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Ground truth energies for hierarchies of segmentations



B. Ravi Kiran, Jean Serra

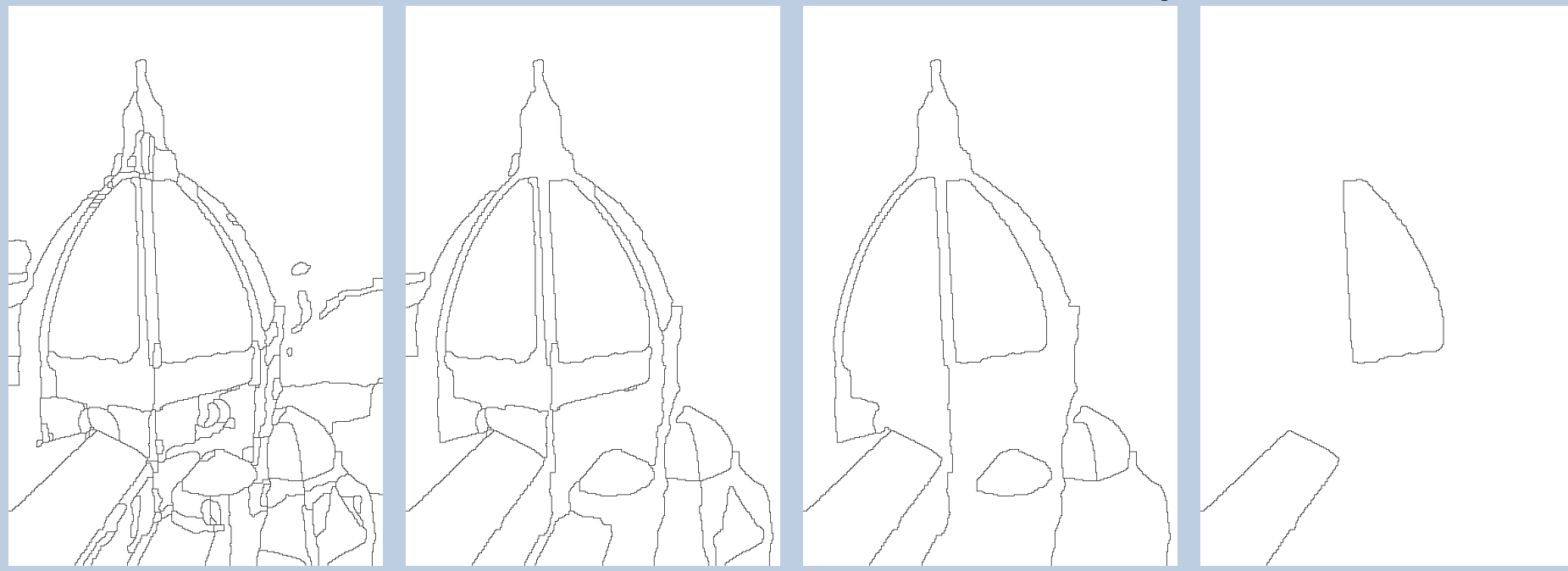
kiran@esiee.fr, j.serra@esiee.fr

http://www.esiee.fr/kiranr/HierarchEvalGT.html

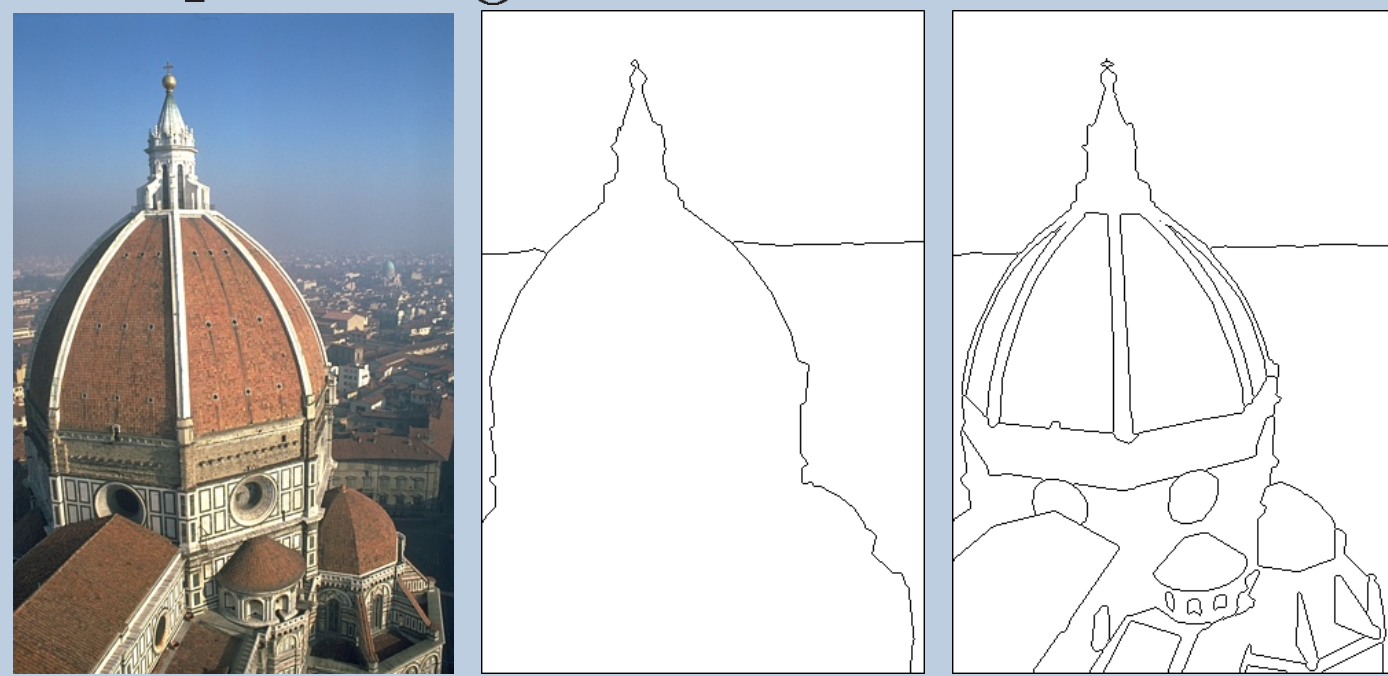
Problems

- Given a hierarchy H and ground truth partition G find the partition in H
