CVPR

VIRTUAL JUNE 19-25

Dense Label Encoding for Boundary Discontinuity Free Rotation Detection

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X. Yang, et al. “Dense Label Encoding for Boundary Discontinuity Free Rotation Detection.” In CVPR21.

Virtual. 2021

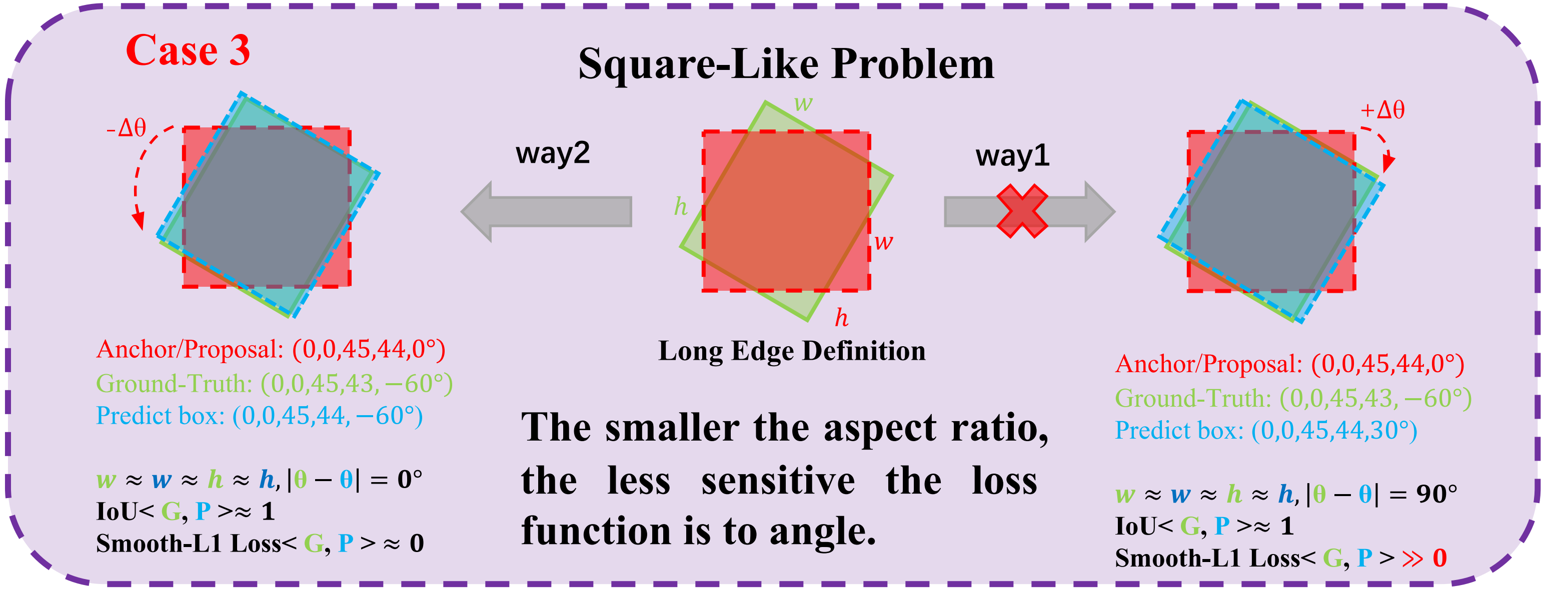
Limitations of CSL

- **Issue 1:** Thick prediction layer

$$\mathrm{Th}_{reg.} = A$$

$$\mathrm{Th}_{onehot} = \mathrm{Th}_{csl} = A \times AR/\omega$$

- **Issue 2:** Unfriendliness to small aspect ratio objects



Densely Coded Label (DCL)

