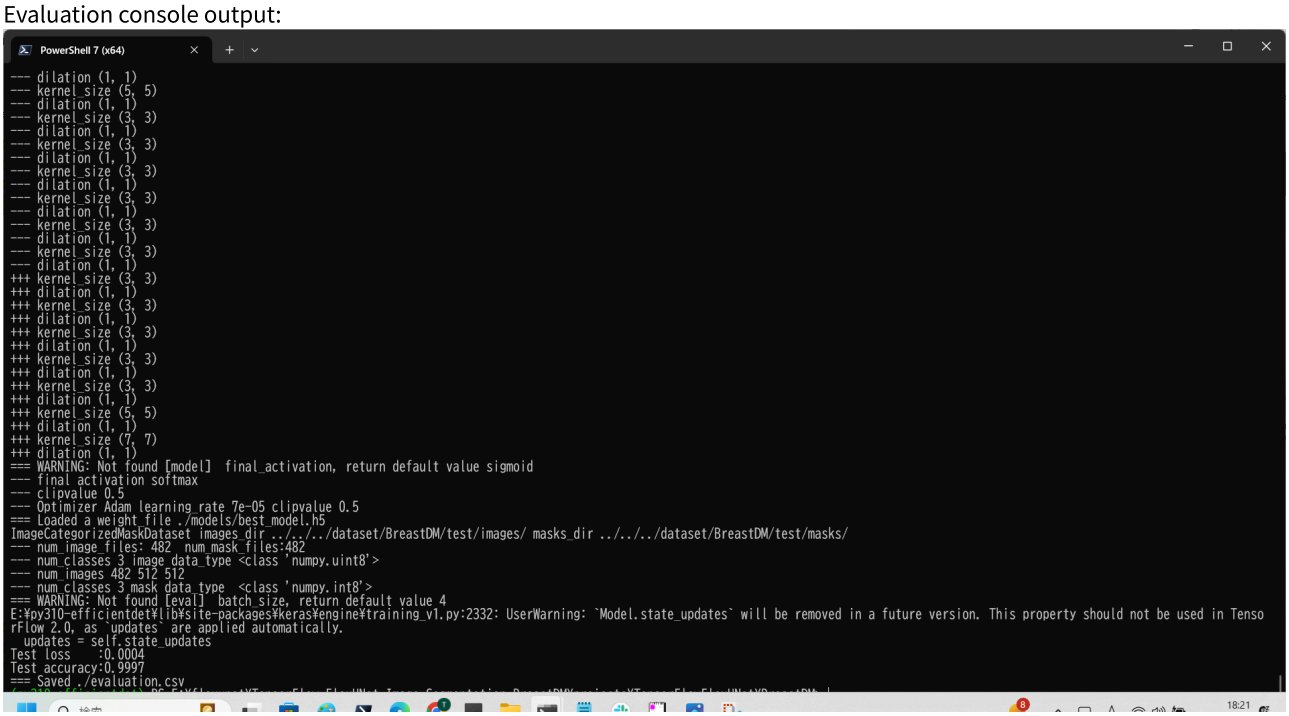
Please move to **./projects/TensorFlowFlexUNet/BreastDM** folder,
and run the following bat file to evaluate TensorFlowFlexUNet model for BreastDM.

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

This bat file simply runs the following command.

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

Evaluation console output:



evaluation.csv

The loss (categorical_crossentropy) to this BreastDM/test was very low and dice_coef_multiclass very high as shown below.

```
categorical_crossentropy,0.0004
dice_coef_multiclass,0.9997
```

