CornerNet——基于关键点的目标检测算法

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什么是目标检测？

定位（localization）：

图像识别（classification）：

R-CNN (2013.11) → OverFeat (ICLR' 14) → MultiBox (CVPR' 14) → SPP-Net (ECCV' 14) → MR-CNN (ICCV' 15) → DeepBox (ICCV' 15) → AttentionNet (ICCV' 15) →

Fast R-CNN (ICCV' 15) → DeepProposal (ICCV' 15) → Faster R-CNN (NIPS' 15) → OHEM (CVPR' 16) → YOLO v1 (CVPR' 16) → G-CNN (CVPR' 16) → AZNet (CVPR' 16) →

Inside-OutsideNet(ION) (CVPR' 16) → HyperNet (CVPR' 16) → CRAFT (CVPR' 16) → MultiPathNet(MPN) (BMVC' 16) → SSD (ECCV' 16) → GBDNet (ECCV' 16) →

CPF (ECCV' 16) → MS-CNN (ECCV' 16) → R-FCN (NIPS' 16) → PVANET (NIPSW' 16) → DeepID-Net (PAMI' 16) → NoC (TPAMI' 16) → DSSD (arXiv' 17) → TDM (CVPR' 17) → YOLO v2 (CVPR' 17) →

Feature Pyramid Net(FPN) (CVPR' 17) → RON (CVPR' 17) → DCN (ICCV' 17) → DeNet (ICCV' 17) → CoupleNet (ICCV' 17) → RetinaNet (ICCV' 17) → DSOD (ICCV' 17) →

Mask R-CNN (ICCV' 17) → SMN (ICCV' 17) → YOLO v3 (arXiv' 18) → SIN (CVPR' 18) → STDN (CVPR' 18) → RefineDet (CVPR' 18) → MLKP (CVPR' 18) → Relation-Net (CVPR' 18) →

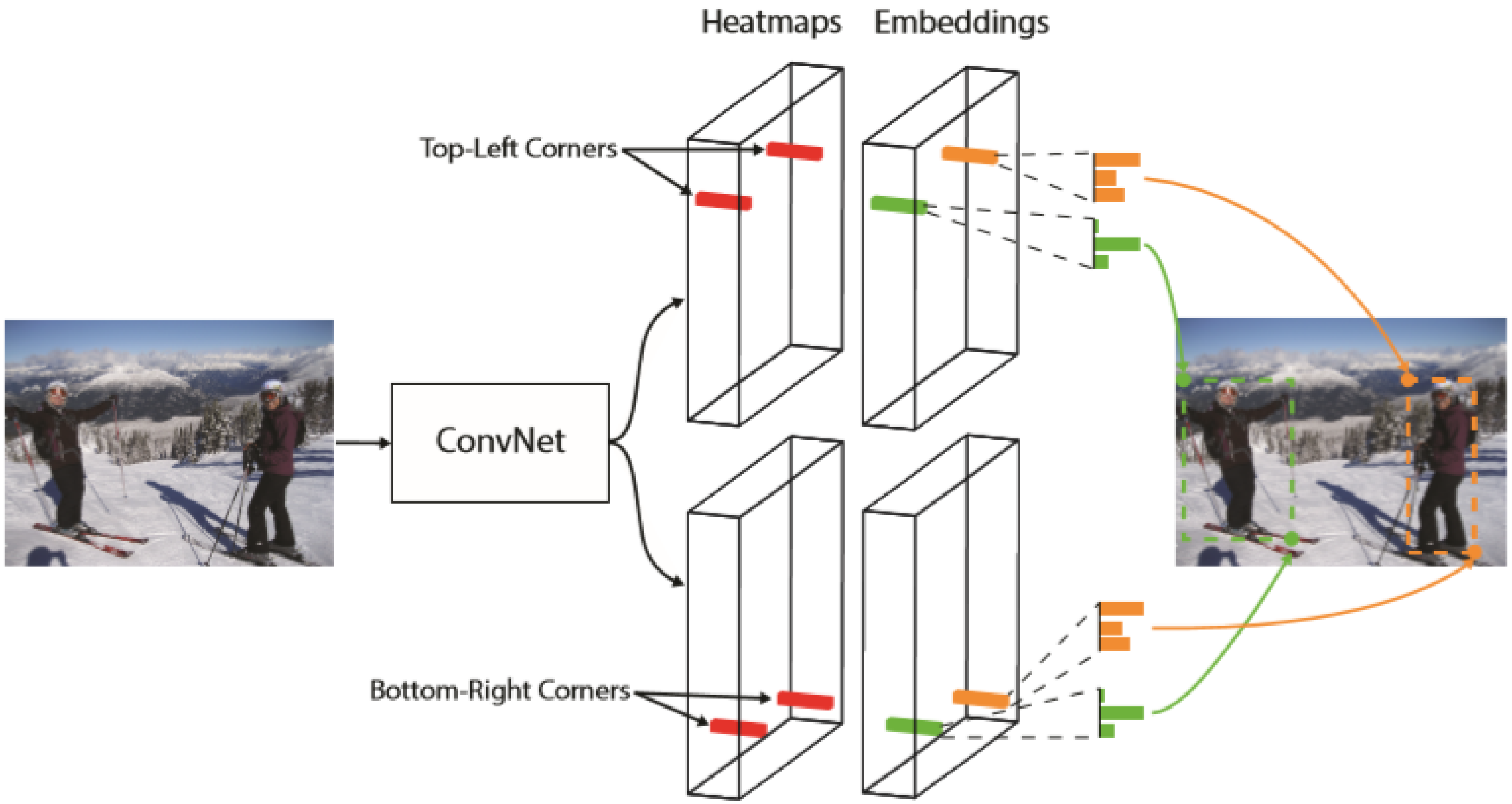
Cascade R-CNN (CVPR' 18) → RFBNet (ECCV' 18) → CornerNet (ECCV' 18) → PFPNet (ECCV' 18) → Pelee (NIPS' 18) → HKRM (NIPS' 18) → R-DAD (AAAI' 19) → M2Det (AAAI' 19) ···

