Symmetric Parts and Their Role in Object Recognition

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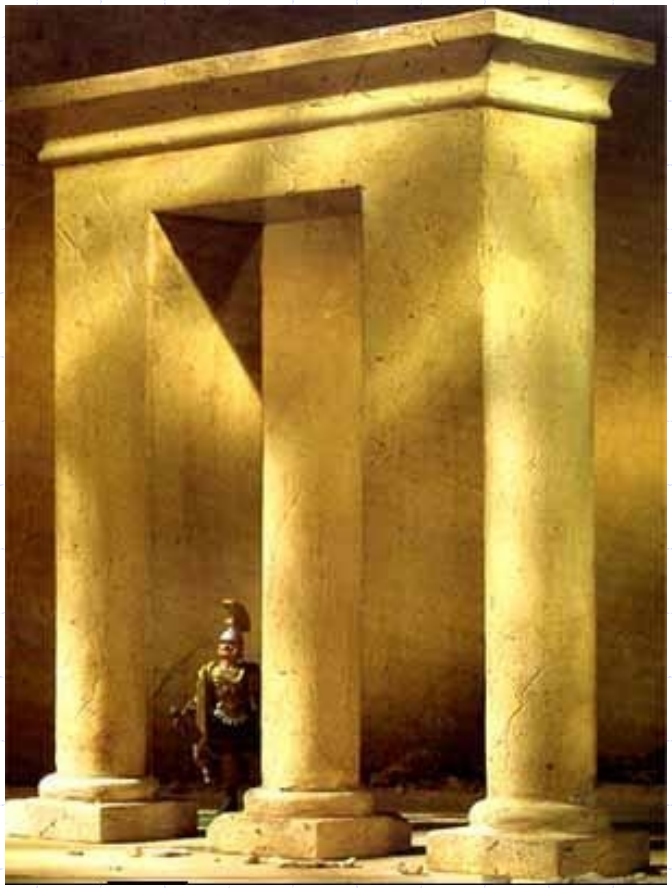
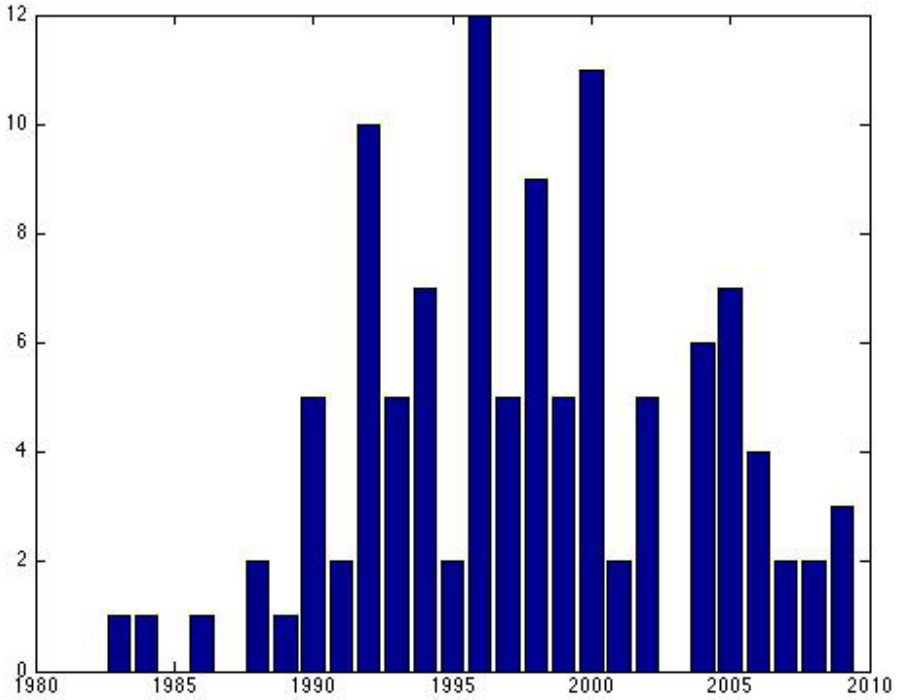
CVPR 2011 Workshop on
Symmetry
Detection from Real-World Images

Perceptual Grouping

The Rise and Fall of Perceptual Grouping





Perceptual grouping papers at ICCV, CVPR, ECCV, and ICPR, as tracked by the USC computer vision bibliography.

Detection Categorization Model

extract generic features

group/ abstract features

Model database (30,000 objects)

select candidates (index)

top

single candidate (plane)

airplane

bird

verify (detect) candidates

interpretation

The Need for Mid-Level Shape Priors

- A detector provides a strong shape prior, precluding the need for perceptual grouping.
- But recognition as detection won't scale to large databases.
- An informative shape index requires domain-independent intermediate shape priors: perceptual grouping!

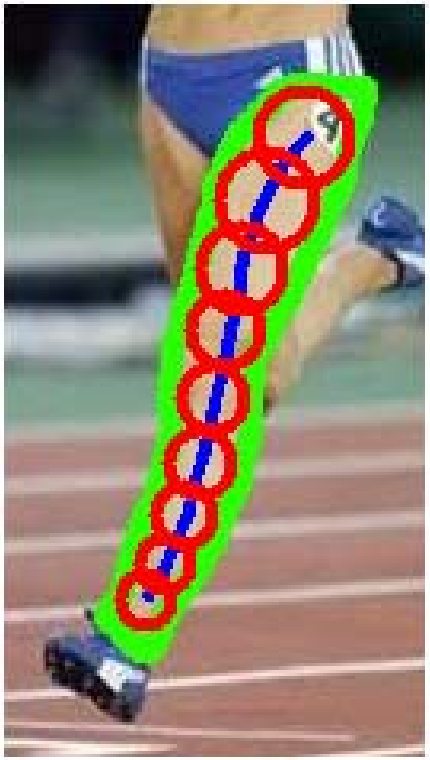
Symmetry: A Powerful Mid-Level Shape Prior

- Many objects in our world can be modeled as configurations of symmetric parts, e.g., humans, animals, plants, and a vast array of man-made objects.
- This regularity has shaped the evolution of the human visual system, which can quickly detect symmetry as a non-accidental feature.
- How do we computationally model symmetric parts, and how do we recover (and group) them from real images?

