

# Finding Four-Leaf Clovers: A Benchmark for Fine-Grained Object Localization

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mIoU (%) (Left). Results for semantic segmentation.

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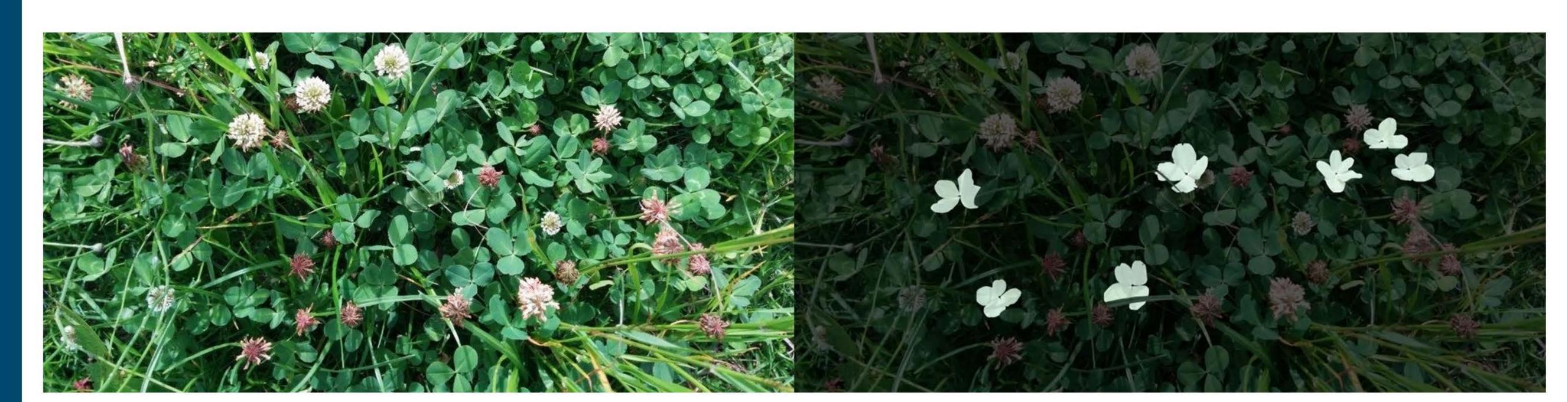
#### INTRODUCTION

Fine-grained object recognition is a challenging open problem, in which the goal is to distinguish subordinate categories within entry-level categories. In other words, fine-grained recognition and, specifically, fine-grained localization is akin to looking for a needle in a haystack.

A large variety of applications require the study not only of fine-grained object categorization, but also of fine-grained localization. Fine-grained localization is characterized by imbalanced problems with a small inter-class variance, and a large intra-class variation.

Our main contribution is to present a comprehensive experimental framework, with highly detailed annotations, for studying fine-grained object localization tasks. We introduce the Four-Leaf Clover (FLC) Dataset, a novel benchmark for studying five different fine-grained localization tasks: object detection, semantic segmentation, instance segmentation, instance parsing, and semantic boundary detection.