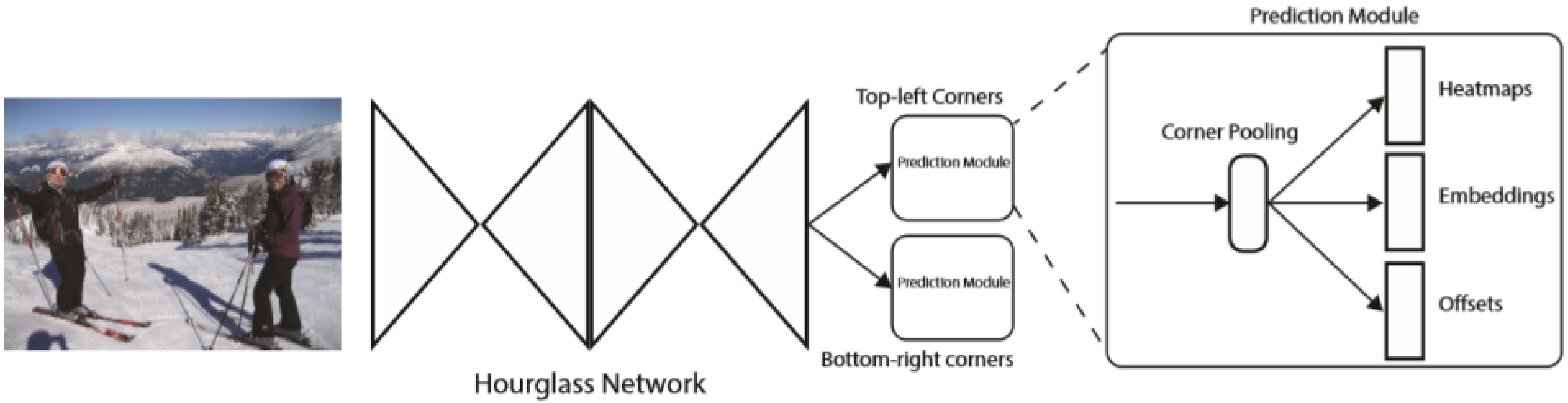
CornerNet: Detecting Objects as Paired Keypoints

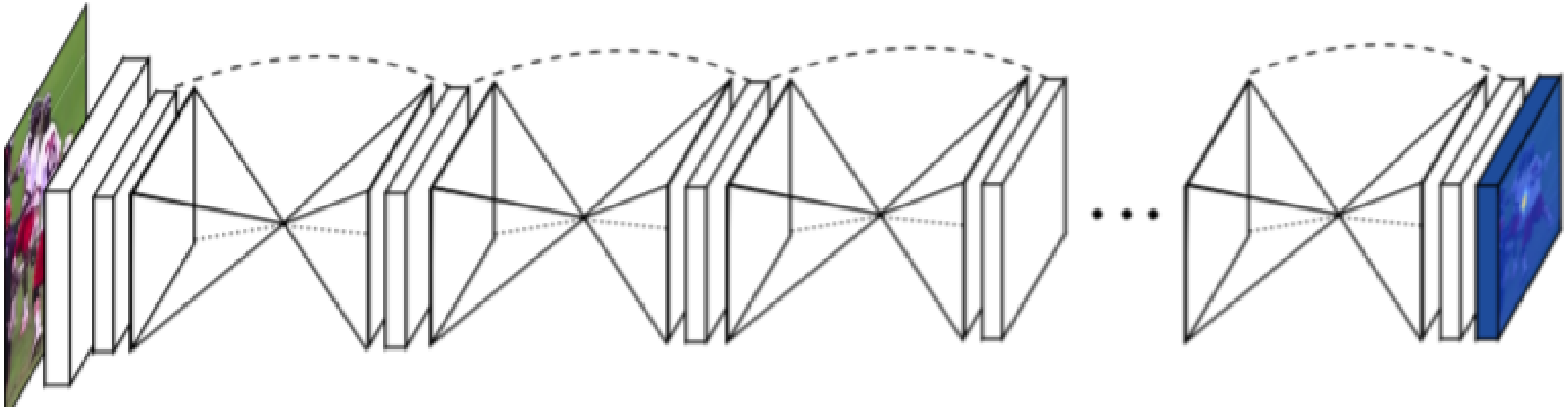
Abstract :We propose CornerNet, a new approach to object detection where we detect an object bounding box as a pair of keypoints, the top-left corner and the bottom-right corner, using a single convolution neural network. By detecting objects as paired keypoints, we eliminate the need for designing a set of anchor boxes commonly used in prior single-stage detectors. In addition to our novel formulation, we introduce corner pooling, a new type of pooling layer that helps the network better localize corners. Experiments show that CornerNet achieves a 42.2% AP on MS COCO, outperforming all existing one-stage detectors.

H. Law and J. Deng. Cornernet: Detecting objects as paired keypoints. In Proceedings of the European Conference on Computer Vision (ECCV), pages 734–750, 2018.

