Multi-Dimensional Contour Vectors
for
Category Representations

Christoph Rasche

Justus-Liebig Universität Giessen
Germany

GazeCom

When we see a novel image…

Rosch et al 75

Basic-Level Assignment

Chair

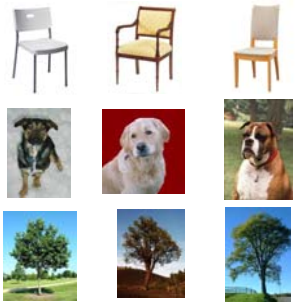
Dog

Tree

…occurs within *150ms*!

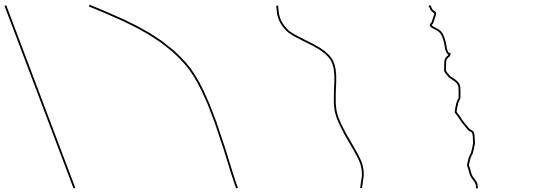
Structural Variability

Witkin & Tenenbaum 83 , Draper et al 96, Palmer 99, Rasche 05, Basri & Jacobs 97



→ still unsolved

Geometric Aspects of Contours



orientation, length

curvature ('bendness')

'wiggliness'

edginess

- involves more preprocessing than any other approach
  → counter-intuitive given speed: plausible?

Parallel Pop-Out Phenomena

Treisman & Gormican 1988

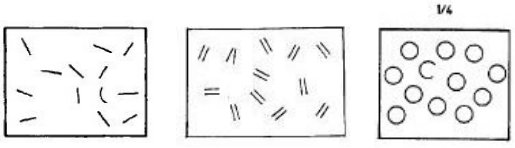
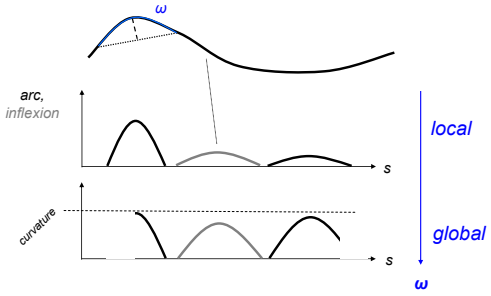


Fig 5 Fig 10 Fig 11

Traditional: saliency
Alternative: a decomposition of structure into multi-dimensional space

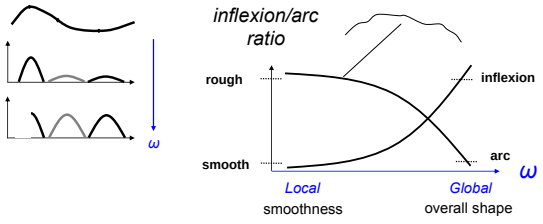
Arc-Inflexion Discrimination Filter



→ local/global space

Fischler & Bolles, 1983

Reducing to Spectrum



***c**(o, l, b, t, w, e)*

Can explain…

Treisman & Gormican 1988

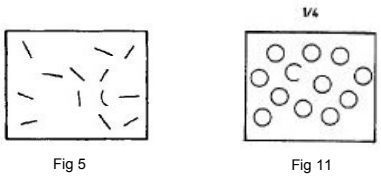
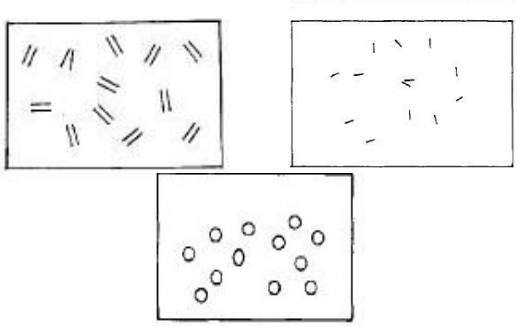


Fig 5 Fig 11

*Saliency = var(**c**)*

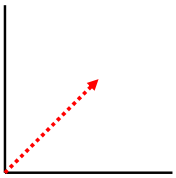
And now to Structural Relations…

Treisman & Gormican 1988



Symmetric Axis Transform

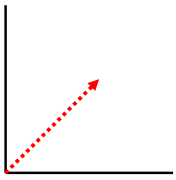
Blum 74



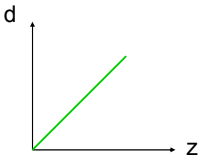
Symmetric Axis
equidistance between corresponding contour points

