Regarding Salient Object Segmentation

Yunfan Liu & Steven Peterson

The Usual Segments

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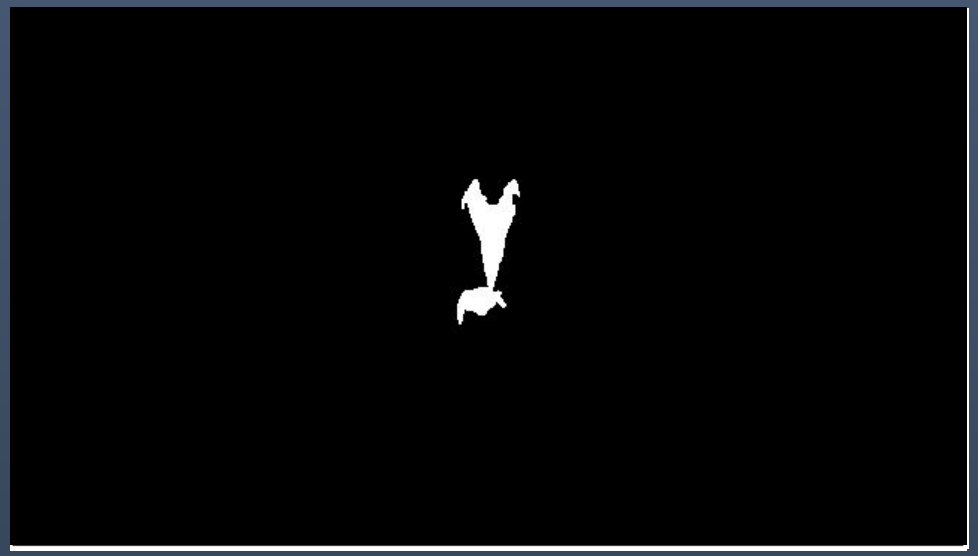
Outline

- Background
- Paper critiques:
  - Saliency Propagation (Gong et. al. *CVPR*, 2015)
  - Fixation Prediction and Dataset Bias (Li et. al. *CVPR*, 2015)
  - Feature Integration Theory based method (Frintrop et. al. *CVPR*, 2015)
- Our implementation
- Evaluation
- Conclusions

Visual Saliency

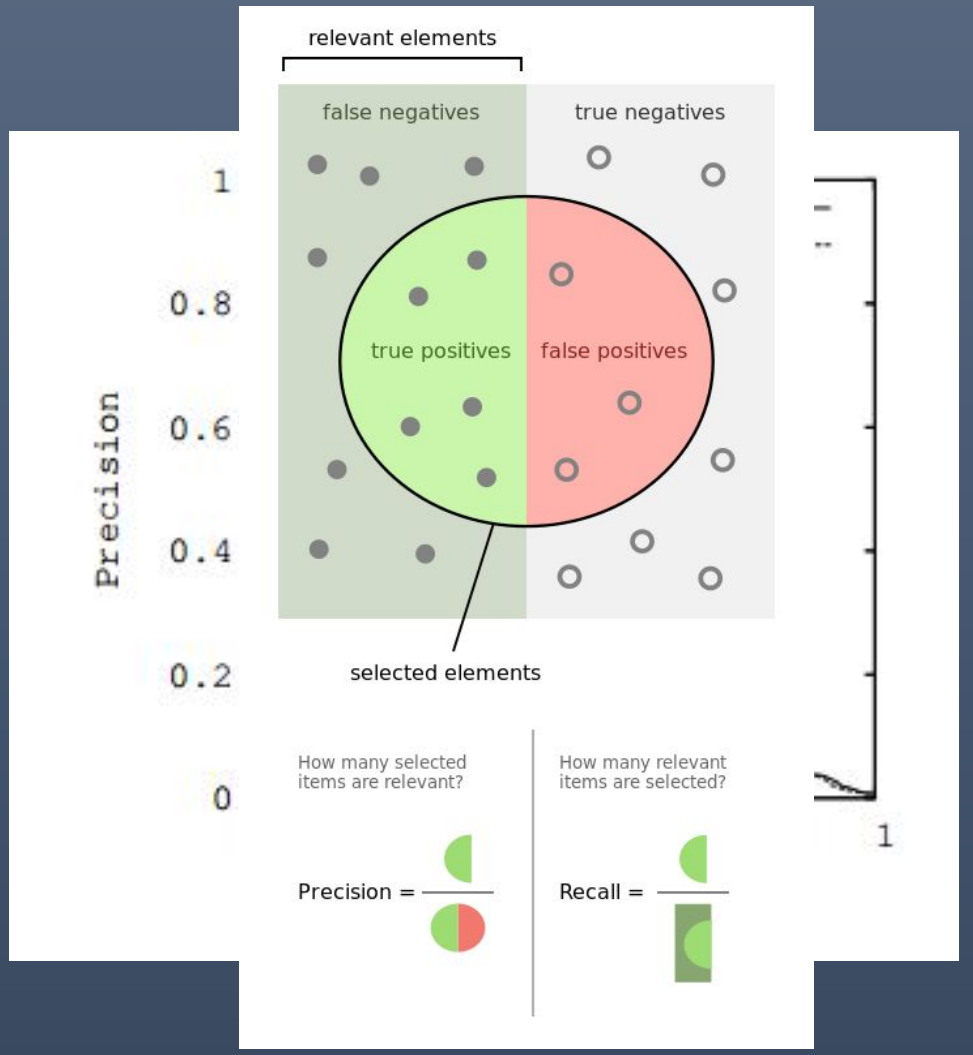
- Goal: detect regions that attract human attention
  - Like a line-up
- Bottom-up vs. top-down
- Papers explore various issues with salient object segmentation

