CS 395T Visual Recognition
Learning to Detect a Salient Object

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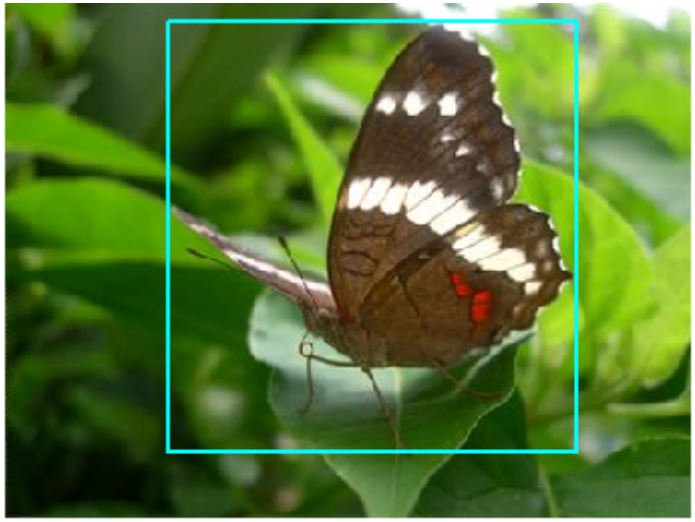
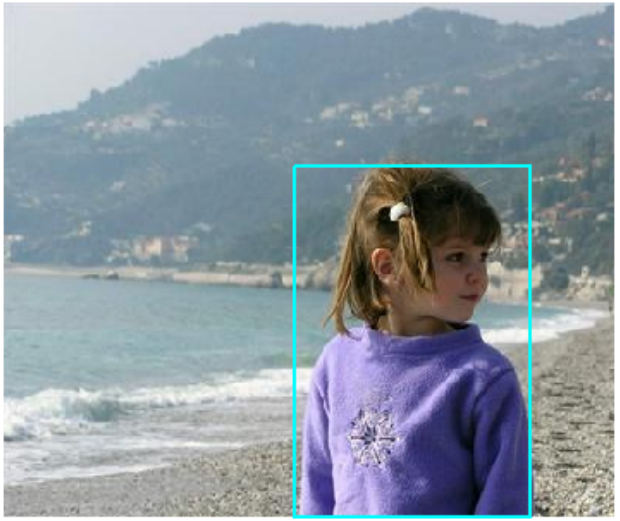
Goal of this paper

- Detect the (unique) salient object in an image





- Applications
  - Image resizing
  - Object recognition

Overview

- General steps
- MSRA dataset
- Different salient feature maps
- CRF inference & learning
- Results
- Multiple salient object detection
- Conclusions

MSRA dataset

- 20000 images with user labeled bounding boxes of salient objects

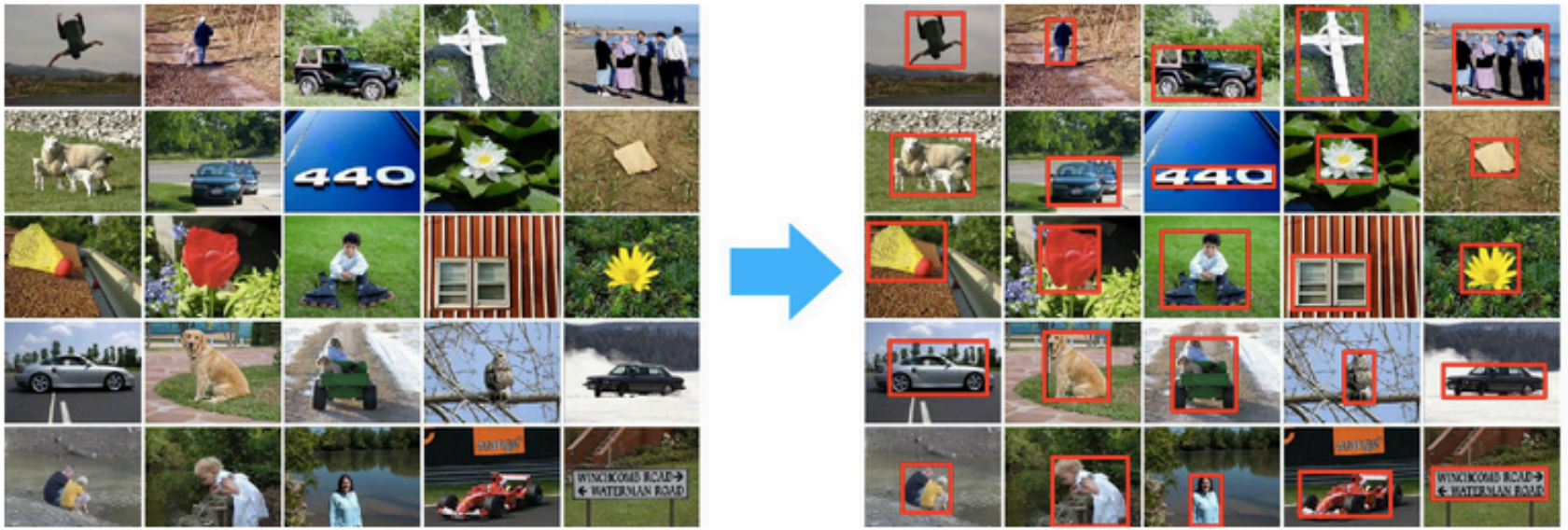
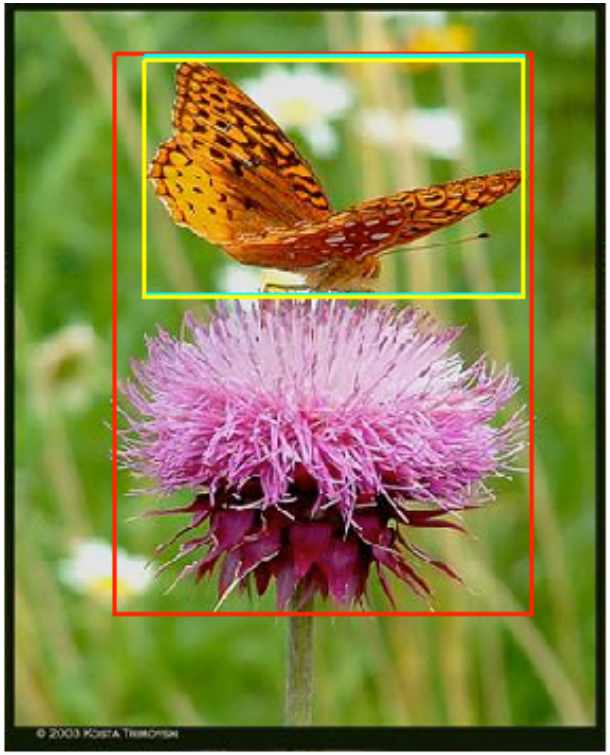


image credit: http://research.microsoft.com/en-us/um/people/jiansun/SalientObject/salient_object.htm

