Training workflow

I. Train from Scratch

II. **Initial** Dataset: Data 1 (train n=220/valid n=30/test n=20)

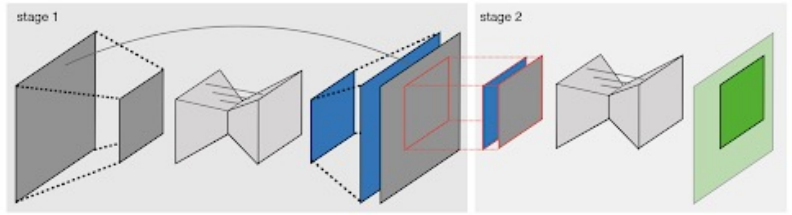
- Test with n=20
- Test with Data 2 (n=211)

III. **More** Dataset: Data 1 + Data 2 (n=481)

IV. Label Data 4 (n=570)

Data	Label	Confirmed by a surgeon	N (per patient)
1	O	O	270
2	O	O	211
3	O	X	39
4	X	-	570

3D Cascaded Unet



	1st model	2nd model
A	Baseline (pretrained model) training	Baseline (pretrained model)
B		Random crop
C		Random crop + augmentation
D	Augmentation	Baseline (pretrained model)
E		Random crop
F		Random crop + augmentation

Model – 1st Model

Framework	Tensorflow
Model	**Cascaded 3d U-net**
Initialization Weight	Pancreas cancer pretrained model
Loss Function	Average Dice Coefficient
Optimizer	Adam
Epochs	100
Learning Rate	1e-4
Metric	Dice Coefficient
Input Image Size	**256x256x96**
Image Preprocessing	Mean/SD

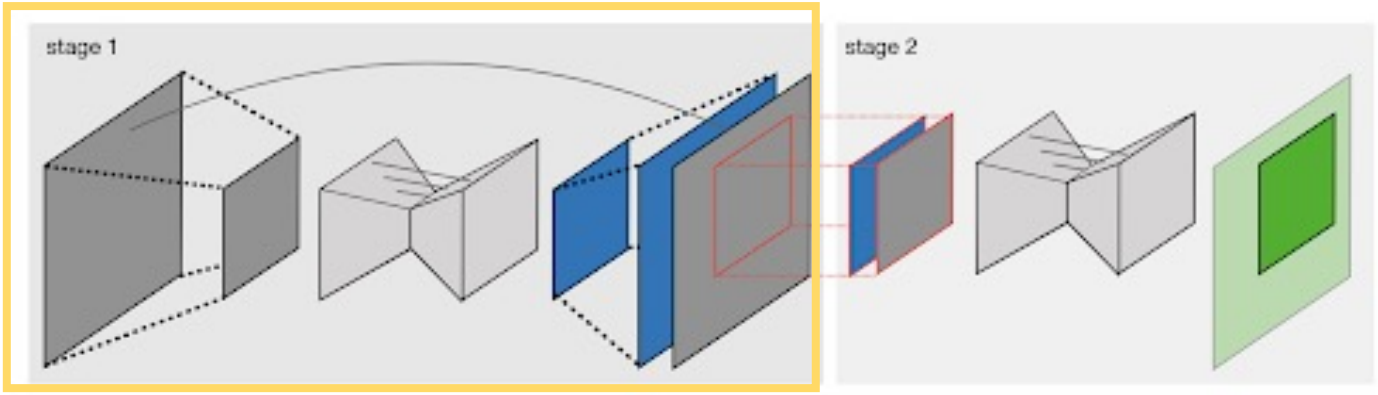
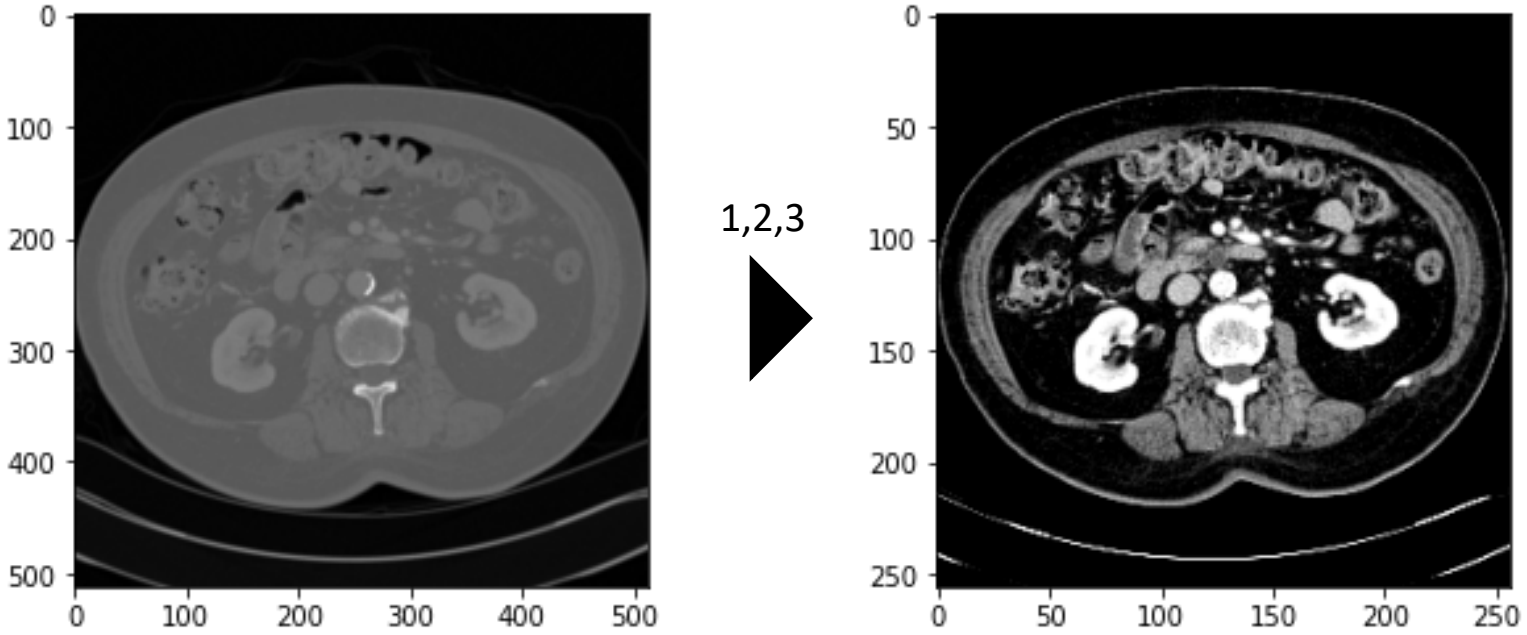