Website: **www.stevenbenedict.ie**
Credit: *The Usual Suspects*. By Christopher McQuarrie. Gramercy Pictures, 1995.



Evaluation Method

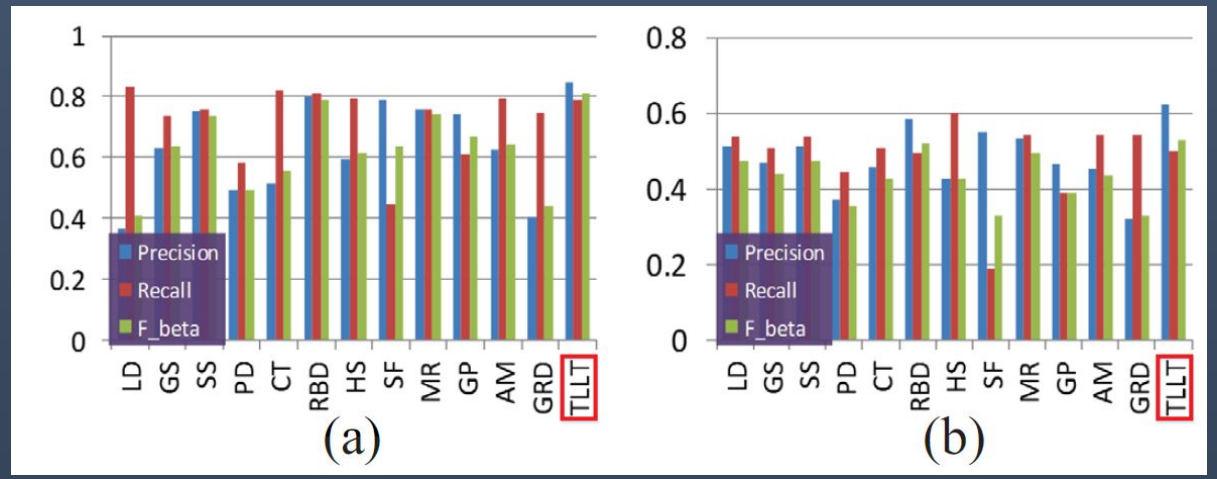
- $Recall = \frac{TP}{TP+FN}$
- $Precision = \frac{TP}{TP+FP}$
- $f_\beta^W = (1+\beta^2)\frac{R*P}{R+\beta P}$ with $\beta = 1$
  - Harmonic mean