 - Closest from $H \rightarrow G$
 - Closest from $G \rightarrow H$
- Compare any hierarchy H with multiple ground truth partitions G_i of image.
- Compare any two hierarchies H_1, H_2 , with respect to a common partition G .

Partitions in the hierarchy:



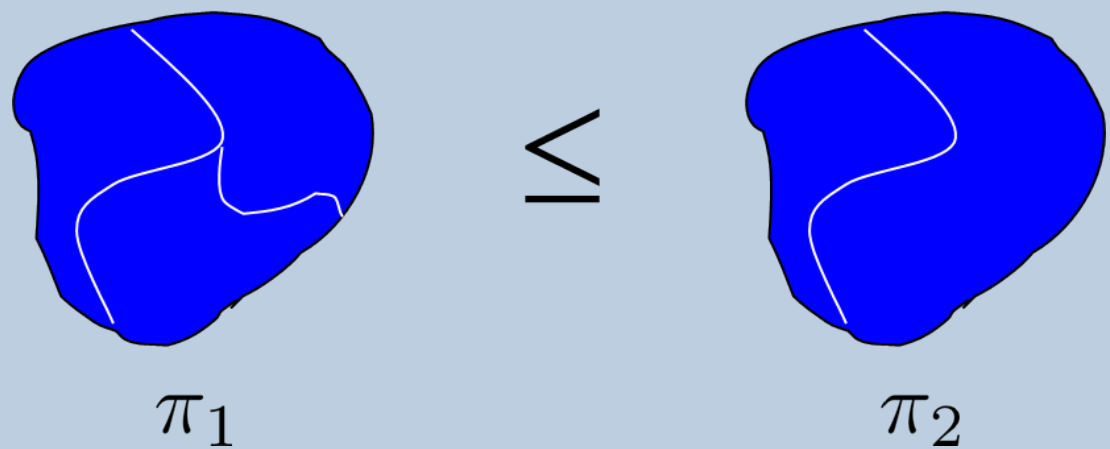
Input image and Ground truths:



Basic Concepts

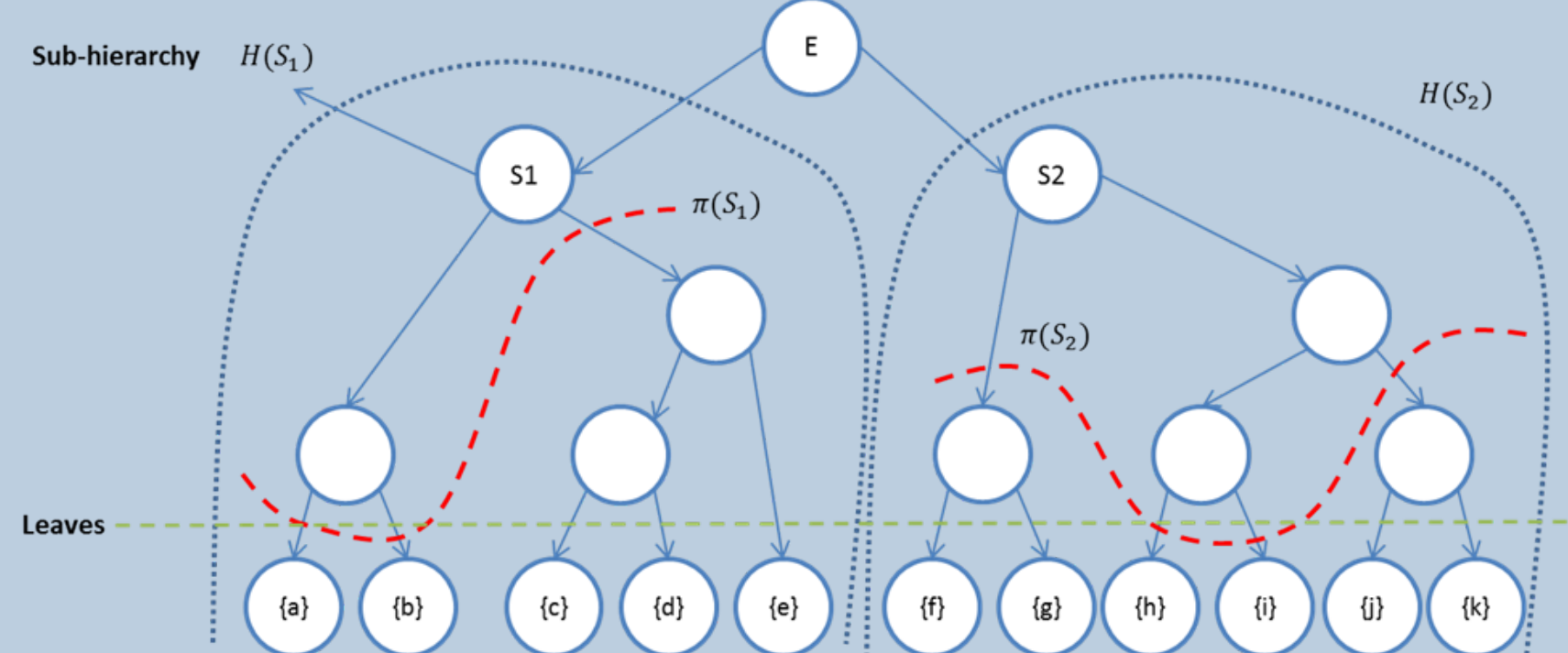
A hierarchy of partitions is a chain of increasing partitions of some finite set E .

$$H = \{\pi_i, 0 \leq i \leq n \mid i \leq k \leq n \Rightarrow \pi_i \leq \pi_k\},$$