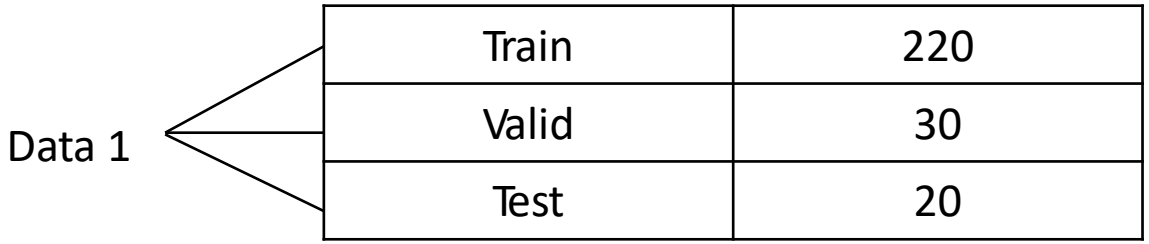
Image Preprocessing

1. Resizing to 96x256x256
2. Images clipped to [-100, 200] HU units

   (window level: 50, width: 300)
3. Mean= 0.19, SD= 0.26



Train with Data 1 (Total n = 270)

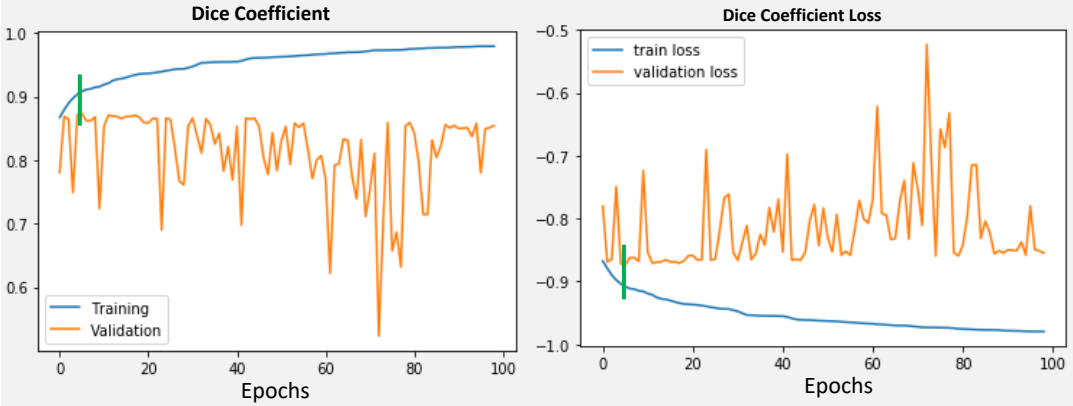


1st + 2nd Model Baseline (pretrained)

	1st model	2nd model
A	Pretrained Model	Pretrained model
B		Random crop
C		Random crop + augmentation
D	Augmentation	Pretrained model
E		Random crop
F		Random crop + augmentation

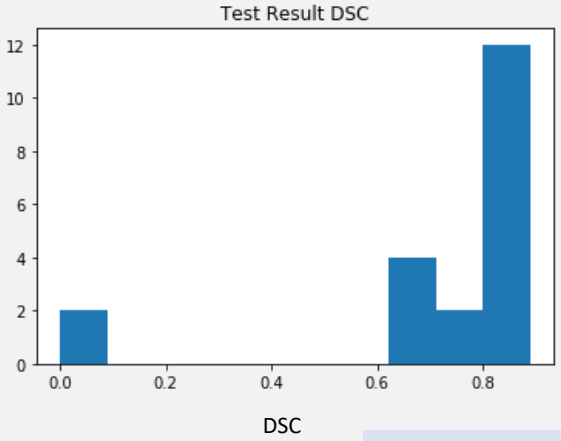
1st + 2nd Model Baseline (pretrained)

1st Model : Pretrained Model



Training Accuracy (DSC): **0.97**

Validation Accuracy (DSC): **0.84**



DSC	CT per patient
[0, 0.5)	2 (10%)
[0.5, 0.6)	-
[0.6, 0.7)	3 (15%)
[0.7, 0.8)	3 (15%)
[0.8, 0.9)	12 (60%)
[0.9, 1)	-

