Exercise 6 - DEEP LEARNING

Code Implemented

- `SRDataset` class: in the `./code/dataset.py`
- `BasicSRModel` class: in the `./code/models.py`
- Training loop: in the `./code/train.py`
- Model evaluation:
  - in `./code/eval.py`
  - visualization is in `./code/eval.ipynb`
- The configurations are in `./configs`
- To run the code, make sure you use the following file structure

```
.
├── configs
│   ├── 1e-2.yaml
│   ├── 1e-3.yaml
│   ├── 1e-5.yaml
│   ├── 1e-6.yaml
│   ├── baseline.yaml
│   └── residual.yaml
├── runs
│   ├── baseline
│   ├── lr1e-2
│   ├── lr1e-3
│   ├── lr1e-5
│   ├── lr1e-6
│   └── residual
├── models
├── best_models
│   ├── model_best_lr_1E-02.pth
│   ├── model_best_lr_1E-03.pth
│   ├── model_best_lr_1E-04.pth
│   ├── model_best_lr_1E-05.pth
│   ├── model_best_lr_1E-06.pth
│   └── model_res_best_lr_1E-04.pth
├── train
└── eval
```

- Run
  - For the training (baseline model), you should use the command in `./code`:

```
python train.py --config ../configs/baseline.yaml
```

- For the evaluation(baseline model), you should use the command in `./code`:

```
python eval.py --config ../configs/baseline.yaml
```

- Or you can directly use the `eval.ipynb` file.

1.1. Task 1 - Datasets, Preprocessing and Data loading

- The result of dataset testing is

```
* Dataset contains 301 image(s).
```

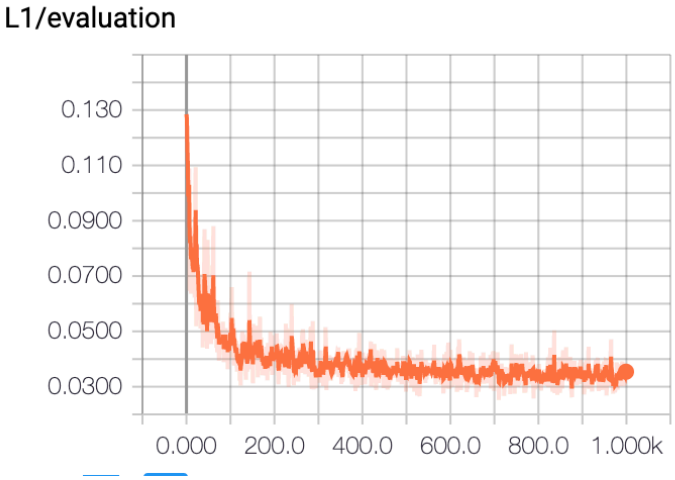
1.2. Task 2 - Derivations and deeper understanding

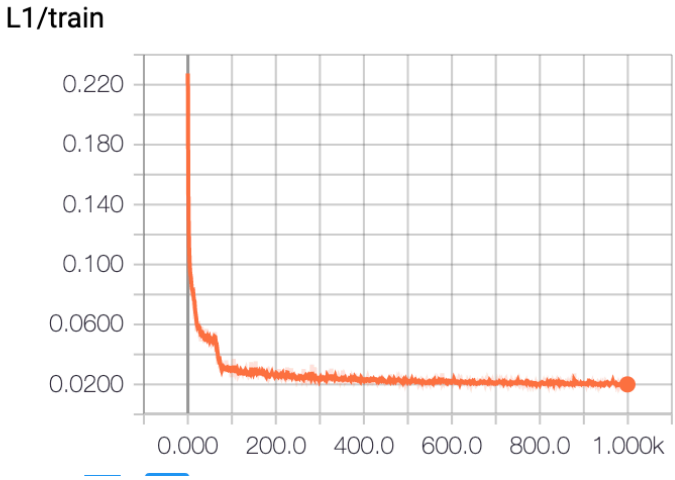
- The result of model testing is:

```
372803
```