MSRA dataset

- Ground truth: labeled by 3-9 users

consistent labeling



inconsistent labeling

General steps

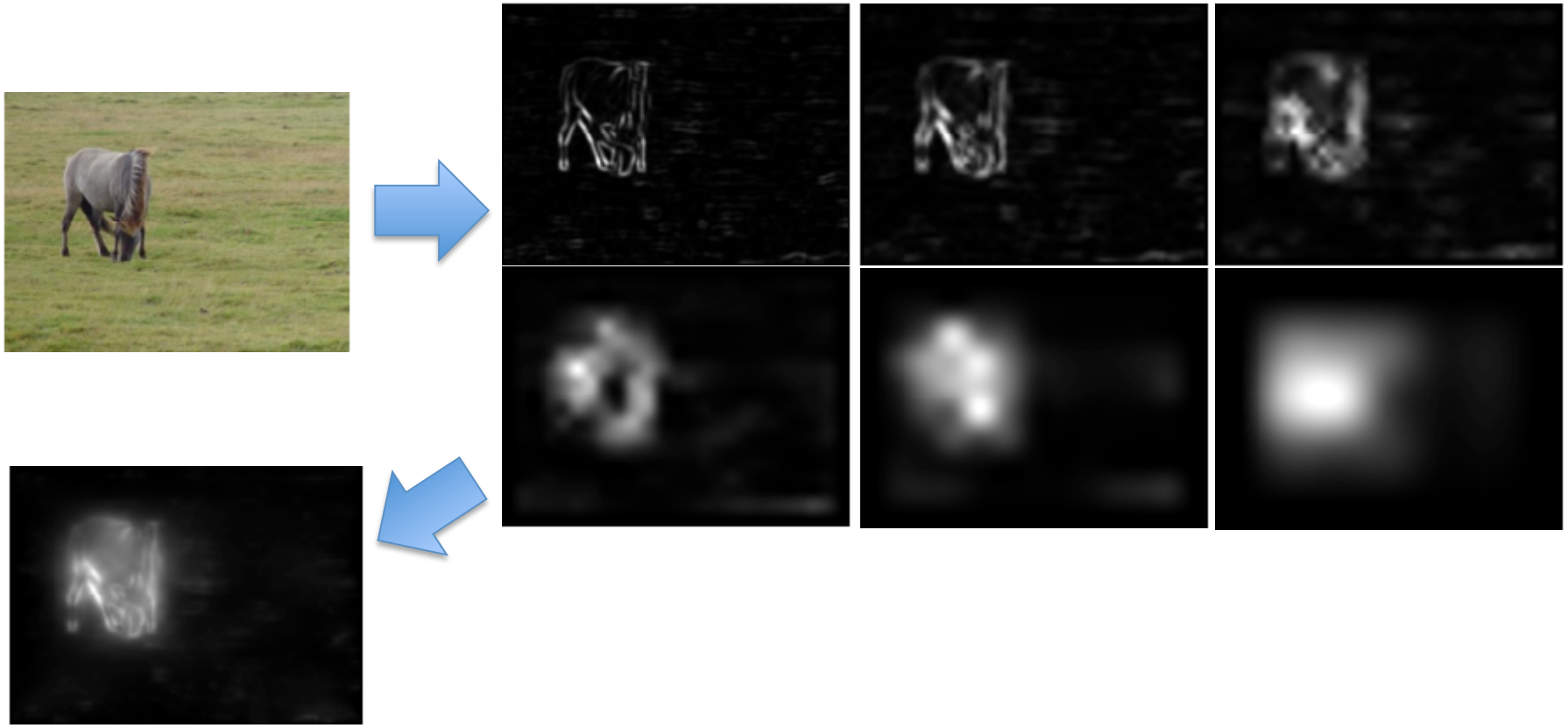
saliency feature maps

binary saliency map

search for bounding box

Salient feature maps

- Multi-scale contrast
  - 6-level Gaussian pyramid

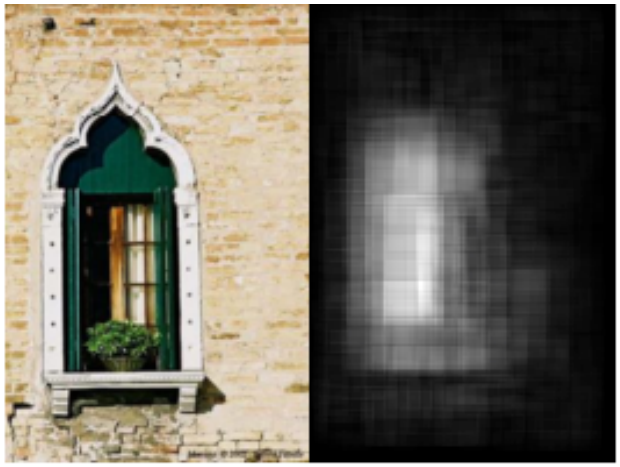


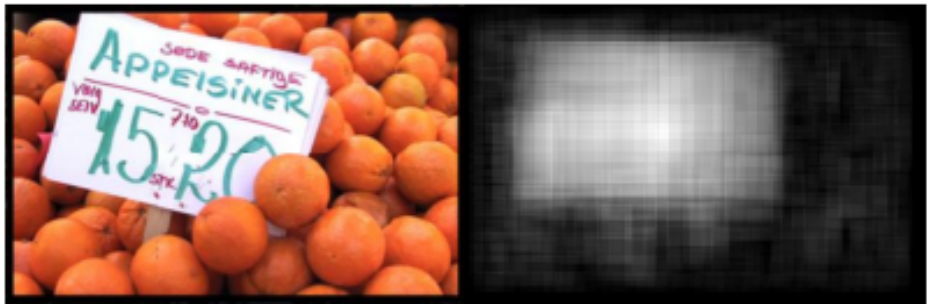
Salient feature maps

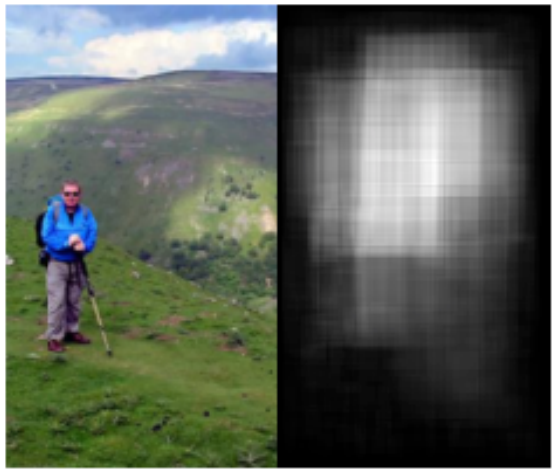
- Multi-scale contrast

Salient feature maps

- Center-surround histogram