Website: https://en.wikipedia.org/wiki/Precision_and_recall

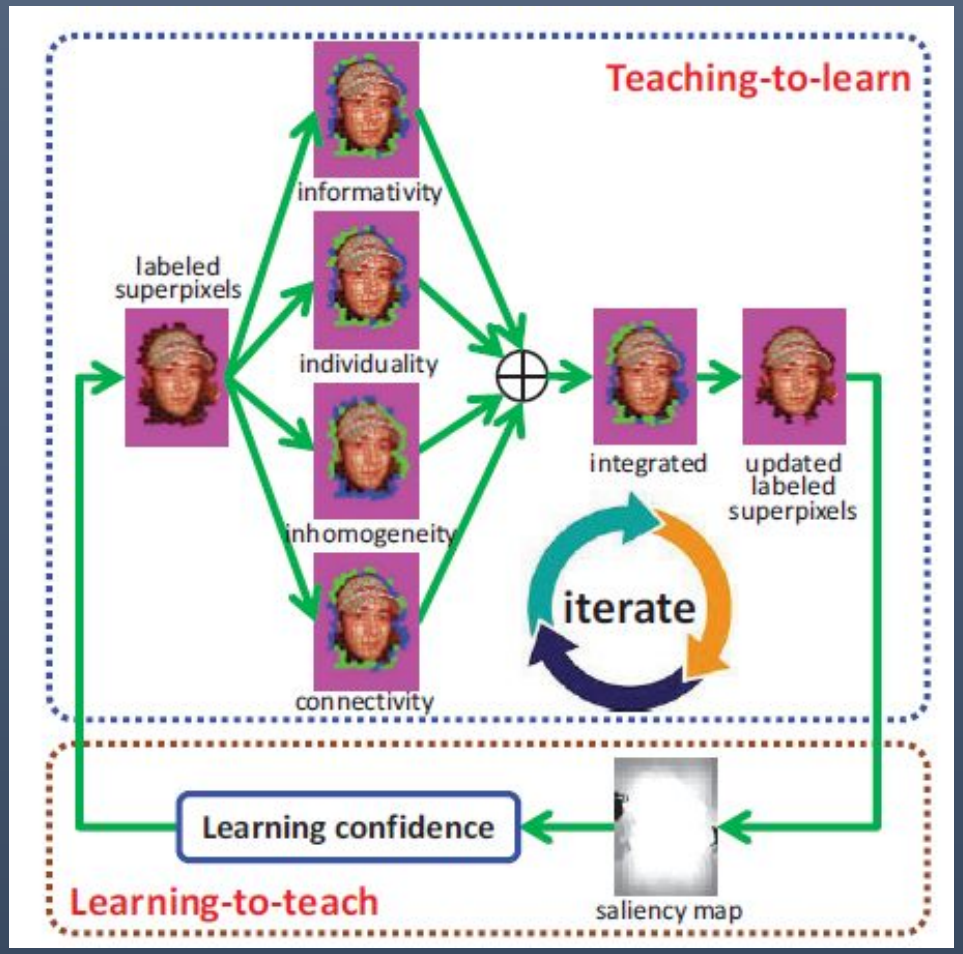
Paper 1: Saliency Propagation

- Problem: inhomogeneous neighboring superpixels
- Iteratively propagate labels to superpixels
- Use ‘starting simple’ approach to drive propagation
  - Teacher and learner