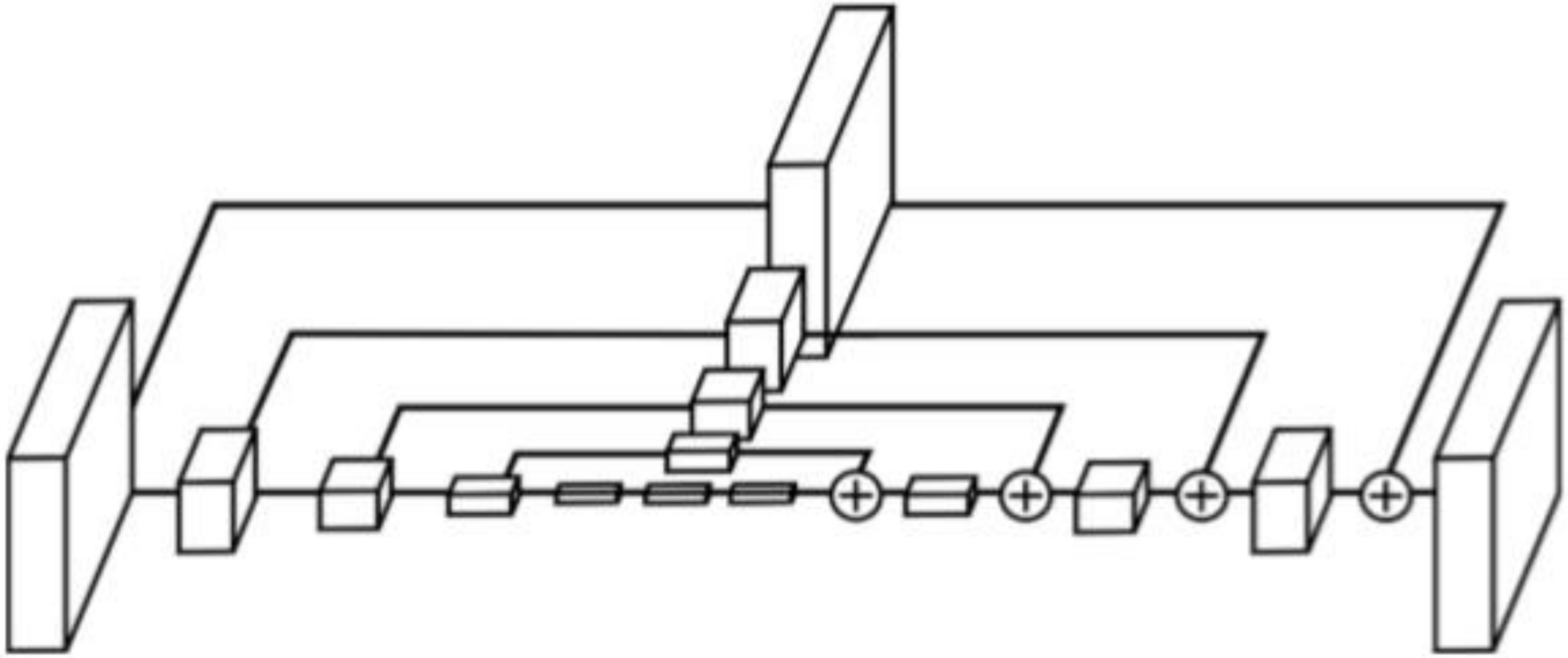
CornerNet: Detecting Objects as Paired Keypoints