Mean (DSC): **0.72**

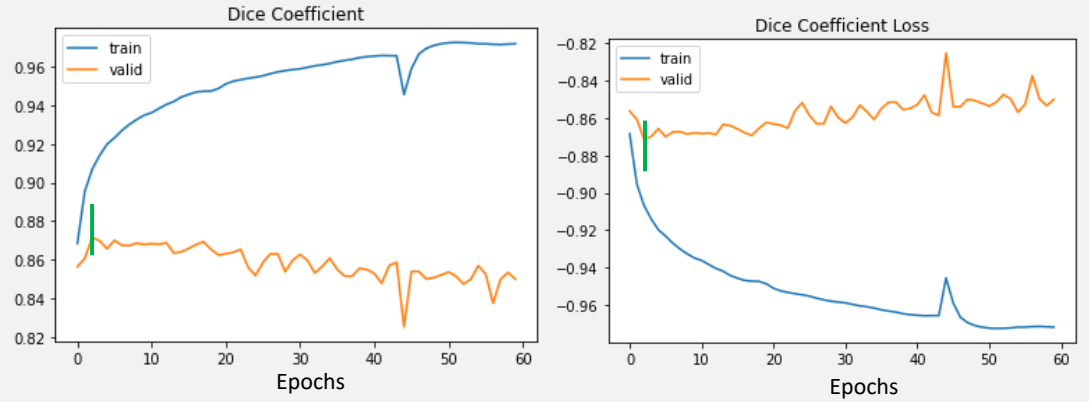
SD (DSC): 0.25

DSC >= 0.5

Mean (DSC): 0.80

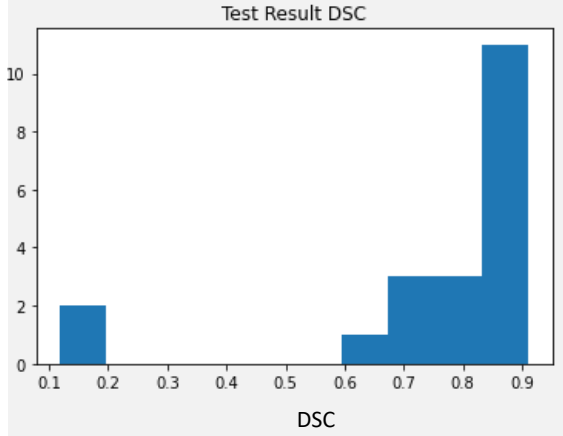
SD (DSC): 0.07

2nd Model : Pretrained Model



Training Accuracy (DSC): **0.97**

Validation Accuracy (DSC): **0.85**



DSC	CT per patient
[0, 0.5)	2 (10%)
[0.5, 0.6)	-
[0.6, 0.7)	3 (15%)
[0.7, 0.8)	3 (15%)
[0.8, 0.9)	10 (50%)
[0.9, 1)	2 (10%)

Mean (DSC): **0.75**

SD (DSC): 0.21

DSC >= 0.5

Mean (DSC): 0.82

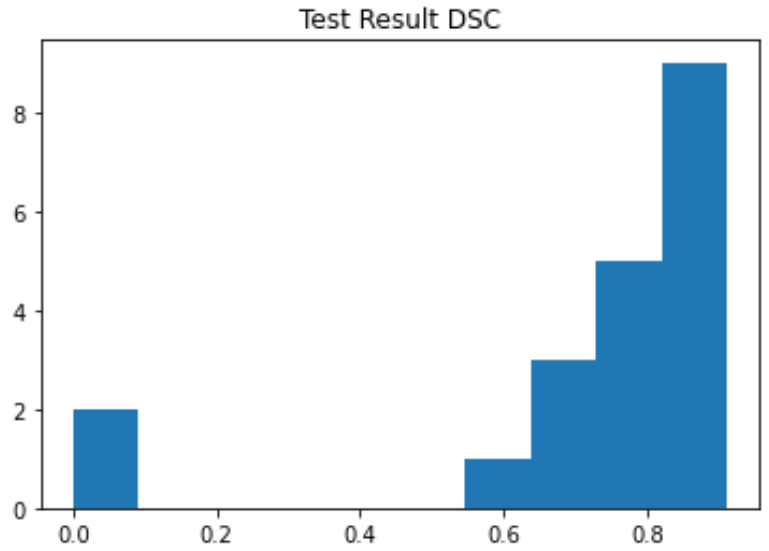
SD (DSC): 0.08

'/workspace/resources/project/segmentation/2nd_basic_preprocess/tr_0.9068_va_0.8713.h5'

1st : pretrained + 2nd : pretrained Model Test Result

Input data:
n=20
Size=256x256x96

A



DSC	CT per patient
[0, 0.5)	2 (10%)
[0.5, 0.6)	-
[0.6, 0.7)	4 (20%)
[0.7, 0.8)	3 (15%)
[0.8, 0.9)	8 (40%)
[0.9, 1)	3 (15%)

- **3.66e-06**
- **2.87e-05**

DSC >= 0.5

Mean (DSC): 0.80

SD (DSC): 0.09

Mean (DSC): **0.72**

SD (DSC): 0.26

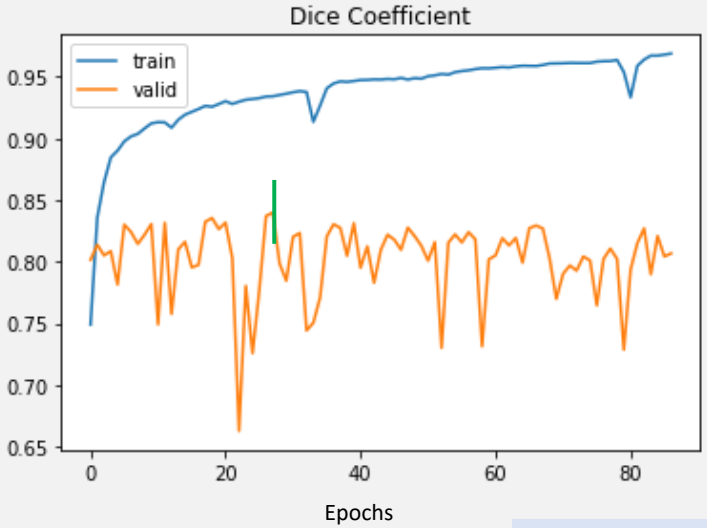
1st Model (augmentation)