MSRA 1000 ECSSD

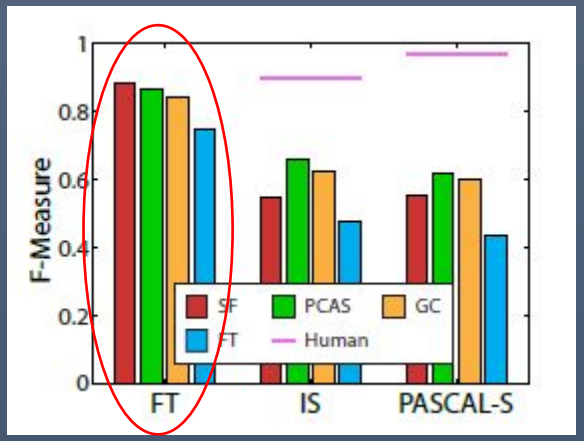
Gong et. al. *CVPR*, 2015



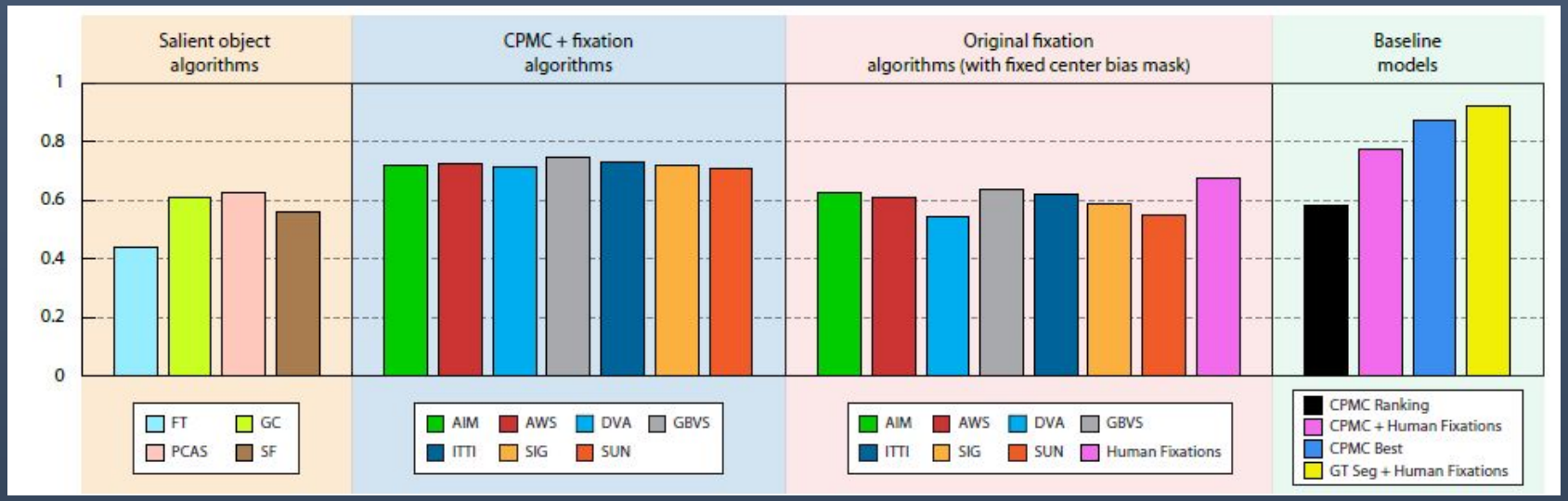
Gong et. al. *CVPR*, 2015

Paper 2: Fixation Prediction and Dataset Bias

- Problem: dataset design bias
- 4 algorithms across 3 datasets for segmentation
  - Created PASCAL-S dataset with fixations
- Created own algorithm
  - Segmentation
  - Human fixations



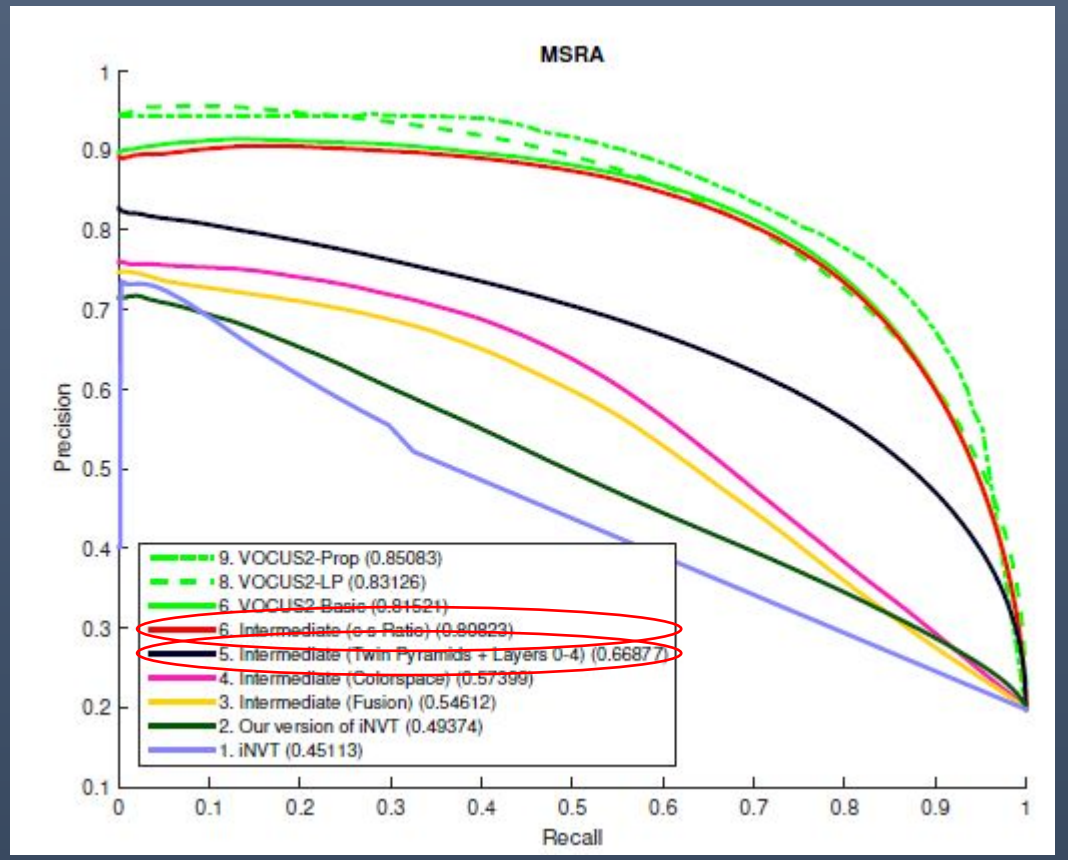
Li et. al. *CVPR*, 2015



Li et. al. *CVPR*, 2015

Paper 3: Feature Integration Theory (FIT)