#### THE FLC DATASET



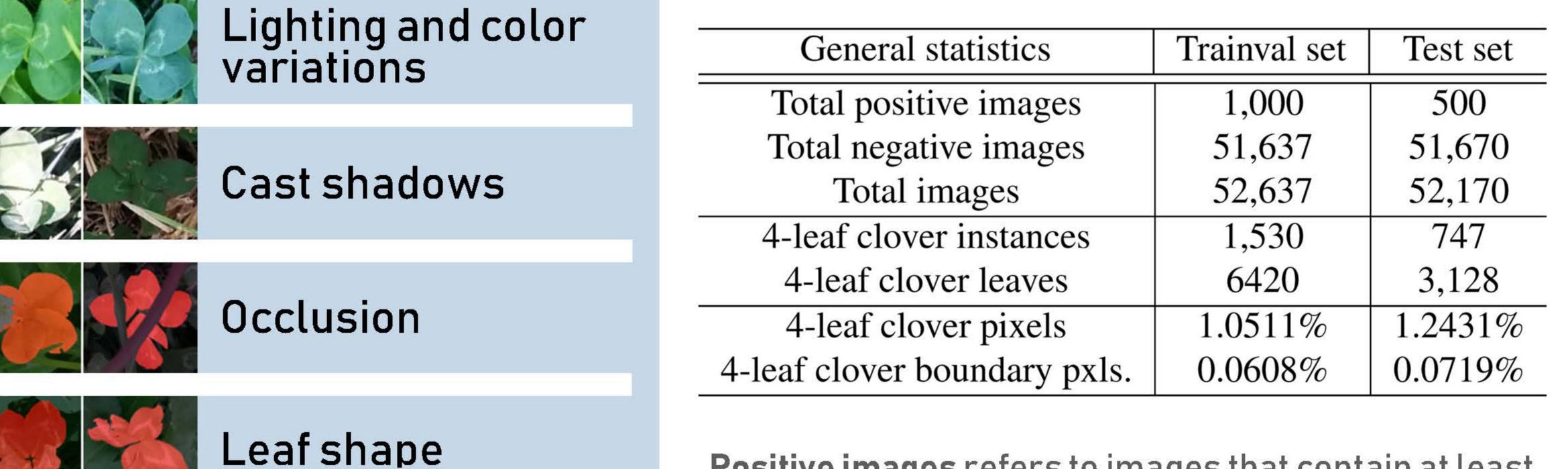
Dataset	Classification	Detection	Semantic Sem.	Instances	Boundaries	Parsing
Imagenet [1]	Δ	Δ	×	×	×	×
PASCAL [2]	$\triangle$	$\triangle$	$\triangle$	$\triangle$	$\triangle$	×
MS-COCO [3]	$\triangle$	$\triangle$	×	$\triangle$	×	×
DAVIS [4]	$\triangle$	$\triangle$	×	$\triangle$	×	×
ADE20K[5]	×	$\triangle$	$\triangle$	$\triangle$	×	$\triangle$
CityScapes [6]	×	$\triangle$	$\triangle$	$\triangle$	×	×
iNaturalist [7]	*	$\triangle$	×	×	×	×
Cats & Dogs [8]	*	$\triangle$	$\triangle$	×	×	×
CUB-200 [9]	*	$\triangle$	Δ	×	×	×
CompCars [10]	*	$\triangle$	×	×	×	×
VegFru [11]	*	×	×	×	×	×
CDVCE [12]	*	$\triangle$	×	×	×	×
FLC	×	*	*	*	4	*

Comparison of FLC to major visual recognition datasets. Clubs indicates that a dataset allows to study a recognition problem at a fine-grained level, triangle ( $\Delta$ ) indicates that the version of the problem is not finegrained, and (x) indicates that a dataset does not allow to study a problem.



Examples of the level of detail in segmentation annotations of the FLC dataset.

#### CHALLENGES OF THE FLCD DATASET STATISTICS



Positive images refers to images that contain at least one 4-leaf clover.

4-leaf clover pixels and 4-leaf clover boundary pixels refer to the rate of the total of positive pixels over the total of pixels in the FLCD.

