A Morphological Tree of Shapes for Color Images

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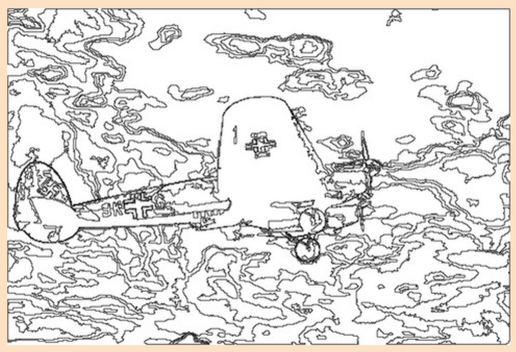
Tree of Shapes ⇝



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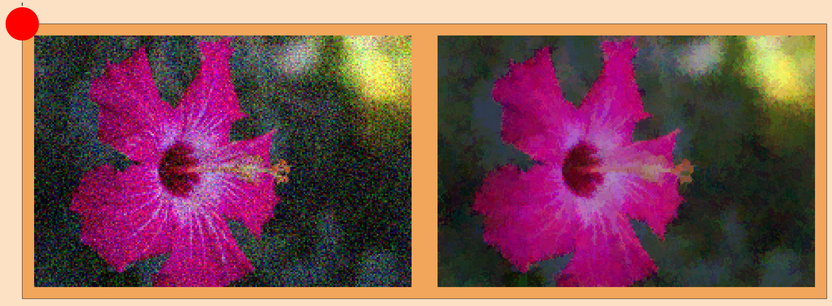
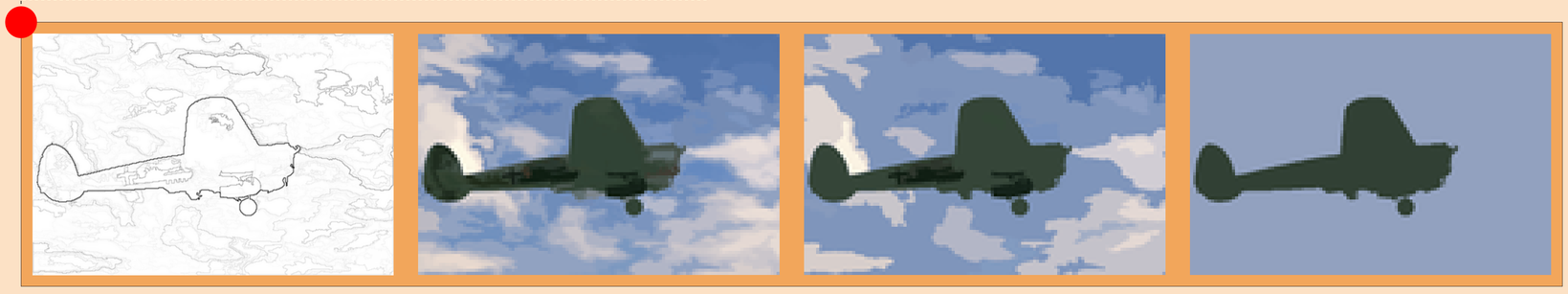
Applications:
- Denoising
- Object detection
- Image Simplification
- Hierarchical Segmentation...





Denoising (left) and hierarchical image simplification using the saliency map (right) built from the Color Tree of Shapes.

At a Glance

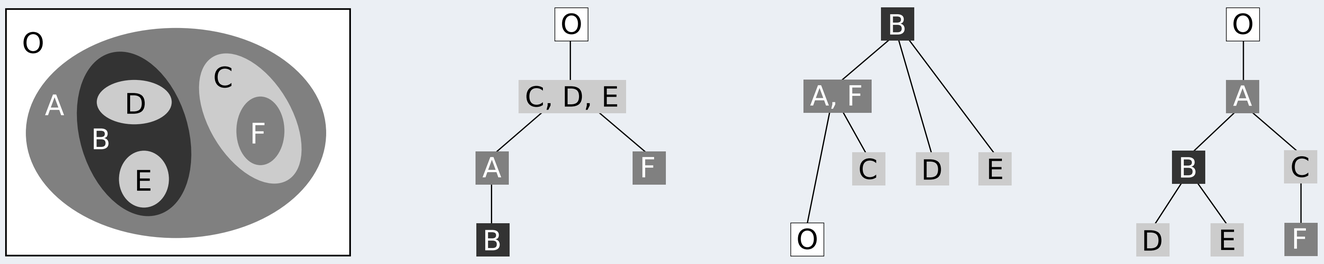
Motivation. The Tree of Shapes (ToS) provides an *high-level representation of the image structure*.