Heatmaps
Embeddings
Top-Left Corners
ConvNet
Bottom-Right Corners

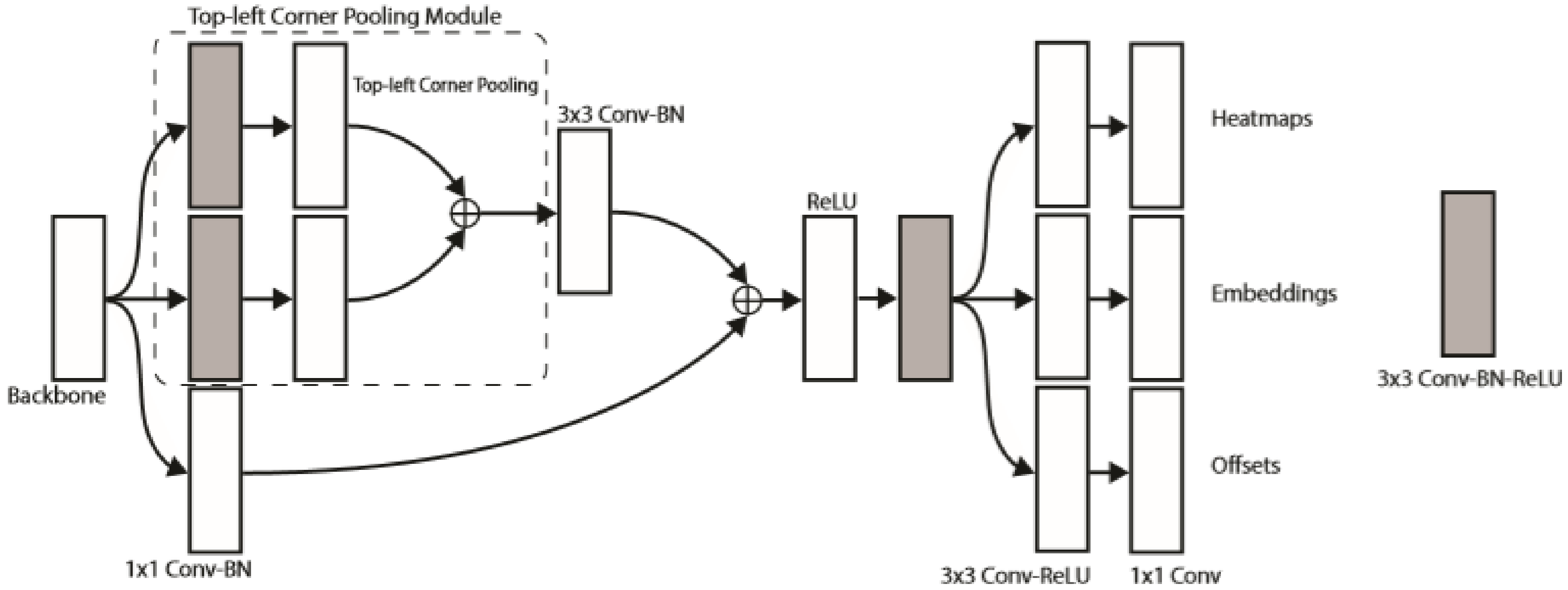


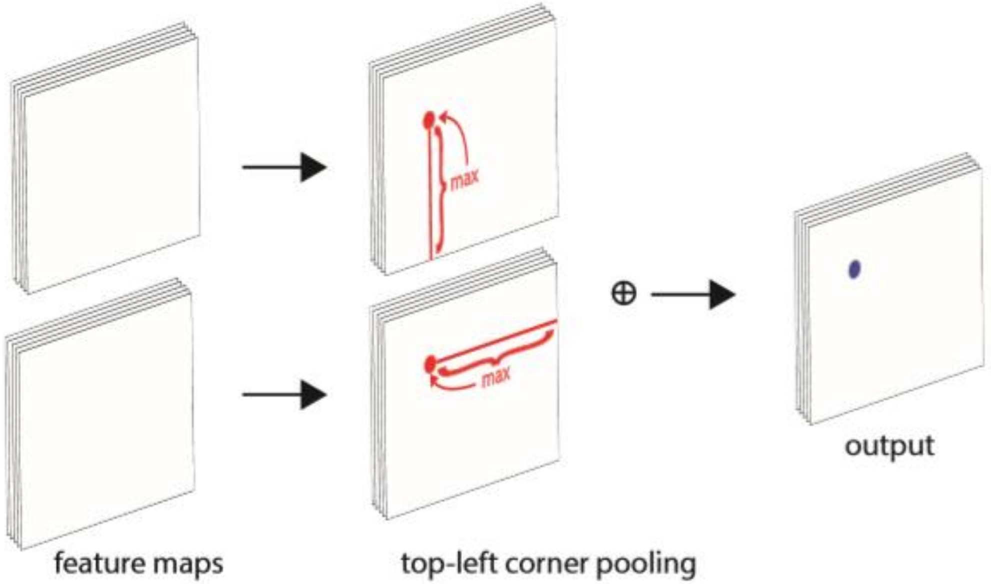


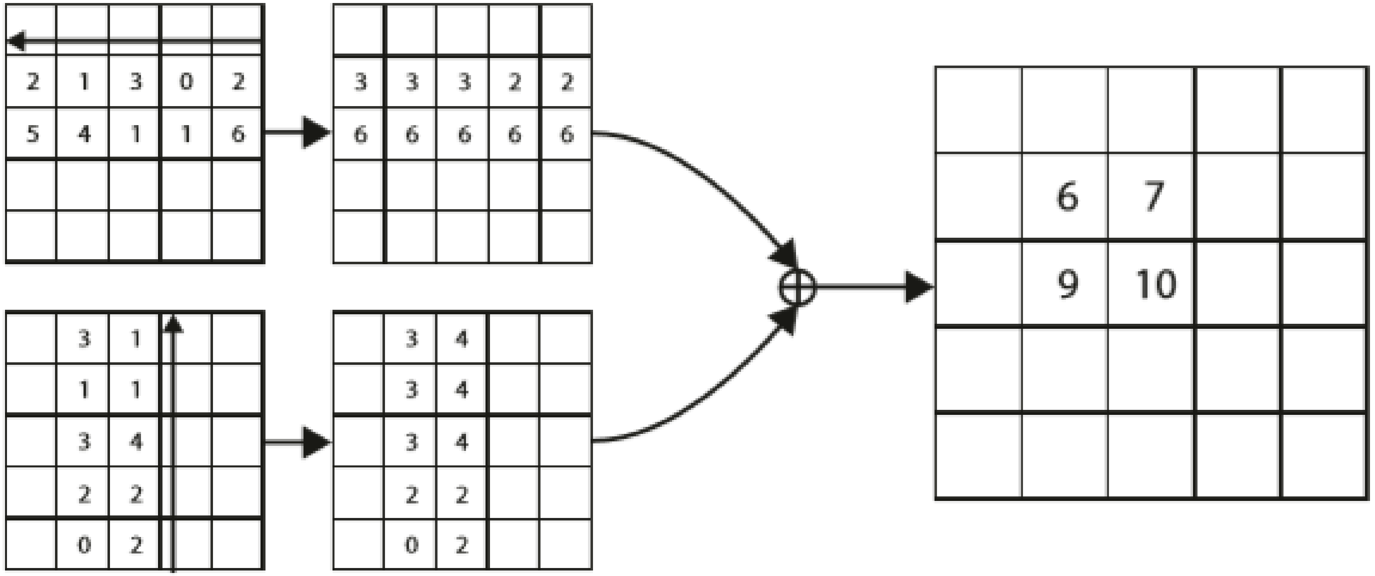
Newell, A., Yang, K., and Deng, J. (2016). Stacked hourglass networks for human pose estimation. In European Conference on Computer Vision, pages 483–499. Springer.



