CS512 - Project presentation

Camouflaged Object Detection

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Camouflaged Object Detection (COD)

What is it?

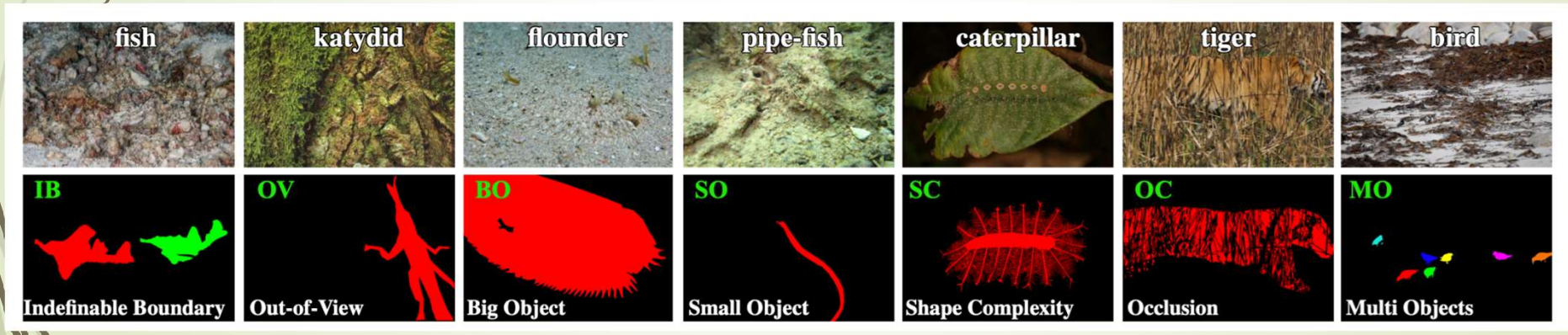
Task: Identify objects that are seamlessly embedded in their surroundings.

Difficulty: High intrinsic similarities between the target object and the background.

Other tasks: Generic Object Detection, Salient Object Detection

Motivation:

Solving this problem is very beneficial for applications in the fields of computer vision (e.g., for search-and-rescue work, or rare species discovery), medical image segmentation, agriculture (locust detection to prevent invasion), art, etc



COD10K dataset

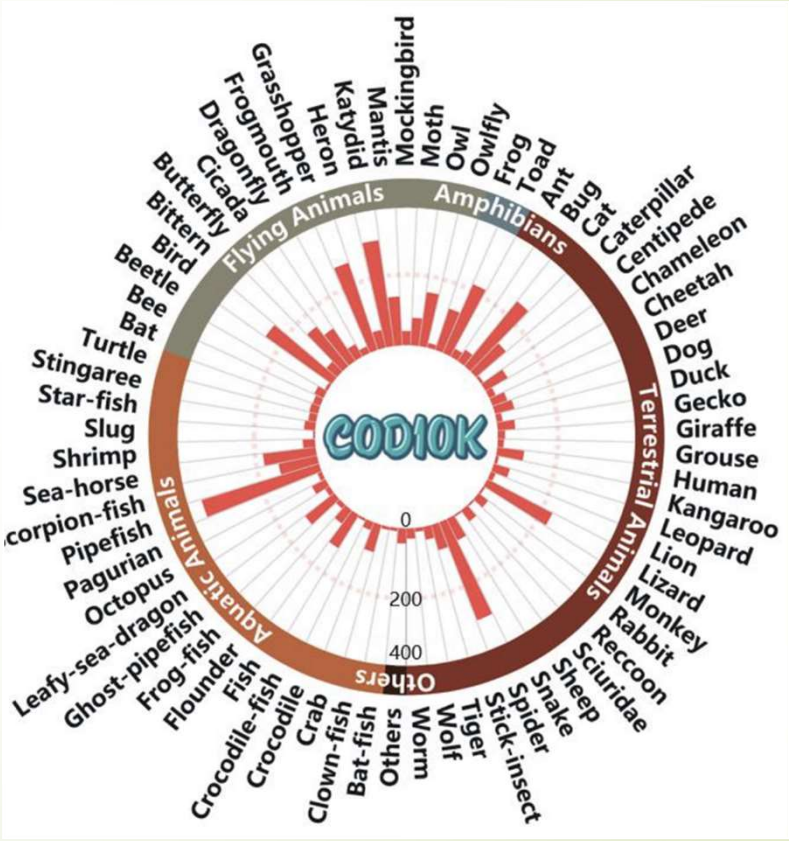
CHAMELEON 2018 : Has only 76 images with manually annotated object-level ground-truths.