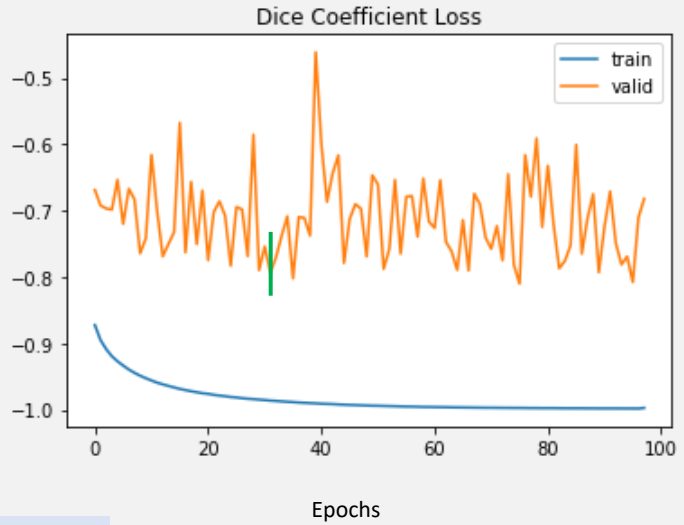
	1st model	2nd model
A	Pretrained	Pretrained
B		Random crop
C		Random crop + augmentation
D	Augmentation*	Pretrained
E		Random crop
F		Random crop + augmentation

*Augmentation: Flip horizontally/vertically, Gaussian Blur, Gaussian Noise

1st Model : Augmentation

Train



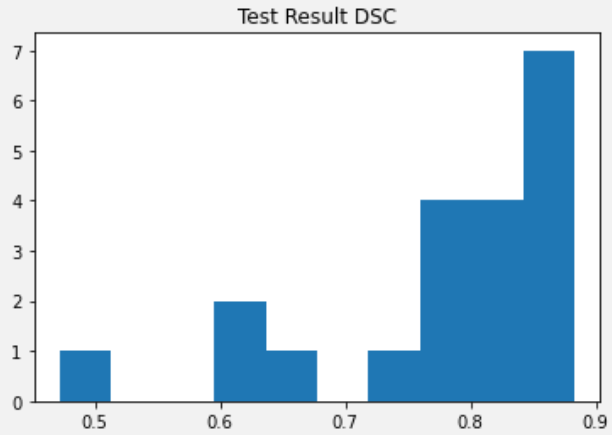


Input image size: 256x256x96

Training Accuracy (DSC): **0.96**

Validation Accuracy (DSC): **0.80**

Test



DSC	CT per patient
[0, 0.5)	1 (5%)
[0.5, 0.6)	-
[0.6, 0.7)	3 (15%)
[0.7, 0.8)	5 (25%)
[0.8, 0.9)	11 (55%)
[0.9, 1)	-

DSC >= 0.5

Mean (DSC): 0.79

SD (DSC): 0.08

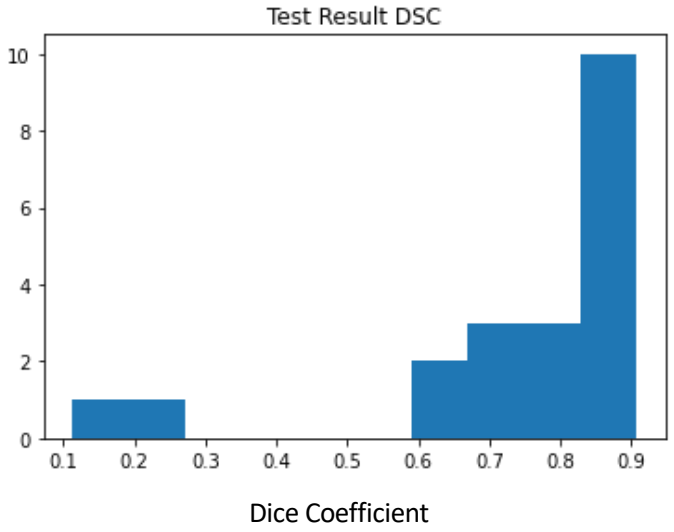
Mean (DSC): **0.78**

SD (DSC): 0.10

1st : pretrained + 2nd : pretrained Model Test Result

Input data:
n=20
Size=256x256x96

D



DSC	CT per patient
[0, 0.5)	2 (10%)
[0.5, 0.6)	-
[0.6, 0.7)	5 (25%)
[0.7, 0.8)	2 (10%)
[0.8, 0.9)	9 (45%)
[0.9, 1)	2 (10%)