works better for homogeneous background

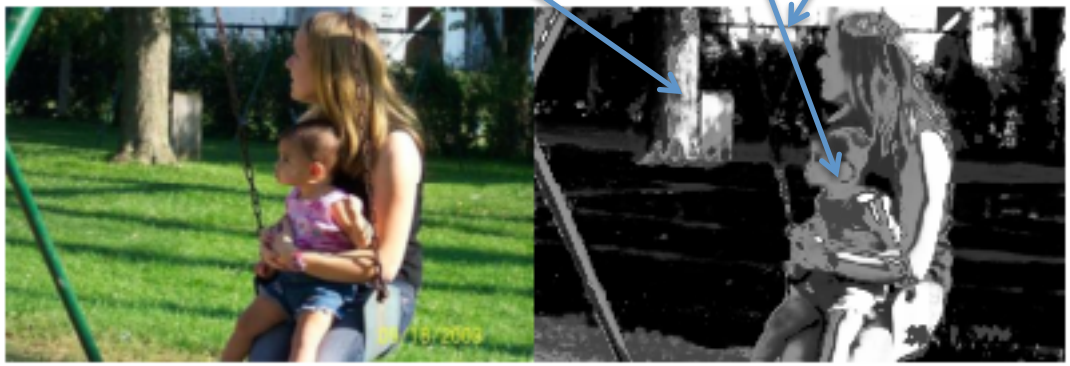
Salient feature maps

- Color spatial distribution
  - 6-component GMM modeling of color

skin of people (partially colluded by clothes

image borders

special object in background

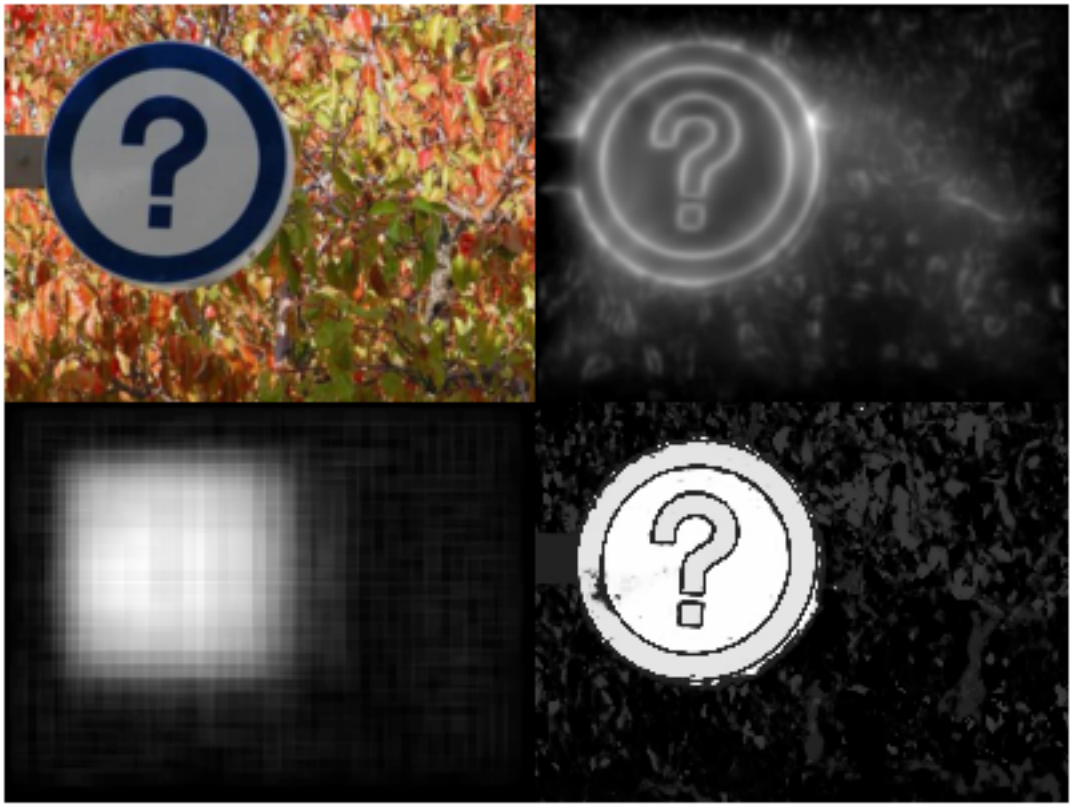


CRF inference & learning

- Binary labeling
- Weighting parameters learned from user labeling (bounding boxes, not binary salient maps)
- Brute force search of bounding box
  - 7 aspect ratios (1:2 to 2:1)
  - 11 window sizes (2% to 60% of the image area)