Prediction Module



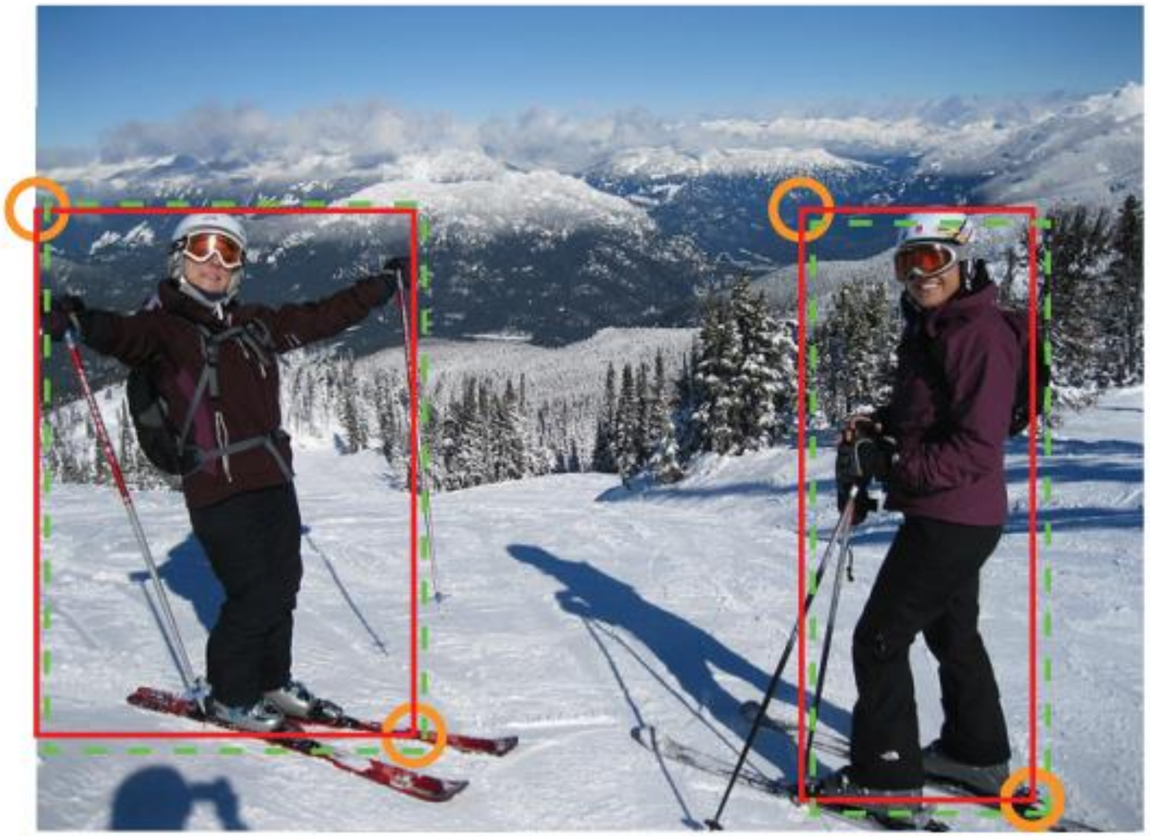




$$t_{ij} = \begin{cases} \max\left(f_{t_{ij}}, t_{(i+1)j}\right) & \text{if } i < H \\ f_{t_{Hj}} & \text{otherwise} \end{cases}$$

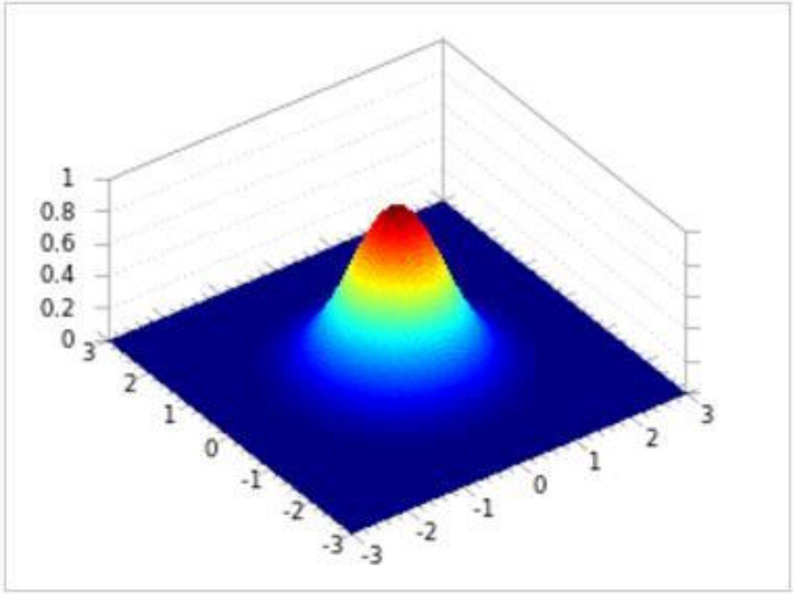
$$l_{ij} = \begin{cases} \max\left(f_{l_{ij}}, l_{i(j+1)}\right) & \text{if } j < W \\ f_{l_{iW}} & \text{otherwise} \end{cases}$$

CornerNet——corners



$$e^{\frac{-(x^2+y^2)}{2\sigma^2}}$$

$$\sigma=\frac{1}{3}r$$



$$L_{det} = \frac{-1}{N} \sum_{c=1}^{C} \sum_{i=1}^{H} \sum_{j=1}^{W} \begin{cases} (1-p_{cij})^{\alpha} \log(p_{cij}) & \text{if } y_{cij} = 1 \\ (1-y_{cij})^{\beta} (p_{cij})^{\alpha} \log(1-p_{cij}) & \text{otherwise} \end{cases}$$