5 Inference

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

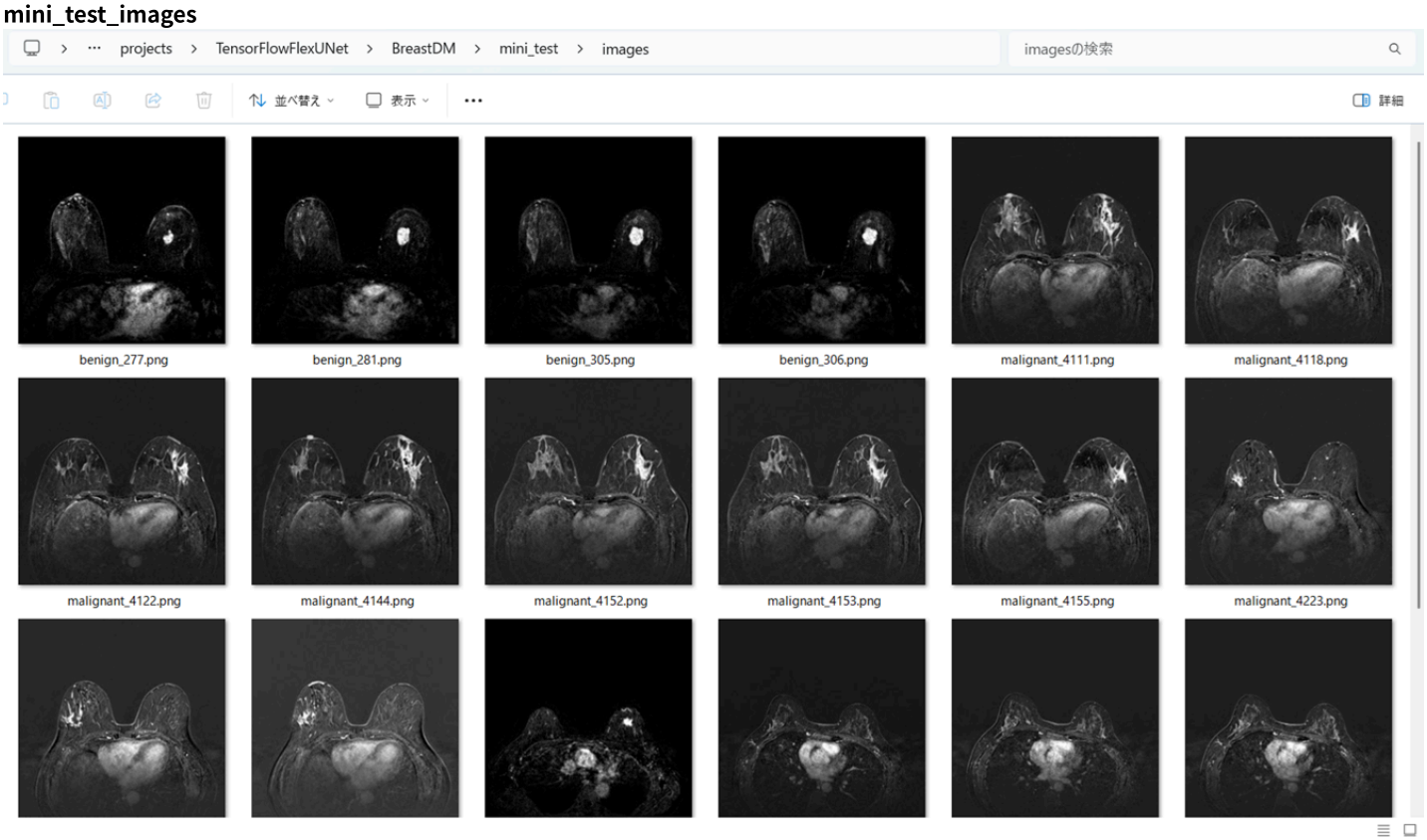
```
./3.infer.bat
```

This simply runs the following command.