- **Use Densely Coded Label (DCL) instead of Sparsely Coded Label (SCL) (for Issus 1)**

$$\underbrace{\mathrm{Th}_{bcl} = \mathrm{Th}_{gcl}}_{\mathrm{TH}_{dcl}} = A \times \lceil \log_2(AR/\omega) \rceil$$

where A indicates the number of anchors. AR represents angle range. W indicates the angle discretization granularity

- **Example：A=21, AR=180, w=1**

$\mathrm{Th}_{reg} = 21$, $\mathrm{Th}_{onehot}=\mathrm{Th}_{csl}=3780$, $\mathrm{Th}_{dcl}=168$

Base Model	ω	GFlops	ΔGFlops	Params (M)	ΔParams	Training Time
RetinaNet-Reg	-	139.35	-	36.97	-	-
RetinaNet-CSL	1	254.96	+82.96%	45.63	+23.42%	~3x
RetinaNet-BCL	1	143.87	**+3.24%**	37.31	**+0.92%**	~**1x**
RetinaNet-GCL	1	143.87	**+3.24%**	37.31	**+0.92%**	~**1x**

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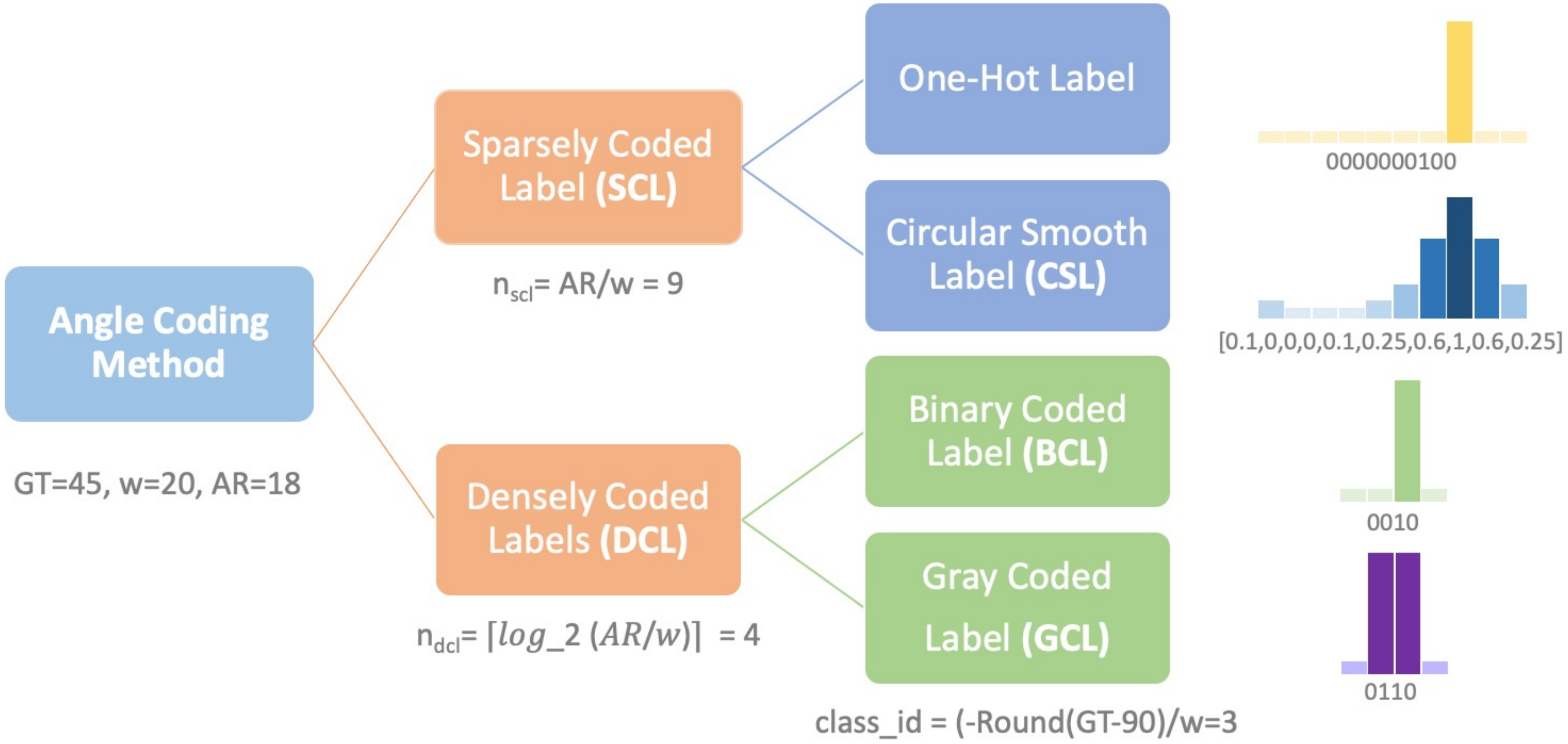