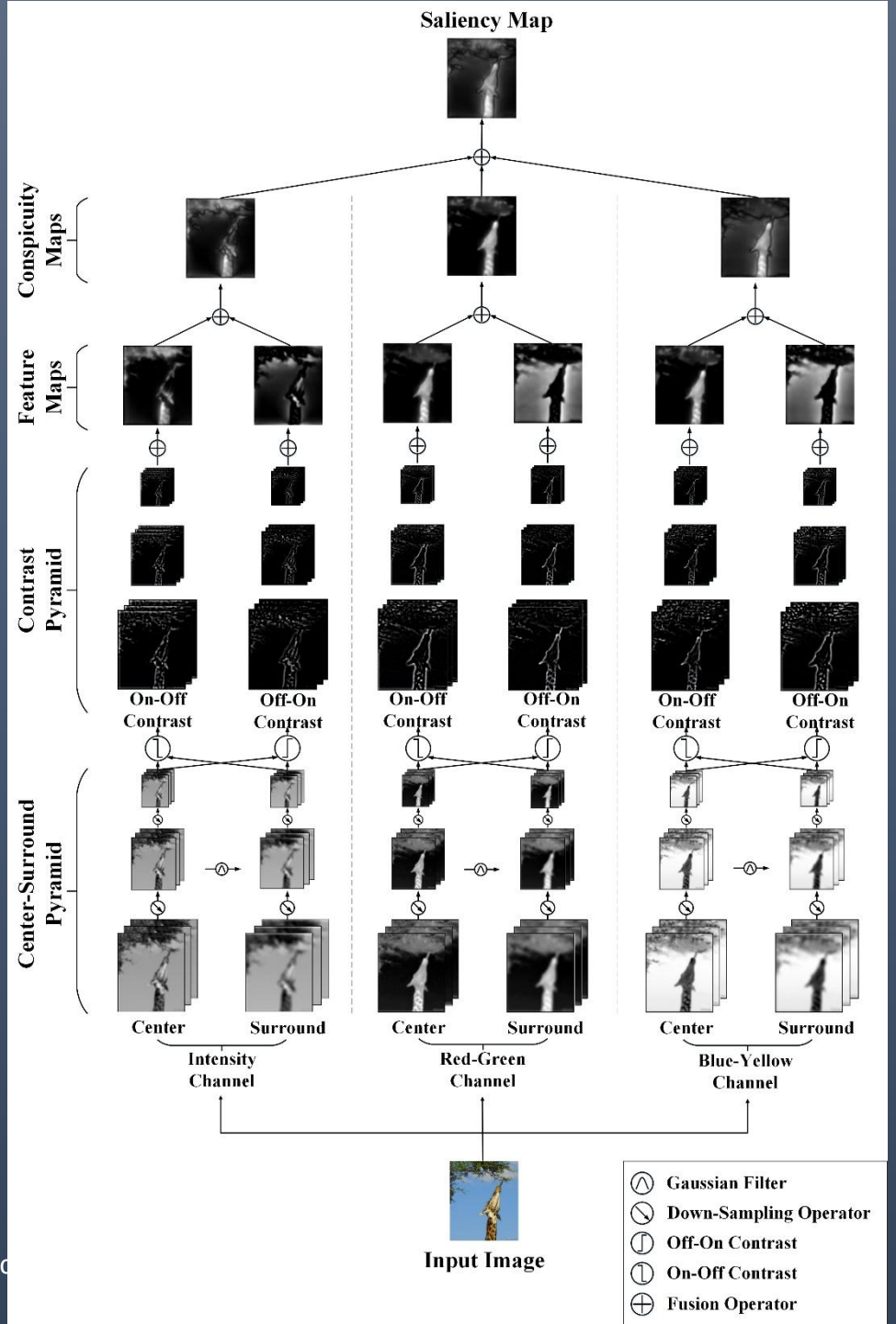
- Problem: essential ideas of saliency
- FIT: many features processed in parallel in brain
- VOCUS2 model augments traditional iNVT
- 2 major improvements
  - Twin pyramids
  - Tunable center-surround ratio