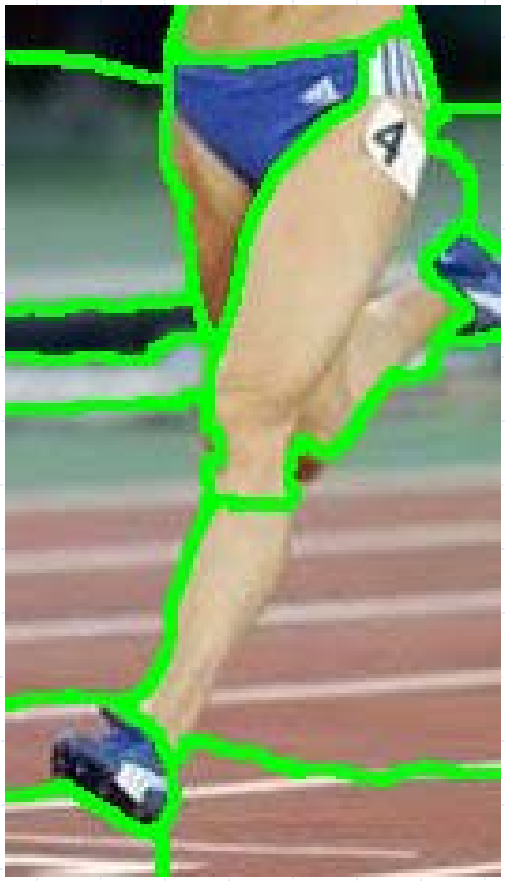
Multiscale Symmetric Part Detection and Grouping

Levinshtein, Sminchisescu, and Dickinson (ICCV 2009)