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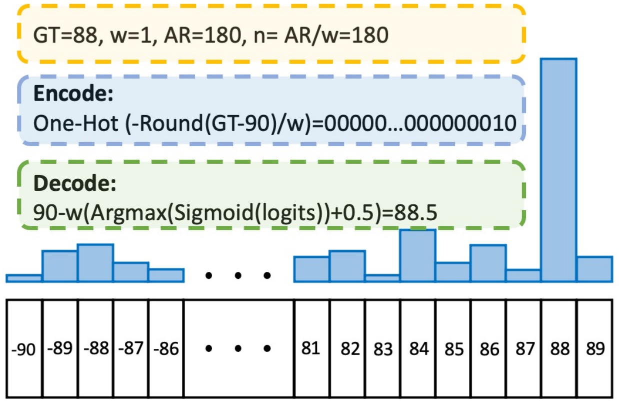
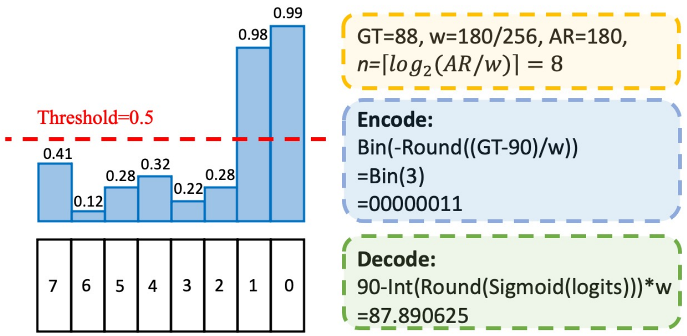
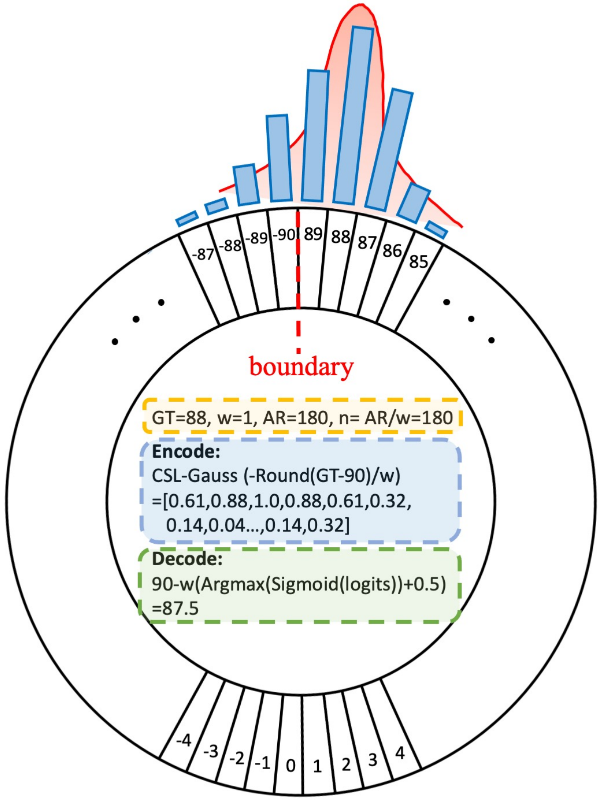