CAMO 2019 : 2500 images covering eight categories.

COD10K 2020 : 6000 images for training and 4000 images for testing, randomly chosen from the entire dataset.

Images categories :

- **Camouflaged Objects**
- **Non-Camouflaged Objects**
- **Background Objects**



Model Intuition

The model is inspired by the hunting operation of a predator. Biologists have shown that a predator will first identify whether a potential prey exists (search), then identify (identification) the target, and finally catch it.

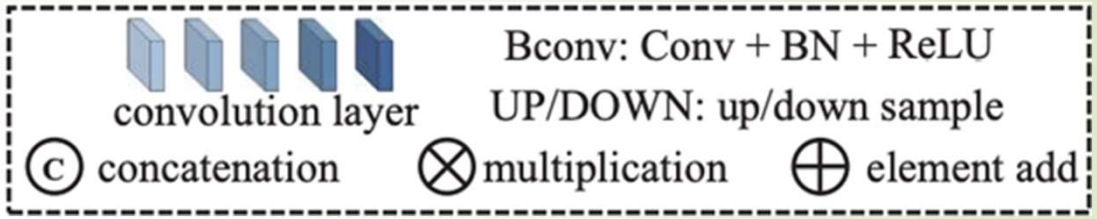
The model simulates the first two stages of hunting, including:

A Search Module: SM
Which is responsible for searching a camouflaged object.

An Identification Module: IM
Which is used to precisely detect the camouflaged object.

