Car Segmentation Model Based on Unet Variations

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Introduction

Developing a segmentation model for car parts is a foundation for more complex work on cars, such as deducing the orientation of vehicles, and locating and accessing damages, all of which could be of huge value in various settings.

Data: Introduction and Augmentation

We have 3494 training data, 30 test data, and 8 classes as shown in the figure 2. Each data is in *.npy* format, with a dimension of (4,256,256). The first three channels are the normalized RGB channels and the last one is the mask channel, where 0 denotes background and digits 1-8 denote class label.

Before training, we first conducted data augmentation as the following diagram. Augmented result of *cycleGAN/332.jpg* can be viewed in figure 3. Finally, we included 6988 data into model training.

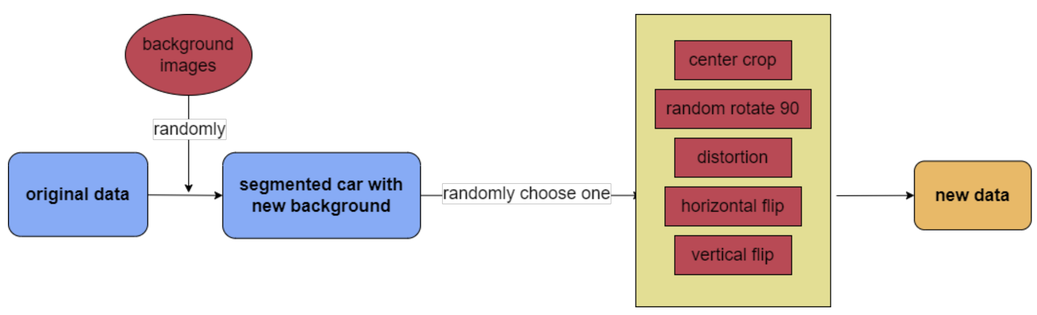

Figure 1: Process of Data Augmentation

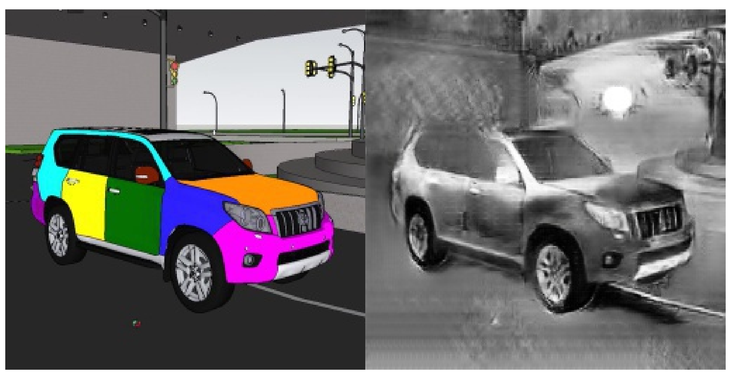

Figure 2: original image and label

Figure 3: augmented image

Model Architecture: Unet and Nested-Unet

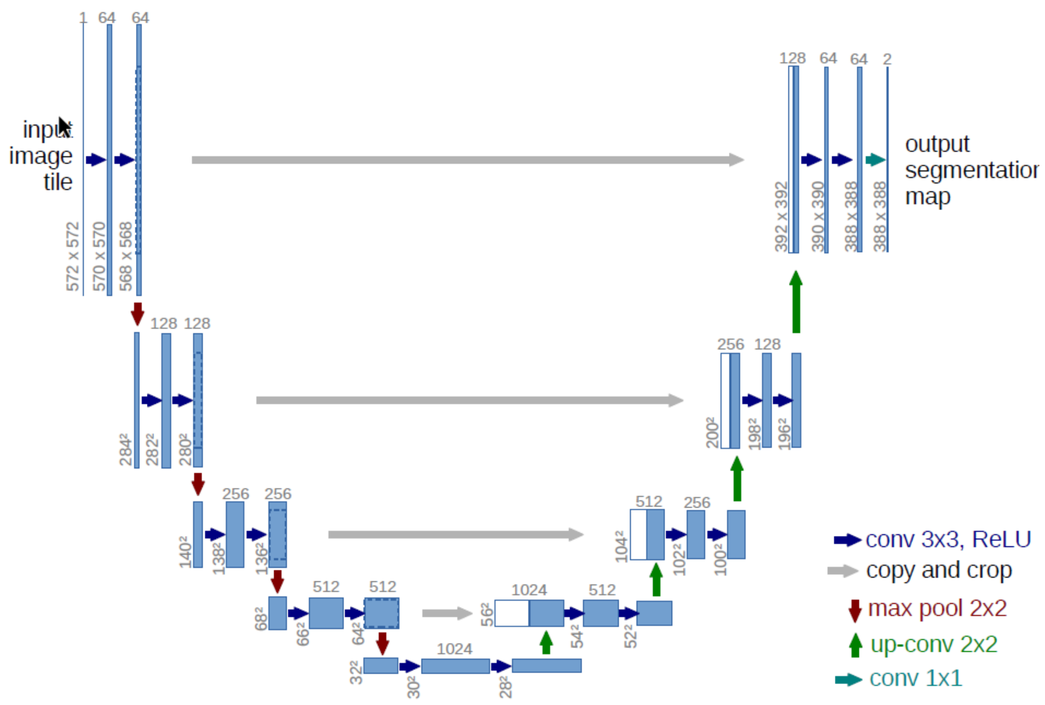

Figure 4: Unet [1]