1.3. Task 3 - Implement the Training Loop

- The L1 loss during training is shown below





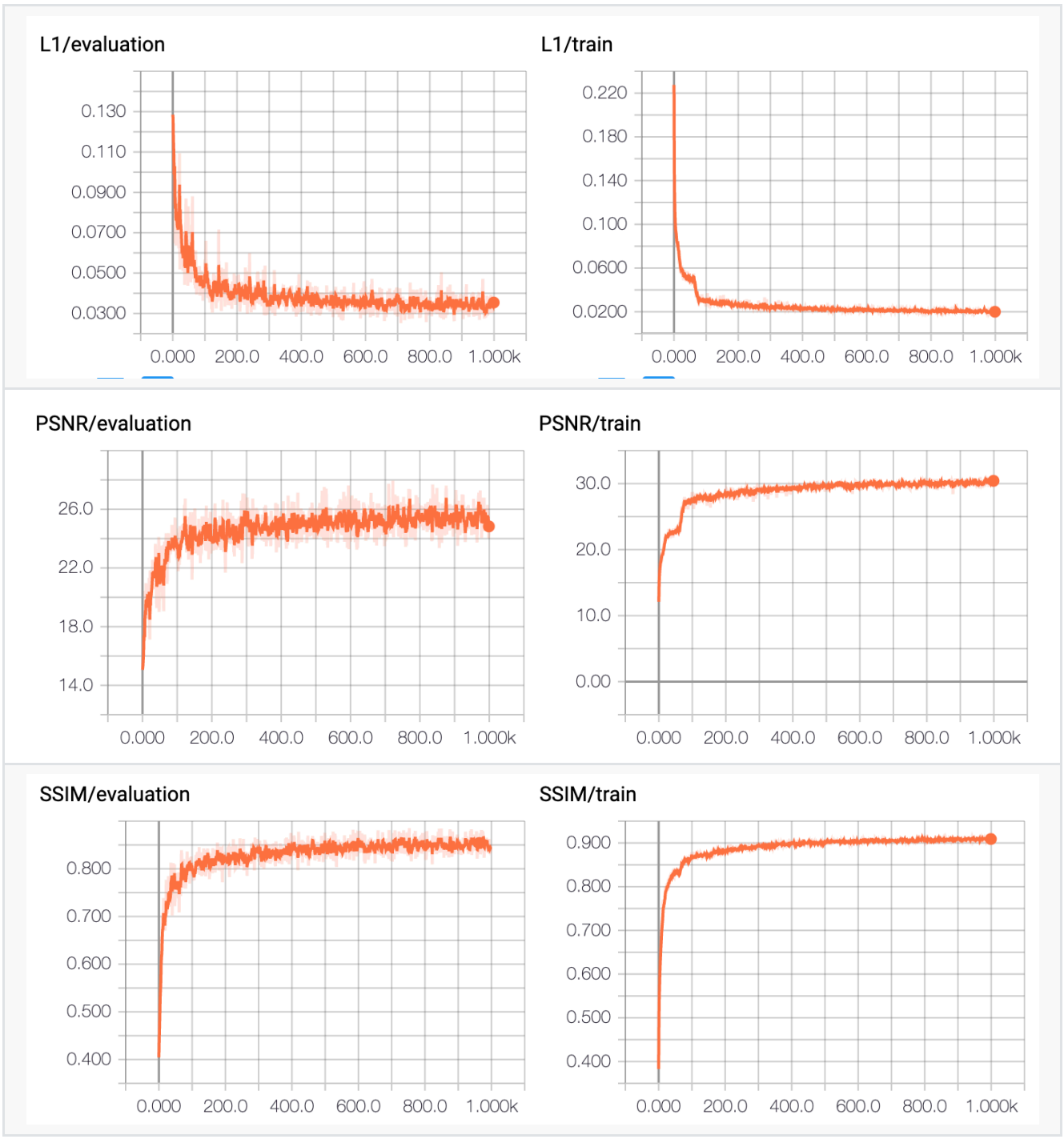
- The parameters are saved per 200 epochs, also, the model with minimum training loss is also saved .

1.4. Task 4 - Model Evaluation

- Table of evaluation result:

	PSNR	SSIM
Bilinear (baseline)	25.757679	0.867994
Bicubic (baseline)	24.444685	0.856417
Nearest (baseline)	21.104866	0.758209