Key Idea: Superpixels as Deformable Maximal Discs



Multiscale Superpixel Segmentation

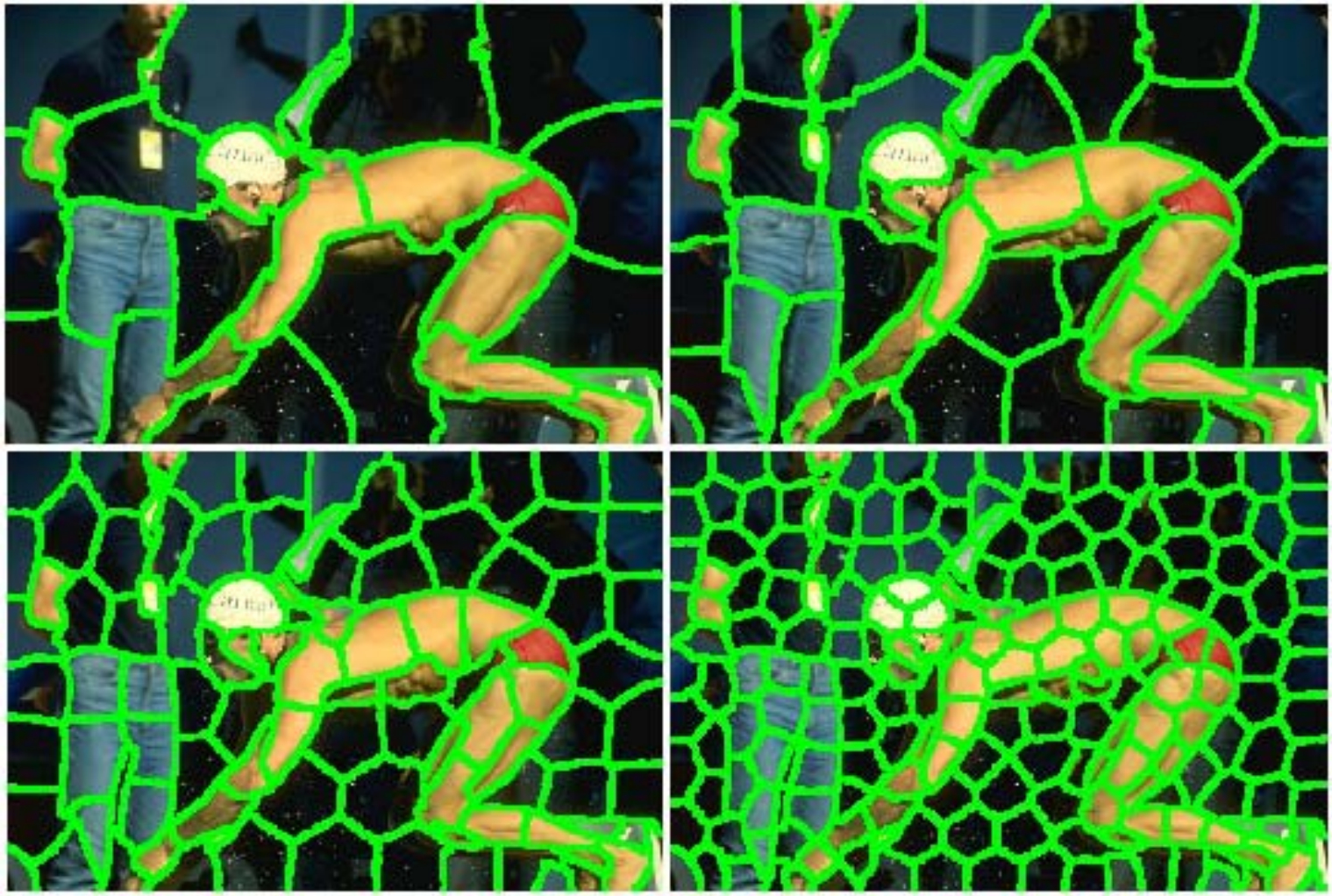


Too coarse

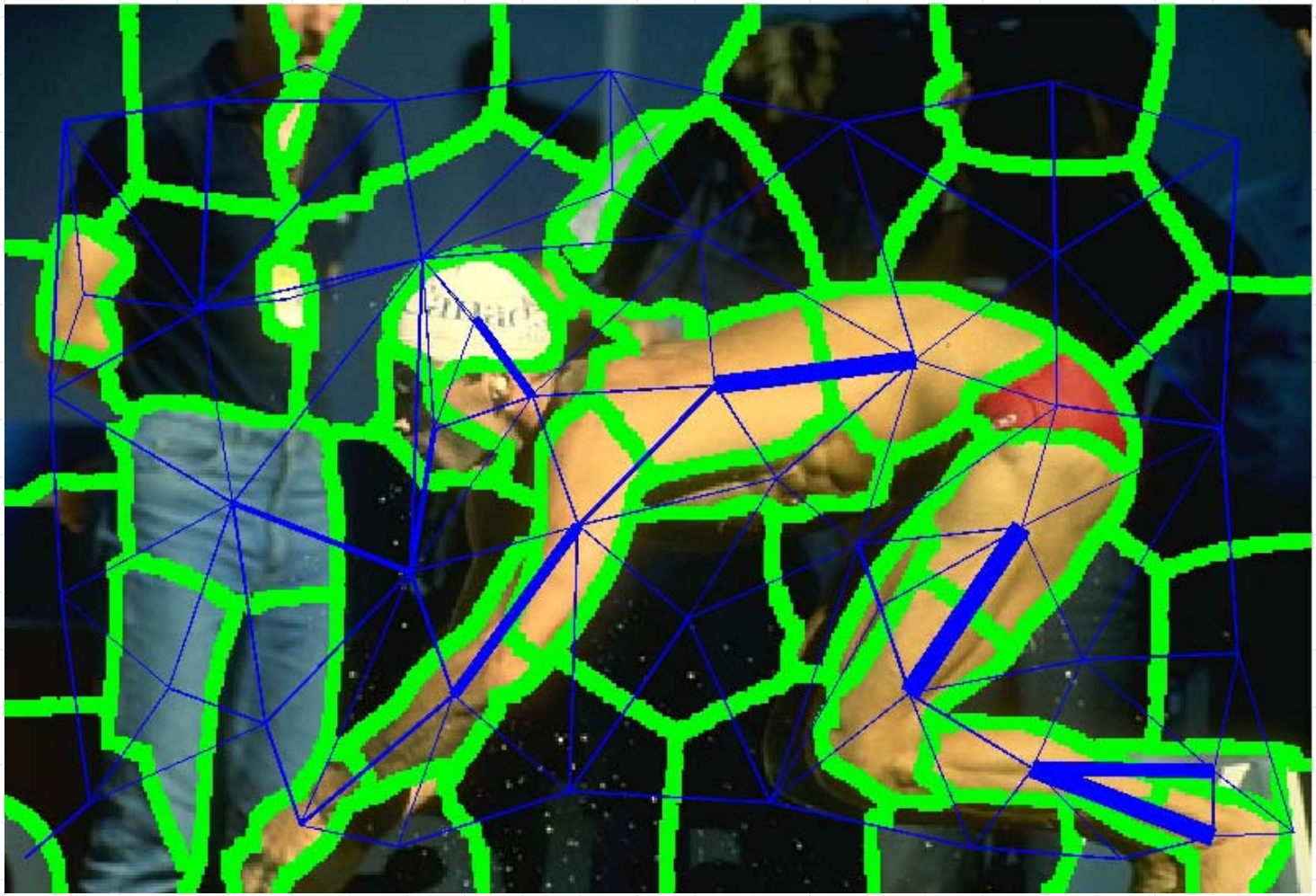
Just right

Too fine

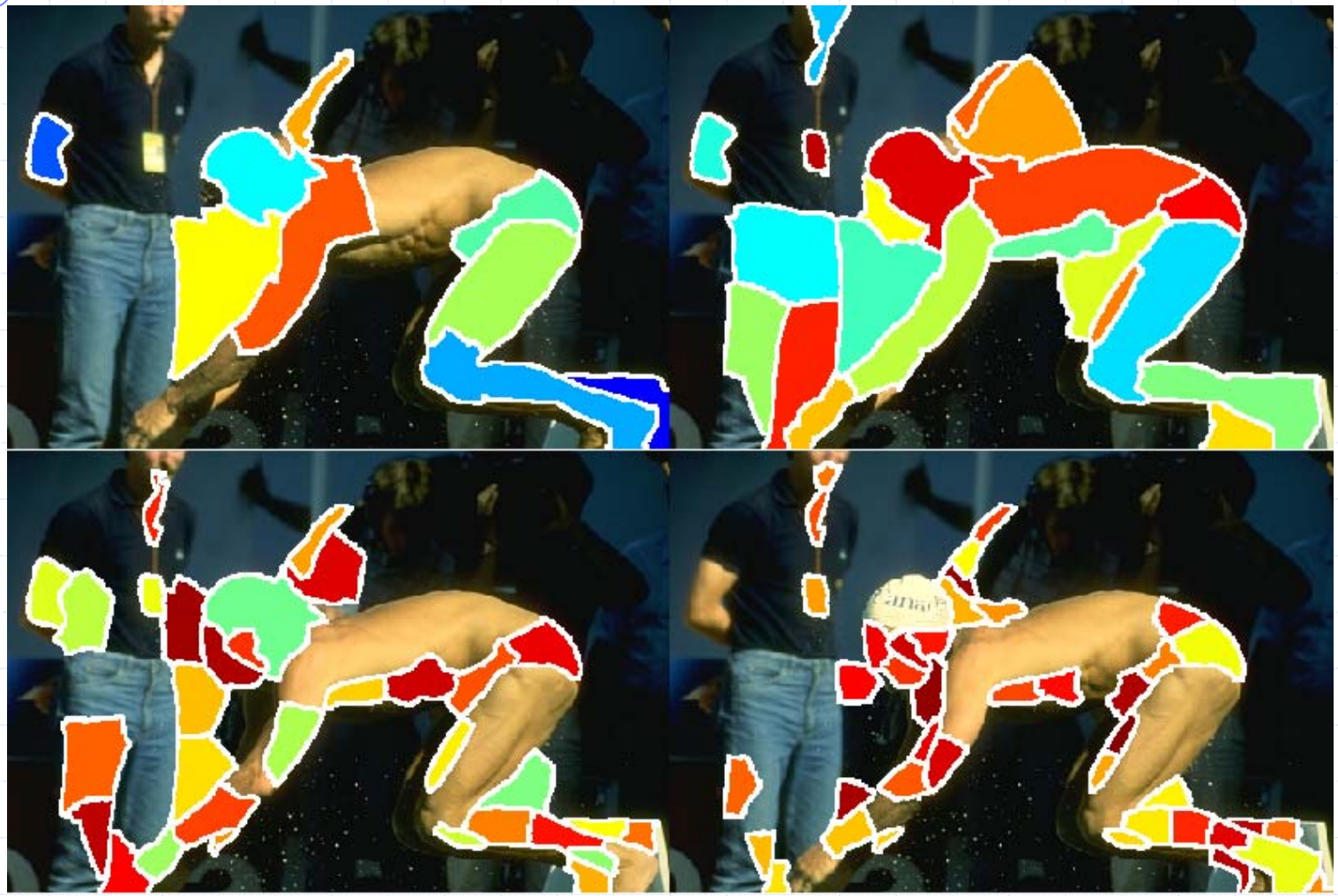
Back to Our Input Image