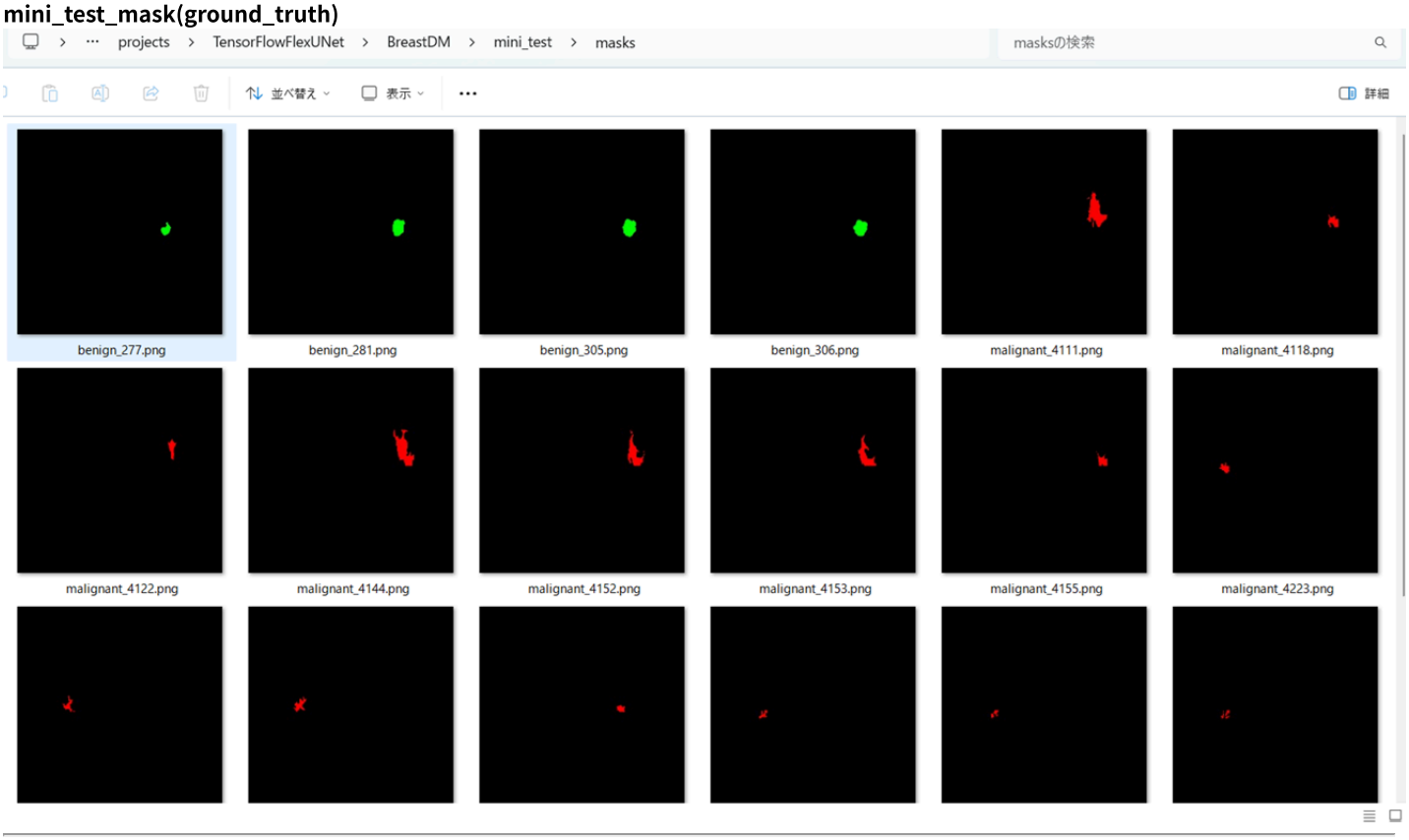
```
python ../../../src/TensorFlowFlexUNetInferencer.py ./train_eval_infer_aug.config
```

