

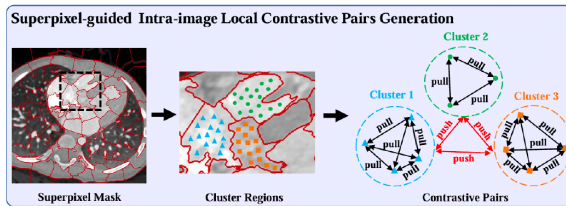
MILabTIP, JBHI

MILab1SuperCL: ()2MACL: 1“SuperCL: Superpixel Guided Contrastive Learning for Medical Image Segmentation Pre-Training”IEEE Transactions on Image Processing2“Multi-level Asymmetric Contrastive Learning for Medical Image Segmentation Pre-training”IEEE Journal of Biomedical and Health Informatics

SuperCL:

1.

SLIC 1 Intra-image Local Contrastive Pairs, ILCP



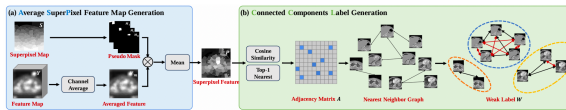
1.

2.

Inter-image Global Contrastive Pairs, IGCP

1ASP

2CCLASP 2



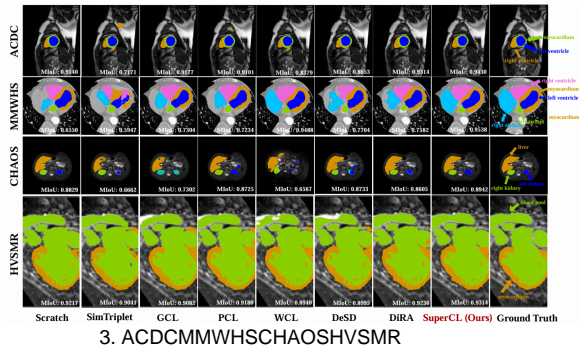
2.