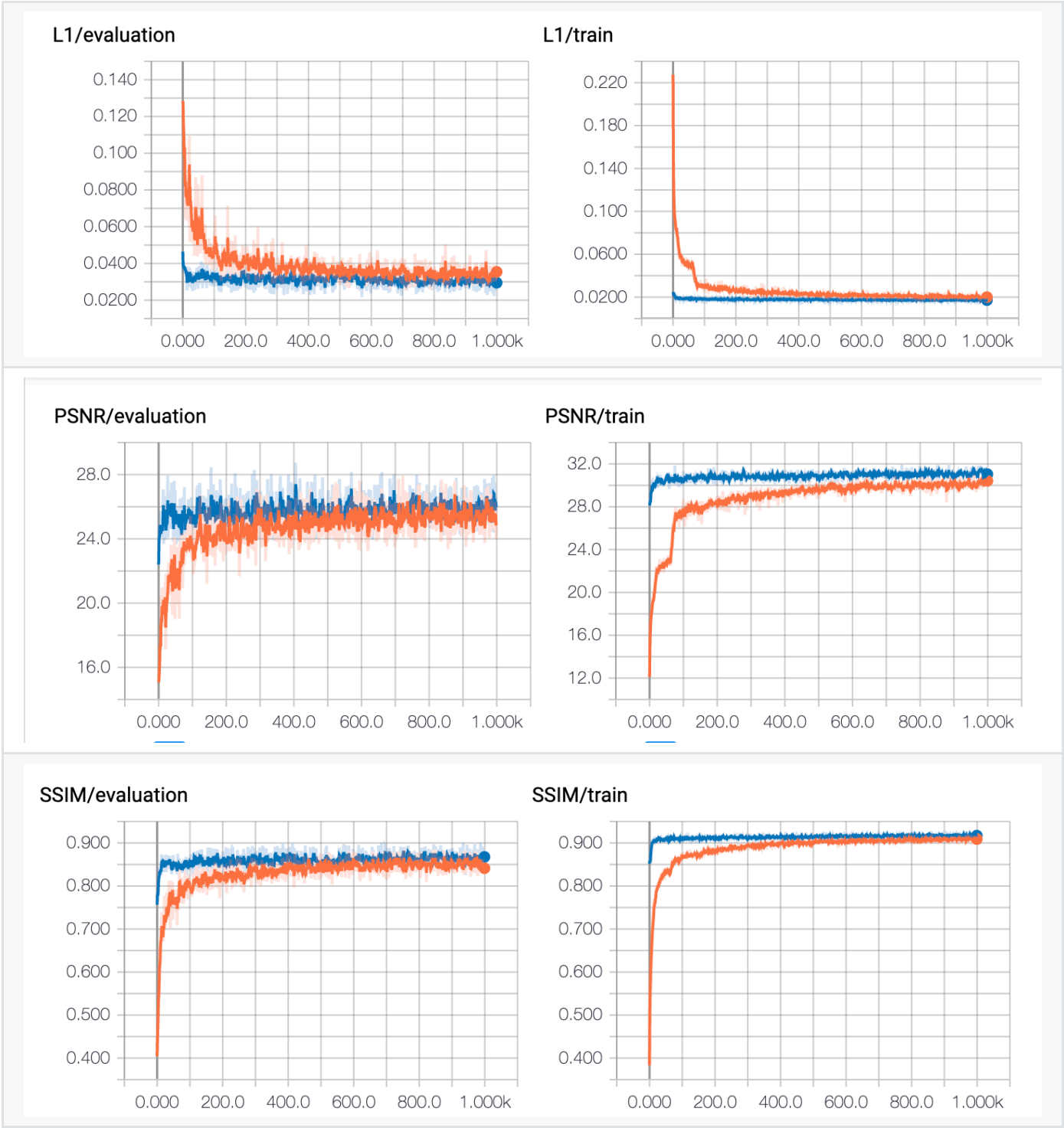
- The evolution of the validation loss and training loss (L1, PSNR and SSIM) is shown below:



1.5. Task 5 - Exploration

A Different Model

- Training: The training loss plot is shown below (the blue one represents the residual, and the orange one represents the baseline model)
    - **Comparison**: Since the residual connections directly add the result of bilinear interpolation to the output, the performance is always better than the baseline model (lower l1 loss and higher PSNR, SSIM).