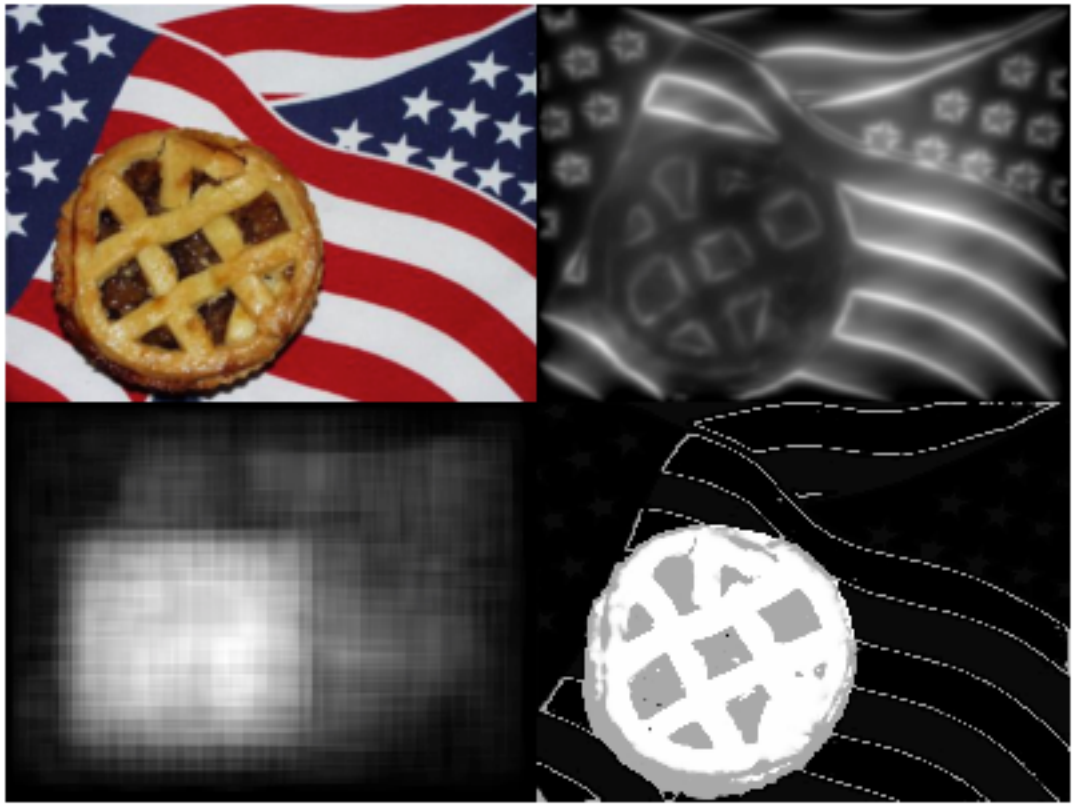
Results

- Success for easy examples



Results

- Success for harder examples

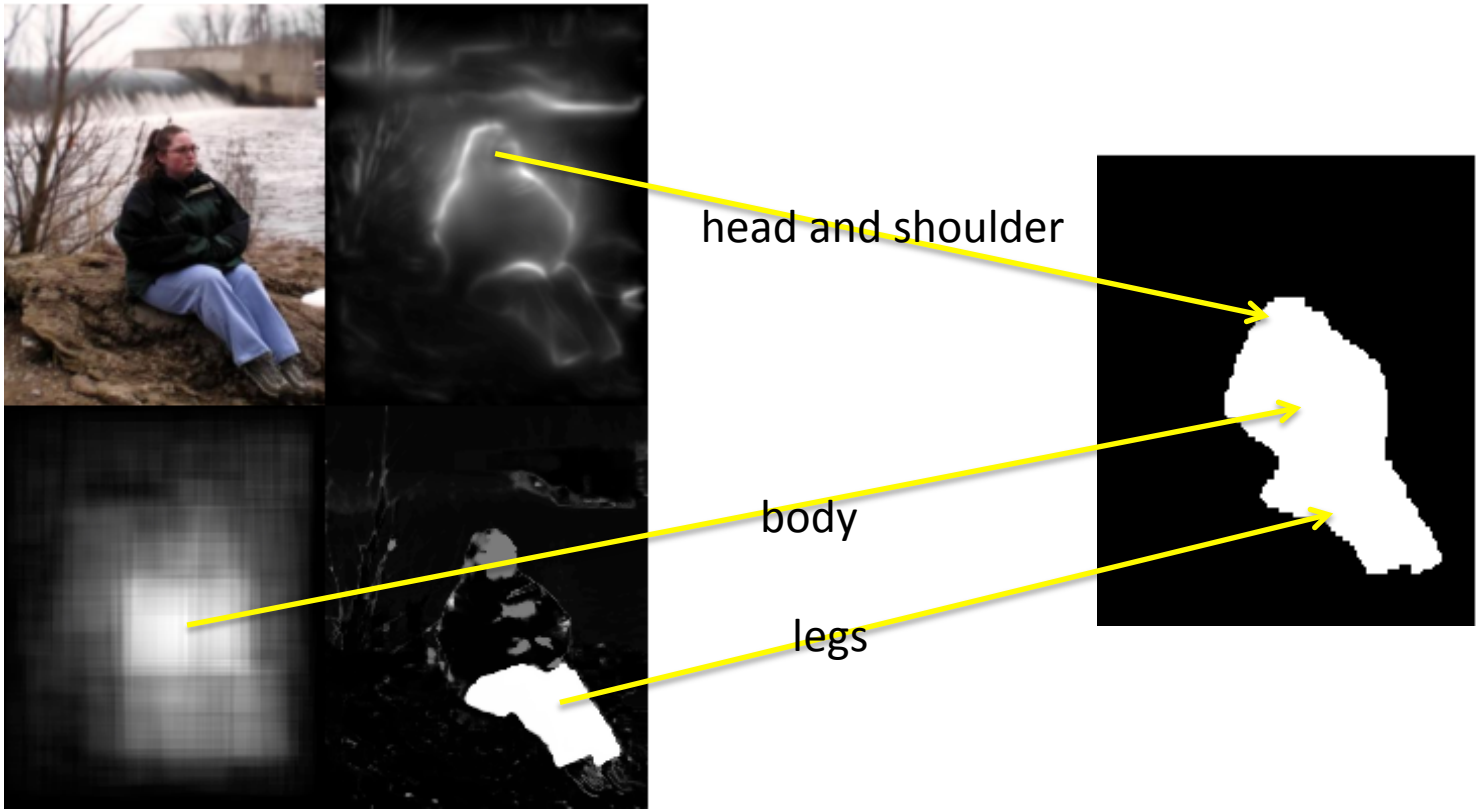


Results

- Success for harder examples

Results

- Three cues perfectly complement each other

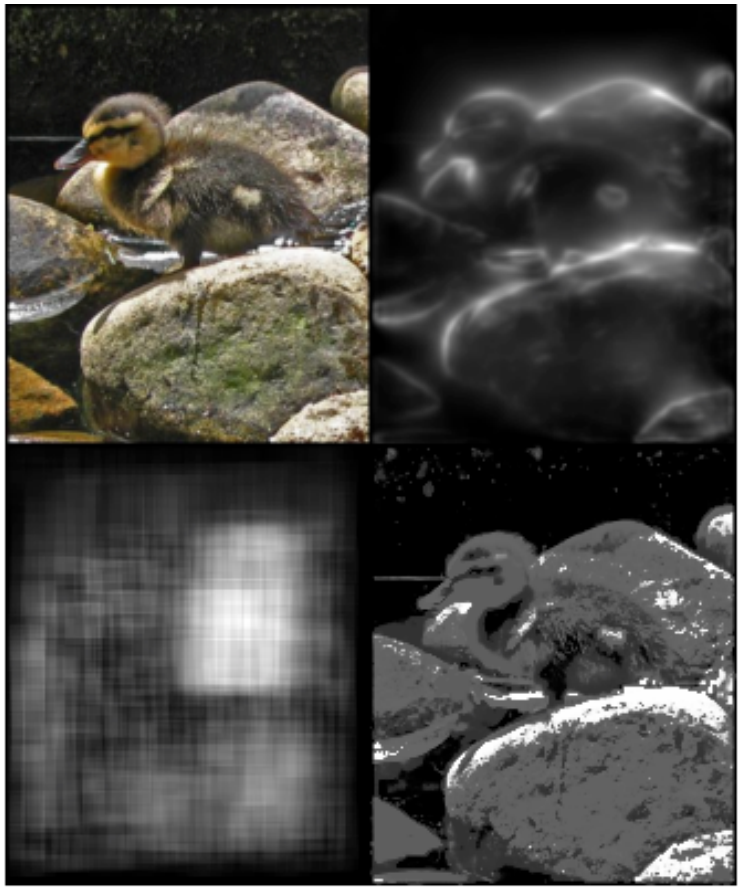


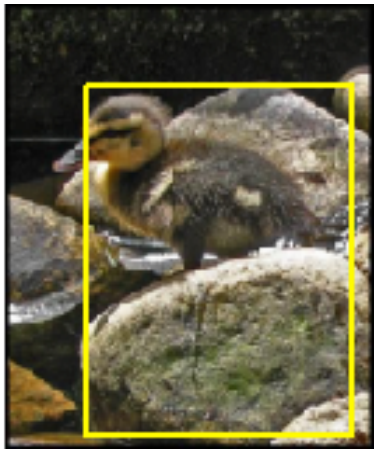
Results

- Failure : very complicated scene

Results

