

Familiar Configuration Enables Figure/Ground Assignment in Natural Scenes

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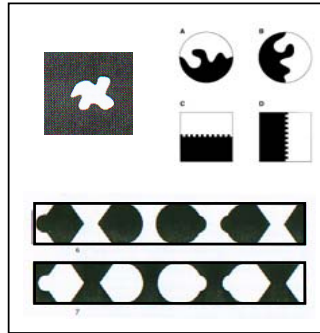
VSS05 Abstract

Figure/ground organization is a step of perceptual organization that assigns a contour to one of the two abutting regions. Peterson et al showed that familiar configurations of contours, such as outlines of recognizable objects, provide a powerful cue that can dominate traditional f/g cues such as symmetry. In this work we: (1) provide an operationalization of "familiar configuration" in terms of prototypical local shapes, without requiring global object recognition; (2) show that a classifier based on this cue works well on images of natural scenes.

Shape context [Belongie, Malik & Puzicha ICCV01, Berg & Malik CVPR01] is a shape descriptor which summarizes local arrangement of edges, relative to the center point, in a log-polar fashion. We cluster a large set of these descriptors to construct a small list of prototypical shape configurations, or "shapemes" (analogous to phonemes). Shapemes capture important local structures such as convexity and parallelism.

For each point along a contour, we measure the similarity of its local shape descriptor to each shapeme. These measurements are combined using a logistic regression classifier to predict the figure/ground label. We test it on a Berkeley Figure/ground Dataset which consists of 200 natural images w/ human-marked f/g labels. By averaging the classifier outputs over all points on each contour, we obtain an accuracy of 72% (chance is 50%). This compares favorably to the traditional f/g cues used in [Fowlkes et al 03]. Enforcing consistency constraints at junctions increases the accuracy further to 79%, making it a promising model of figure/ground organization.

Figure/Ground Organization

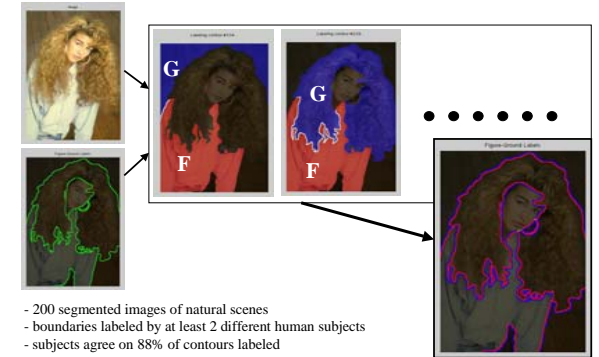


A contour belongs to one of the two abutting regions: one region has a definite shape (figure); the other is shapeless (ground).

Classical figure/ground cues:

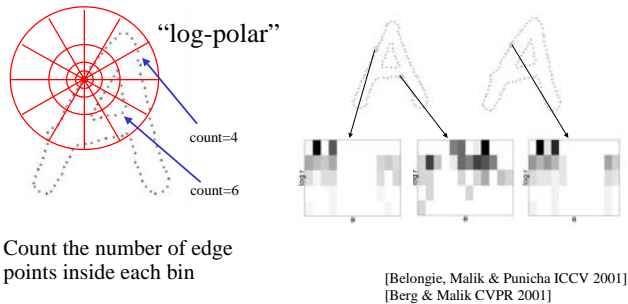
- Surroundedness
- Size
- Orientation
- Contrast
- Symmetry
- Convexity
- Parallelism
- Lower Region
-

Berkeley Figure/Ground Dataset



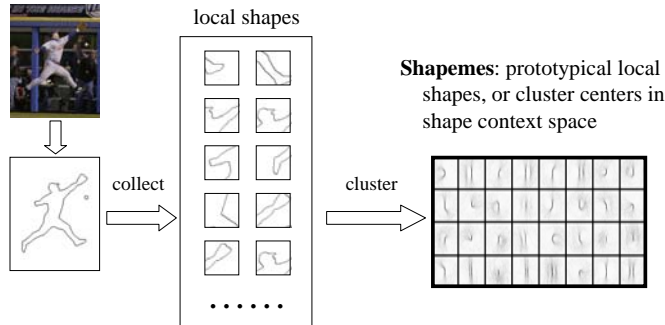
- 200 segmented images of natural scenes
- boundaries labeled by at least 2 different human subjects
- subjects agree on 88% of contours labeled

Shape Contexts



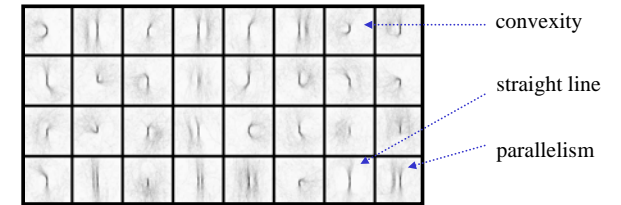
[Belongie, Malik & Puzicha ICCV 2001]
[Berg & Malik CVPR 2001]

Shapemes: Prototypical Local Shapes



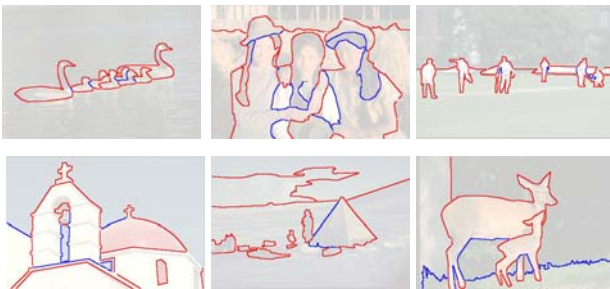
Shapemes: prototypical local shapes, or cluster centers in shape context space

Shapemes for Figure/Ground



- Given a local shape, measure its similarity to each of the shapemes;
- Use this set of similarity measures as a feature vector to train a logistic classifier to predict the figure/ground label

Results on Natural Scenes



Red: correct Blue: incorrect

Performance Evaluation

Chance	50%
Shapemes (w/ Geometric Blur)	64%
Shapemes + human-marked boundaries	72%
Shapemes + human-marked boundaries + enforcing consistency at T-junctions (work in progress)	79%
Human (Consistency between subjects)	88%

Conclusion

- **Shapemes** (prototypical local shapes) captures important mid-level cues such as convexity, parallelism and texture.
- A local classifier based on shapemes performs well on figure/ground assignment, achieving 64% accuracy by itself and 72% if averaged over human-marked boundaries.
- **Familiar configuration** enables figure/ground assignment in natural scenes

Reference

- Peterson & Gibson (1994) Object recognition contributions to figure-ground organization: Operations on outlines and subjective contours, in *Perception & Psychophysics*, 56, 551-564.
- Belongie, Malik & Puzicha (2001) Matching shapes, in proceedings, ICCV 2001, page 454-461.
- Berg & Malik (2001) Geometric blur for template matching, in CVPR 2001, page 607-614.
- Fowlkes, Martin & Malik (2003) On measuring the ecological validity of local figure-ground cues, ECVF 2003, Paris.