消融实验

Table 1 DICE loss function.

Method	HyperParameter				Validation		Test			
	LR	r	λ	p	Saved epoch	IoU(%)	Precision(%)	Recall(%)	F1(%)	IoU(%)
Baseline	0.001	-	-	-	98	66.81	80.47	81.78	78.33	67.52
Baseline+FC	0.001	2	0.1	-	100	66.54				
	0.001	4	0.1	-	100	**66.91**				
	0.001	4	0.2	-	75	66.86				
	0.001	4	0.3	-	87	**67.16**	82.53	80.56	78.93	68.36
Baseline+Dropout	0.001	-	-	0.1	100	66.11				
	0.001	-	-	0.2	89	65.59				
	0.001	-	-	0.3	93	65.95				
	0.001	-	-	0.4	89	65.37				
	0.001	-	-	0.5	94	**66.57**	82.13	80.95	78.42	67.87
	0.001	-	-	0.6	94	66.15				
	0.001	-	-	0.7	82	65.20				
	0.001	-	-	0.8	93	65.78				
	0.001	-	-	0.9	99	65.87				
Proposed	0.001	4	0.3	0.1	86	66.55				
	0.001	4	0.3	0.2	75	66.69				
	0.001	4	0.3	0.3	87	67.32				
	0.001	4	0.3	0.4	87	67.03				
	0.001	4	0.3	0.5	100	**67.78**	82.50	81.45	79.51	68.90
	0.001	4	0.3	0.6	90	67.27				
	0.001	4	0.3	0.7	89	67.04				
	0.001	4	0.3	0.8	100	66.87				
	0.001	4	0.3	0.9	100	66.89				

Table 2 BCE loss function.

Method	HyperParameter				Validation		Test			
	LR	r	λ	p	Saved epoch	IoU(%)	Precision(%)	Recall(%)	F1(%)	IoU(%)
Baseline	0.001	-	-	-	100	65.42	82.87	79.00	78.51	67.46
Baseline+FC	0.001	2	0.1	-	88	**67.43**	82.79	80.47	79.40	68.60
	0.001	4	0.1	-	87	66.88				
	0.001	2	0.2	-	84	66.82				
	0.001	2	0.3	-	91	66.95				
Baseline+Dropout	0.001	-	-	0.1	97	63.23				
	0.001	-	-	0.2	100	64.87				
	0.001	-	-	0.3	100	**65.44**	83.18	77.79	77.66	66.72
	0.001	-	-	0.4	95	64.10				
	0.001	-	-	0.5	85	63.32				
	0.001	-	-	0.6	100	64.56				
	0.001	-	-	0.7	99	63.65				
	0.001	-	-	0.8	100	64.40				
	0.001	-	-	0.9	97	63.79				
Proposed	0.001	2	0.1	0.1	61	66.95				
	0.001	2	0.1	0.2	86	67.12				
	0.001	2	0.1	0.3	81	66.58				
	0.001	2	0.1	0.4	81	66.94				
	0.001	2	0.1	0.5	98	66.98				
	0.001	2	0.1	0.6	93	67.05				
	0.001	2	0.1	0.7	97	**67.55**	81.54	82.16	79.43	68.62
	0.001	2	0.1	0.8	80	66.94				
	0.001	2	0.1	0.9	93	67.52				

Table 3 DICE+BCE loss function.