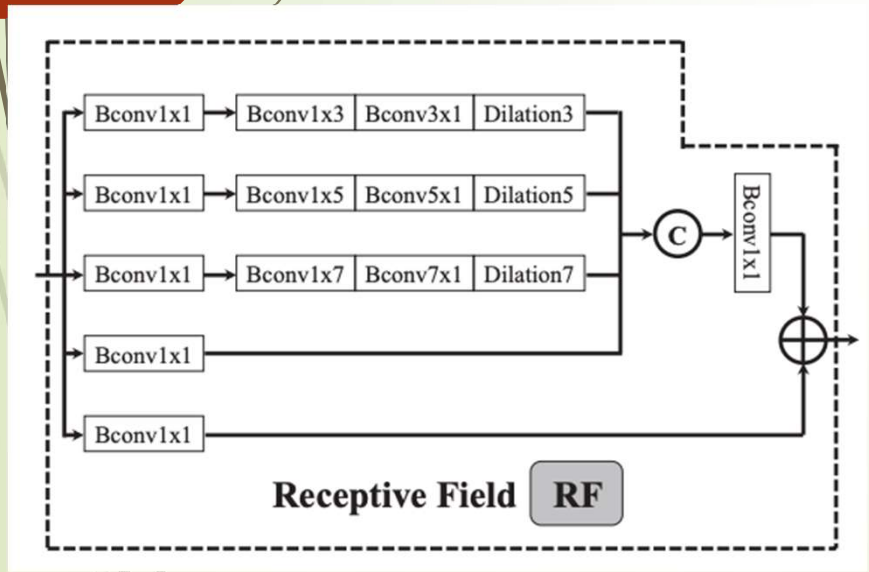
Model components

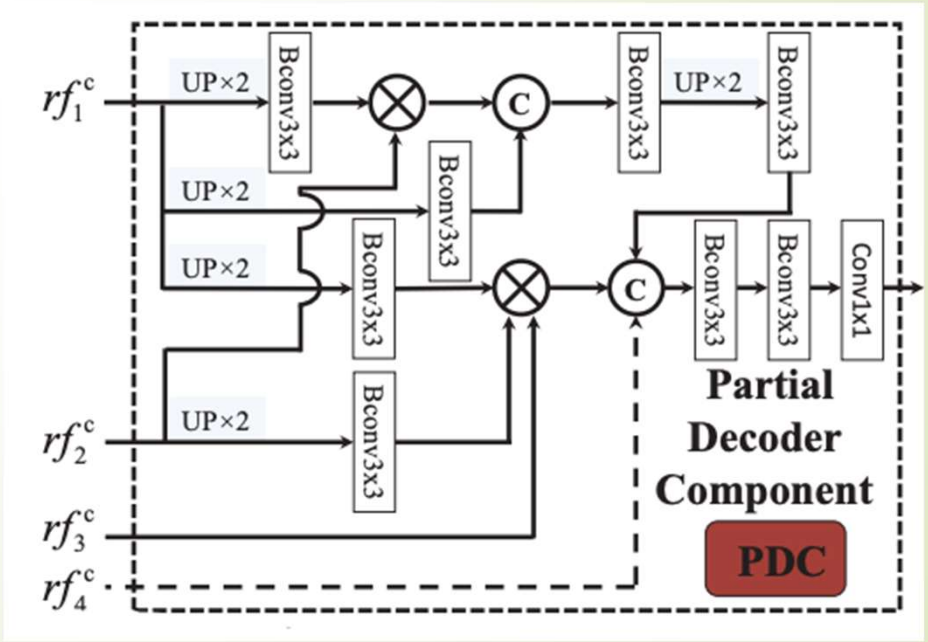
- Implemented using the Keras Functional API
- Blue layers from ResNet50 pre-trained on ImageNet



Reproduces the search and identification stages of animal predation.

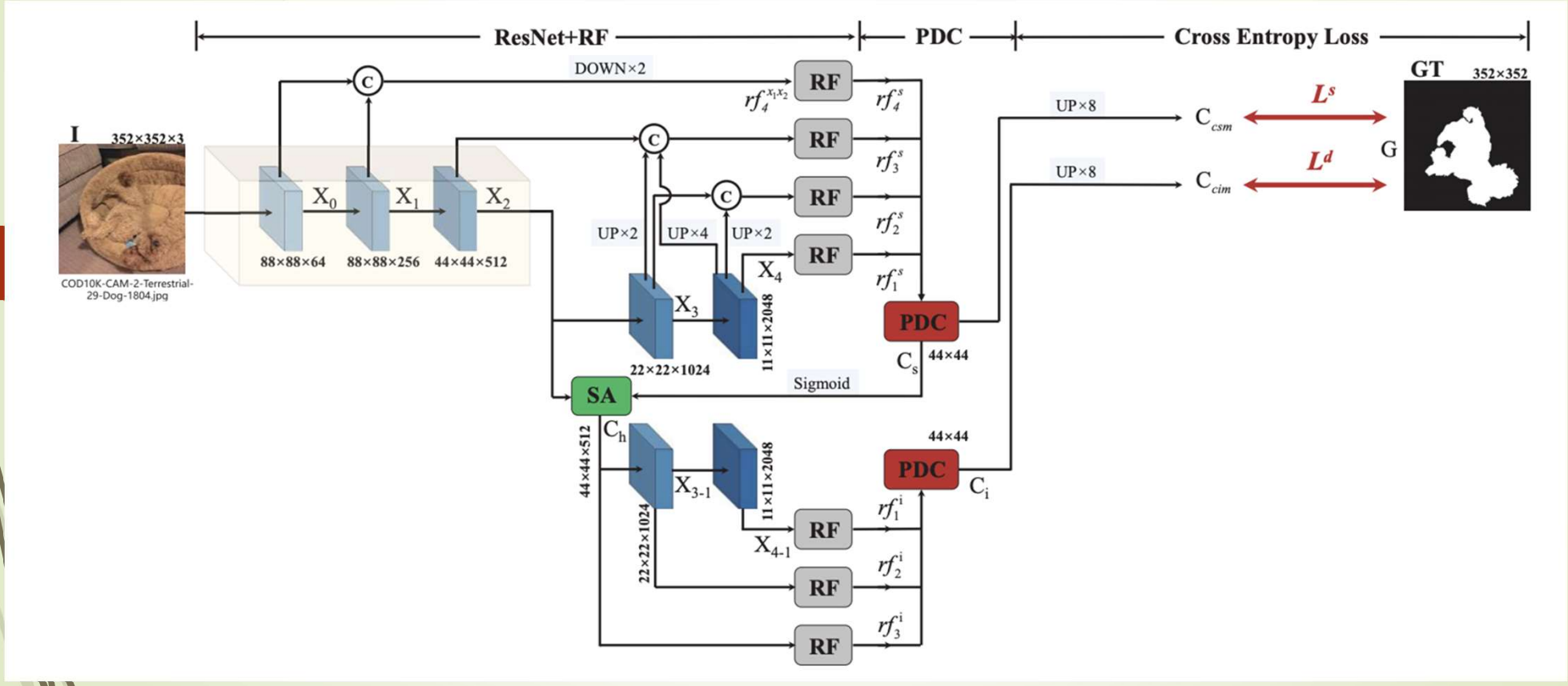
Mimics the structure of RFs in the human visual system