---

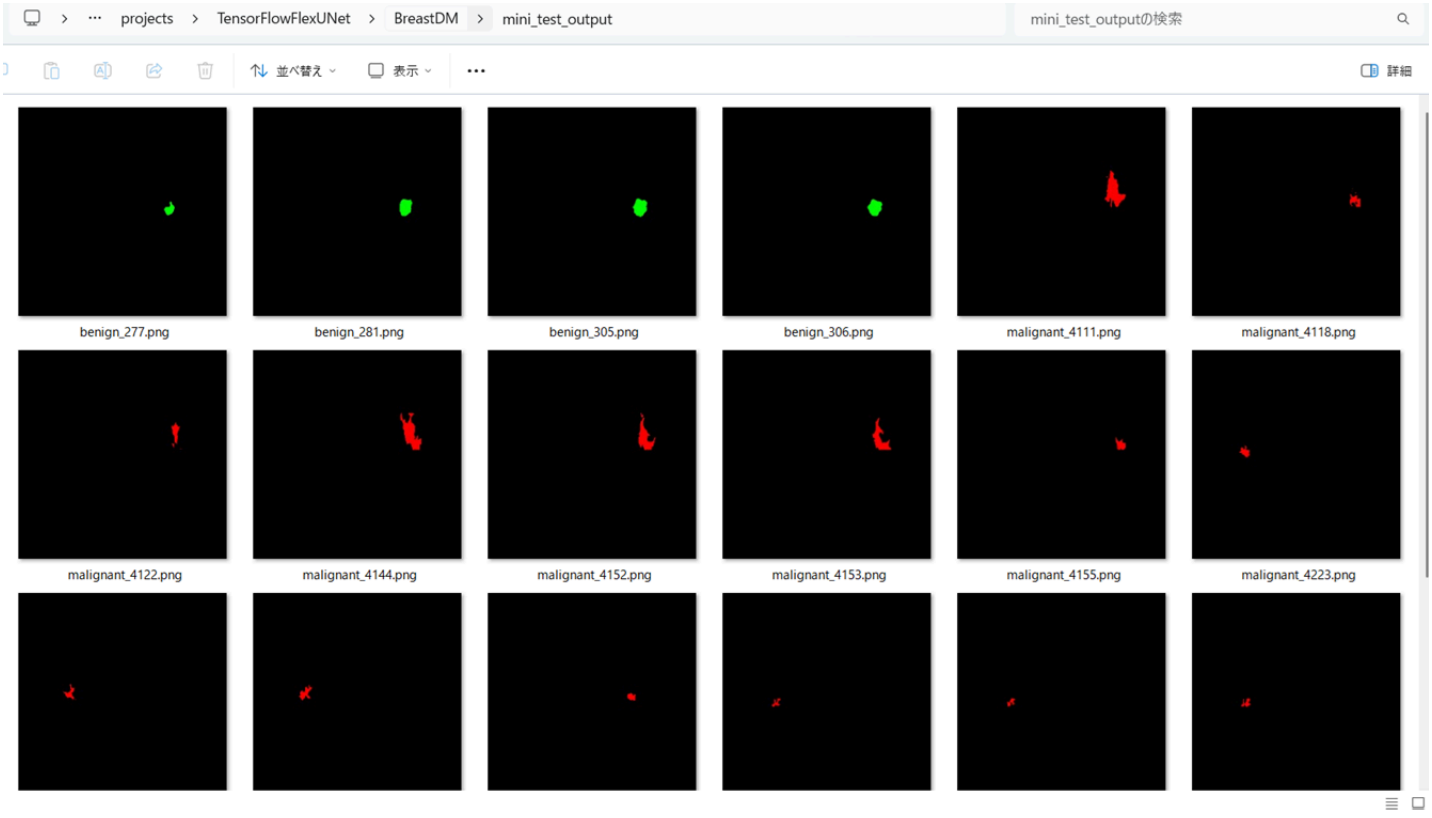
mini_test_images



mini_test_mask(ground_truth)