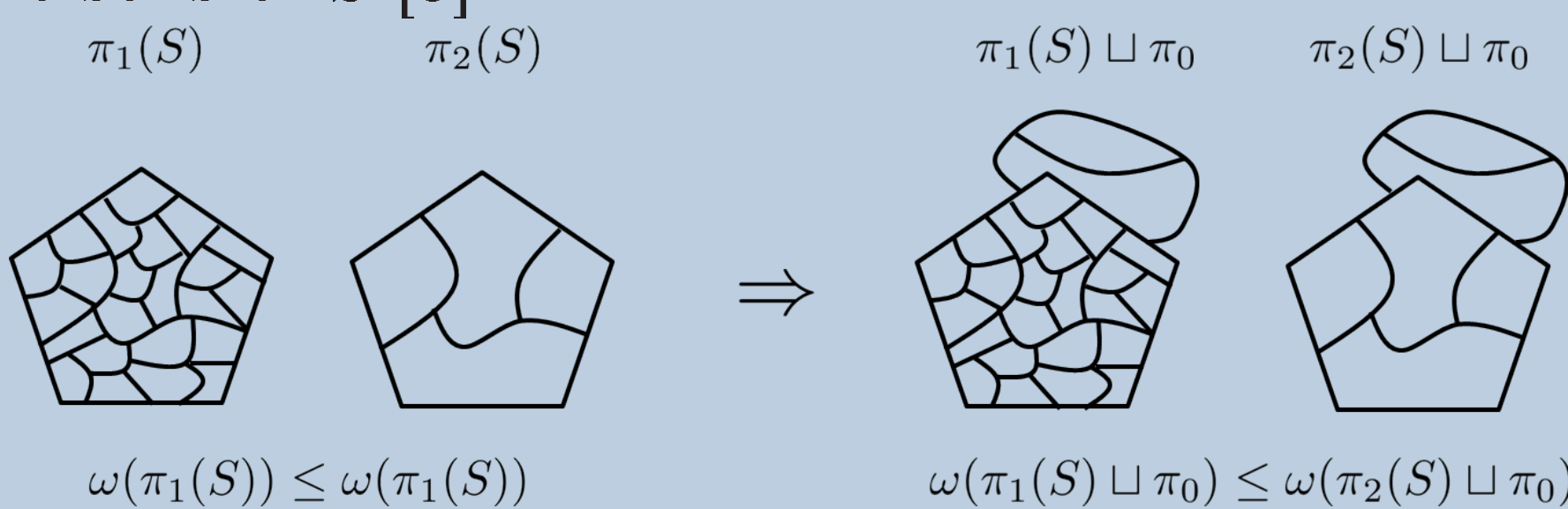
And each node or partial partition in the hierarchy is given an energy $\omega : \pi(S) \rightarrow \mathbb{R}^+$

Partition versus cuts:

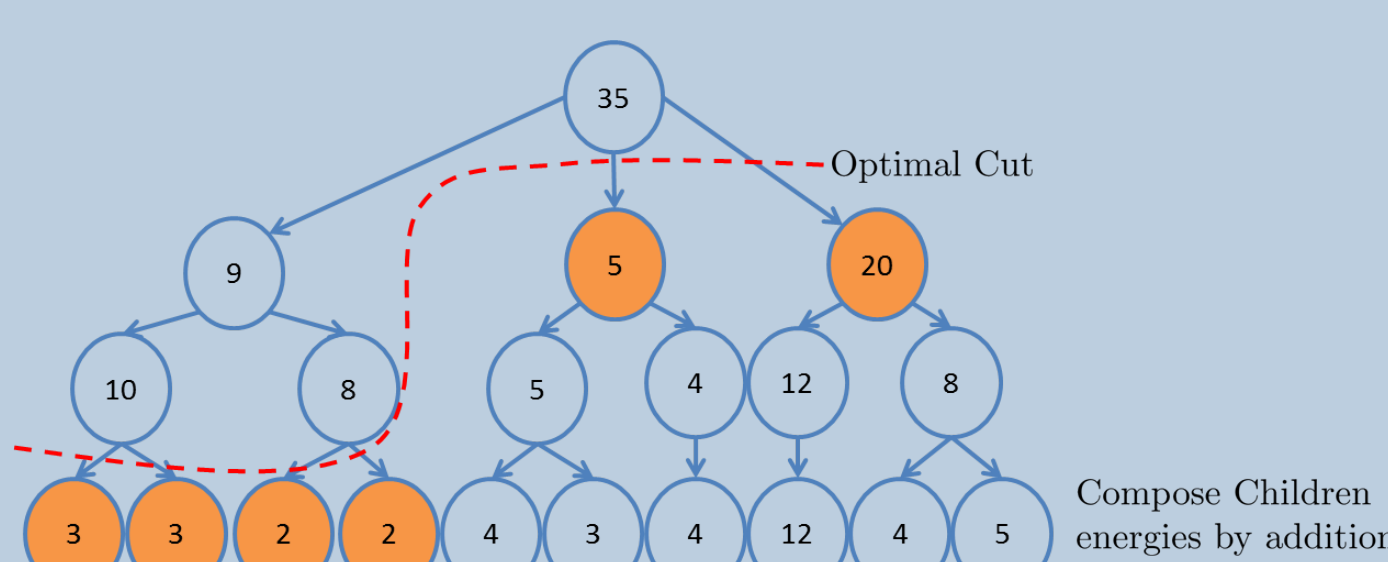


Number of possible cuts in the hierarchy increases more than exponentially with number of levels.

Theorem : When the energy is h -increasing and singular, then the temporary optimum at node S is either: S itself or the union of the optimal cuts of the sons of S [3]



This can be calculated by a bottom up dynamic program, that calculates the optimum at each partial partition S .



References

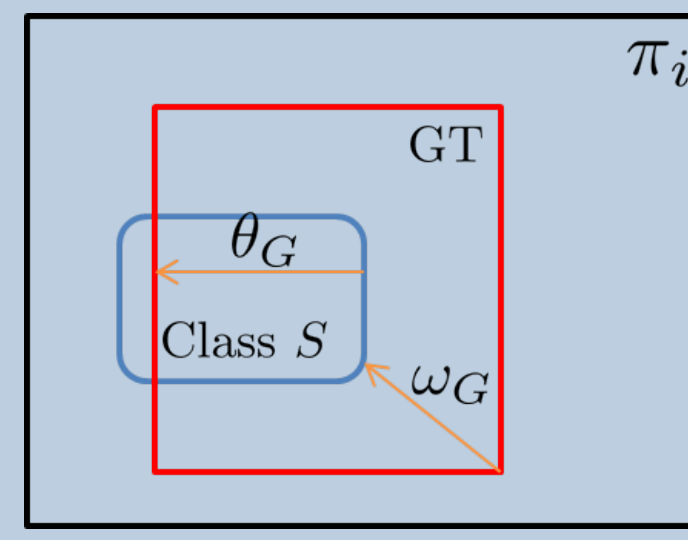
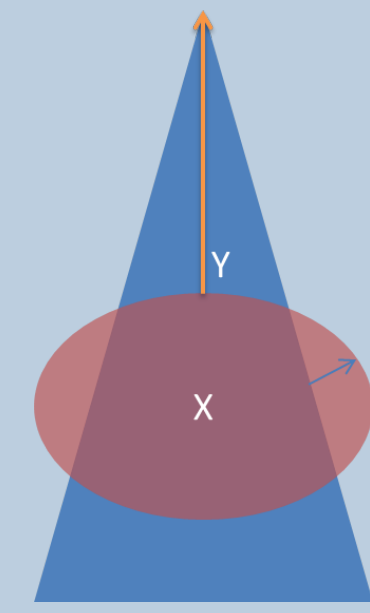
- Arbelaez, P., Maire, M., Fowlkes, C., Malik, J.: Contour Detection and Hierarchical Image Segmentation. IEEE PAMI 33 (2011)
- Jordi Pont-Tuset and Ferran Marqués, Supervised Assessment of Segmentation Hierarchies - In ECCV 2012, 5-46
- Global-local optimizations on hierarchies of segmentations B Ravi Kiran, Jean Serra, Special issue CV applying PR, PR Letters 2013

