Conditional Representation Learning for Customized Tasks

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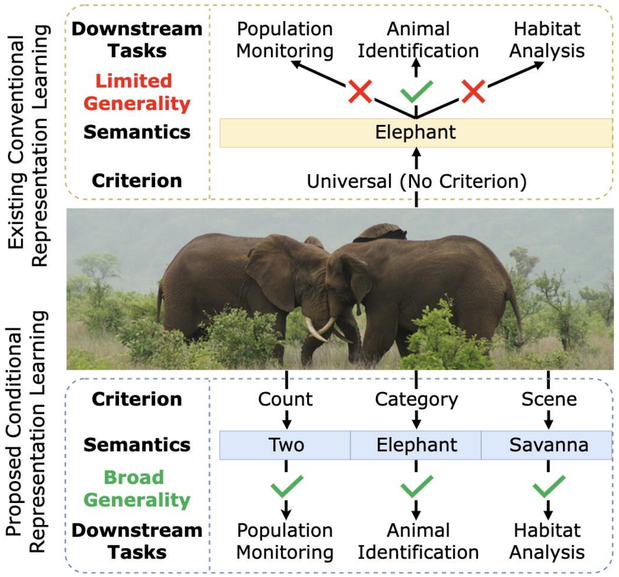
NEURAL INFORMATION PROCESSING SYSTEMS

Motivation

Existing representation learning learns a universal representation that prioritizes the dominant semantics while overlooking other meaningful features.



In contrast, our proposed conditional representation learning (CRL) extracts representations conditioned on specific criteria, significantly enhancing its generality.

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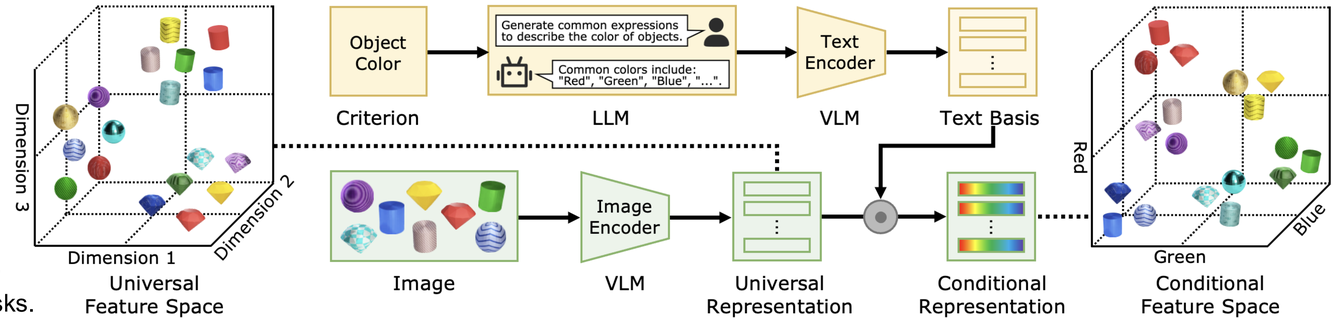
Method

