Project page at https://www.mpi-inf.mpg.de/wsob

Weakly Supervised Object Boundaries

Anna Khoreva[1] Rodrigo Benenson[1] Mohamed Omran[1] Matthias Hein[2] Bernt Schiele[1]

[1] Max Planck Institute for Informatics, Saarbrücken, Germany

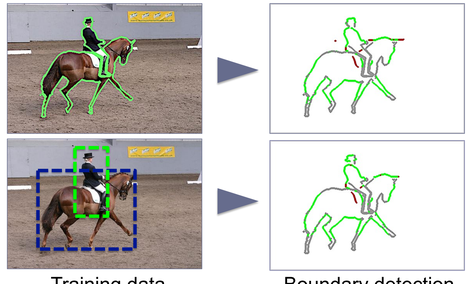
[2] Saarland University, Saarbrücken, Germany

Motivation

Goal: High quality object boundaries from bounding box annotations.

Full supervision
Significant annotation effort is required.

Weak supervision
Bounding box annotation requires 2 clicks per object.



Training data Boundary detection

Framework

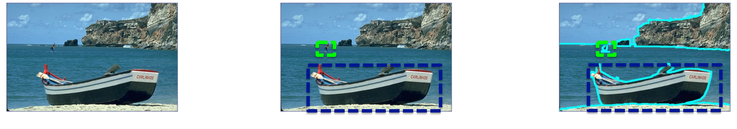
Boundary detection tasks:

Generic boundaries | Object-specific boundaries | Class-specific object boundaries

BSDS [Martin et al., ICCV'01] | VOC [Everingham et al., IJCV'15] | COCO [Lin et al., ECCV'14] | SBD [Hariharan et al., ICCV'11]

Levels of supervision:

Fully unsupervised | Detection annotations | Detection and generic boundary annotations

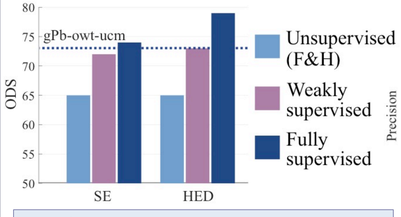


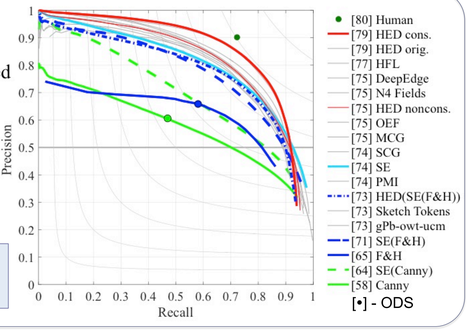
Baselines:

- SE: Structured Edge Forests [Dollar et al., PAMI'15]
- HED: Holistically-nested Edge Detection [Xie & Tu, ICCV'15]

Robustness to Annotation Noise

BSDS: generic boundaries





SE and HED are robust to annotation noise during training.

Weakly Supervised Boundary Annotations

Approach: Generate weakly supervised annotations to train boundary detector.

Ground truth

Combination of sources:

Detection bounding boxes [BBs, Fast-RCNN, Girshick, ICCV'15] | Graph-based segmentation [F&H, Felzenszwalb et al., IJCV'04] | Box driven segmentations [GrabCut, Rother et al., SIGGRAPH'04] | Object proposals [SeSe, Uijlings et al., IJCV'13], [MCG, Pont-Tuset et al., arXiv'15]

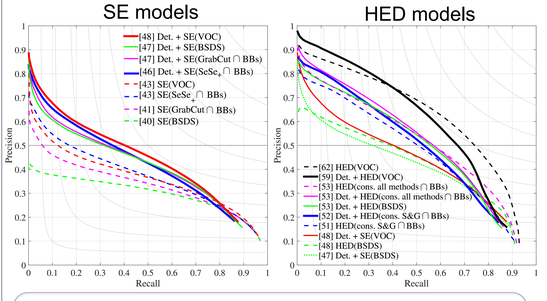
Generated annotations:

F&H ∧ BBs | SeSe ∧ BBs | SE(SeSe ∧ BBs) | consensus S&G ∧ BBs | consensus all methods ∧ BBs

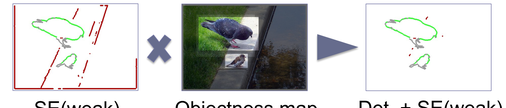
Positive boundaries | Ignore boundaries | Ignore region | Negative boundaries

Experimental Results

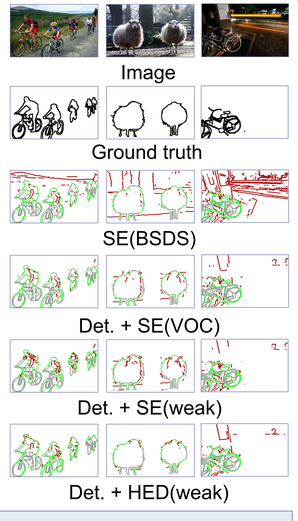
VOC: object-specific boundaries



Detection boxes at test time to improve boundaries

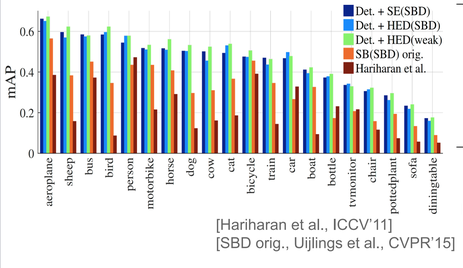


SE(weak) | Objectness map | Det. + SE(weak)



Weakly supervised object boundaries can reach the full supervision quality.

SBD: class-specific object boundaries



[Hariharan et al., ICCV'11]
[SBD orig., Uijlings et al., CVPR'15]

	Family	Method	mF	mAP
Other	GT	Hariharan et al.	28	21
SE	GT	SB(SBD) orig.	39	32
		SB(SBD)	43	37
		Det. + SE(SBD)	**51**	**45**
	Weakly super-vised	SB(SeSe ∧ BBs)	40	34
		SB(MCG ∧ BBs)	42	35
		Det. + SE(SeSe ∧ BBs)	48	42
		Det. + SE(MCG ∧ BBs)	**51**	**45**
HED	GT	HED(SBD)	44	41
		Det. + HED(SBD)	49	45
	Weakly super-vised	HED(cons. MCG ∧ BBs)	41	37
		HED(cons. S&G ∧ BBs)	44	39
		Det. + HED(cons. MCG ∧ BBs)	48	44
		Det. + HED(cons. S&G ∧ BBs)	**52**	**47**

While training an object detector one can also get high quality object boundary detector for free!