SINet Model

Search Attention (SA) : An attention mechanism that eliminates interference from irrelevant features. By applying a convolution with a Gaussian filter



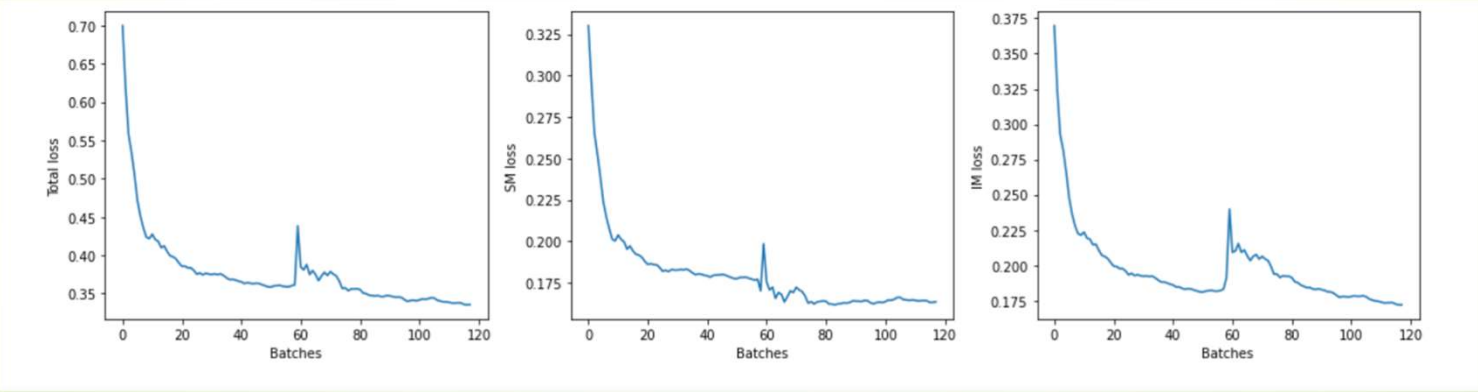
Loss Functions & Training

The model uses the Cross-entropy loss

Total loss: $L = L^{s}_{CE}(C_{csm}, G) + L^{i}_{CE}(C_{cim}, G)$

Training parameters:

- Epochs: 40
- Batch size: 20
- Optimizer: Adam
- Learning rate: 1e-4

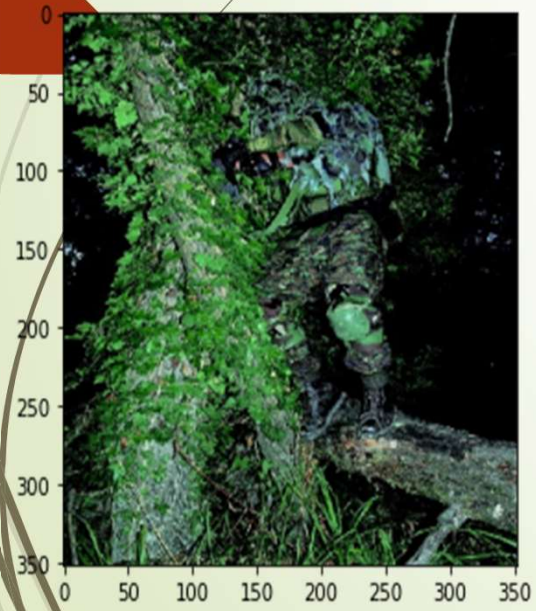


Results & Training time

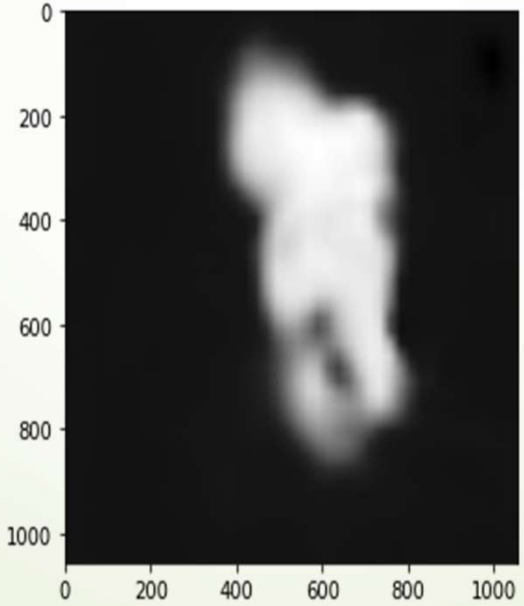
Training on Kaggle: Tesla P100-PCIE-16GB GPU

The result after training for 40 epochs over the dataset. (2 hours):

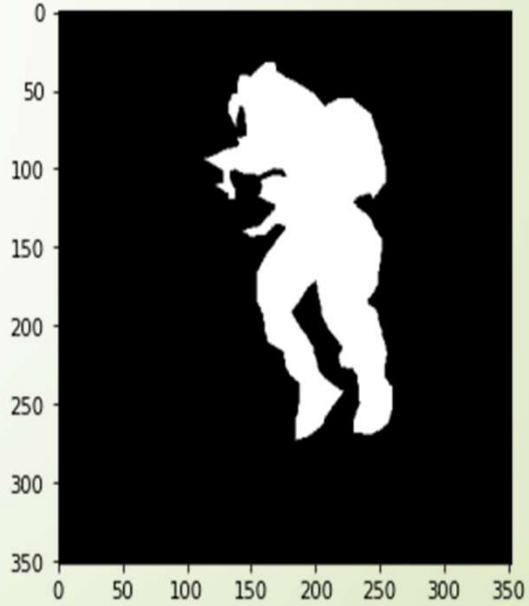
Input image



Model's result



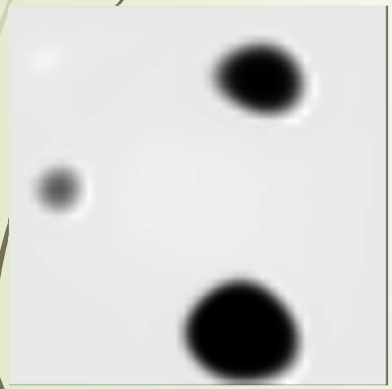
Ground truth



Progression over time

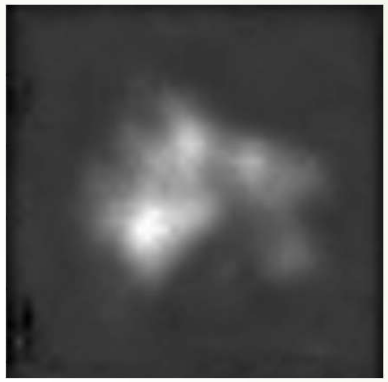
Input image:

One seahorse camouflaged between sea algae of the same color.



Result 1:

After training for 2 epochs over the dataset.



Result 2:

After training for 40 epochs over the dataset. (2 hours)

Problems and Further improvements:

Two problems:

- **Search Attention function: SA** $C_h = f_{max}(g(\mathcal{X}_2, \sigma, \lambda), C_s),$

  f_max, a maximum function that highlights the initial camouflage regions of Cs: difficult to implement in Keras.

- **Loading resnet50 weights**:

  The SINet architecture uses an old version of ResNet50, with slight modifications in the layers => weights loading problems.

References:

Original paper:

https://openaccess.thecvf.com/content_CVPR_2020/papers/Fan_Camouflaged_Object_Detection_CVPR_2020_paper.pdf

Pytorch implementation of SINet:

https://github.com/DengPingFan/SINet/tree/master/Src

Video explanation of Camouflaged Object Detection:

https://www.youtube.com/watch?v=0MKrTekrPUQ

Thank you

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