Local half Hausdorff measures: Ground truth energies

Hausdorff distance: Smallest disc dilation of X that contains Y and of X to contain Y

$$d_H(X, Y) = \max \{ \sup_{x \in X} \inf_{y \in Y} d(x, y), \sup_{y \in Y} \inf_{x \in X} d(x, y) \}$$

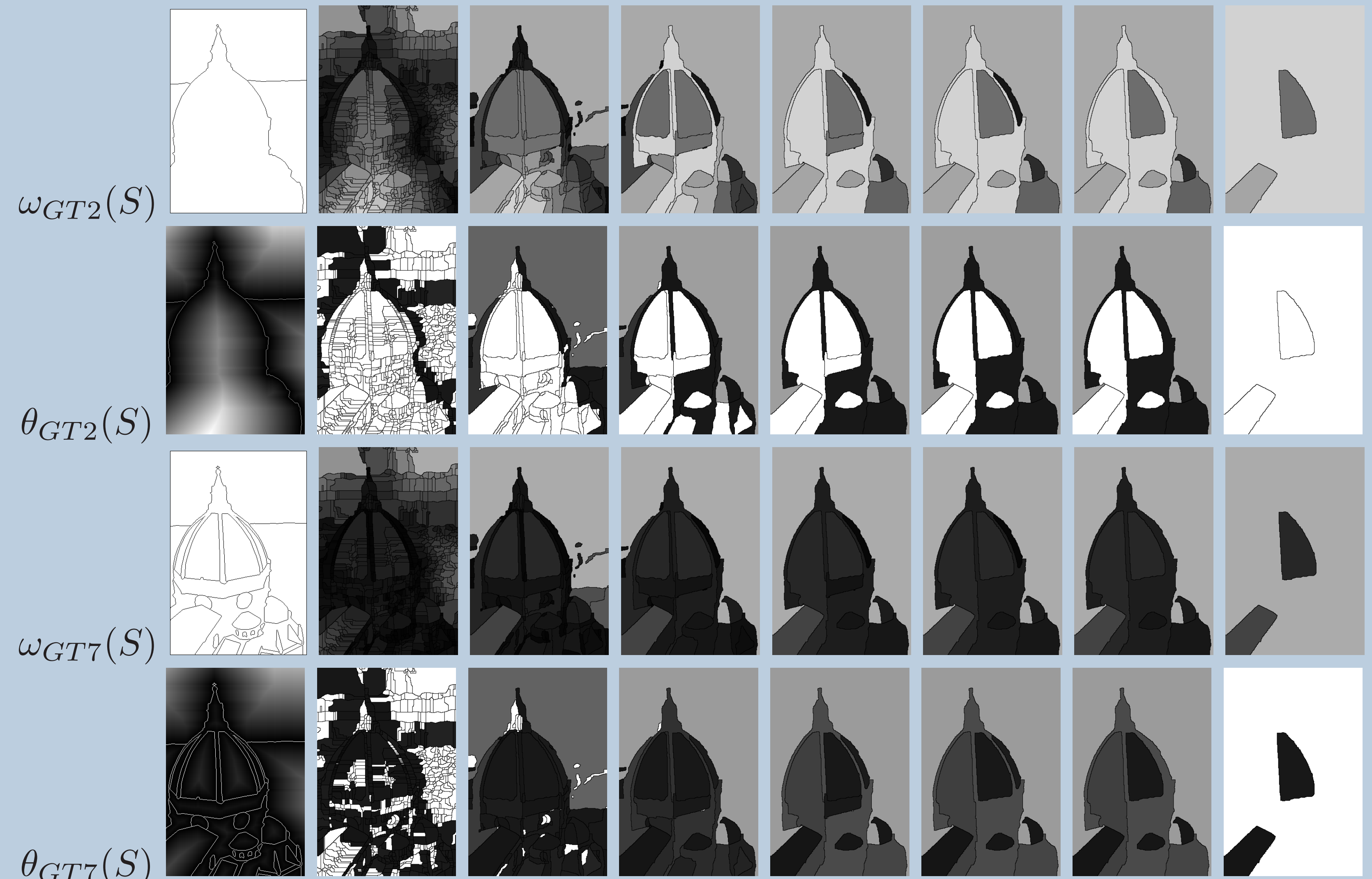
Problems: Global measure, large variations when object are asymmetric w.r.t each other