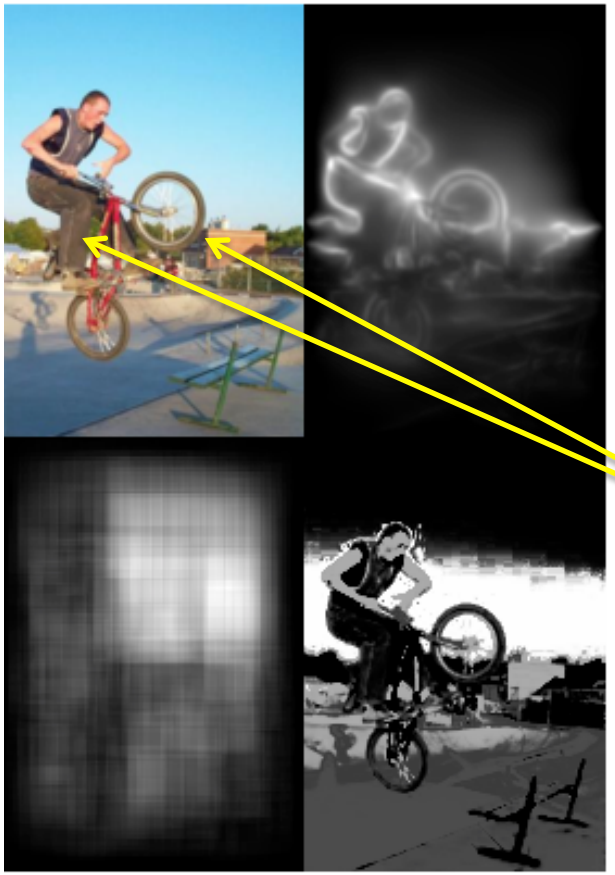
- Failure : similar to background





Results

- Failure: spatially apart components with similar color



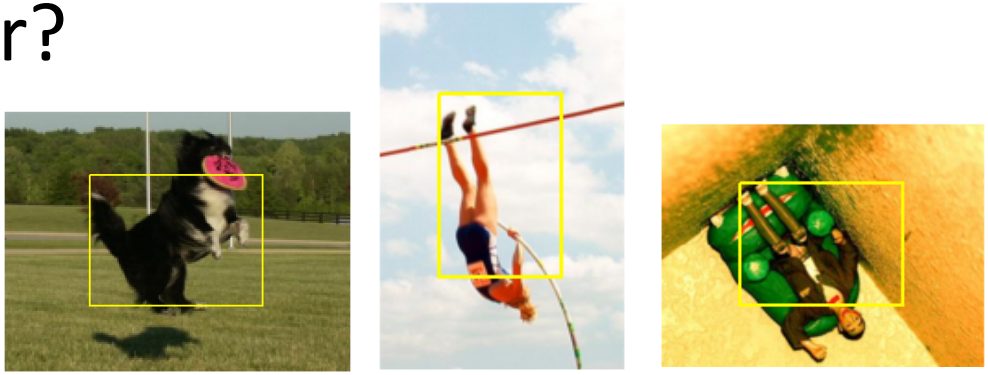
similar color

Not always a problem unless the image is very colorful
(More components in GMM needed)

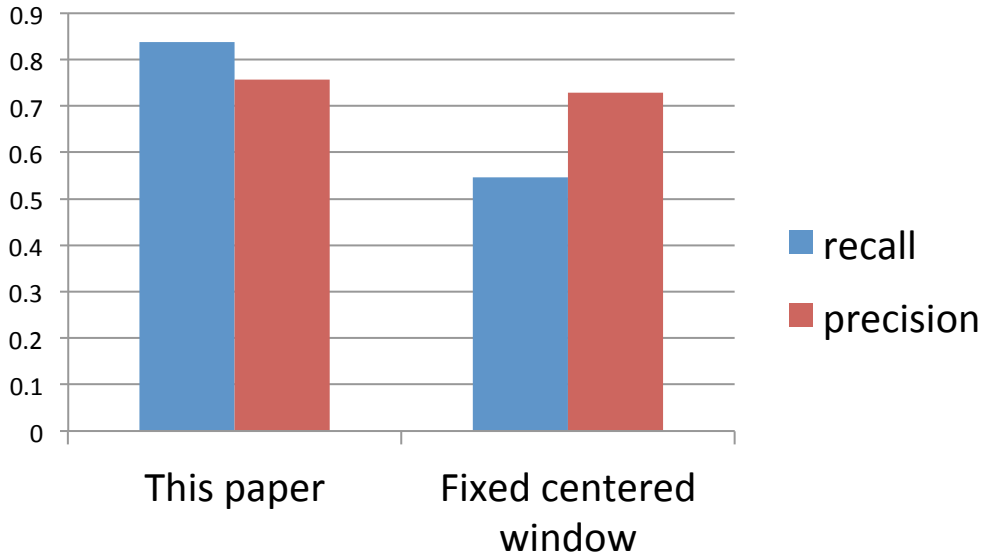
Results

- How much better than just putting a fixed size window in the center?