- **0.25**
- **0.11**

DSC >= 0.5

Mean (DSC): 0.80

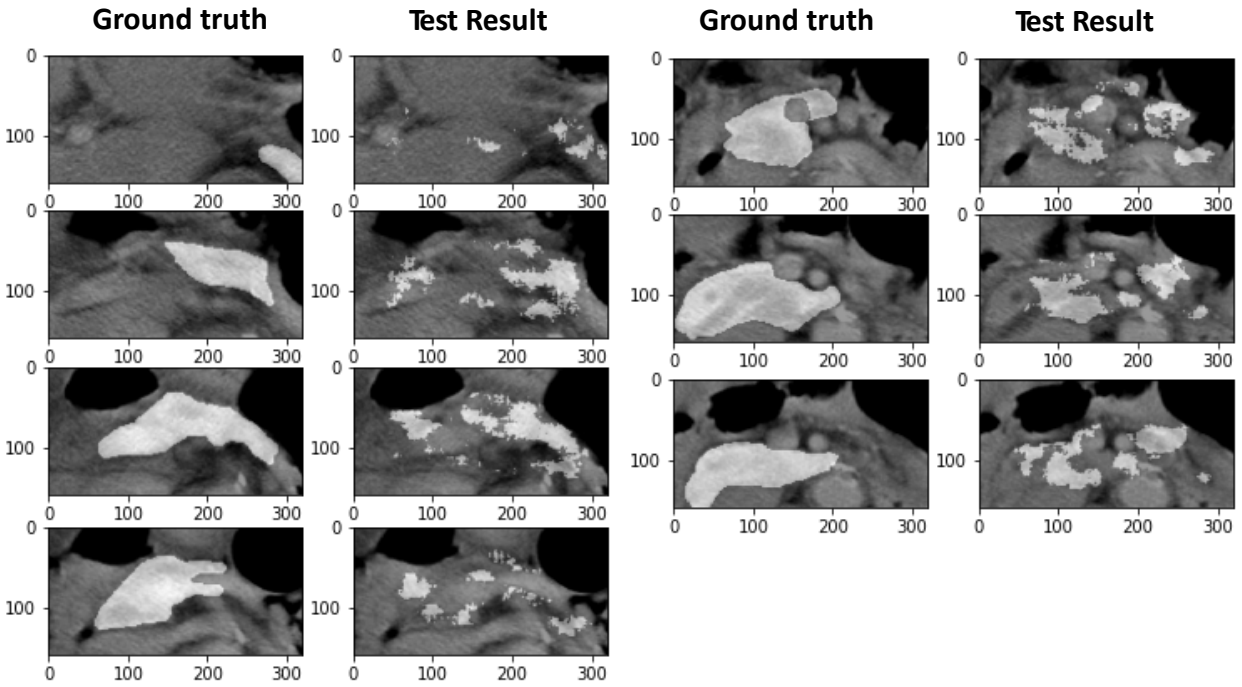
SD (DSC): 0.09

Mean (DSC): **0.74**

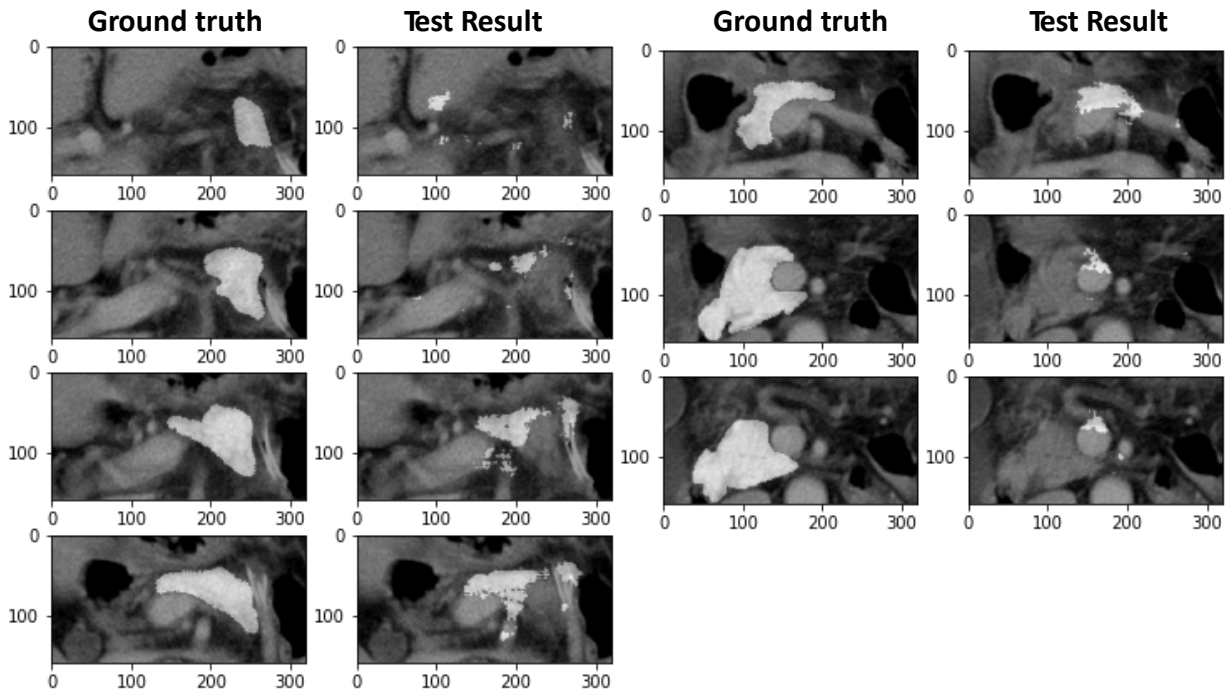
SD (DSC): 0.20

1st : aug + 2nd : pretrained Model Test Result

DSC = 0.25



DSC = 0.11



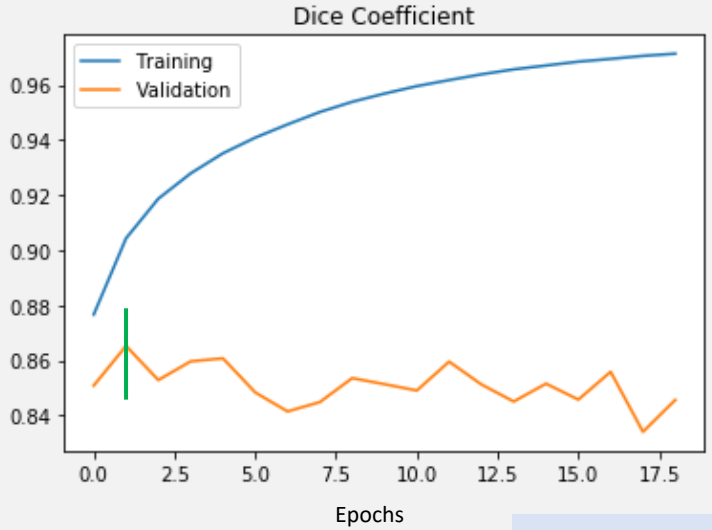
2nd model : random cropping, random cropping + augmentation

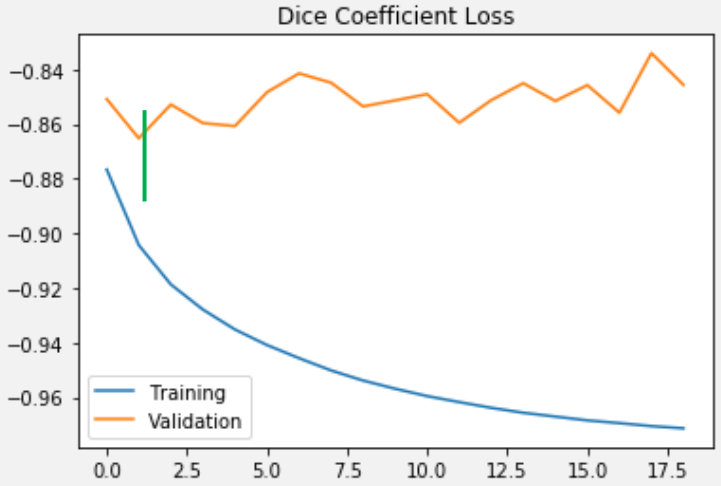
1.6 (1) 2nd Model with random crop

	1st model	2nd model
A	Pretrained Model	Pretrained
B		Random crop
C		Random crop + augmentation
D	Augmentation*	Pretrained
E		Random crop
F		Random crop + augmentation