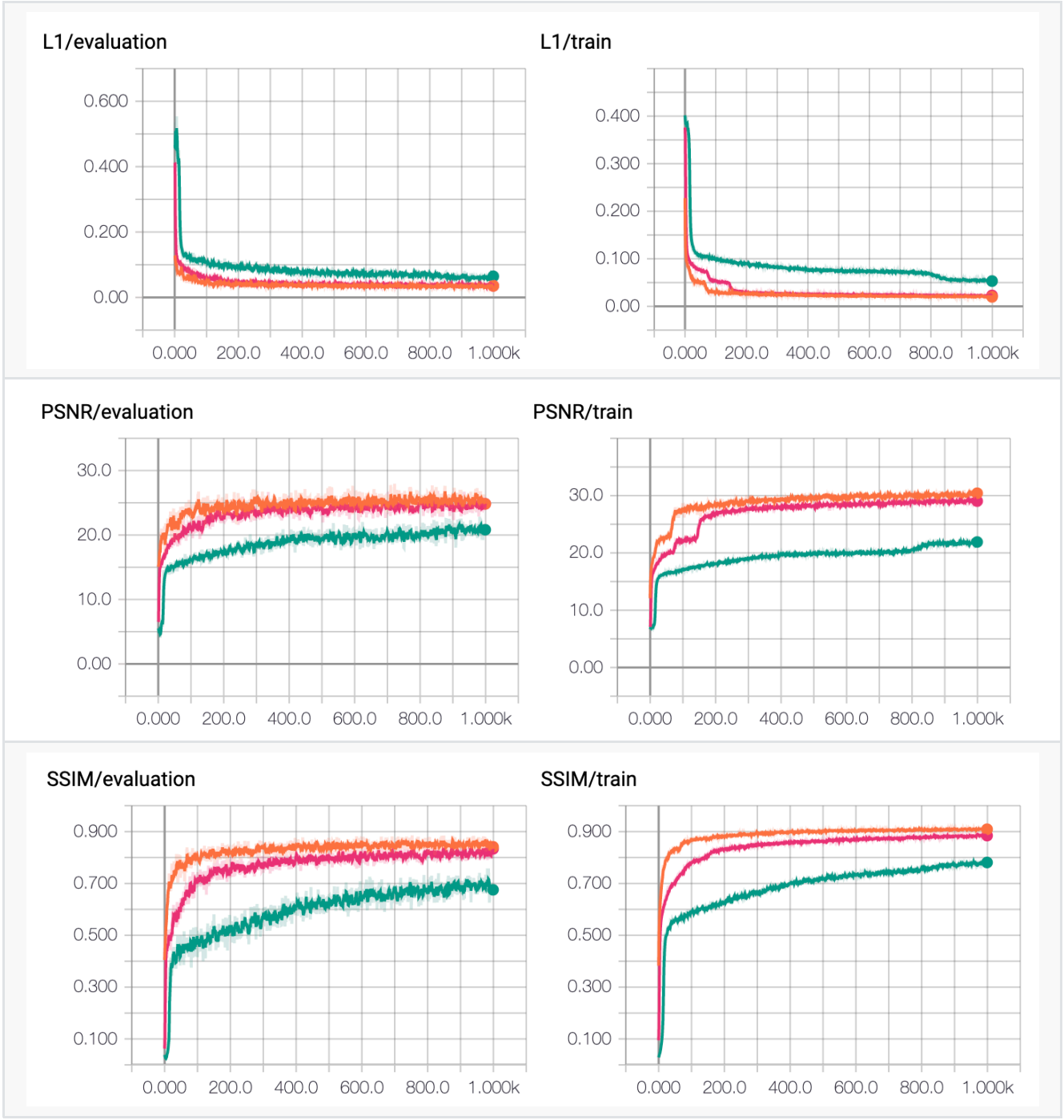


- Evaluation: Table of evaluation result:

	PSNR	SSIM
Bilinear (baseline)	25.757679	0.867994
Bicubic (baseline)	24.444685	0.856417
Nearest (baseline)	21.104866	0.758209
Bilinear (Resnet)	27.583456	0.898651
Bicubic (Resnet)	26.075844	0.885841
Nearest (Resnet)	22.011930	0.780135

Effect of the Learning Rate

- Training: The training loss plot with different learning rate is shown below (the blue one represents the residual, and the orange one represents the baseline model)
    - Without large learning rate (without 1e-2, 1e-3): orange (1e-4), pink (1e-5), green (1e-6)
    - The performance is better as learning rate getting larger in this range



- However, for the large learning rate, the performance is not stable (1e-2 red, 1e-3 blue)

Different Downscaling During Inference

- Table of evaluation result:

	PSNR	SSIM
Bilinear (baseline)	25.757679	0.867994
Bicubic (baseline)	24.444685	0.856417
Nearest (baseline)	21.104866	0.758209
Bilinear (Resnet)	27.583456	0.898651
Bicubic (Resnet)	26.075844	0.885841
Nearest (Resnet)	22.011930	0.780135

- Images of superresolution result with different downscaling methods
  - As shown in the following two examples, the algorithm does have the effect to do superresolution task. However, the generated image is darker than the original one.
  - Comparison:
    - Since we use bilinear interpolation to train the model, the result of blinear interpolation is better than the other two (brighter and sharper result).
    - For the nearest neighbor, the detailed texture is different from the other two methods. The result is not smooth enough because there are some strange veins in the texture.
    - For the bicubic interpolation, the result is over smoothened compared with bilinear result.

High resolution (ground truth)	Low resolution	
		
Bilinear	Bicubic	Nearest neighbor
		

High resolution (ground truth)	**Low resolution**	
		
Bilinear	Bicubic	Nearest neighbor