¼ size; same aspect ratio



$$Precision = \sum_x g_x a_x / \sum_x a_x$$
$$Recall = \sum_x g_x a_x / \sum_x g_x$$



Multiple salient object detection

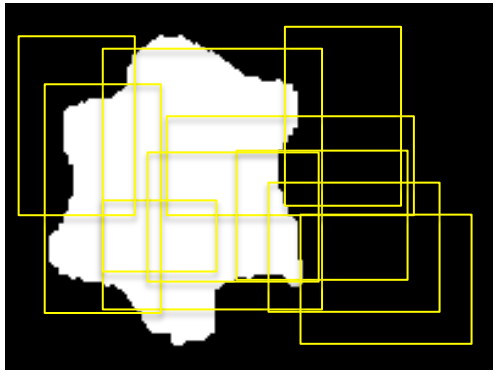
- PASCAL VOC 2007 dataset
  - Multiple salient objects
  - More complicated scenes



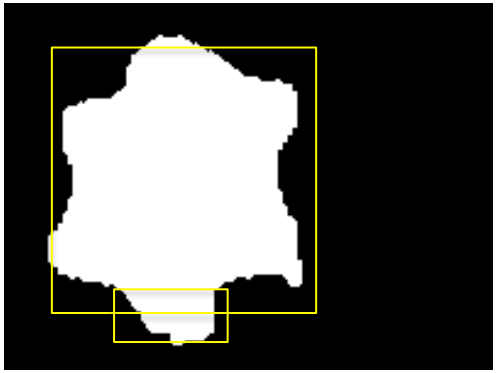


Multiple salient object detection

generate the binary mask



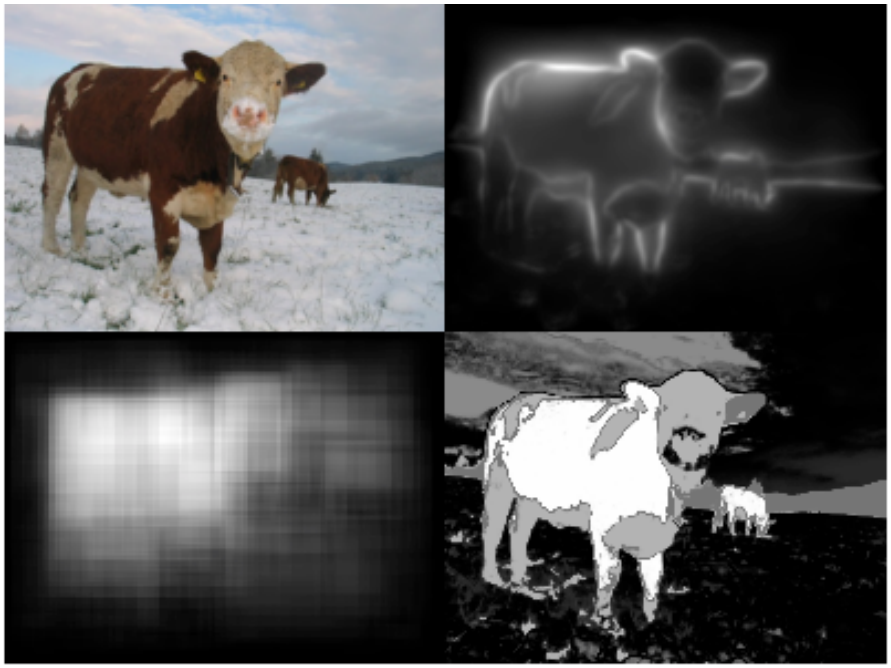
score each possible window

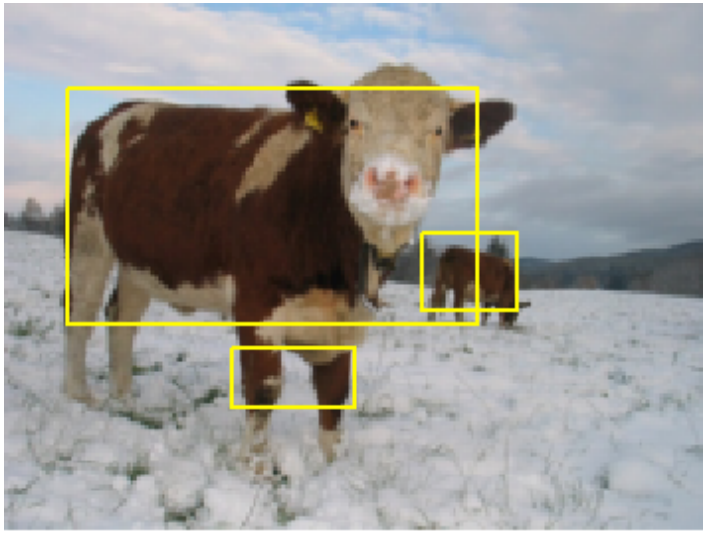


Non-maximum suppression: remove a window if it overlaps with another window with a higher score

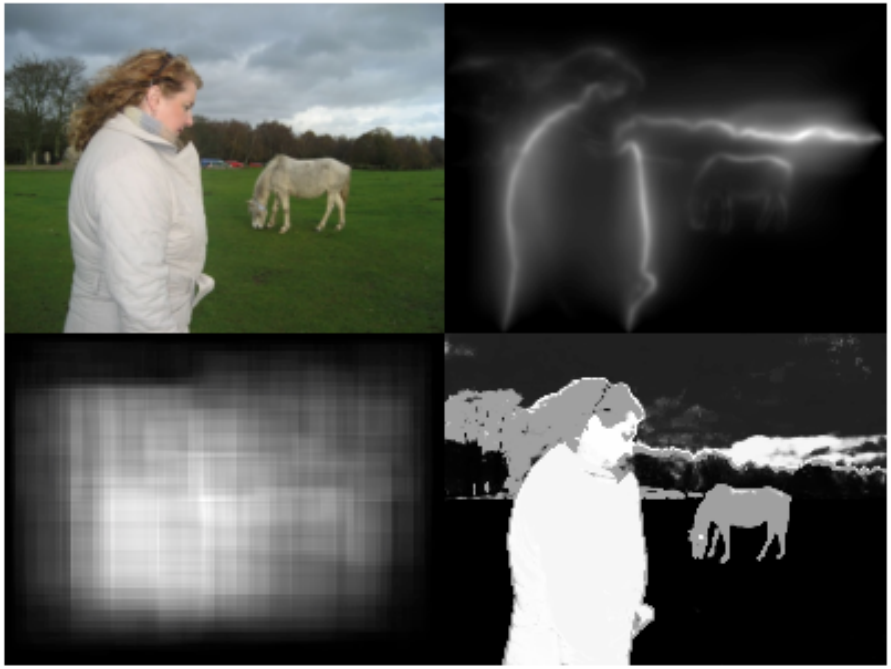
score = # saliency pixels × (# saliency pixels / window area)