2nd Model : random crop

Train



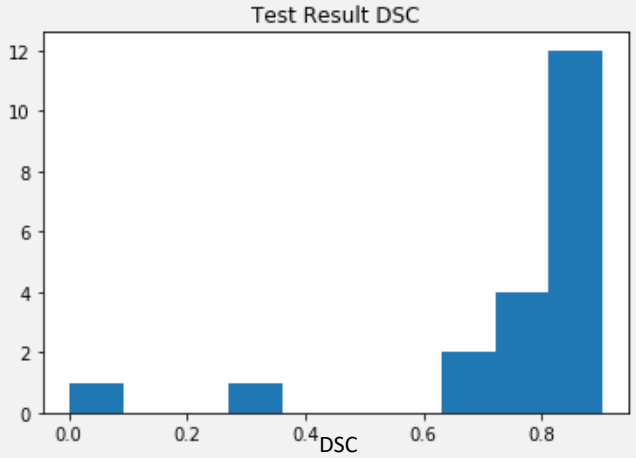


Training Accuracy (DSC): **0.9714**

Validation Accuracy (DSC): **0.8456**

Input image size: 256x256x96

Test



DSC	N of Images (per patient)
[0, 0.5)	2 (10%)
[0.5, 0.6)	-
[0.6, 0.7)	1 (5%)
[0.7, 0.8)	3 (15%)
[0.8, 0.9)	3 (15%)
[0.9, 1)	13 (65%)

Mean (DSC): **0.7567592057166621**

SD (DSC): 0.21433322354244294

DSC >= 0.5

Mean (DSC): 0.8223452568054199

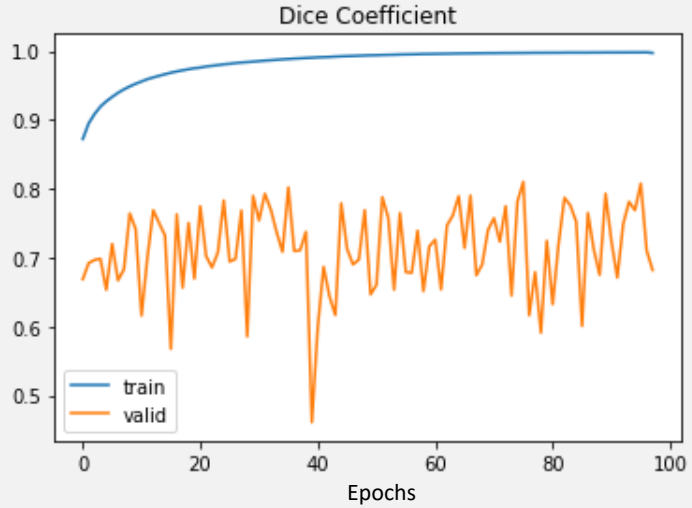
SD (DSC): 0.07070190239616547

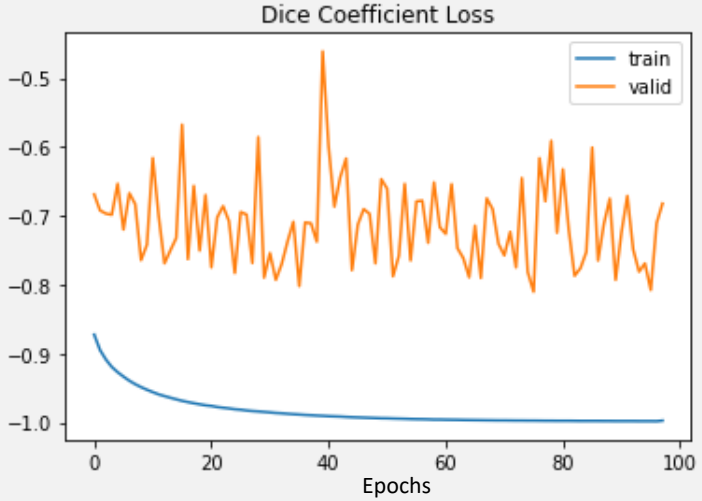
2nd Model with random crop + augmentation