Method	HyperParameter				Validation		Test			
	LR	r	λ	p	Saved epoch	IoU(%)	Precision(%)	Recall(%)	F1(%)	IoU(%)
Baseline	0.001	-	-	-	99	66.03	80.94	80.05	77.63	66.79
Baseline+FC	0.001	2	0.1	-	93	**67.72**	82.48	81.11	79.56	68.89
	0.001	4	0.1	-	89	67.25				
	0.001	2	0.2	-	97	67.30				
	0.001	2	0.3	-	93	67.21				
Baseline+Dropout	0.001	-	-	0.1	77	65.24				
	0.001	-	-	0.2	89	65.85				
	0.001	-	-	0.3	94	65.31				
	0.001	-	-	0.4	98	65.81				
	0.001	-	-	0.5	77	66.13				
	0.001	-	-	0.6	82	64.23				
	0.001	-	-	0.7	98	65.82				
	0.001	-	-	0.8	100	**66.47**	81.74	79.84	77.78	67.10
	0.001	-	-	0.9	94	65.67				
Proposed	0.001	2	0.1	0.1	98	67.48				
	0.001	2	0.1	0.2	97	67.84				
	0.001	2	0.1	0.3	92	67.95				
	0.001	2	0.1	0.4	100	67.54				
	0.001	2	0.1	0.5	97	**68.12**	81.97	81.98	79.81	69.04
	0.001	2	0.1	0.6	91	67.80				
	0.001	2	0.1	0.7	97	67.76				
	0.001	2	0.1	0.8	98	67.54				
	0.001	2	0.1	0.9	92	67.74				

Table 4 Focal loss function.

Method	HyperParameter				Validation		Test			
	LR	r	λ	p	Saved epoch	IoU(%)	Precision(%)	Recall(%)	F1(%)	IoU(%)
Baseline	0.001	-	-	-	97	63.73	80.54	78.61	76.40	65.27
Baseline+FC	0.001	2	0.1	-	64	**64.28**				
	0.001	4	0.1	-	87	64.12				
	0.001	2	0.2	-	78	**65.29**	82.78	77.10	76.87	65.72
	0.001	2	0.3	-	86	64.29				
Baseline+Dropout	0.001	-	-	0.1	100	63.42				
	0.001	-	-	0.2	98	63.29				
	0.001	-	-	0.3	74	**64.63**	78.10	82.28	77.35	66.17
	0.001	-	-	0.4	96	63.84				
	0.001	-	-	0.5	99	64.27				
	0.001	-	-	0.6	95	63.89				
	0.001	-	-	0.7	99	64.12				
	0.001	-	-	0.8	94	63.32				
	0.001	-	-	0.9	92	63.49				
Proposed	0.001	2	0.2	0.1	97	62.81				
	0.001	2	0.2	0.2	73	63.12				
	0.001	2	0.2	0.3	86	63.94				
	0.001	2	0.2	0.4	87	61.90				
	0.001	2	0.2	0.5	56	63.58				
	0.001	2	0.2	0.6	86	**65.41**	80.75	79.54	77.37	66.05
	0.001	2	0.2	0.7	95	64.58				
	0.001	2	0.2	0.8	74	62.04				
	0.001	2	0.2	0.9	59	62.72				

Table 5 Tversky loss function.

Method	HyperParameter				Validation		Test			
	LR	r	λ	p	Saved epoch	IoU(%)	Precision(%)	Recall(%)	F1(%)	IoU(%)
Baseline	0.001	-	-	-	99	66.15	78.03	84.29	78.20	67.28
Baseline+FC	0.001	2	0.1	-	91	**67.43**	78.40	85.52	79.67	68.69
	0.001	4	0.1	-	84	66.83				
	0.001	2	0.2	-	100	67.36				
	0.001	2	0.3	-	94	66.82				
Baseline+Dropout	0.001	-	-	0.1	100	66.23				
	0.001	-	-	0.2	94	66.54				
	0.001	-	-	0.3	91	66.38				
	0.001	-	-	0.4	91	66.20				
	0.001	-	-	0.5	82	66.54				
	0.001	-	-	0.6	99	66.29				
	0.001	-	-	0.7	77	65.89				
	0.001	-	-	0.8	97	**66.66**	76.54	86.21	78.76	67.61
	0.001	-	-	0.9	94	65.18				
Proposed	0.001	2	0.1	0.1	86	67.25				
	0.001	2	0.1	0.2	94	**67.49**	79.05	84.99	79.78	68.86
	0.001	2	0.1	0.3	99	67.41				
	0.001	2	0.1	0.4	91	67.16				
	0.001	2	0.1	0.5	97	67.42				
	0.001	2	0.1	0.6	87	66.74				
	0.001	2	0.1	0.7	84	66.86				
	0.001	2	0.1	0.8	86	67.41				
	0.001	2	0.1	0.9	78	67.03				

Table 6 Focal Tversky loss function.