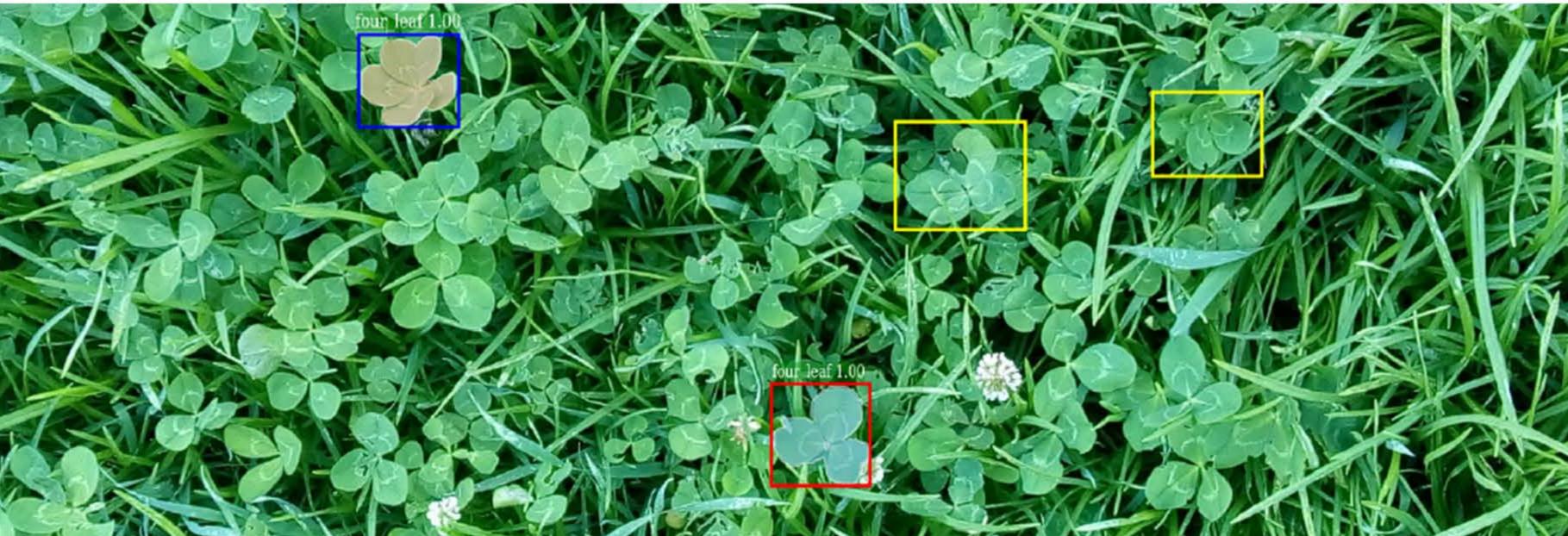
## TASKS



Semantic Boundary Detection

### EXPERIMENTS

			Note:	Object Detection						
Dataset	Method	mAP@.5(%)	mAP@[.5, .95] (%) all	mAP@[.5, .95] (%) small	mAP@[.5, .95] (%) medium	mAP@[.5, .95] (%) large				
	Mask R-CNN ResNet50+FPN	56.4	35.6	0.0	29.6	35.8				
HILC test (Hill)	Mask R-CNN ResNet50+FPN	6.20	4.10	0.0	0.00	8.0				



Leaf 3D orientation

Different clover

(Top). results using Mask R-CNN for the task of detection.

shows one false positive (red), two false negatives

#### EXPERIMENTS

#### Semantic Segmentation

FLC (Positives) FLC	MaskR-CNN R50 MaskR-CNN R50	32.71 7.71	(Bottom-left). Qualitative result on the test set.	(Bottom-right). Annot tions of same imag	





#### Instance Segmentation

Method

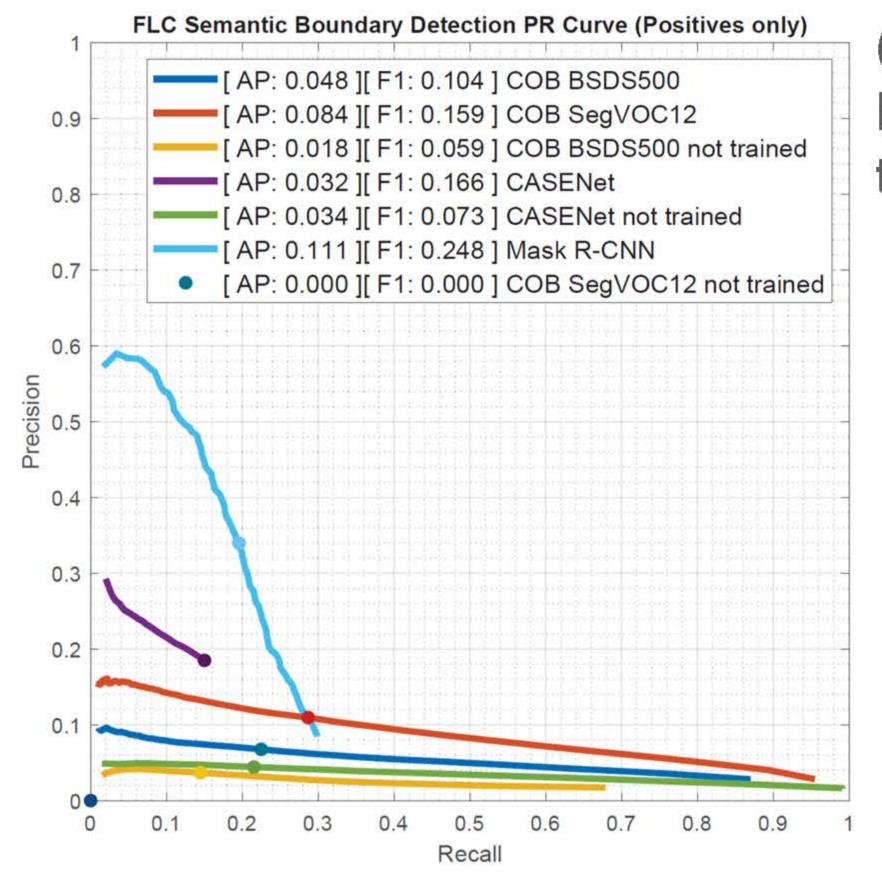
Dataset	Method	mAP@[.5,.95](%	
FLC (Positives)	MaskR-CNN R50	39.9	
FLC (Full)	MaskR-CNN R50	4.7	