	1st model	2nd model
A	Pretrained Model	Pretrained model
B		Random crop
C		Random crop + augmentation
D	Augmentation*	Pretrained model
E		Random crop
F		Random crop + augmentation

2nd Model : random crop + random augmentation

Train



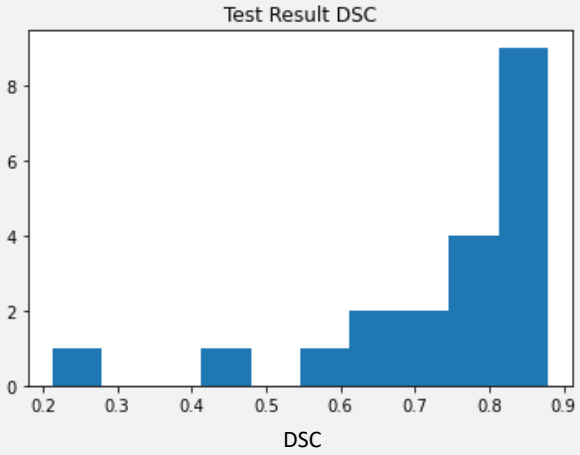


Training Accuracy (DSC): **0.97**

Validation Accuracy (DSC): **0.84**

Input image size: 320x160x80

Test



DSC	N of Images (per patient)
[0, 0.5)	2 (10%)
[0.5, 0.6)	1 (5%)
[0.6, 0.7)	3 (15%)
[0.7, 0.8)	5 (25%)
[0.8, 0.9)	9 (45%)
[0.9, 1)	-

DSC >= 0.5

Mean (DSC): 0.78

SD (DSC): 0.09

Mean (DSC): **0.73**

SD (DSC): 0.16

Test results (n=20)

Data 1

1.7 Test n=20

1st Model (96x256x256)	2nd Model (80x160x320)	1st + 2nd model		
		DSC (mean ± SD)	DSC < 0.5	
Scratch	Scratch	**0.65** ± 0.23	• 0.41 • 0.43 • 0.37 • 0.36 • 0.28 • **0.08**	**G-1**
Pretrained Model	Pretrained	**0.72** ± 0.26	• **3.66e-06 (a)** • 2.87e-05 (b)	**A-1**
	Random Crop	**0.72** ± 0.27	• **1.42e-05 (a)** • 0.33 • 1.13e-03 (b)	**B-1**
	Random Crop + Augmentation	**0.68** ± 0.26	• 2.60e-05 (a) • 0.38 • **6.19e-06 (b)**	**C-1**
Augmentation	Pretrained	**0.74** ± 0.21	• 0.25 (a) • **0.11** (b)	**D-1**
	Random Crop	**0.70** ± 0.27	• 0.18 (a) • 0.34 • 0.27 • **2.75e-04 (b)**	**E-1**
	Random Crop + Augmentation	**0.70** ± 0.20	• 0.27 (a) • 0.47 • **0.19 (b)**	**F-1**

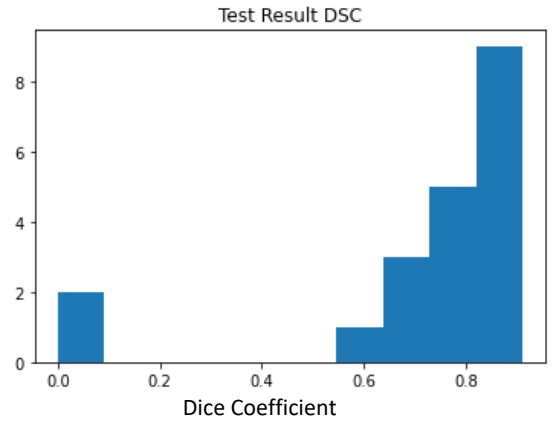
Best DSC

Best a,b

Test (n=20)

A-1

(1st pretrained + 2nd baseline)



DSC	N of Images (per patient)
[0, 0.5)	2 (10%)
[0.5, 0.6)	-
[0.6, 0.7)	4 (20%)
[0.7, 0.8)	3 (15%)
[0.8, 0.9)	8 (40%)
[0.9, 1)	3 (15%)

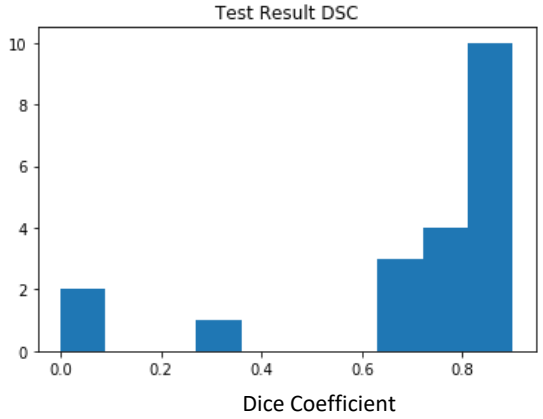
- **3.66e-06**
- **2.87e-05**

Mean (DSC): **0.72**

SD (DSC): 0.26

B-1

(1st pretrained + 2nd rand crop)