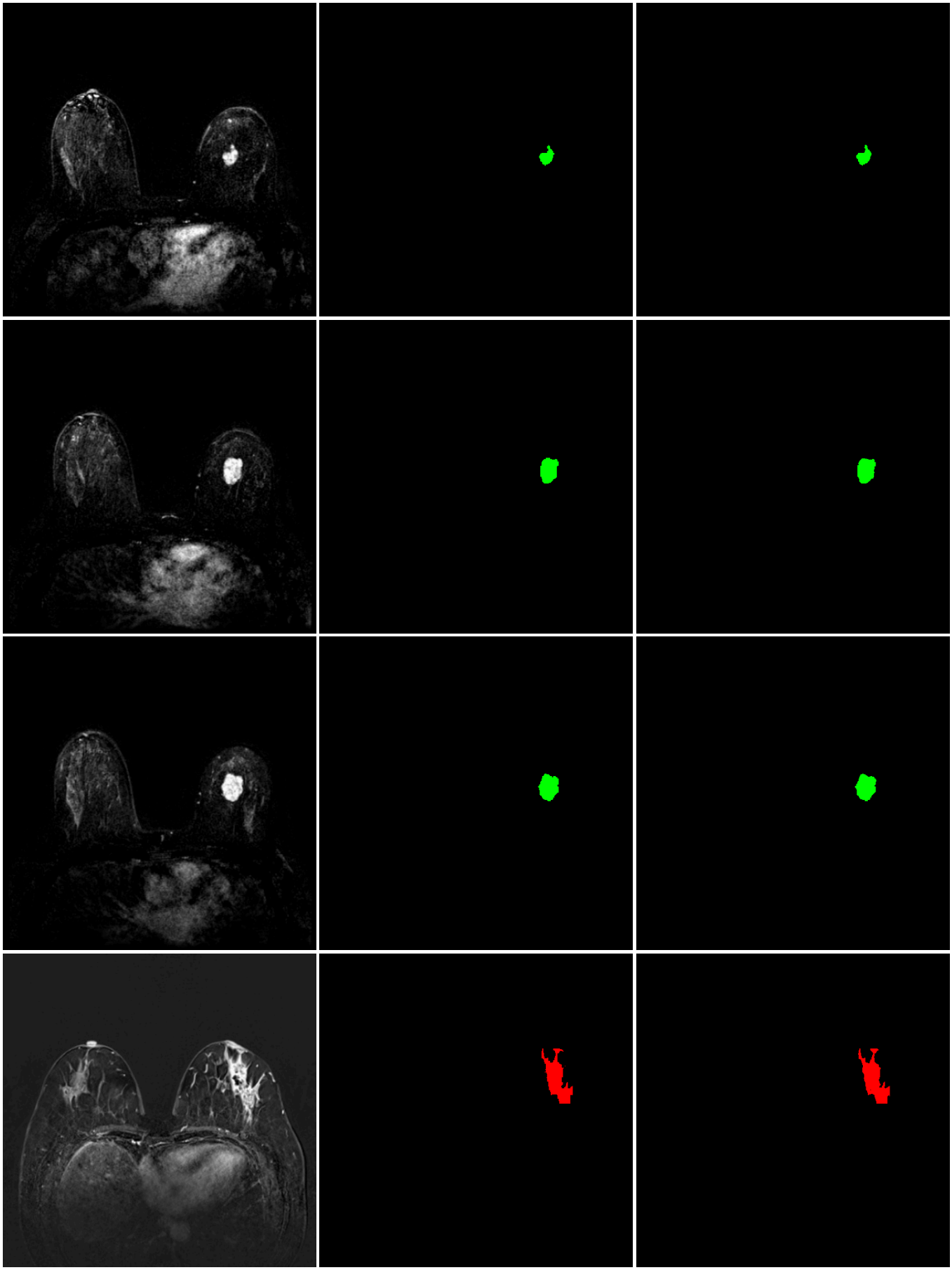


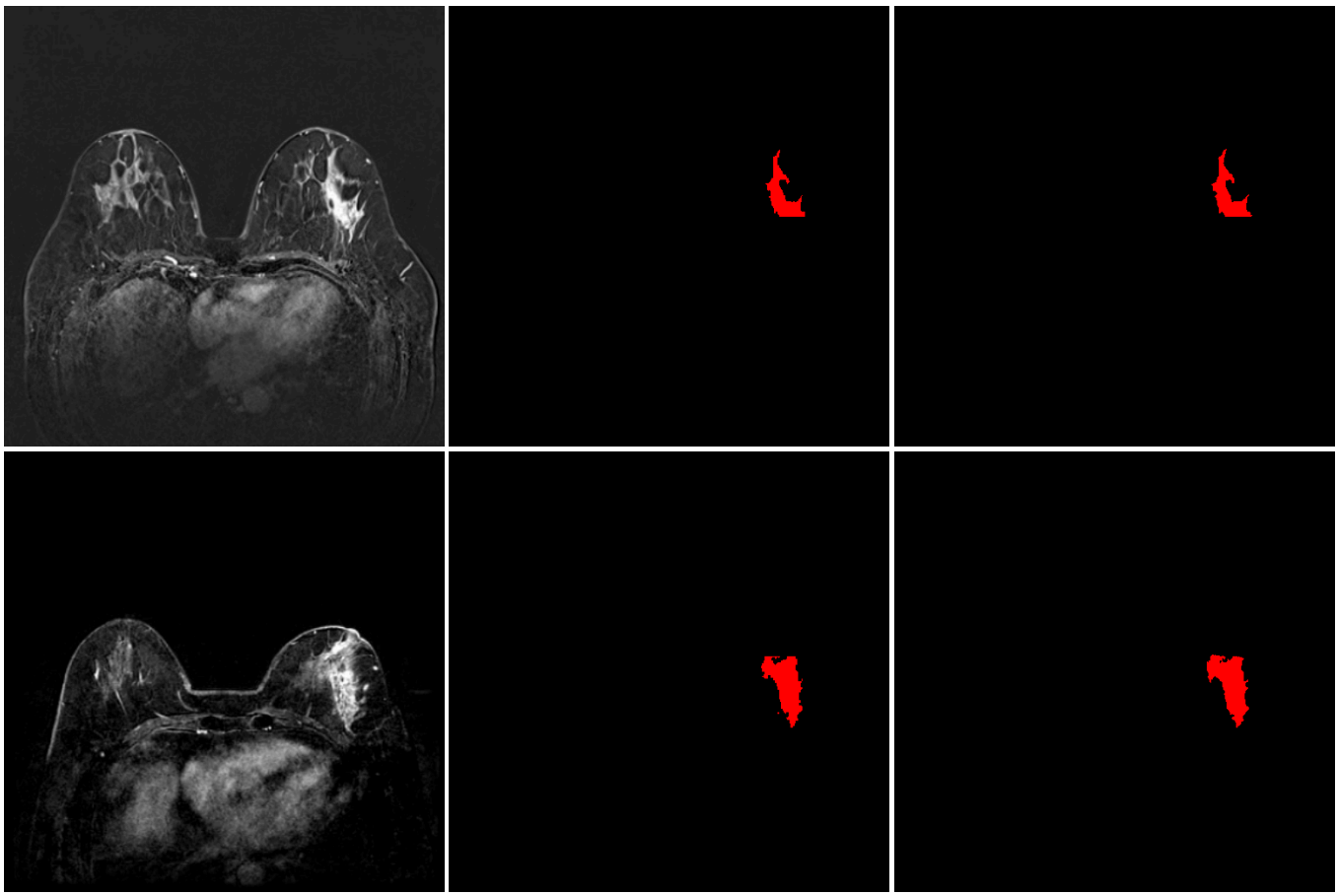
Inferred test masks



Enlarged images and masks of 512x512 pixels
rgb_map = (benign:green, malignant:red)

Image	Mask (ground_truth)	Inferred-mask





References

1. BreastDM: A DCE-MRI dataset for breast tumor image segmentation and classification
Xiaoming Zhao, Yuehui Liao, Jiahao Xie, Xiaxia He, Shiqing Zhang, Guoyu Wang
, Jiangxiong Fang , Hongsheng Lu, Jun Yu
https://doi.org/10.1016/j.compbiomed.2023.107255
https://www.sciencedirect.com/science/article/abs/pii/S0010482523007205

2. Tensorflow-Image-Segmentation-Malignant-BreastDM
Toshiyuki Arai @antillia.com
https://github.com/sarah-antillia/Tensorflow-Image-Segmentation-Malignant-BreastDM