Frintrop et. al. *CVPR*, 2015

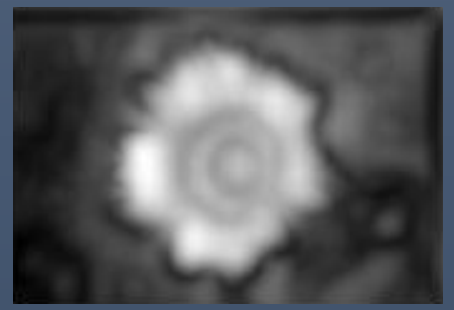
Structure of VOCUS2

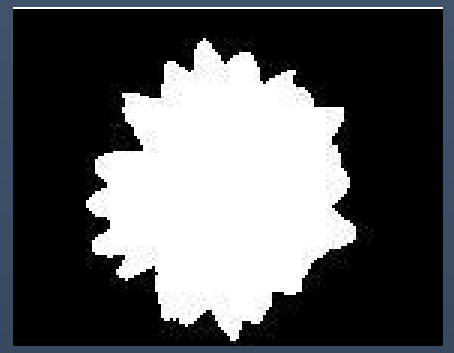
- 3 input channels
  - Twin pyramids (center & surround)
  - Scale-space structure (Lowe, 2004)
- Contrast pyramids
  - On-off vs. off-on
  - Bright objects on dark background vs. bright objects on dark background
- Fushion steps
  - Cross-scale summation
  - Various operators



Optional Pre-processing

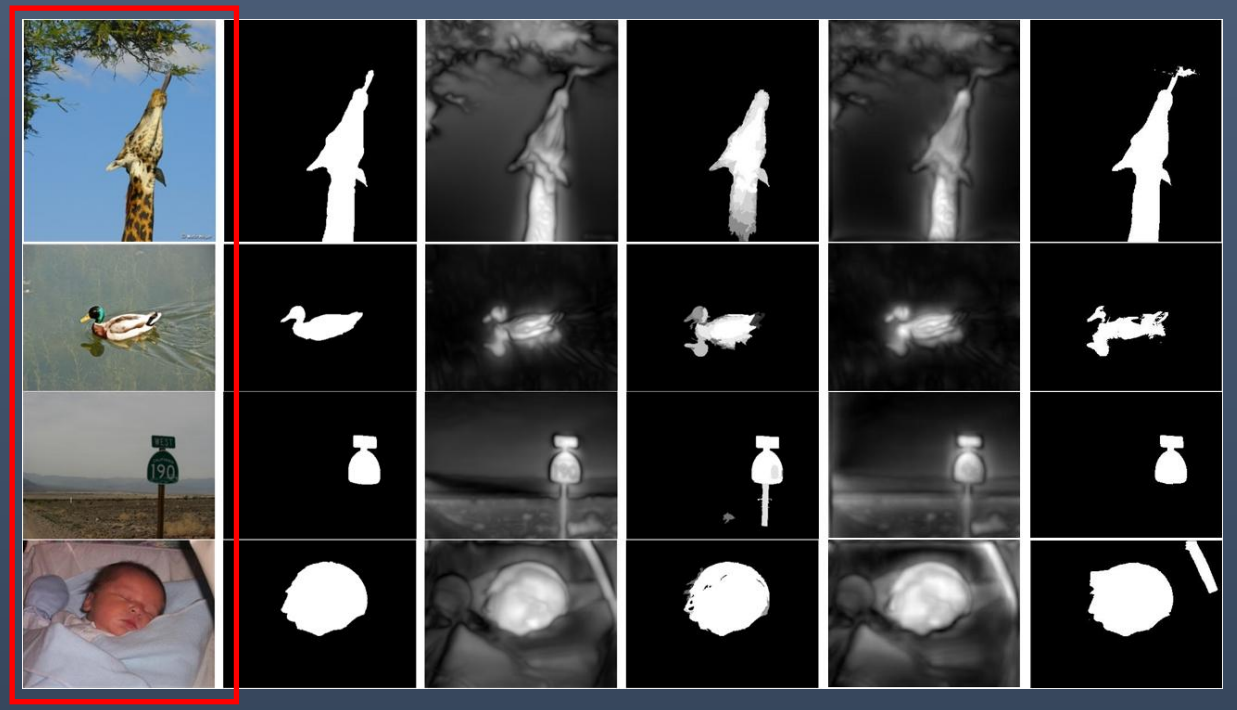
- Center-bias prior
  - Popular datasets are heavily center-biased.
  - $S_{bias}(x, y) = S(x, y) \cdot G(x, y; \theta)$
- Segment-based
  - Pre-segmentation (SLIC, mean shift…)
  - Maximum detection + region-growing
    → Saliency Proposal
  - Thresholding
    → Final result