1. Given a criterion, let LLM output related descriptive texts.

2. Feed images and texts into the VLM to get embeddings I and T.

3. Obtain conditional representations $\mathrm{R} = IT^\top$ and apply to downstream tasks.



Experiment

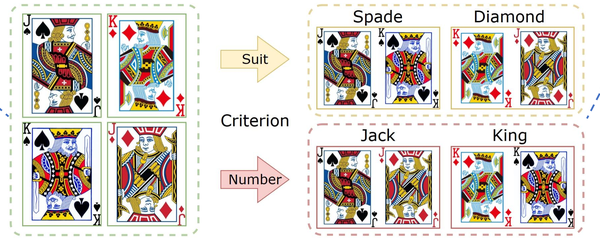
❖ Few-shot Classification

Method	Clevr4-10k									Mean
	Texture			Shape			Color			
	1	5	10	1	5	10	1	5	10	
CLIP [34]	17.46	29.39	36.26	58.16	83.17	89.47	26.85	57.33	70.00	52.01
ALIGN [19]	18.80	34.35	45.22	**73.40**	91.82	95.02	20.08	41.89	56.45	53.00
MetaCLIP [48]	17.68	30.96	39.03	70.13	91.69	95.47	22.37	46.71	61.74	52.86
BLIP2 [23]	15.93	25.23	32.58	72.91	**95.18**	97.88	28.96	60.53	73.25	55.83
CLIP+CRL	18.76	35.54	45.54	58.67	86.61	92.29	**65.28**	**88.89**	**93.08**	64.96
ALIGN+CRL	**20.91**	**41.77**	**54.92**	63.05	92.74	96.25	60.26	87.38	92.56	**67.76**
MetaCLIP+CRL	18.14	34.89	44.69	66.36	92.01	95.50	62.41	88.45	92.50	66.11
BLIP2+CRL	16.35	34.67	47.28	73.22	95.12	**97.90**	63.75	86.16	92.13	67.40

Method	Clevr4-10k			Cards						Mean
	Count			Number			Suits			
	1	5	10	1	5	10	1	5	10	
CLIP [34]	17.50	23.43	25.45	20.63	33.73	41.84	37.65	56.36	65.98	35.84
ALIGN [19]	14.64	21.63	25.16	16.97	24.70	29.15	34.67	52.75	61.78	31.27
MetaCLIP [48]	16.61	22.64	24.92	37.47	55.03	65.16	20.71	35.16	42.97	35.63
BLIP2 [23]	16.92	25.63	29.38	27.21	45.54	55.94	44.61	70.14	78.16	43.73
CLIP+CRL	**23.38**	29.59	32.40	17.66	44.52	51.09	37.10	67.16	72.64	41.73
ALIGN+CRL	18.16	32.62	36.80	17.39	30.61	35.93	42.13	76.36	80.11	41.12
MetaCLIP+CRL	17.36	26.29	29.93	**42.32**	**71.88**	**77.32**	25.30	50.53	56.90	44.20
BLIP2+CRL	23.06	**34.86**	**39.07**	23.47	61.19	70.05	**49.57**	**80.44**	**84.06**	**51.75**

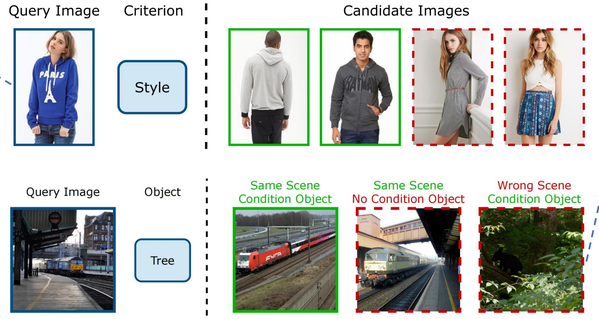
❖ Fashion Retrieval

Method	Texture	Fabric	Shape	Part	Style	Mean
Random	6.69	2.69	3.23	2.55	1.97	3.38
Triplet [43]	13.26	6.28	9.49	4.43	3.33	7.36
CSN [43]	14.09	6.39	11.07	5.13	3.49	8.01
ASEN [29]	15.13	7.11	12.39	5.51	3.56	8.74
ASEN++ [7]	15.60	7.67	14.31	6.60	4.07	9.64
RPF [8]	15.62	8.30	15.02	7.38	4.77	10.22
CLIP [34]	9.14	4.68	7.86	4.26	4.48	6.08
CLIP+CRL†	11.03	6.76	11.80	5.56	4.42	7.93
CLIP+CRL	**16.88**	**9.31**	**16.98**	**7.54**	**5.95**	**11.33**



Now we could apply CRL to...

And more ?