(a) SCL： One-Hot Label



(b) DCL：Binary Coded Labe



(c) SCL: Circular Smooth Label

ADARSW

- **Angle Distance and Aspect Ratio Sensitive Weighting (for Issus 2)**

$$W_{ADARSW}(\Delta\theta) = |\sin(\alpha(\Delta\theta))| = |\sin(\alpha(\theta_{gt} - \theta_{pred}))|$$

$$\alpha = \begin{cases} 1, & (h_{gt}/w_{gt}) > r \\ 2, & otherwise \end{cases}$$

(a) Ground Truth (b) Prediction after using ADARSW

Ablation Experiments

- **When angle discretization granularity w is too small, too many angle categories, then classification affects performance**
- **When angle discretization granularity w is too large, the theoretical error is too large, thus the upper limit of performance is low**

Method	ω	BR	SV	LV	SH	HA	5-mAP$_{50}$	mAP$_{50}$	mAP$_{75}$	mAP$_{50:95}$
Reg	-	34.52	51.42	50.32	73.37	55.93	53.12	62.21	26.07	31.49
CSL	180/180	35.94	53.42	61.06	81.81	62.14	58.87	64.40	32.58	35.04
BCL	180/4	30.74	40.54	50.98	72.07	59.54	50.77	62.38	24.88	31.01
	180/8	36.65	52.58	60.46	82.24	61.60	58.71	**66.17**	33.14	35.77
	180/32	**39.83**	54.41	60.62	80.81	60.32	**59.20**	65.93	**35.66**	**36.71**
	180/64	38.22	**54.70**	60.16	80.75	60.11	58.79	65.00	34.31	36.00
	180/128	36.76	53.73	**61.35**	**82.52**	58.42	58.56	65.14	34.28	35.69
	180/180	37.42	53.72	58.70	80.73	**63.31**	58.78	65.83	33.94	36.35
	180/256	37.66	53.83	60.66	80.43	60.74	58.66	64.97	33.52	35.21
	180/512	37.93	53.85	58.52	80.04	60.87	58.24	64.88	33.09	34.99
GCL	180/4	30.90	41.20	48.30	72.93	60.16	50.70	62.98	23.83	30.81
	180/8	36.88	51.10	59.81	82.40	61.57	58.35	65.23	33.92	35.29
	180/32	38.04	**54.77**	60.88	**82.75**	61.24	**59.54**	65.11	**34.67**	36.15
	180/64	**38.05**	54.36	60.59	81.84	60.39	59.05	64.78	33.23	35.67
	180/128	37.74	54.36	59.43	81.15	60.51	58.64	**66.13**	33.65	**36.34**
	180/256	35.81	53.78	58.35	81.45	59.84	57.85	64.87	33.77	35.97
	180/512	37.99	54.23	**61.61**	80.84	**62.13**	59.36	64.34	34.08	35.92