Sample results

- Produces pixel-precise output
- Results appear qualitatively similar
  - Input image
  - Ground truth
  - Basic (paper)
  - Segment-based (paper)
  - Basic (ours)
  - Segment-based (ours)

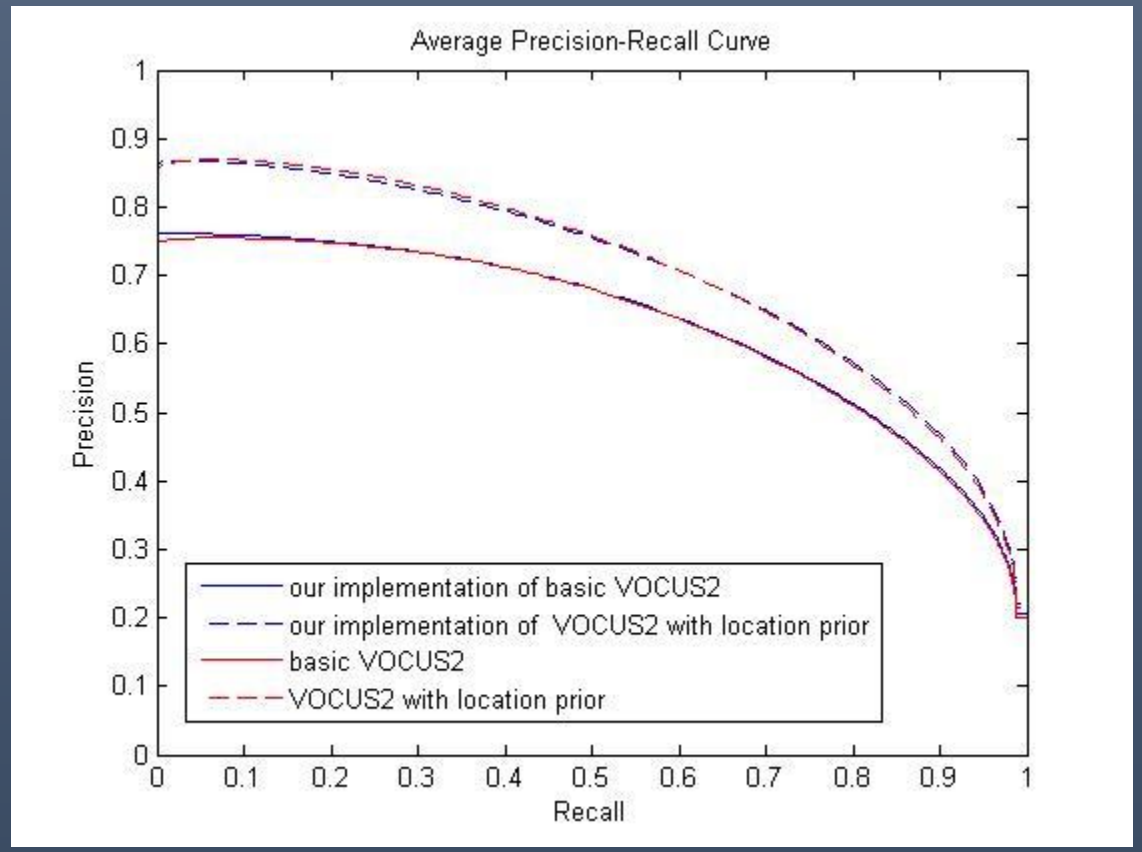


Evaluation

- Recall-precision curves
- Weighted f-measure
  - Averaged on MSRA-10k, SED1, SED2, ECSSD and PASCAL-S
  - More than 12,000 images

Weighted f-measure	VOCUS2	Our Version
Basic	0.3217	0.3287
Center-bias	0.3750	0.3800