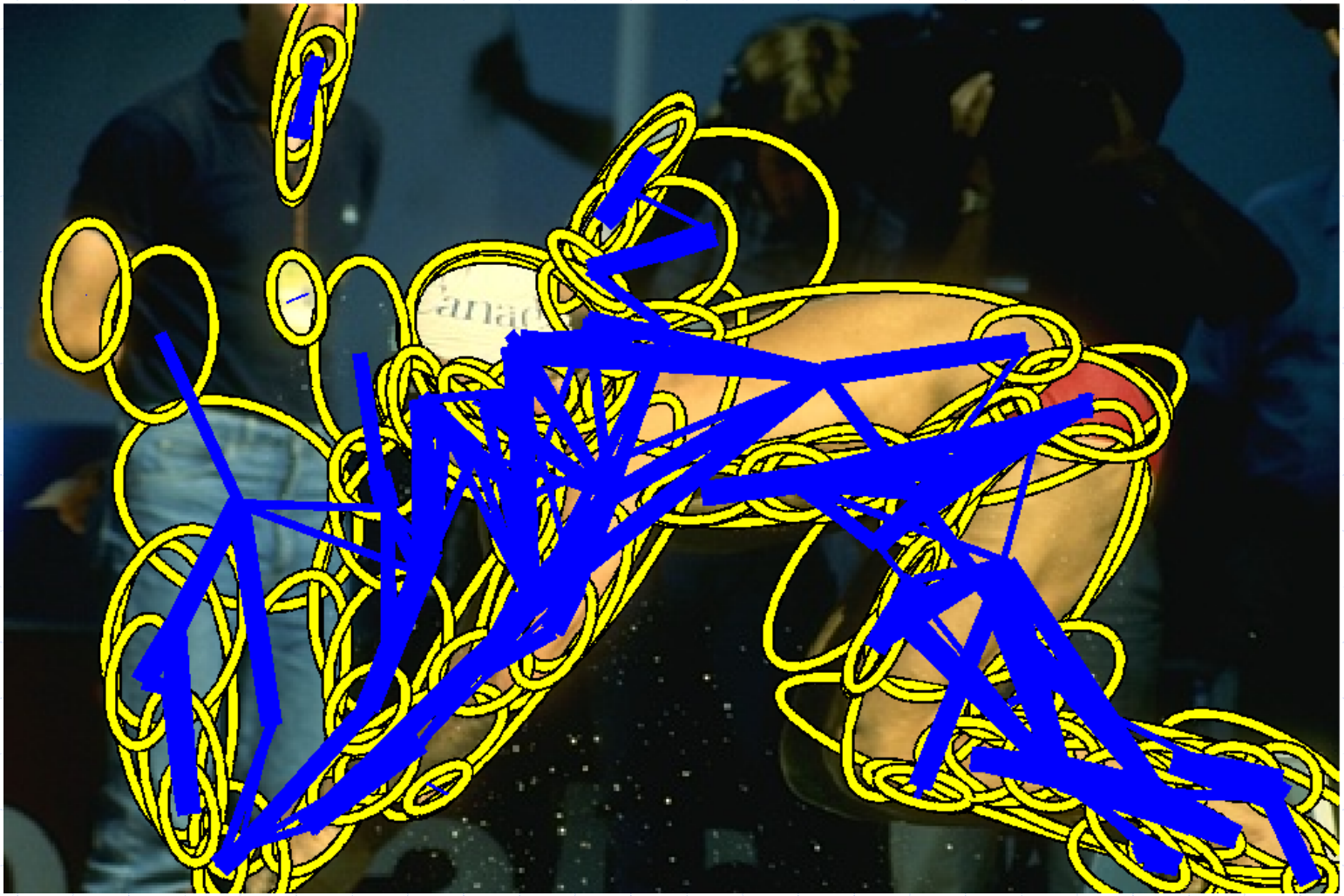
Superpixel Affinity



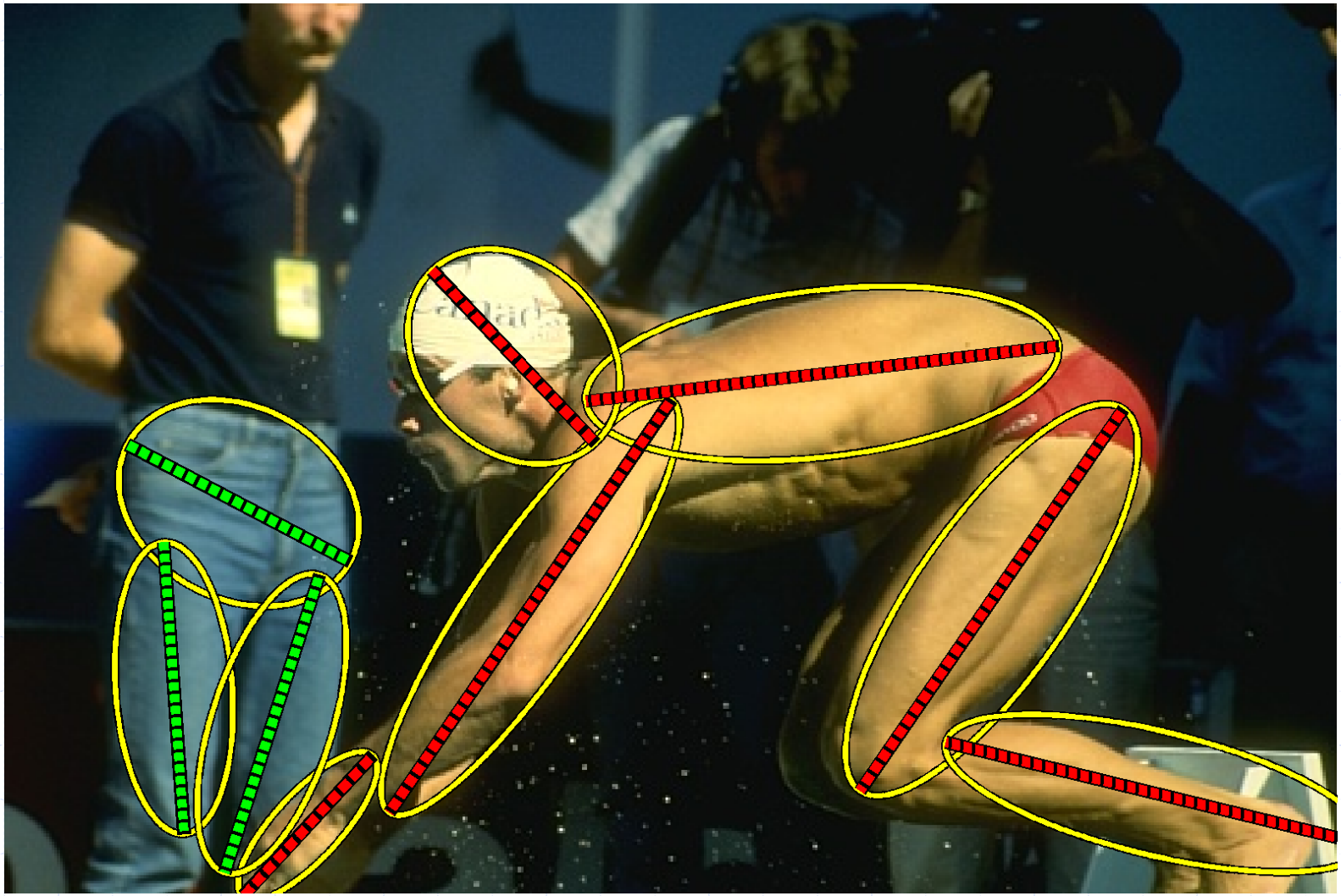
Multiscale Part Detection

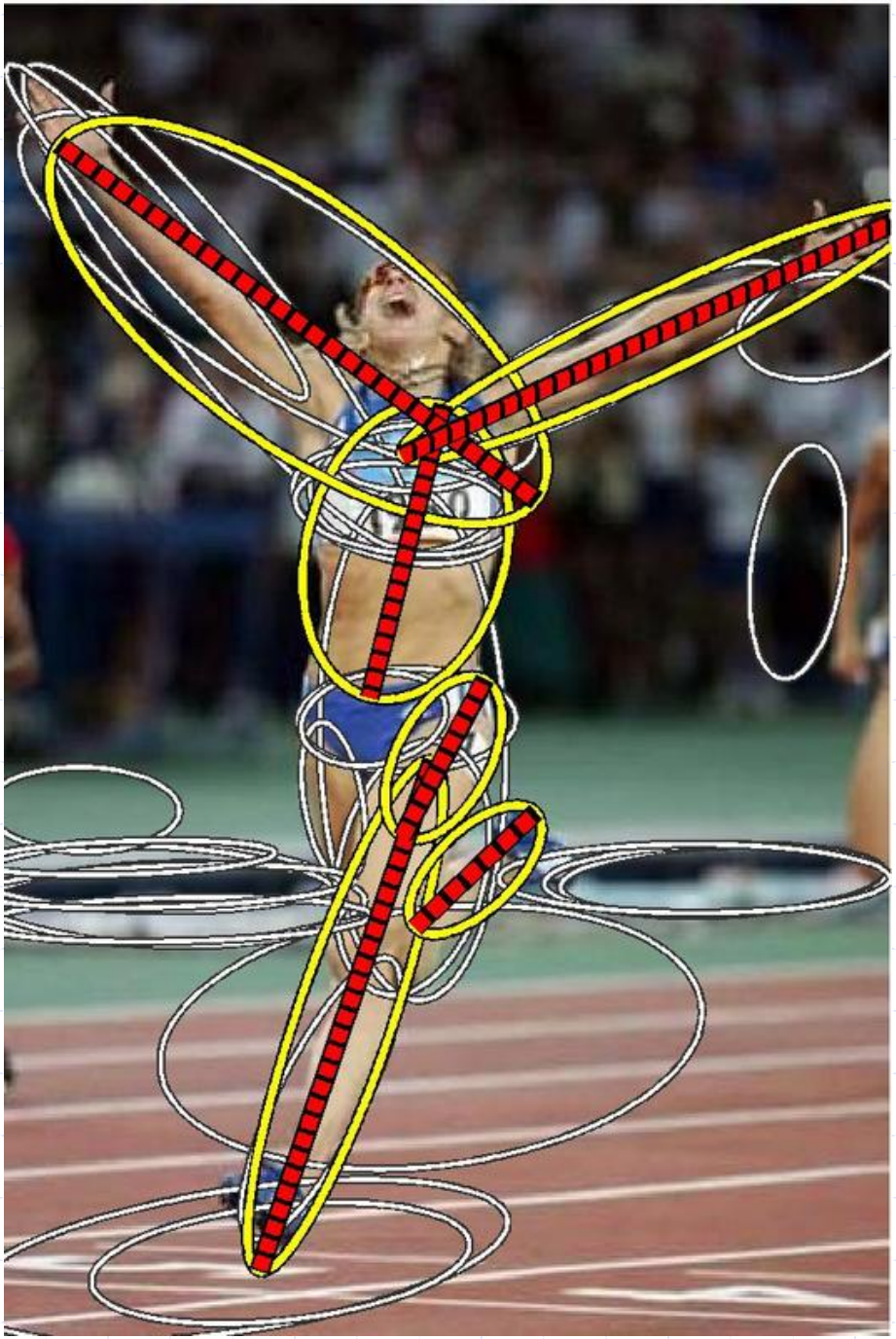


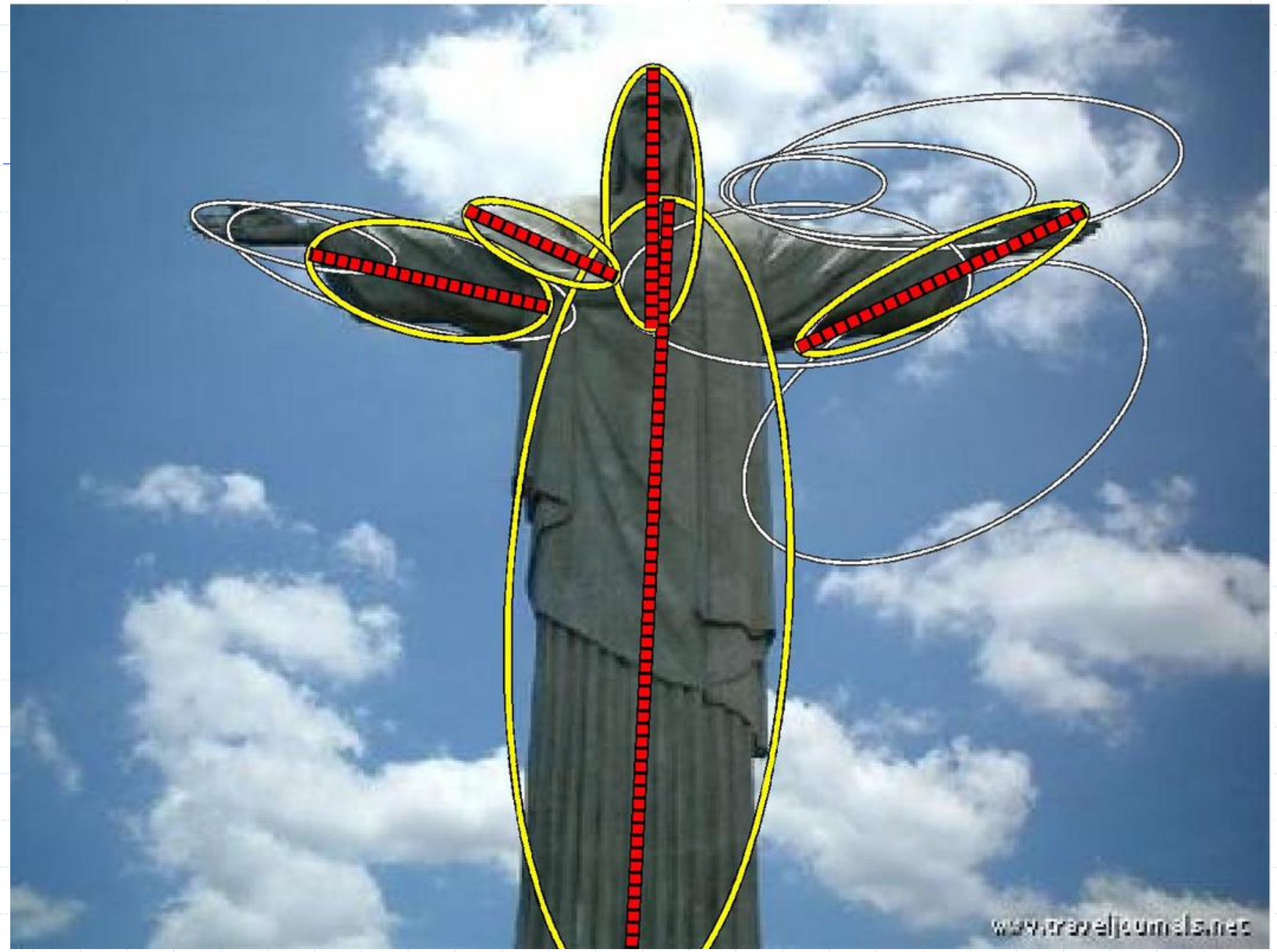
Part Affinity



Final Part Groups