Local Hausdorff measures

$$\omega_G(S) = \frac{1}{\partial S} \int_{\partial S} g(x) dx$$

$$\theta_G(S) = \frac{1}{G \cap S} \int_{G \cap S} g(x, \partial S) dx$$



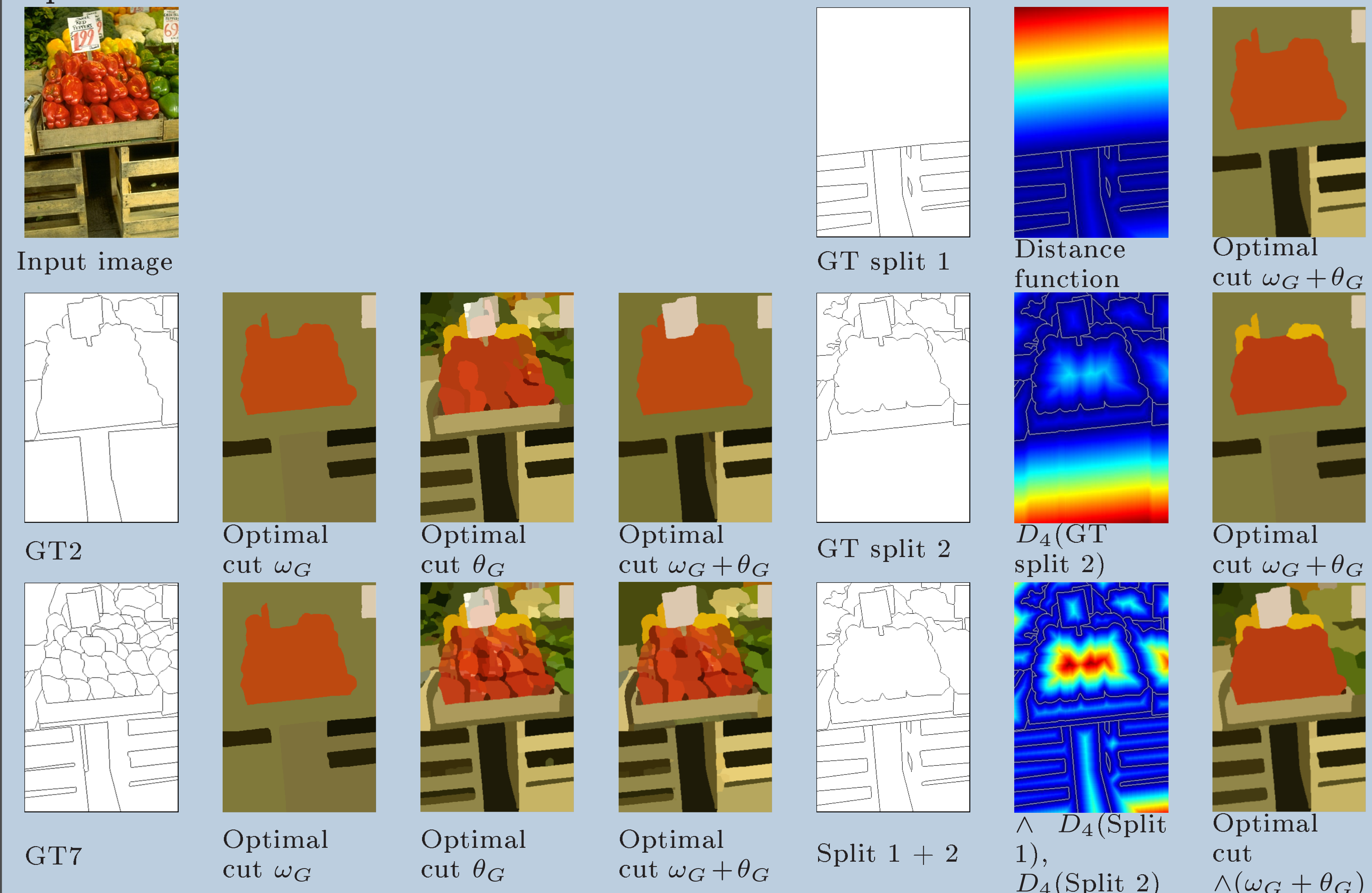
Ground truth energy distribution $\omega(S)$ and $\theta(S)$. Ground truth and associated distance function on left, energy distribution right.