Method	HyperParameter				Validation		Test			
	LR	r	λ	p	Saved epoch	IoU(%)	Precision(%)	Recall(%)	F1(%)	IoU(%)
Baseline	0.001	-	-	-	97	66.48	76.76	85.70	78.56	67.49
Baseline+FC	0.001	2	0.1	-	91	**66.38**				
	0.001	4	0.1	-	81	65.90				
	0.001	2	0.2	-	92	**67.18**	78.03	85.06	78.87	67.92
	0.001	2	0.3	-	94	66.89				
Baseline+Dropout	0.001	-	-	0.1	97	66.42				
	0.001	-	-	0.2	82	65.78				
	0.001	-	-	0.3	99	66.02				
	0.001	-	-	0.4	97	66.04				
	0.001	-	-	0.5	95	**66.46**	78.26	84.70	78.60	67.63
	0.001	-	-	0.6	93	66.14				
	0.001	-	-	0.7	94	65.67				
	0.001	-	-	0.8	98	65.38				
	0.001	-	-	0.9	98	65.59				
Proposed	0.001	2	0.2	0.1	84	66.90				
	0.001	2	0.2	0.2	99	67.37				
	0.001	2	0.2	0.3	99	**67.58**	77.82	86.01	79.52	68.43
	0.001	2	0.2	0.4	99	67.31				
	0.001	2	0.2	0.5	100	67.29				
	0.001	2	0.2	0.6	96	66.68				
	0.001	2	0.2	0.7	87	66.99				
	0.001	2	0.2	0.8	94	66.98				
	0.001	2	0.2	0.9	78	66.31				

在其他模型架构上的对比实验

Table 7 FCN-8s.

Method(FCN-8s)	HyperParameter				Validation		Test			
	LR	r	λ	p	Saved epoch	IoU(%)	Precision(%)	Recall(%)	F1(%)	IoU(%)
Baseline	0.001	-	-	-	97	52.10	70.04	68.82	64.80	52.75
Baseline+FC	0.001	2	0.1	-	98	**52.96**				
	0.001	4	0.1	-	89	52.57				
	0.001	2	0.2	-	98	51.94				
	0.001	2	0.3	-	79	52.83				
Proposed	0.001	2	0.1	0.1	94	**53.15**	70.25	69.52	65.68	53.52
	0.001	2	0.1	0.2	79	52.72				
	0.001	2	0.1	0.3	97	52.75				
	0.001	2	0.1	0.4	97	53.09				
	0.001	2	0.1	0.5	98	52.97				
	0.001	2	0.1	0.6	99	52.16				
	0.001	2	0.1	0.7	76	52.89				
	0.001	2	0.1	0.8	98	53.11				
	0.001	2	0.1	0.9	99	52.97				

Table 8 SegNet.

Method(SegNet)	HyperParameter				Validation		Test			
	LR	r	λ	p	Saved epoch	IoU(%)	Precision(%)	Recall(%)	F1(%)	IoU(%)
Baseline	0.001	-	-	-	66	56.84	76.62	71.21	71.01	57.75
Baseline+FC	0.001	2	0.1	-	62	59.75				
	0.001	4	0.1	-	51	**60.56**				
	0.001	4	0.2	-	61	59.07				
	0.001	4	0.3	-	65	57.13				
Proposed	0.001	4	0.1	0.1	95	60.81				
	0.001	4	0.1	0.2	49	60.70				
	0.001	4	0.1	0.3	73	60.53				
	0.001	4	0.1	0.4	61	60.52				
	0.001	4	0.1	0.5	88	61.82				
	0.001	4	0.1	0.6	78	61.50				
	0.001	4	0.1	0.7	96	**61.92**	79.56	76.72	75.76	63.53
	0.001	4	0.1	0.8	61	60.35				
	0.001	4	0.1	0.9	97	59.99				

Table 9 Res-U-Net.