❖ Unsupervised Classification

Method	Clevr4-10k									Mean
	Texture			Shape			Color			
	NMI	ACC	ARI	NMI	ACC	ARI	NMI	ACC	ARI	
CC [25]	0.16	11.34	0.00	**94.66**	**96.89**	**93.90**	16.54	11.42	0.07	36.11
SCAN [40]	0.41	11.97	0.86	90.99	89.10	84.03	0.20	11.51	0.01	32.12
Multi-Map [54]	3.77	17.25	1.81	67.48	66.01	57.40	56.83	56.46	45.73	41.42
CLIP [34]	1.11	13.09	0.41	74.22	73.19	64.15	0.83	12.23	0.27	26.61
ALIGN [19]	1.36	13.30	0.41	89.33	86.77	83.37	0.47	11.79	0.10	31.88
MetaCLIP [48]	1.44	12.75	0.42	80.54	77.17	71.58	0.32	11.85	0.06	28.46
BLIP2 [23]	0.79	12.32	0.28	86.98	85.68	81.17	0.99	11.92	0.24	31.15
CLIP+CRL	10.74	25.11	6.35	78.69	83.05	72.42	**88.67**	**88.05**	**82.30**	59.49
ALIGN+CRL	**15.08**	**26.08**	**9.18**	88.27	87.63	81.83	85.07	76.15	72.69	60.22
MetaCLIP+CRL	12.74	25.89	7.28	87.32	88.15	82.98	88.35	86.27	81.08	**62.23**
BLIP2+CRL	6.46	18.77	3.37	90.11	88.91	84.52	84.67	81.97	74.85	59.29

Method	Clevr4-10k			Cards						Mean
	Count			Number			Suits			
	NMI	ACC	ARI	NMI	ACC	ARI	NMI	ACC	ARI	
CC [25]	2.08	14.67	1.09	24.91	26.34	12.30	24.94	39.21	16.87	18.05
SCAN [40]	3.42	14.29	1.23	11.11	18.21	17.60	15.01	32.02	9.48	13.60
Multi-Map [54]	11.38	20.13	7.67	16.32	20.61	7.95	14.02	46.65	11.08	17.31
CLIP [34]	9.50	19.02	5.70	16.84	18.91	8.44	16.52	43.74	12.93	16.84
ALIGN [19]	0.63	12.50	0.19	14.86	17.51	6.47	3.49	31.72	2.31	9.96
MetaCLIP [48]	7.62	17.27	3.97	17.39	19.78	9.04	15.48	38.72	13.11	15.82
BLIP2 [23]	6.11	16.36	3.13	24.34	25.25	13.08	31.26	47.04	22.25	20.98
CLIP+CRL	25.57	26.24	12.54	24.79	28.19	12.14	39.71	67.15	37.59	30.44
ALIGN+CRL	22.78	26.59	12.18	20.12	25.32	10.24	42.94	50.79	34.47	27.27
MetaCLIP+CRL	12.22	20.80	6.18	39.07	41.63	24.37	45.19	58.71	36.97	31.68
BLIP2+CRL	**28.55**	**30.92**	**16.28**	**46.55**	**48.35**	**32.31**	**60.86**	**76.07**	**55.94**	**43.98**

❖ Conditional Similarity Retrieval

Method	Focus			Change			Mean
	R@1	R@2	R@3	R@1	R@2	R@3	
$\text{CLIP}_{\text{image}}$	9.4	17.0	25.4	7.6	17.1	25.5	17.0
$\text{CLIP}_{\text{text}}$	7.4	14.0	23.0	8.1	16.4	24.7	15.6
$\text{CLIP}_{\text{image+text}}$	11.5	20.1	29.2	9.8	20.0	28.9	19.9
Pic2Word [35]	9.9	19.3	27.4	8.6	18.2	26.1	18.3
SEARLE [1]	10.8	18.2	27.9	8.3	15.6	25.8	17.8
LinCIR [15]	10.1	19.1	28.1	7.9	16.3	25.7	17.9
CIG [46]	10.6	19.2	27.4	7.9	16.9	25.4	17.9
CLIP+CRL	15.4	26.7	35.8	17.0	27.8	37.8	26.8
Combiner* [41]	16.6	27.7	37.2	18.0	32.2	41.6	28.9
CLIP+CRL*	**19.7**	**32.7**	**41.3**	**21.0**	**35.9**	**44.8**	**32.6**