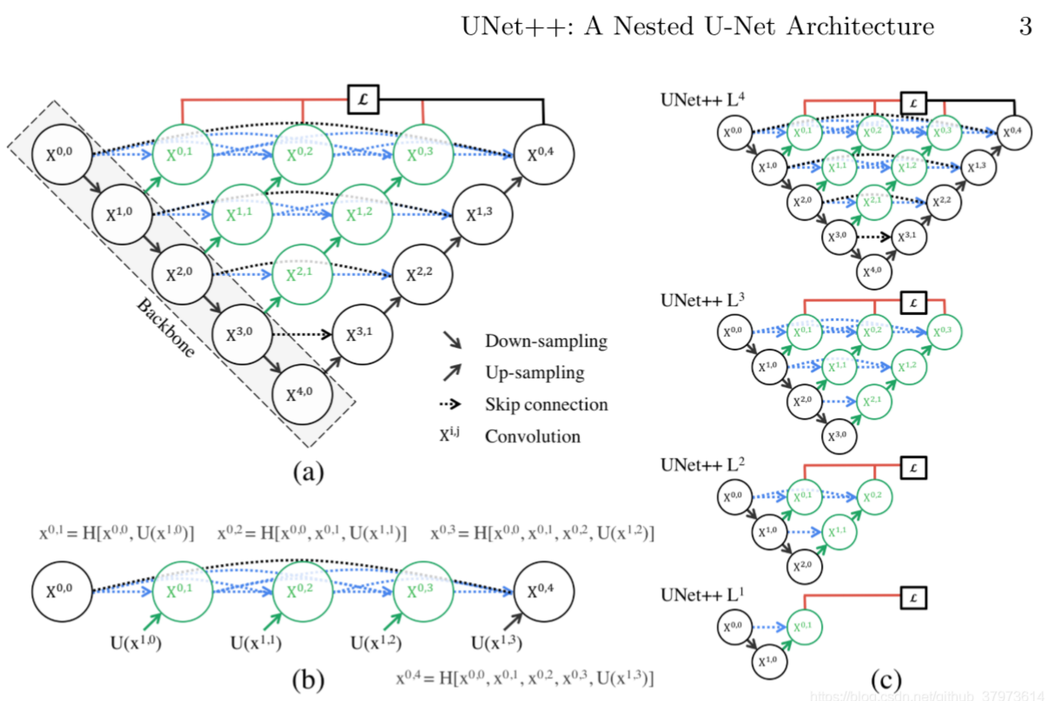

Figure 5: Unet++ [2]

Experiment Result

- Criteria Method: hybrid loss function combined of *Focal* and *Dice* loss

$$Loss = L_{Focal} + L_{Dice}$$

- Evaluation Method: *IOU* (Intersection Over Union)

$$\frac{TP}{TN + FP + FN}$$

- Result:

Table 1: testing Result(IOU) for Unet and Nested-Unet

Model	epoch	Individual IOU Result							
		front bumper	front door	back door	front fender	rear bumper	side frame	trunk	bonnet
Unet	95	0.5315	0.4331	0.4756	0.3423	0.4471	0.4448	0.1708	0.1907
Unet	60	0.6443	0.5246	0.5104	0.3275	0.5534	0.5299	0.4124	0.4638
Unet	20	0.4367	0.0277	0.2881	0.1661	0.2911	0.3446	0.2452	0.1059
NUnet	95	0.6917	0.5763	0.5921	0.3719	0.5494	0.6478	0.3970	0.5308
NUnet	60	0.6585	0.5502	0.5691	0.3718	0.5335	0.5826	0.4486	0.4016
NUnet	20	0.6529	0.4188	0.5337	0.3490	0.4873	0.5504	0.3619	0.3654

We first develop Unet model then improved it by Nested-Unet model. Unet did a acceptable job while Nest-Unet outperformed Unet in terms of all classed segmentation. Nest-Unet model has a good visual performance on test cases, especially for the images with a clear and intact car.

However, some test cases fail to perform responsible segmentation, probably due to poor image quality or rare perspective, which left us with future improvements.

Result Visualization

Figure 6: Unet: 29

Figure 7: Unet: 20

Figure 8: Unet: 24

Figure 9: Unet: 52

Figure 10: NUnet: 29

Figure 11: NUnet: 20

Figure 12: NUnet: 24

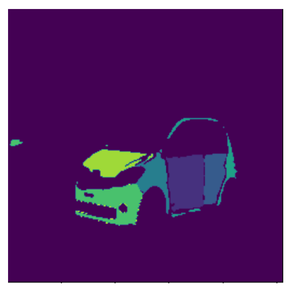

Figure 13: NUnet: 52

Future Work

In the future, We should add cross-validation to see if our model is overfitting or underfitting, as well as explore more data augmentation methods and model architecture and hyperparameters, even consider using more advanced deep learning models and methods.

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References

[1] O. Ronneberger, P. Fischer, and T. Brox. U-net: Convolutional networks for biomedical image segmentation. *CoRR*, abs/1505.04597, 2015. URL `http://arxiv.org/abs/1505.04597`.

[2] Z. Zhou, M. M. R. Siddiquee, N. Tajbakhsh, and J. Liang. Unet++: A nested u-net architecture for medical image segmentation. *CoRR*, abs/1807.10165, 2018. URL `http://arxiv.org/abs/1807.10165`.