Multiple salient object detection



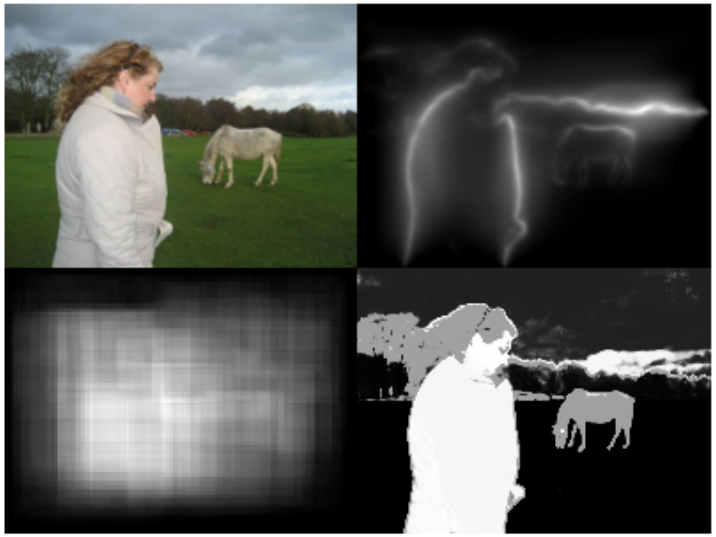


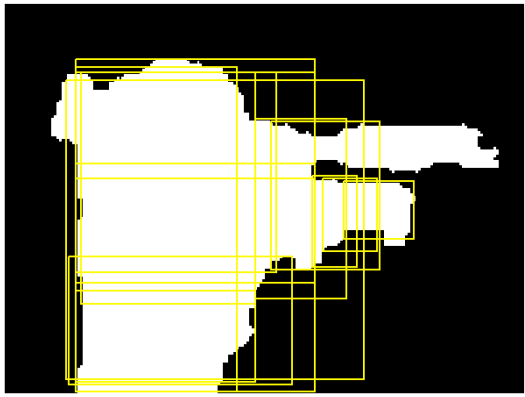
Multiple salient object detection

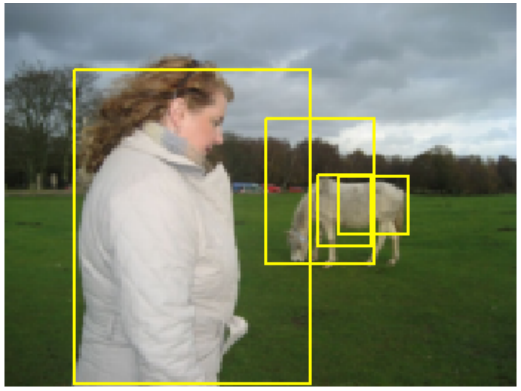


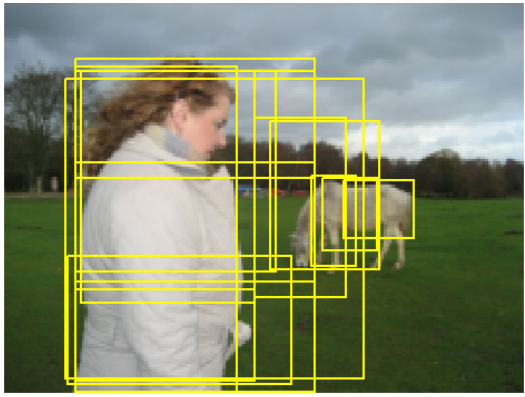
Multiple salient object detection

- Different overlap threshold in NMS







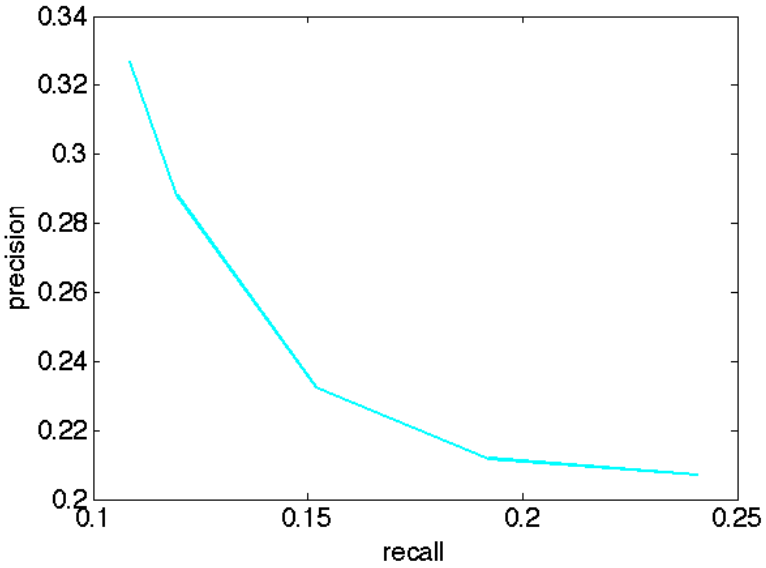


threshold = 0.5

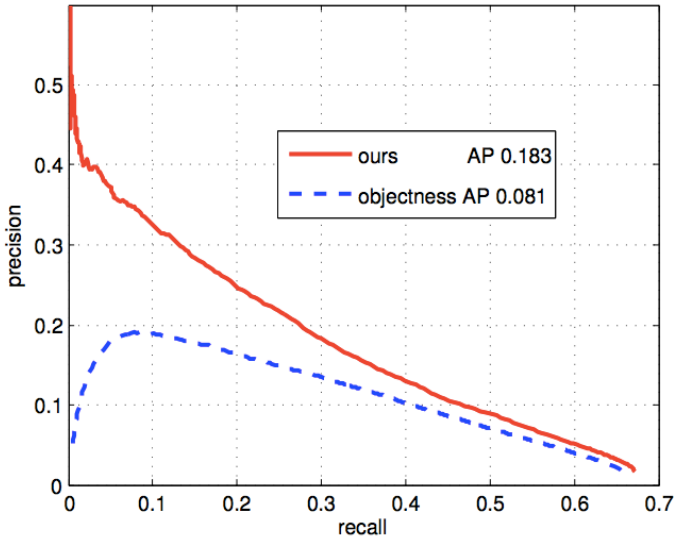
threshold = 0.8

Multiple salient object detection

- Precision-Recall Curve on PASCAL VOC 2007
  - 1000 images; 3004 objects



This paper

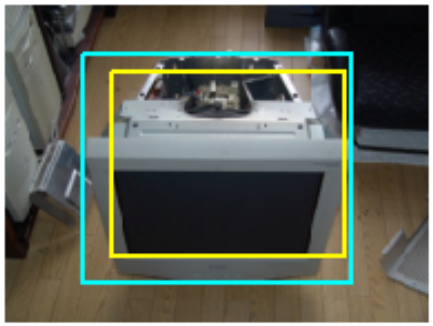


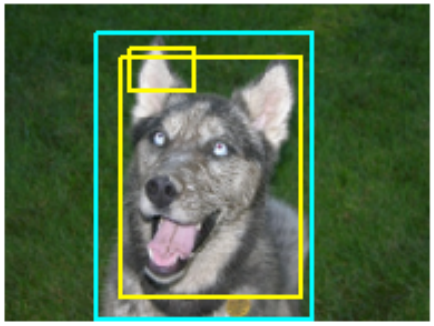
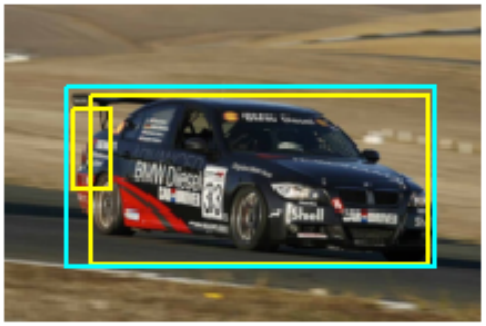
Algorithm that especially designed to detect multiple salient objects