平衡因子

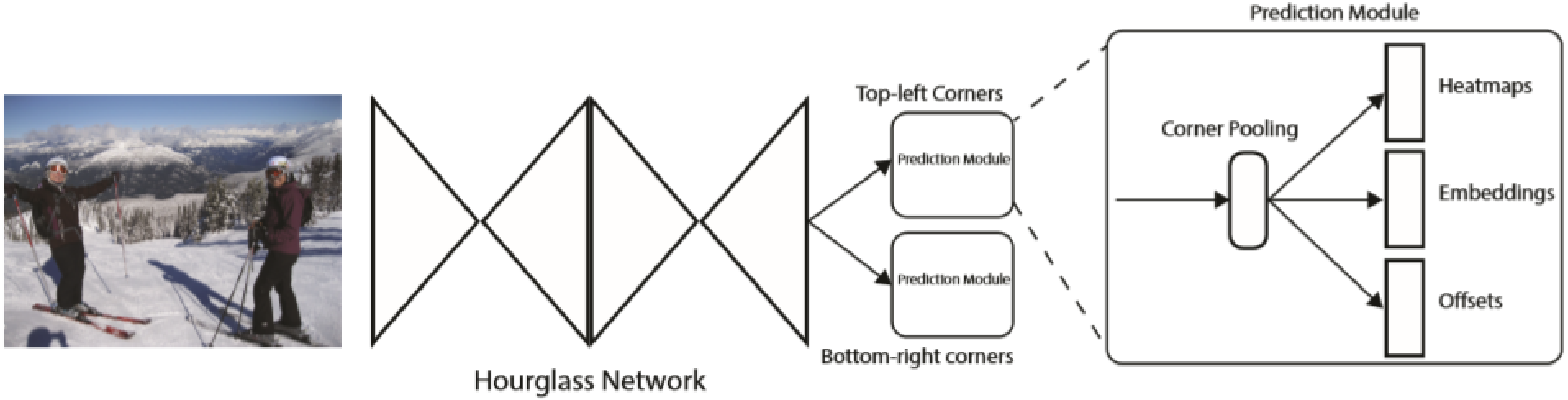
focal loss

- 样本类别分类不均衡
- 样本正负案例不均衡

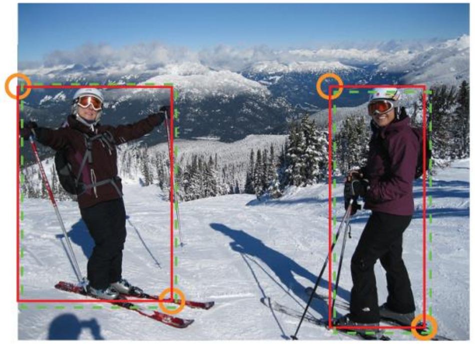
α=2,β=4

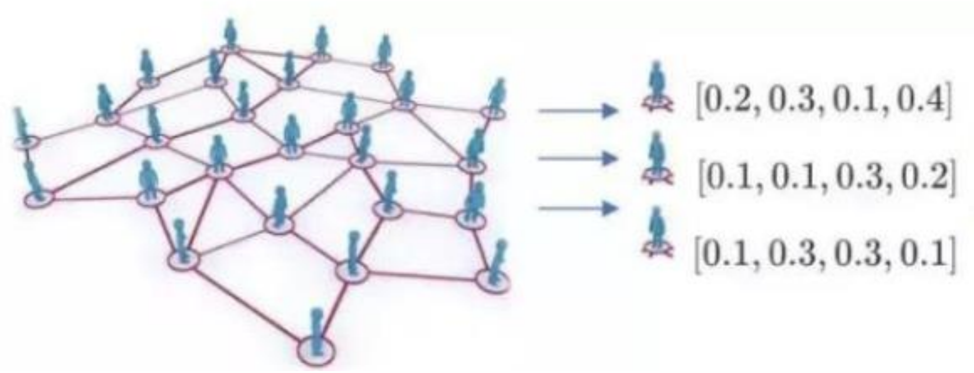
y_{cij} 是用非标准化高斯增强的ground-truth热图

p_{cij} 是预测热图中C类位置(i , j)的得分


Hourglass Network
Top-left Corners
Prediction Module
Prediction Module
Bottom-right corners
Prediction Module
Corner Pooling
Heatmaps
Embeddings
Offsets