Method(Res-U-Net)	HyperParameter				Validation		Test			
	LR	r	λ	p	Saved epoch	IoU(%)	Precision(%)	Recall(%)	F1(%)	IoU(%)
Baseline	0.001	-	-	-	100	64.57	82.56	78.61	77.18	66.45
Baseline+FC	0.001	2	0.1	-	77	65.90				
	0.001	4	0.1	-	72	**65.95**				
	0.001	4	0.2	-	93	65.58				
	0.001	4	0.3	-	99	65.64				
Proposed	0.001	4	0.1	0.1	81	**66.02**	81.56	79.98	77.86	67.00
	0.001	4	0.1	0.2	73	65.42				
	0.001	4	0.1	0.3	77	65.52				
	0.001	4	0.1	0.4	99	65.33				
	0.001	4	0.1	0.5	81	65.21				
	0.001	4	0.1	0.6	89	65.50				
	0.001	4	0.1	0.7	84	65.54				
	0.001	4	0.1	0.8	86	65.48				
	0.001	4	0.1	0.9	66	65.12				

Table 10 Att-U-Net.

Method(Att-U-Net)	HyperParameter				Validation		Test			
	LR	r	λ	p	Saved epoch	IoU(%)	Precision(%)	Recall(%)	F1(%)	IoU(%)
Baseline	0.001	-	-	-	98	64.48	82.09	78.20	76.39	65.76
Baseline+FC	0.001	2	0.1	-	85	67.01				
	0.001	4	0.1	-	85	66.81				
	0.001	2	0.2	-	100	66.25				
	0.001	2	0.3	-	99	**67.30**				
Proposed	0.001	2	0.3	0.1	80	66.50				
	0.001	2	0.3	0.2	66	66.18				
	0.001	2	0.3	0.3	85	66.43				
	0.001	2	0.3	0.4	74	66.41				
	0.001	2	0.3	0.5	100	66.32				
	0.001	2	0.3	0.6	98	66.27				
	0.001	2	0.3	0.7	99	65.86				
	0.001	2	0.3	0.8	100	66.87				
	0.001	2	0.3	0.9	79	**67.15**	82.58	80.50	79.01	68.23

Table 11 U-Net++.

Method(U-Net++)	HyperParameter				Validation		Test			
	LR	r	λ	p	Saved epoch	IoU(%)	Precision(%)	Recall(%)	F1(%)	IoU(%)
Baseline	0.001	-	-	-	92	66.87	82.17	81.08	78.99	68.18
Baseline+FC	0.001	2	0.1	-	92	67.44				
	0.001	4	0.1	-	88	67.09				
	0.001	2	0.2	-	93	**67.63**				
	0.001	2	0.3	-	88	67.57				
Proposed	0.001	2	0.2	0.1	75	67.23				
	0.001	2	0.2	0.2	93	67.81				
	0.001	2	0.2	0.3	77	67.32				
	0.001	2	0.2	0.4	98	67.91				
	0.001	2	0.2	0.5	86	**68.19**	81.31	83.01	79.98	69.13
	0.001	2	0.2	0.6	88	67.78				
	0.001	2	0.2	0.7	86	67.26				
	0.001	2	0.2	0.8	99	67.29				
	0.001	2	0.2	0.9	93	67.84				

Table 12 PSP-Net

Method(PSP-Net)	HyperParameter				Validation		Test			
	LR	r	λ	p	Saved epoch	IoU(%)	Precision(%)	Recall(%)	F1(%)	IoU(%)
Baseline	0.001	-	-	-	99	66.60	82.64	79.87	78.52	67.99
Baseline+FC	0.001	2	0.1	-	80	68.02				
	0.001	4	0.1	-	82	**68.54**				
	0.001	4	0.2	-	100	68.35				
	0.001	4	0.3	-	100	68.52				
Proposed	0.001	4	0.1	0.1	98	68.59				
	0.001	4	0.1	0.2	98	68.32				
	0.001	4	0.1	0.3	100	**68.73**	81.31	84.02	80.83	70.31
	0.001	4	0.1	0.4	97	68.68				
	0.001	4	0.1	0.5	99	68.47				
	0.001	4	0.1	0.6	97	68.04				
	0.001	4	0.1	0.7	99	68.16				
	0.001	4	0.1	0.8	99	67.57				
	0.001	4	0.1	0.9	98	67.55				