Optimal Cuts and composition laws

Composition law: Supremum for ω_G and θ_G , Infimum for $\omega_G + \theta_G$

Different proximities: $H \rightarrow G, G \rightarrow H, H \rightarrow G_i, H_i \rightarrow G$

Optimal cuts:



Global Similarity measures to integrate the proximity between a sequence of partitions and a ground truth.

$$P = \frac{1}{N} \sum_{i=0}^1 \frac{\int_{x \in \epsilon(S_i)} (1 - g(x)) \cdot S_i(x) dx}{|S_i|} \quad R = \frac{1}{N} \sum_{i=0}^1 \frac{\int_{x \in G} (1 - g_{S_i}(x)) dx}{|G|} \quad (1)$$

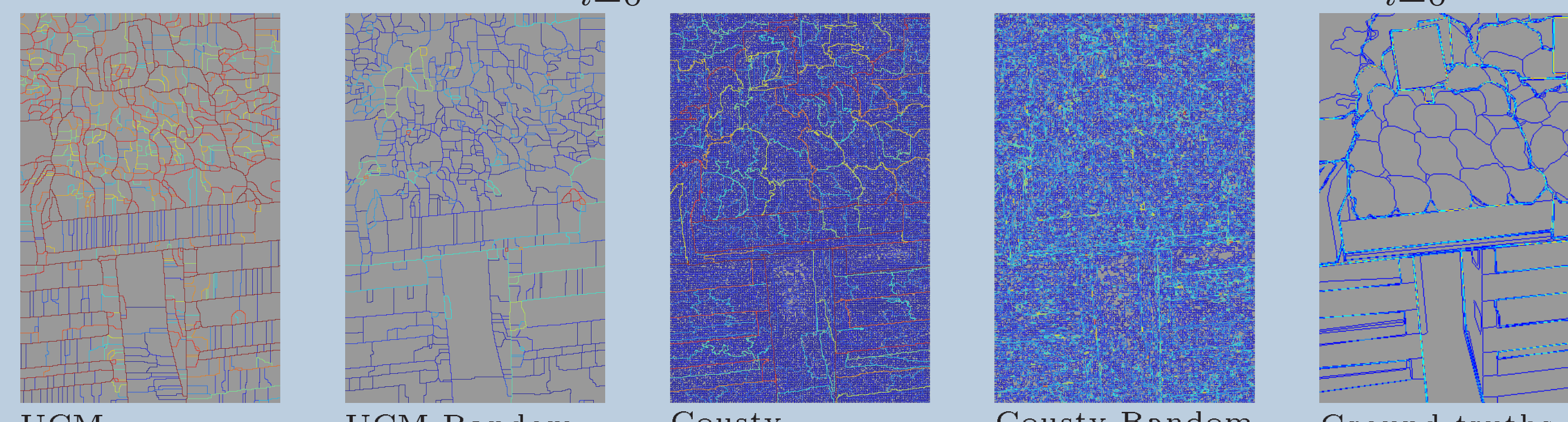


Image 25098	UCM	UCM random	Cousty	Cousty random
Precision energy	4.4	0.27	0.13	0.09
Recall energy	3.9	0.28	0.16	0.10

Precision-Recall Table

Global Precision-Recall integrals (1) measure proximity between hierarchies and set ground truths associated with the image.

- h -increasing energies based on local Hausdorff distances
- Additive and Inf Composition laws for fusing multiple GTs
- Evaluating hierarchies against GTs by global similarity measures