Embedding and vector embedding

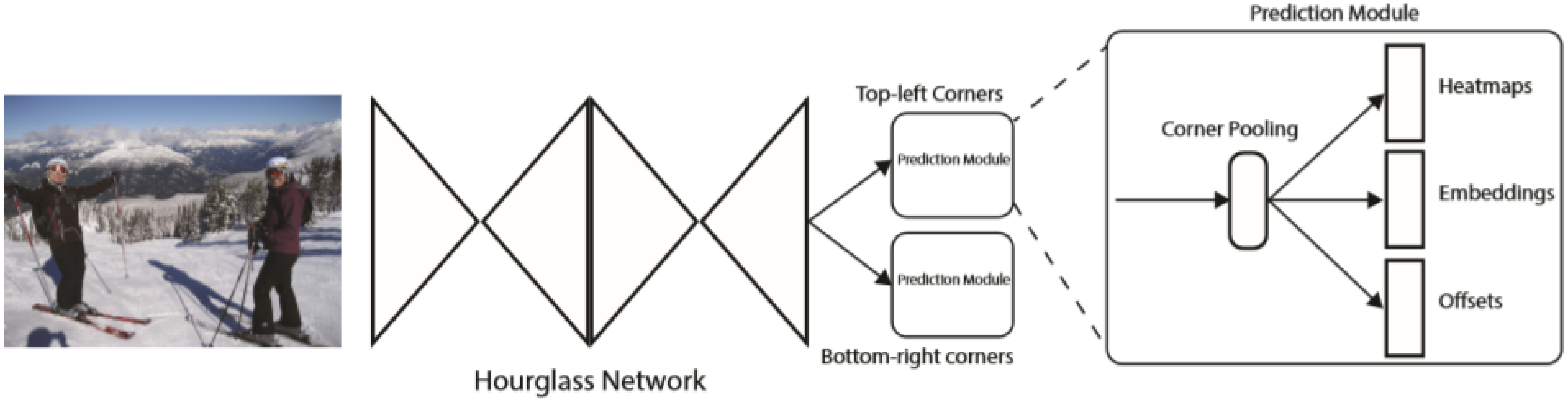




$$L_{pull} = \frac{1}{N}\sum_{k=1}^{N}\left[(e_{t_k} - e_k)^2 + (e_{b_k} - e_k)^2\right]$$

$$L_{push} = \frac{1}{N(N-1)}\sum_{k=1}^{N}\sum_{\substack{j=1 \\ j \neq k}}^{N} \max\left(0, \Delta - |e_k - e_j|\right)$$

Newell, A., Huang, Z., and Deng, J. (2017). Associative embedding: End-to-end learning for joint detection and grouping. In Advances in Neural Information Processing Systems, pages 2274–2284.



Prediction Module
Top-left Corners
Prediction Module
Prediction Module
Bottom-right corners
Hourglass Network
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(x,y) $\longrightarrow$ $\left(\lfloor \frac{x}{n} \rfloor, \lfloor \frac{y}{n} \rfloor\right)$

$$\boldsymbol{o}_k = \left(\frac{x_k}{n} - \left\lfloor \frac{x_k}{n} \right\rfloor, \frac{y_k}{n} - \left\lfloor \frac{y_k}{n} \right\rfloor\right)$$

$$L_{\text{off}} = \frac{1}{N} \sum_{k=1}^{N} \text{SmoothL1Loss}\left(\boldsymbol{o}_k, \hat{\boldsymbol{o}}_k\right)$$

$$L = L_{det} + \alpha L_{pull} + \beta L_{push} + \gamma L_{off}$$

α=0.1,β=0.1,γ=1

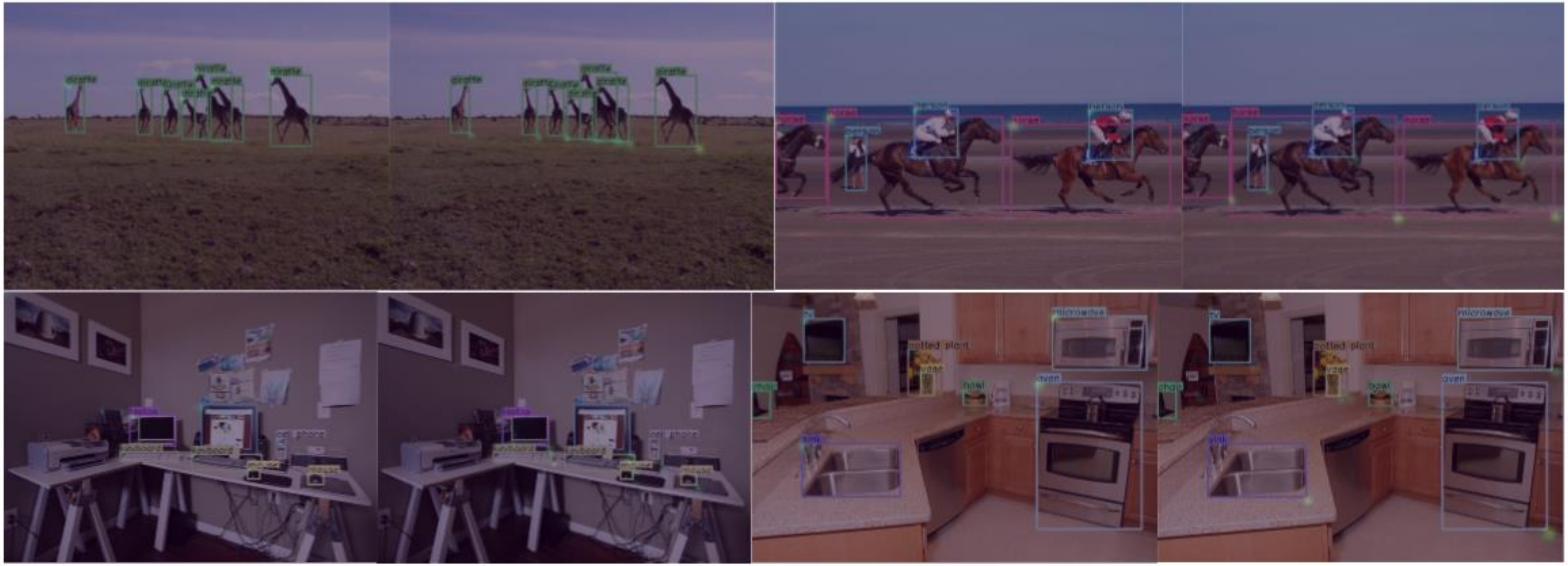
$$L_{det} = \frac{-1}{N} \sum_{c=1}^{C} \sum_{i=1}^{H} \sum_{j=1}^{W} \begin{cases} (1-p_{cij})^{\alpha} \log(p_{cij}) & \text{if } y_{cij}=1 \\ (1-y_{cij})^{\beta} (p_{cij})^{\alpha} \log(1-p_{cij}) & \text{otherwise} \end{cases}$$

$$L_{pull} = \frac{1}{N} \sum_{k=1}^{N} \left[(e_{t_k} - e_k)^2 + (e_{b_k} - e_k)^2 \right]$$

$$L_{push} = \frac{1}{N(N-1)} \sum_{k=1}^{N} \sum_{\substack{j=1 \\ j \neq k}}^{N} \max(0, \Delta - |e_k - e_j|)$$

$$L_{off} = \frac{1}{N} \sum_{k=1}^{N} \mathrm{SmoothL1Loss}(\boldsymbol{o}_k, \hat{\boldsymbol{o}}_k)$$