ICCV 2011 “Salient Object Detection by Composition”

Multiple salient object detection

- Still acceptable if there's only one salient object



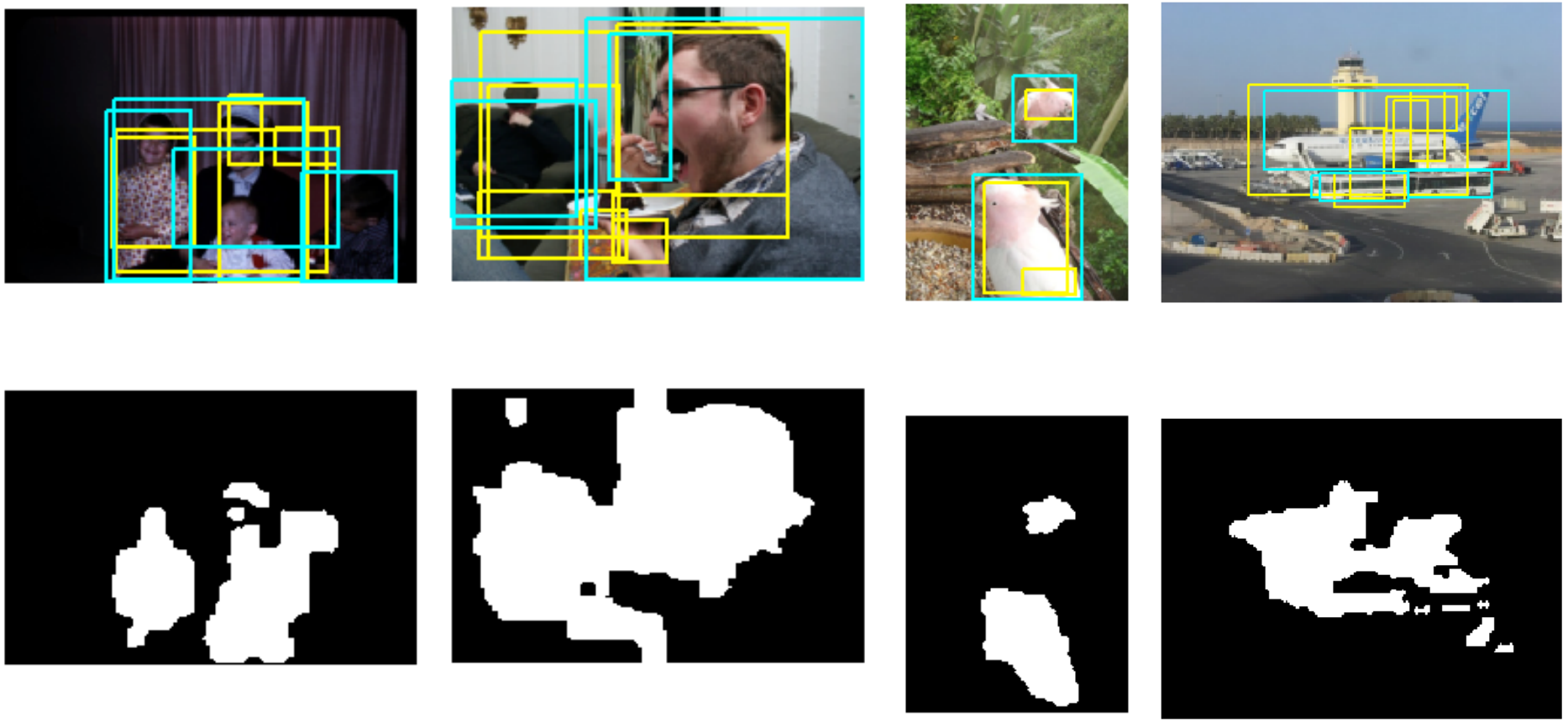





Multiple salient object detection

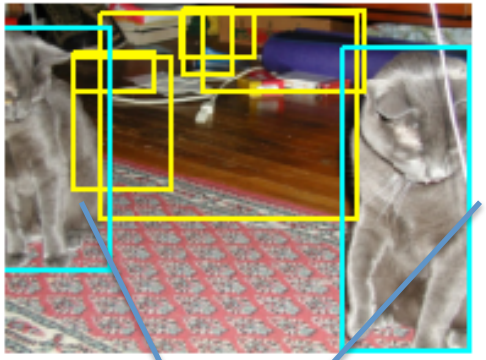
- A few successful results on multi-object detection

The binary masks are correct and separable.

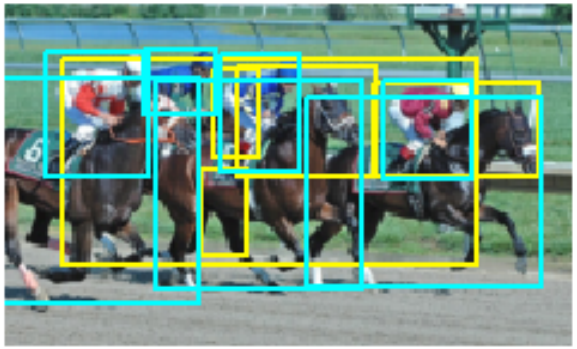


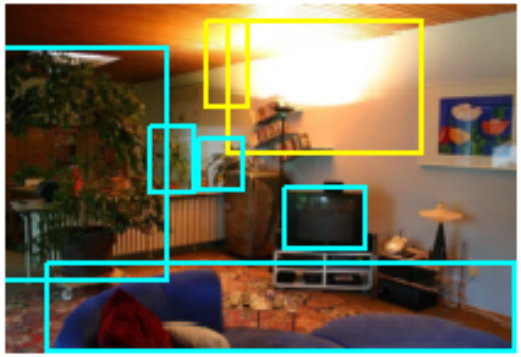
Multiple salient object detection

- Failure examples



too far away





binary mask completely wrong

hard to separate

Is the ground truth really salient?

Conclusions

- Works well for single salient object detection.
  - Three cues complement each other
  - Bounding box annotation is very robust to errors in binary saliency labeling.
  - MSRA dataset is relatively simple: Central fixation bias naïve baseline works well too.
- The algorithm is not suitable for multi-object detection.
  - Only one connected components most of the time
  - Binary salient mask fails
    - Spatially wide spread of objects will make the color spatial distribution cue less accurate.