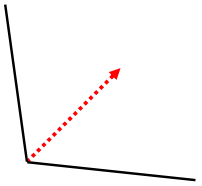
- Global-Local processing Kovacs, Julesz
- Biological motion perception
- Location of Gaze Fixation Kowler

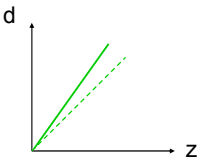
Symmetric Signature

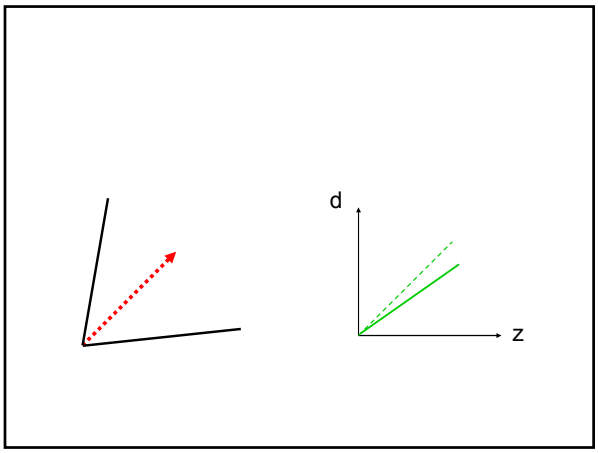


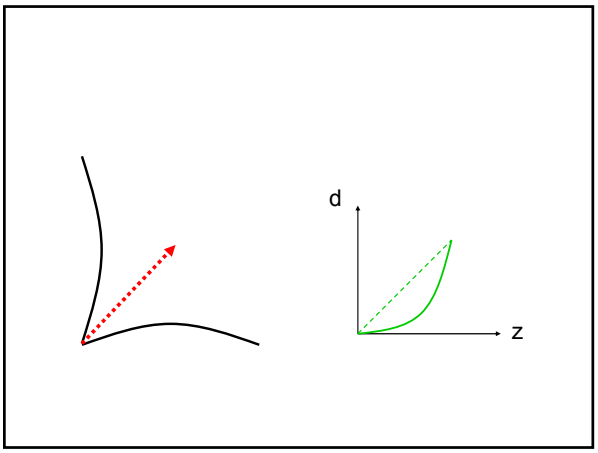
equidistance
vs.
arc length

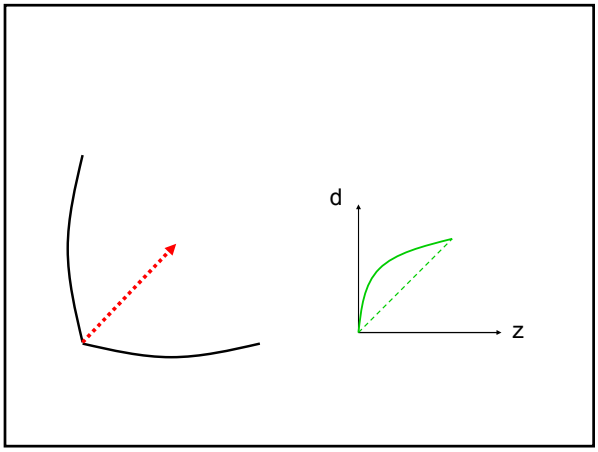




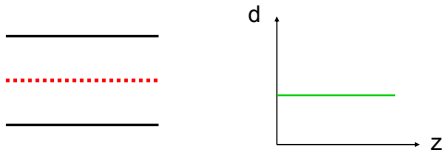




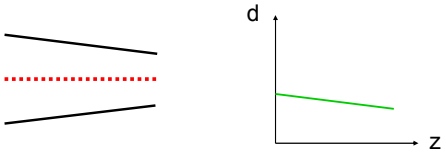




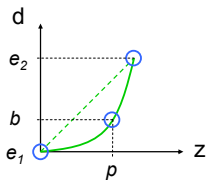
Parallel Contours



Converging Contours



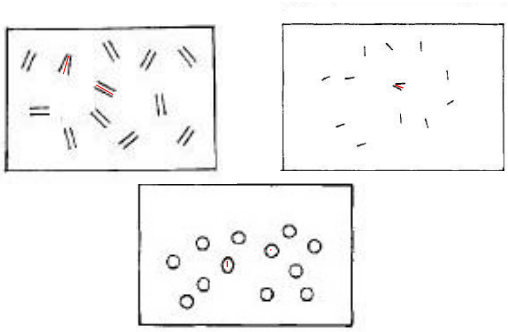
Parameterization



a*(o, l, e_1, e_2, b, p)*

Et voilá…

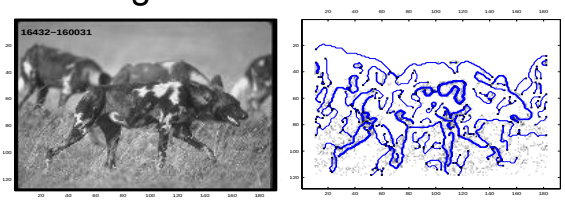
Treisman & Gormican 1988



Evaluation using COREL collection

- 600 classes à 100 images each
- 357 classes correspond to basic-level categories (*car, coast, door, insect, bird*,…)
- Divided into 112 basic-level categories

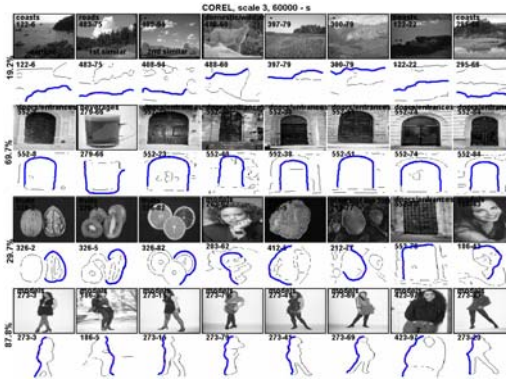
Adding Contextual Dimensions



$\mathbf{c}(o, l, b, t, w, e, \ r, c_m, c_s, f_m, f_s)$

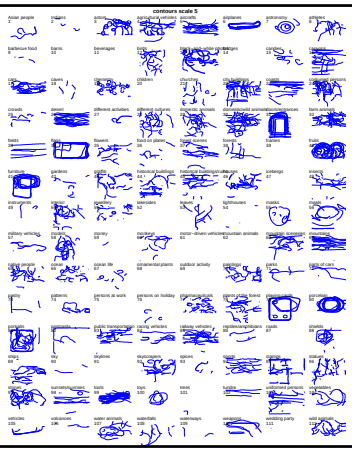