SuperCL 10%SuperCLDice 3.98%Jaccard 4.90%25% SuperCL 2.89% Dice MMWHS 90%Dice

Labelset	Method	ACDC (100 patients)			MMWHS (20 patients)			HVSIMR (10 patients)			CHAOS (20 patients)						
		DSC (%)	JC (%)	HD95 (ASD)	DSC (%)	JC (%)	HD95 (ASD)	DSC (%)	JC (%)	HD95 (ASD)	DSC (%)	JC (%)	HD95 (ASD)				
10%	Scratch	79.99	67.39	8.58	3.82	83.04	48.89	9.31	3.39	72.81	59.02	34.34	10.18	51.76	37.51	23.08	9.90
	SimCLR [5]	78.60	65.47	8.11	3.36	61.70	46.59	9.67	3.53	75.78	62.34	25.16	6.22	53.22	38.11	22.28	9.04
	MoCo [16]	81.34	69.13	8.12	3.20	57.54	42.62	11.33	4.15	76.20	62.79	27.45	8.33	53.14	36.49	21.45	9.53
	BYOL [12]	77.55	64.17	9.05	3.96	63.75	49.54	9.34	3.61	73.57	59.87	29.79	8.51	50.45	35.66	24.20	10.32
	SwAV [2]	82.11	70.20	6.35	2.46	64.27	49.96	10.31	3.98	76.28	62.91	24.09	6.42	49.87	35.04	19.75	8.86
	SimSiam [7]	71.06	57.01	11.05	4.78	61.37	46.51	10.61	3.89	75.03	61.47	29.73	8.72	41.21	28.87	21.55	10.20
	SimTriplet [10]	71.07	56.07	11.31	5.20	62.52	47.81	10.98	4.10	72.66	58.48	30.72	8.65	32.88	23.14	27.81	12.90
	GCL [1]	84.86	74.07	7.07	2.85	71.41	58.58	7.22	2.55	75.70	62.22	28.15	7.68	58.78	44.00	15.28	6.36
	PCL [51]	84.91	74.16	6.54	2.65	65.98	52.32	5.07	3.16	76.12	63.82	24.50	6.43	63.61	48.23	16.15	9.79
	WCL [55]	75.46	61.52	11.05	4.69	60.82	45.66	9.82	3.92	75.05	61.42	26.09	6.35	56.87	41.39	20.83	9.31
	DsSD [49]	76.02	62.27	10.25	4.15	57.63	42.30	10.89	4.36	74.57	61.16	24.00	6.40	61.93	46.68	18.91	8.39
	DIRA [14]	83.14	71.61	6.73	2.60	57.73	42.95	10.92	3.76	74.87	61.35	27.91	8.01	44.30	31.24	24.63	11.93
	SuperCL (Ours)	86.06	75.79	4.68	1.80	74.56	62.05	6.50	2.22	78.35	65.46	23.23	6.61	69.05	54.09	15.43	6.32
	25%	Scratch	88.99	80.34	3.09	1.24	85.14	74.87	4.66	1.45	81.26	69.23	20.63	5.85	66.11	52.74	12.82
SimCLR [5]		88.55	79.71	4.23	1.47	86.14	76.03	4.59	1.36	80.53	68.50	23.42	6.75	66.15	52.21	11.76	4.75
MoCo [16]		88.38	79.39	5.01	1.55	82.89	71.46	5.40	1.69	81.26	69.18	20.41	5.64	65.33	50.93	15.12	6.40
BYOL [12]		89.27	80.76	4.62	1.64	87.63	78.43	3.83	1.20	81.33	69.30	19.95	5.80	62.49	48.31	14.13	5.71
SwAV [2]		88.99	80.34	4.90	1.78	87.71	78.61	3.78	1.22	81.30	69.18	17.24	4.62	68.12	54.01	12.71	5.15
SimSiam [7]		88.24	79.18	4.85	1.71	82.71	71.19	5.25	1.78	79.70	67.30	22.83	6.31	51.82	39.11	14.82	8.86
SimTriplet [10]		87.99	78.80	5.78	2.00	82.43	70.82	5.24	1.73	80.51	68.24	24.34	7.17	63.55	49.30	13.23	8.98
GCL [1]		88.55	79.67	4.22	1.34	88.01	79.04	4.02	1.17	82.41	70.80	22.08	6.59	76.88	63.48	9.11	3.70
PCL [51]		88.97	80.33	4.17	1.43	86.65	76.90	4.23	1.28	83.13	71.70	20.28	5.17	78.88	66.08	8.82	3.32
WCL [55]		87.25	77.68	5.33	1.61	84.42	73.66	4.82	1.58	81.65	69.75	19.33	5.55	63.87	49.46	11.59	4.70
DsSD [49]		87.14	77.47	6.11	2.19	84.46	73.66	5.15	1.70	81.44	69.44	21.19	5.57	67.96	54.28	11.70	4.90
DIRA [14]		88.92	80.22	4.24	1.48	86.68	77.88	4.46	1.43	81.56	69.67	20.85	5.69	64.80	49.87	13.47	5.69
SuperCL (Ours)		89.68	81.44	3.34	1.17	90.26	82.52	3.36	0.98	83.48	72.18	18.55	4.50	80.02	67.30	7.49	3.03
100%		Scratch	92.07	85.38	3.06	1.07	92.27	85.79	2.71	0.76	84.95	74.33	14.83	3.56	88.63	79.84	4.38

¹ 指标旁向上箭头表示数值越大性能越好，向下箭头表示数值越小性能越好。DSC 和 JC 是百分数(%)，粗体表示最优结果，下划线表示次优结果。

1. SuperCL



3. ACDCMMWHSCHAOSHVSMR

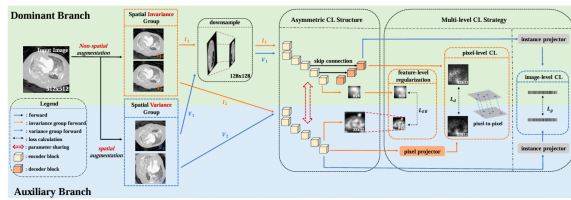
MILabMILab"+X"——

MACL:

Siamese

- 1
- 2
- 3

MACL (Multi-level Asymmetric Contrastive Learning)1(2) MACL-

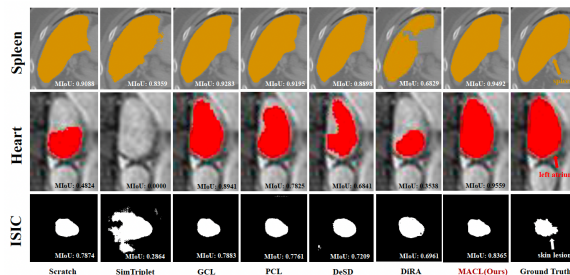


4. MACL

MACL : (1)10% MACL 4 ACDC PCL1.72% DSC225% MACL MMWHS GCL 1.89% DSC 2.88% JC Spleen GCL 1.45% DSC3.42%JC

Labeled	Method	Spleen (41 patients)				ISC (254 images)				Heart (30 patients)				Hippocampus (260 patients)			
		DSC (%)	JC (%)	HD95 (%)	ASD	DSC (%)	JC (%)	HD95 (%)	ASD	DSC (%)	JC (%)	HD95 (%)	ASD	DSC (%)	JC (%)	HD95 (%)	ASD
10%	Scratch	66.63	49.95	12.58	5.78	37.21	77.32	27.47	9.72	73.30	57.85	5.21	1.82	78.27	64.30	1.36	0.51
	SimCLR [5]	60.38	43.24	12.42	4.67	85.85	75.21	23.81	10.32	73.42	58.00	4.22	1.40	75.91	61.78	1.48	0.54
	MoCo [16]	56.49	39.36	21.32	9.35	85.61	74.84	24.56	9.95	68.32	51.88	6.71	2.48	78.27	64.30	1.27	0.46
	BYOL [12]	61.38	44.28	14.56	6.32	87.00	77.00	24.20	10.28	70.34	58.00	6.17	2.16	77.24	62.92	1.39	0.49
	SwAV [2]	61.87	44.79	13.61	6.53	85.85	75.20	24.19	10.45	72.31	56.63	5.95	2.27	76.00	61.29	1.47	0.52
	SimSum [7]	67.88	51.37	12.89	3.65	83.02	70.97	30.04	13.70	58.56	41.41	10.71	5.15	73.45	58.05	1.39	0.49
	SimTriplet [10]	63.56	46.59	16.95	7.54	83.01	70.96	29.27	13.03	57.76	40.61	8.85	3.94	74.80	59.74	1.31	0.46
	GCL [1]	73.40	57.97	11.79	4.99	85.53	74.72	24.37	10.84	76.88	62.44	5.21	1.73	78.14	64.13	1.32	0.46
	PCL [15]	71.22	55.30	11.10	4.97	86.64	76.43	24.41	10.50	78.47	64.57	5.95	2.14	78.13	64.11	1.29	0.47
	DeSD [49]	64.24	47.31	7.18	2.83	83.56	71.76	25.66	11.50	77.55	63.33	5.80	2.28	74.48	59.34	1.64	0.62
DRA [14]	66.23	49.51	20.96	8.93	87.02	77.02	22.91	9.28	70.19	54.07	4.76	1.36	77.15	62.80	1.36	0.50	
MACL (Ours)	80.93	67.97	6.93	2.92	87.45	77.70	21.53	8.91	79.37	65.79	5.40	1.99	78.33	64.38	1.31	0.46	
25%	Scratch	74.99	59.98	9.14	4.33	88.44	79.28	16.32	6.41	78.35	64.41	4.27	1.33	83.48	71.63	1.08	0.35
	SimCLR [5]	81.75	69.13	7.05	3.06	87.82	79.28	17.79	7.18	80.07	66.76	3.48	0.98	83.35	71.46	1.05	0.36
	MoCo [16]	75.98	61.26	8.55	4.09	87.53	77.83	17.87	7.01	75.35	60.45	5.60	2.11	83.94	72.33	0.98	0.33
	BYOL [12]	75.15	60.19	6.34	2.39	88.50	79.38	16.78	6.54	80.70	67.65	4.36	1.16	83.38	71.50	1.04	0.35
	SwAV [2]	80.40	67.23	5.52	2.34	87.90	78.41	17.65	6.77	81.94	69.40	3.98	1.22	83.05	71.02	1.06	0.35
	SimSum [7]	78.70	64.88	8.87	4.56	87.29	77.45	19.31	7.52	71.65	55.83	3.24	1.17	80.60	67.51	1.11	0.37
	SimTriplet [10]	78.81	65.04	8.84	3.96	86.52	76.24	19.50	7.68	76.42	61.83	5.11	1.72	82.01	69.31	1.06	0.35
	GCL [1]	84.37	72.97	6.25	2.52	88.52	79.41	17.55	7.06	82.30	69.92	3.76	0.96	83.63	71.67	1.07	0.37
	PCL [15]	83.55	71.74	7.03	2.96	88.26	78.99	18.04	7.27	82.69	70.49	3.78	0.93	83.98	72.40	0.96	0.33
	DeSD [49]	81.02	68.10	6.59	3.28	87.34	77.52	20.29	8.41	81.50	68.77	4.45	1.43	81.81	69.22	1.08	0.37
DRA [14]	80.80	67.78	7.95	4.17	88.38	79.18	18.96	6.63	79.91	66.54	4.67	1.35	83.60	71.83	1.00	0.33	
MACL (Ours)	85.82	75.16	4.85	1.91	88.96	80.12	17.61	6.79	82.93	70.84	3.85	1.24	84.13	72.61	0.99	0.32	
100%	Scratch	89.92	81.69	4.59	2.12	90.11	82.01	15.71	6.17	91.52	84.36	2.45	0.61	87.00	77.00	0.81	0.27

2. MACL



5. Spleen, Heart and ISC

MILabMILabBio-MIBLab"+X"——