Method	Backbone	AP	AP^{50}	AP^{75}	AP^{s}	AP^{m}	AP^{l}	AR^{1}	AR^{10}	AR^{100}	AR^{s}	AR^{m}	AR^{l}
Two-stage detectors													
DeNet (Tychsen-Smith and Petersson, 2017a)	ResNet-101	33.8	53.4	36.1	12.3	36.1	50.8	29.6	42.6	43.5	19.2	46.9	64.3
CoupleNet (Zhu et al., 2017)	ResNet-101	34.4	54.8	37.2	13.4	38.1	50.8	30.0	45.0	46.4	20.7	53.1	68.5
Faster R-CNN by G-RMI (Huang et al., 2017)	Inception-ResNet-v2 (Szegedy et al., 2017)	34.7	55.5	36.7	13.5	38.1	52.0	-	-	-	-	-	-
Faster R-CNN+++ (He et al., 2016)	ResNet-101	34.9	55.7	37.4	15.6	38.7	50.9	-	-	-	-	-	-
Faster R-CNN w/ FPN (Lin et al., 2016)	ResNet-101	36.2	59.1	39.0	18.2	39.0	48.2	-	-	-	-	-	-
Faster R-CNN w/ TDM (Shrivastava et al., 2016)	Inception-ResNet-v2	36.8	57.7	39.2	16.2	39.8	52.1	31.6	49.3	51.9	28.1	56.6	71.1
D-FCN (Dai et al., 2017)	Aligned-Inception-ResNet	37.5	58.0	-	19.4	40.1	52.5	-	-	-	-	-	-
Regionlets (Xu et al., 2017)	ResNet-101	39.3	59.8	-	21.7	43.7	50.9	-	-	-	-	-	-
Mask R-CNN (He et al., 2017)	ResNeXt-101	39.8	62.3	43.4	22.1	43.2	51.2	-	-	-	-	-	-
Soft-NMS (Bodla et al., 2017)	Aligned-Inception-ResNet	40.9	62.8	-	23.3	43.6	53.3	-	-	-	-	-	-
LH R-CNN (Li et al., 2017)	ResNet-101	41.5	-	-	25.2	45.3	53.1	-	-	-	-	-	-
Fitness-NMS (Tychsen-Smith and Petersson, 2017b)	ResNet-101	41.8	60.9	44.9	21.5	45.0	57.5	-	-	-	-	-	-
Cascade R-CNN (Cai and Vasconcelos, 2017)	ResNet-101	42.8	62.1	46.3	23.7	45.5	55.2	-	-	-	-	-	-
D-RFCN + SNIP (Singh and Davis, 2017)	DPN-98 (Chen et al., 2017)	45.7	67.3	51.1	29.3	48.8	57.1	-	-	-	-	-	-
One-stage detectors													
YOLOv2 (Redmon and Farhadi, 2016)	DarkNet-19	21.6	44.0	19.2	5.0	22.4	35.5	20.7	31.6	33.3	9.8	36.5	54.4
DSOD300 (Shen et al., 2017a)	DS/64-192-48-1	29.3	47.3	30.6	9.4	31.5	47.0	27.3	40.7	43.0	16.7	47.1	65.0
GRP-DSOD320 (Shen et al., 2017b)	DS/64-192-48-1	30.0	47.9	31.8	10.9	33.6	46.3	28.0	42.1	44.5	18.8	49.1	65.0
SSD513 (Liu et al., 2016)	ResNet-101	31.2	50.4	33.3	10.2	34.5	49.8	28.3	42.1	44.4	17.6	49.2	65.8
DSSD513 (Fu et al., 2017)	ResNet-101	33.2	53.3	35.2	13.0	35.4	51.1	28.9	43.5	46.2	21.8	49.1	66.4
RefineDet512 (single scale) (Zhang et al., 2017)	ResNet-101	36.4	57.5	39.5	16.6	39.9	51.4	-	-	-	-	-	-
RetinaNet800 (Lin et al., 2017)	ResNet-101	39.1	59.1	42.3	21.8	42.7	50.2	-	-	-	-	-	-
RefineDet512 (multi scale) (Zhang et al., 2017)	ResNet-101	41.8	62.9	45.7	25.6	45.1	54.1	-	-	-	-	-	-
CornerNet511 (single scale)	Hourglass-104	40.6	56.4	43.2	19.1	42.8	54.3	35.3	54.7	59.4	37.4	62.4	77.2
CornerNet511 (multi scale)	Hourglass-104	42.2	57.8	45.2	20.7	44.8	56.6	36.6	55.9	60.3	39.5	63.2	77.3


giraffe
microwave
potted plant
oven
bowl

CornerNet 实现参考:

https://blog.csdn.net/qq_36492210/article/details/84993195
https://github.com/princeton-vl/CornerNet-Lite
https://github.com/princeton-vl/CornerNet