Ablation Experiments

(a) $\omega = 180/4$

(b) $\omega = 180/32$

(c) $\omega = 180/128$

(d) $\omega = 180/256$

Ablation Experiments

- **Angle Distance and Aspect Ratio Sensitive Weighting**

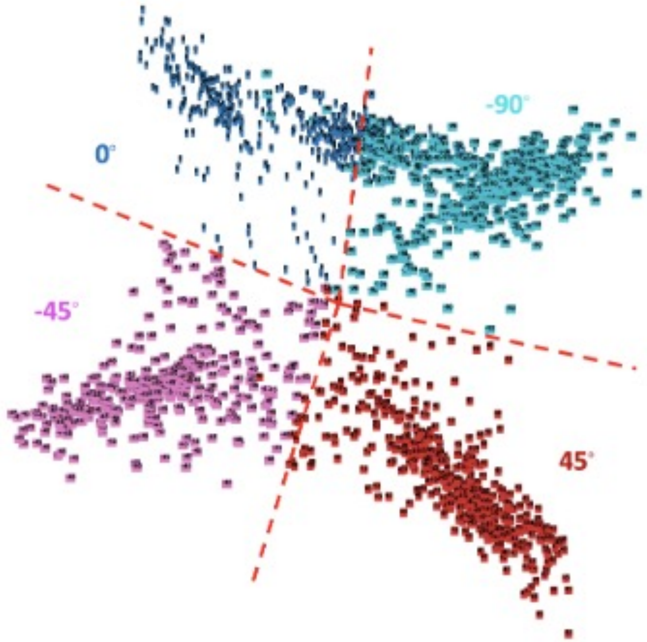
Method	ADARSW	PL	BD	GTF	TC	BC	ST	SBF	RA	SP	HC	10-mAP_{50}	mAP_{50}
BCL		88.63	71.62	65.18	90.70	76.32	78.47	52.26	60.25	66.61	49.15	69.92	66.53
	✓	88.92	72.11	66.32	90.79	79.86	79.03	54.11	63.18	67.86	60.04	**72.22**	**67.39**
GCL		88.52	73.58	64.38	90.80	77.66	76.38	50.84	59.46	65.83	48.42	69.59	66.27
	✓	88.96	75.20	65.24	90.78	79.13	77.95	55.60	61.90	66.18	56.27	**71.72**	**67.02**

- **Verification on different datasets**

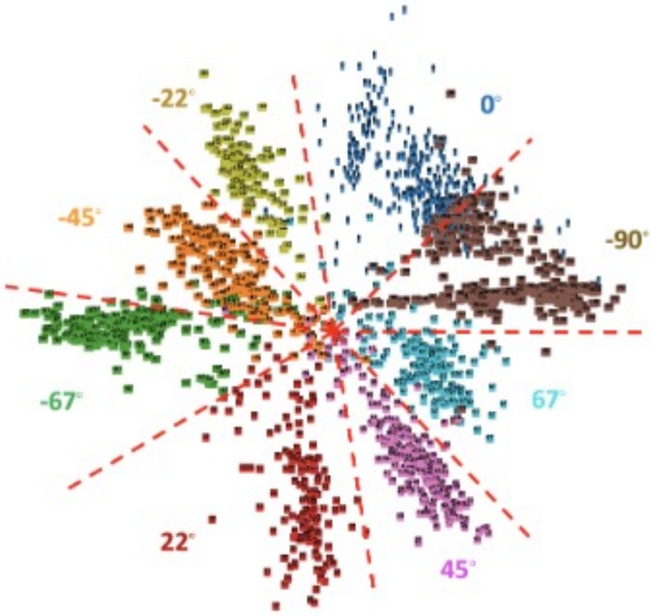
Method	ICDAR2015			UCAS-AOD				MLT		
	Recall	Precision	Hmean	car(07/12)	plane(07/12)	mAP_{50} (07)	mAP_{50} (12)	Recall	Precision	Hmean
RetinaNet-Reg	81.49	83.29	82.38	87.28/90.79	90.42/97.52	88.85	94.16	55.70	**75.24**	64.01
RetinaNet-CSL	80.50	**87.40**	**83.81 (+1.43)**	88.09/**92.93**	90.38/97.22	89.23 (+0.38)	95.07 (+0.91)	58.32	73.62	65.08 (+1.07)
RetinaNet-BCL	**81.61**	84.79	83.17 (+0.79)	**88.15**/92.35	**90.57/97.86**	**89.36 (+0.51)**	**95.10 (+0.94)**	**58.91**	73.14	**65.26 (+1.25)**

Ablation Experiments

- **Visualization**



(a) $\omega = 180/4$



(b) $\omega = 180/8$

Thank You!

- Paper: https://arxiv.org/abs/2011.09670
- Code: https://github.com/yangxue0827/RotationDetection
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