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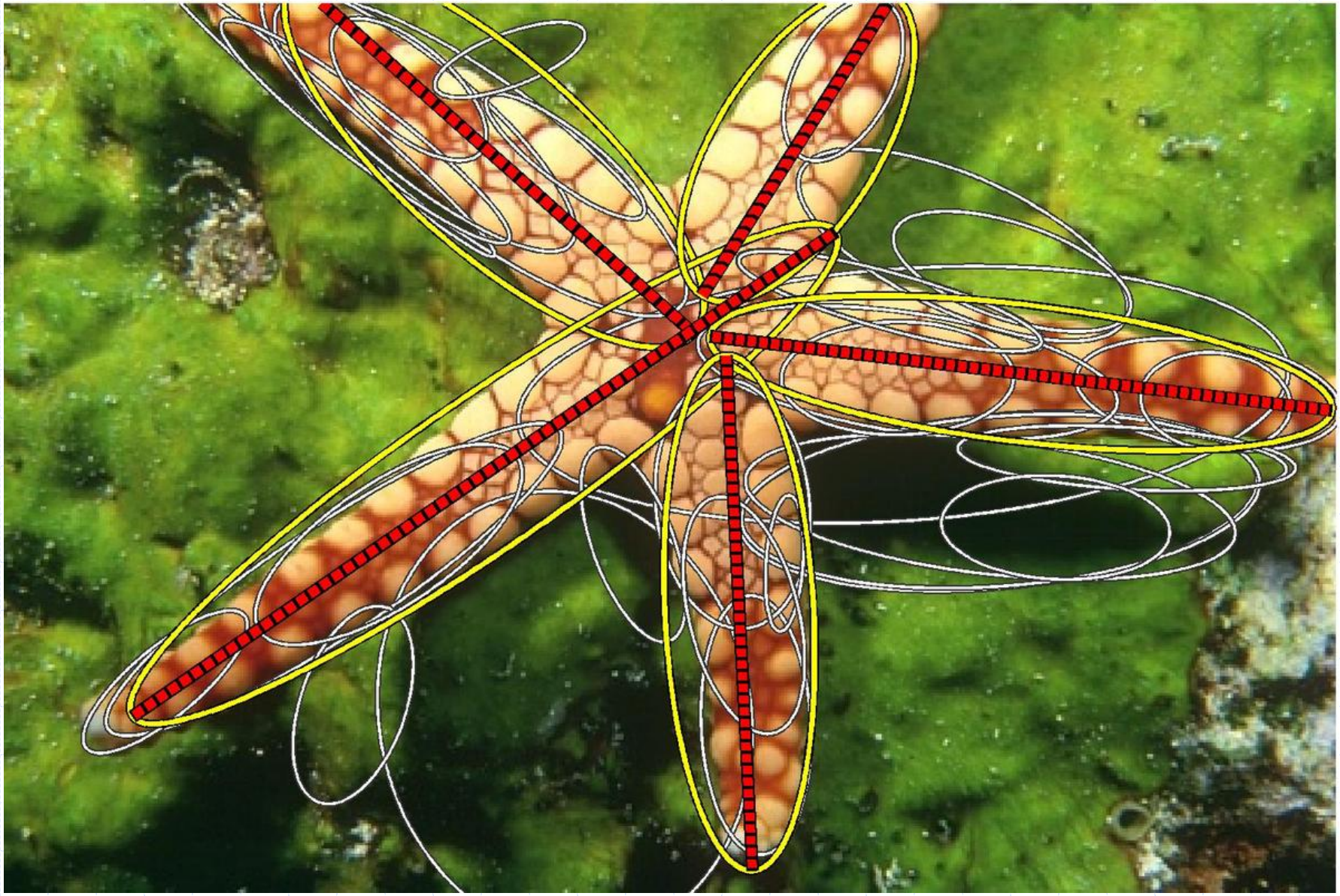
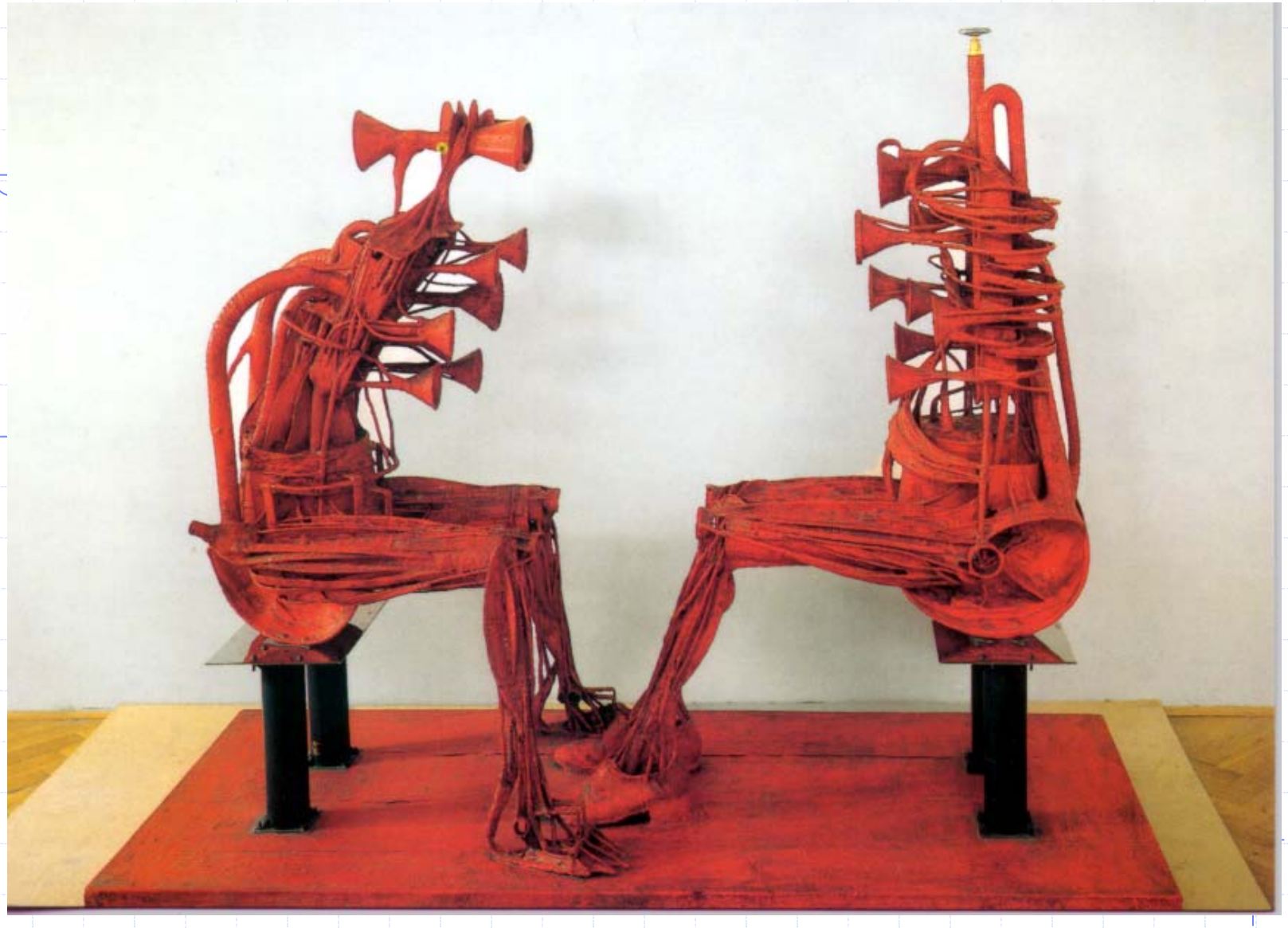
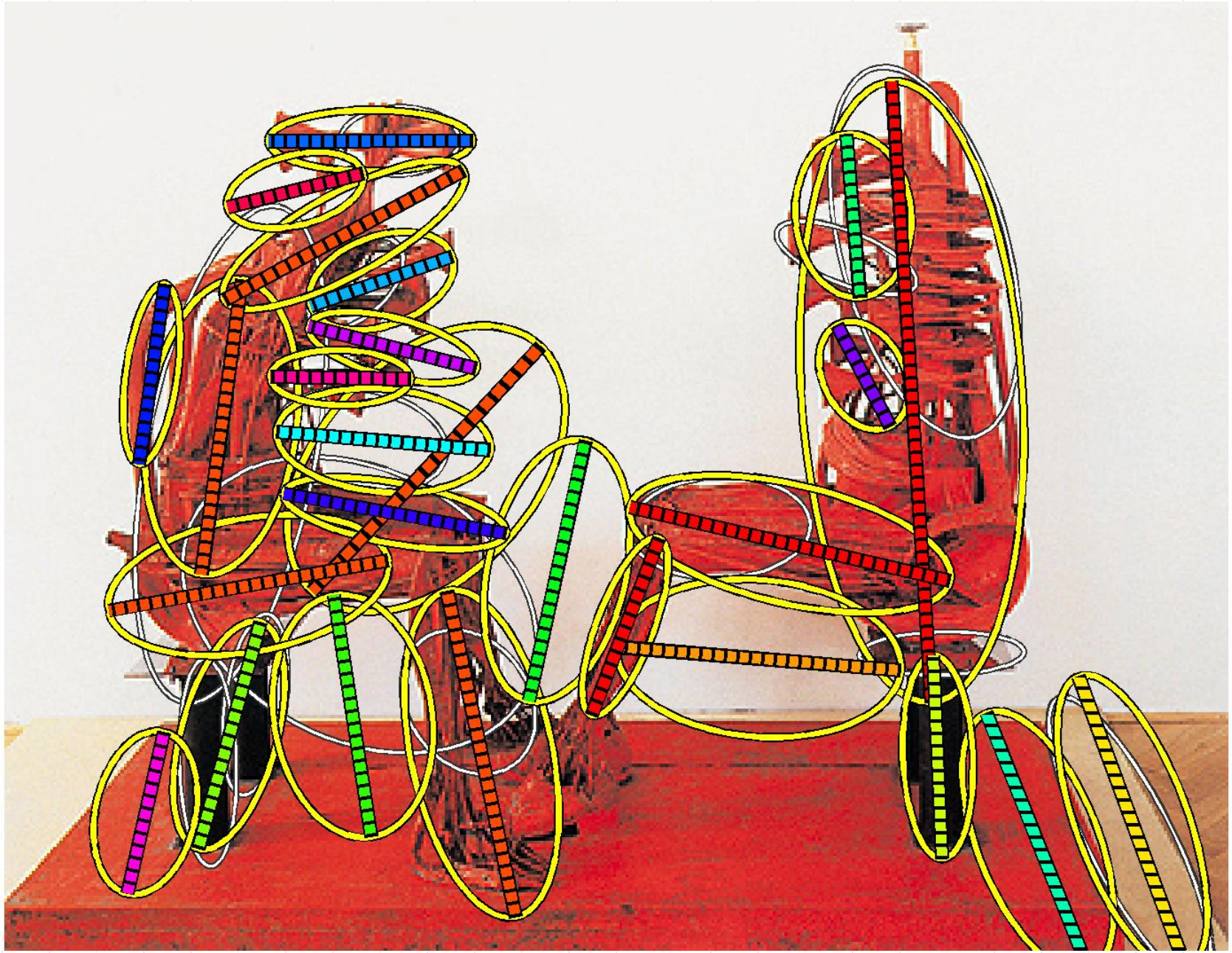




Great Dialog, Karel Nepras, 1966 (Prague National Gallery)



Conclusions

- Scaling categorization from detection to recognition from large databases will require domain-independent perceptual grouping – object-level shape priors must give way to mid-level shape priors.
- Local symmetry provides a natural, powerful basis for part decomposition that supports object categorization.
- Symmetry-based contour grouping is necessary but not sufficient, for we need to abstract the groups before they can be used to query a large database.

Challenges/Open Questions

- What are the appropriate parameters of a symmetric part? (e.g., bending, tapering, pinching, etc.?)
- What are the appropriate attachment relations between parts?
- Should recovered symmetric parts (and their attachments) be 2D or 3D?
- How do we recover abstract symmetric parts and their attachment relations from real images of real objects?