Object Parsing				
Dataset	Method	mAP@[.5,.95] (%		
FLC (Positives)	MaskR-CNN R50	41.73		
FLC (Full)	MaskR-CNN R50	1.3		

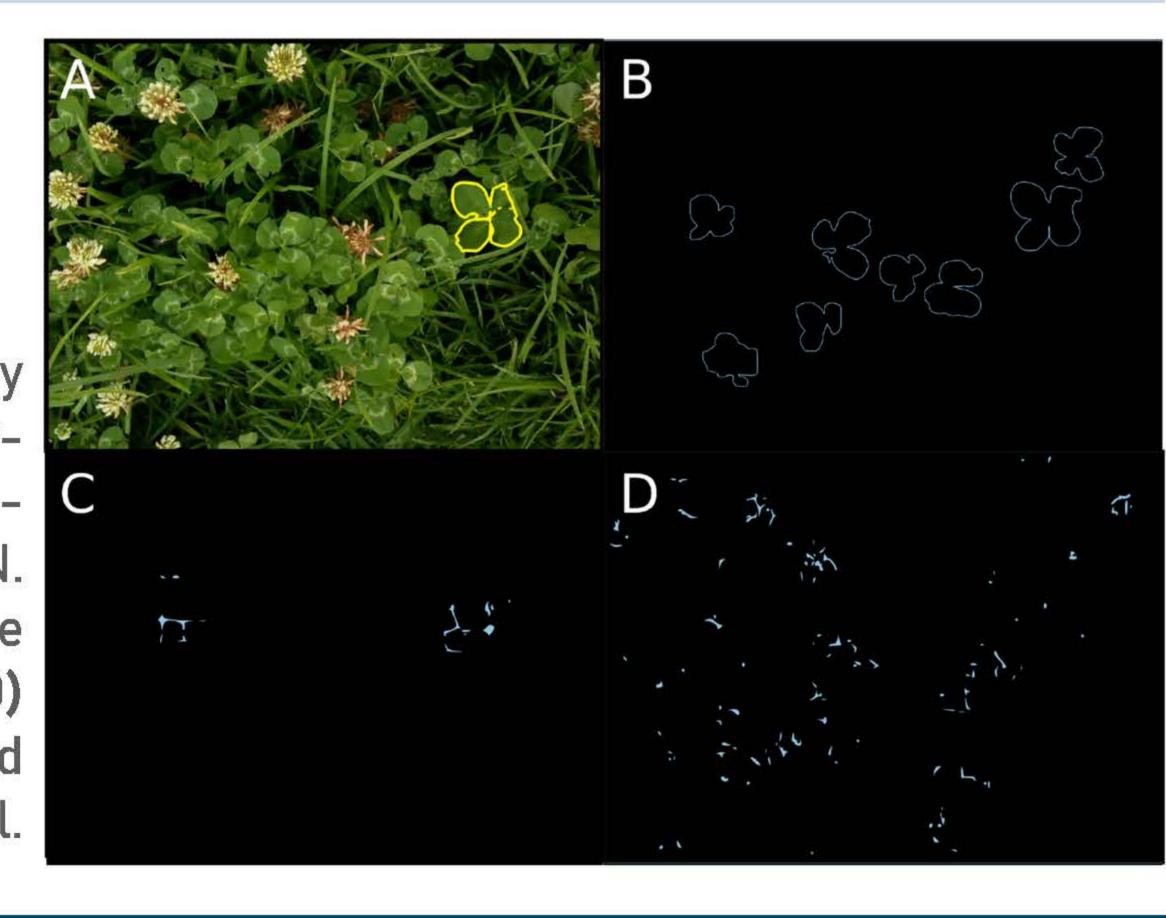


#### **Semantic Boundary Detection**



Boundary detection task PR curves.

(Right). (A) boundary annotation of a fourleaf clover. (B) Result of Mask R-CNN. (C) Result of the CASENet model. (D) Result of the trained COB model.



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[9] Welinder et al. Caltech-UCSD Birds 200. TechnicalReport CNS-TR-2010-001. Caltech. 2010 [10] Yang et al. A large-scale car dataset for fine-grained categorization and verification. CVPR, 2015 [11] Hou et al. Vegfru: A domain-specific dataset for fine-grained visual categorization. ICCV, 2017 [12] Gebru et al. Fine-grained car detection for visual census estimation. AAAI, 2017

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