Weighted f-measurement

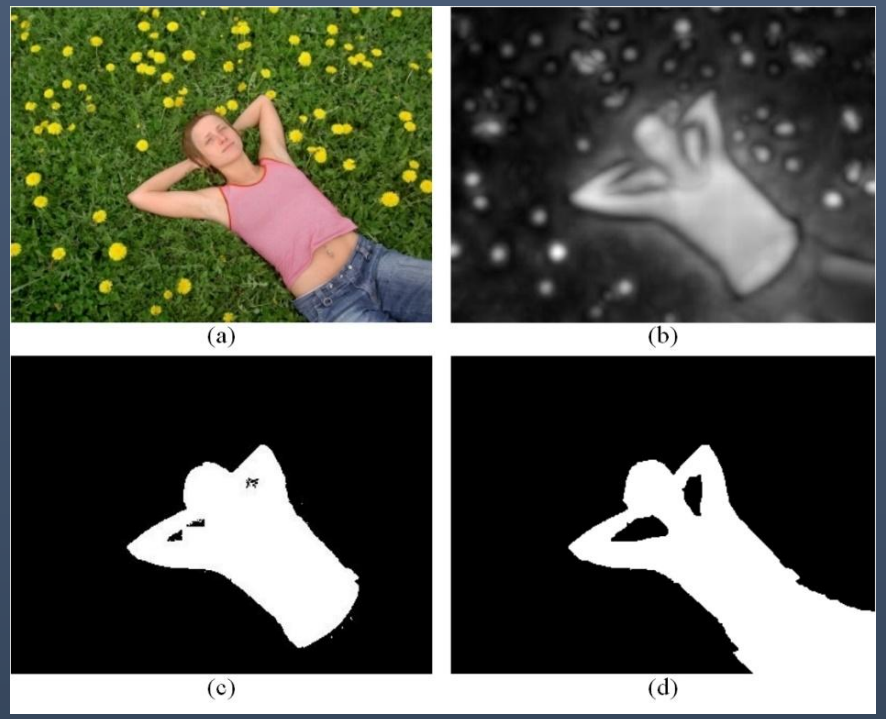


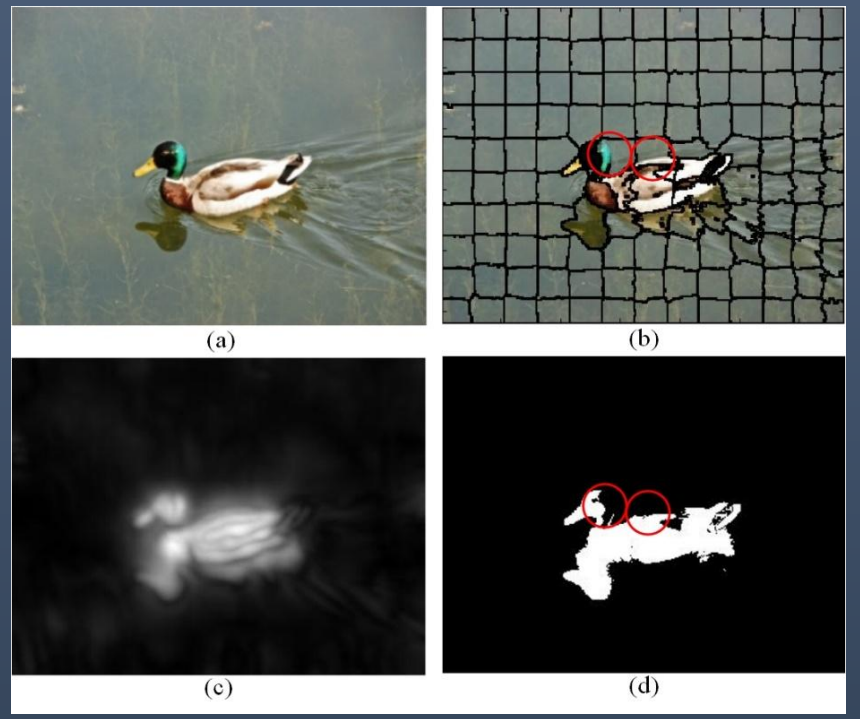
Recall-precision curve

Exploring Limitations of the Method

- Imperfect pre-segmentation
- Limitation of bottom-up method

J. Yang and M. Yang. Top-down visual saliency via joint CRF and dictionary learning. In CVPR, pages 2296-2303. IEEE, 2012.





Conclusions

- Bottom-up saliency: simple with limitations
  - Improvement of benchmarking datasets helpful
- Our implementation appears to be consistent with paper's
  - Qualitatively similar results
  - Similar weighted f-measure and recall-precision curves
  - Different segmentation method and multiple parameters to tune

References

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4. L. Itti, C. Koch, and E. Niebur. A model of saliency-based visual attention for rapid scene analysis. In TPAMI, IEEE, 20(11):1254-1259, 1998.
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