DSC	N of Images (per patient)
[0, 0.5)	3 (15%)
[0.5, 0.6)	-
[0.6, 0.7)	-
[0.7, 0.8)	4 (20%)
[0.8, 0.9)	12 (60%)
[0.9, 1)	1 (5%)

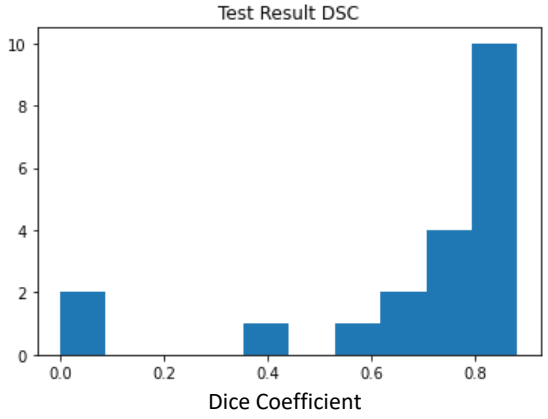
- **1.42e-05**
- **0.33**
- **1.13e-03**

Mean (DSC): **0.72**

SD (DSC): 0.27

C-1

(1st pretrained + 2nd rand crop & aug)



DSC	N of Images (per patient)
[0, 0.5)	3 (15%)
[0.5, 0.6)	-
[0.6, 0.7)	3 (15%)
[0.7, 0.8)	5 (25%)
[0.8, 0.9)	9 (45%)
[0.9, 1)	-

- **2.60e-05**
- **0.38**
- **6.19e-06**

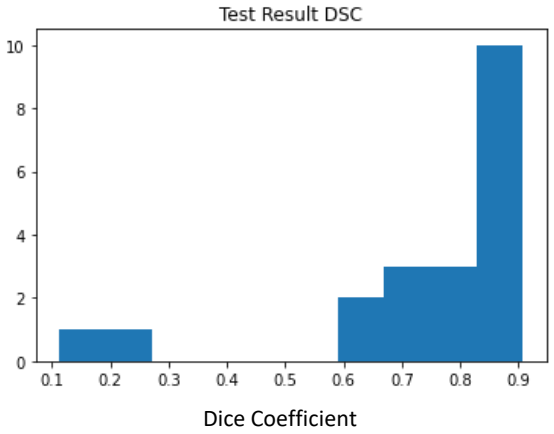
Mean (DSC): **0.68**

SD (DSC): 0.26

Test (n=20)

D-1

(1st rand aug + 2nd pretrained)



DSC	N of Images (per patient)
[0, 0.5)	2 (10%)
[0.5, 0.6)	-
[0.6, 0.7)	5 (25%)
[0.7, 0.8)	2 (10%)
[0.8, 0.9)	9 (45%)
[0.9, 1)	2 (10%)

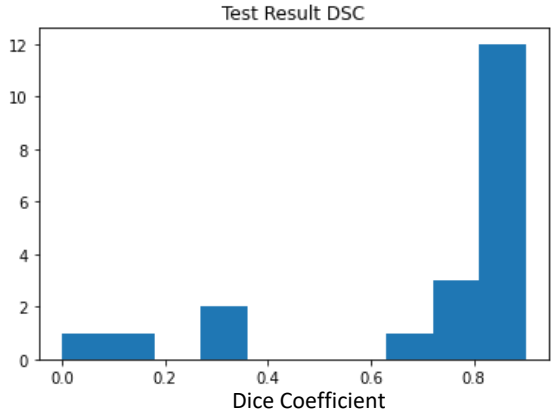
- **0.49**
- **0.27**
- **0.49**
- **0.45**
- **0.49**

Mean (DSC): **0.74**

SD (DSC): 0.21

E-1

(1st rand aug + 2nd rand crop)



DSC	N of Images (per patient)
[0, 0.5)	4 (20%)
[0.5, 0.6)	-
[0.6, 0.7)	-
[0.7, 0.8)	4 (20%)
[0.8, 0.9)	12 (60%)
[0.9, 1)	-

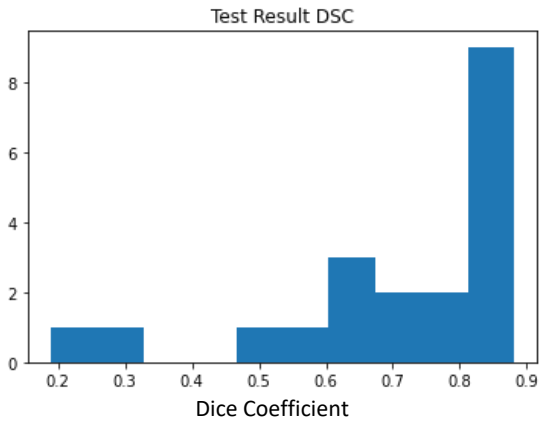
- **0.18**
- **0.35**
- **0.27**
- **2.76e-04**

Mean (DSC): **0.70**

SD (DSC): 0.27

F-1

(1st rand aug + 2nd rand crop & aug)



DSC	N of Images (per patient)
[0, 0.5)	3 (15%)
[0.5, 0.6)	1 (5%)
[0.6, 0.7)	3 (15%)
[0.7, 0.8)	3 (15%)
[0.8, 0.9)	10 (50%)
[0.9, 1)	-

- **0.27**
- **0.47**
- **0.19**

Mean (DSC): **0.70**

SD (DSC): 0.20