$\mathbf{a}(o, l, e_1, e_2, b, p, \ c_m, c_s, f_m, f_s)$

geometry context



Sym-Ax Vector

Category-Specific Contours

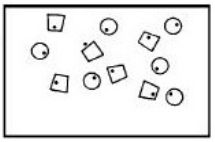


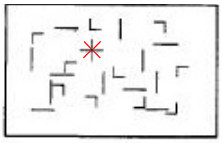
10%

*max(**c** or **a**)*
for
fine/coarse
scales
σ = 2, 3, 5

Future?

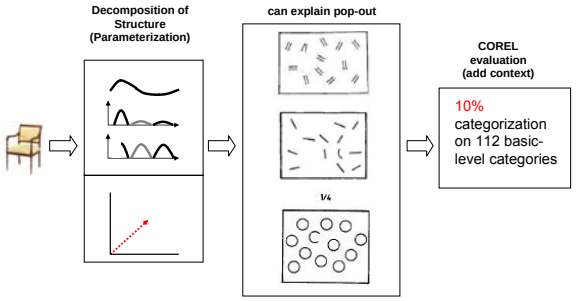
(grouping)





- 15% correct categorization

Summary



→ structural parameterization may be the key to fast categorization

Acknowledgments

Lab support: *Karl Gegenfurtner*

COREL Categorization: *Nadine Hartig*

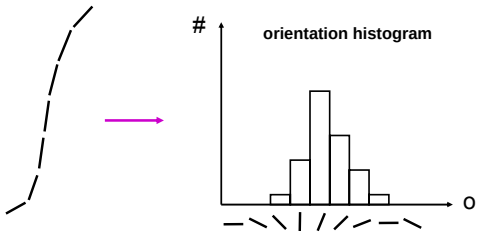
Gaze Com

Gaze-Based Communication Project
European Commission within the Information Society Technologies contract no. IST-C-033816

Comparison?

- Oliva & Torralba:
  scene characterization with Fourier T.
- neural networks/classifiers:
  viewpoint independence of 1 category instance or classification of 2-5 categories
- specialized systems in computer vision:
  – Faces, Characters (Identification!)

Neural Network?



- length, orientation, curvature,…
- V1: long-range horizontal connections
- translation independent