Problem. The definition of the ToS requires a total order on image values, *but* it does not exist such a (natural) total order on multivariate images.

Objective. Extend the ToS computation on color images.

Contribution. A method that computes a hierarchical representation similar to the ToS that does not require to impose any arbitrary total order on colors.

A remainder about the Tree of Shapes



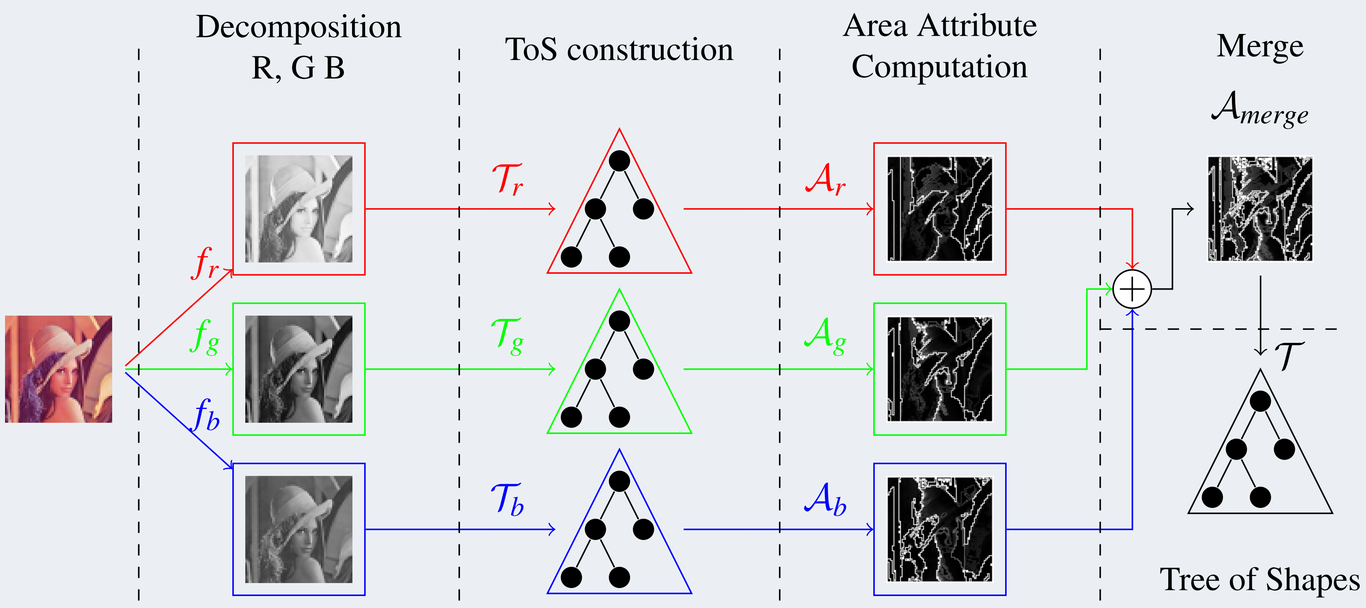
An image u and its min-tree $\mathcal{T}_{\min}$, max-tree $\mathcal{T}_{\max}$ and ToS $\mathcal{T}$.

- The min-tree encodes the inclusion of connected components of $[u \leq \lambda]$.
- The max-tree encodes the inclusion of connected components of $[u \geq \lambda]$.
- The ToS encodes the inclusion of the level-lines by merging the min and max-trees components. It is a self-dual representation of the image.

→ All those trees rely on a total ordering on values.

Our method for a Color Tree of Shapes

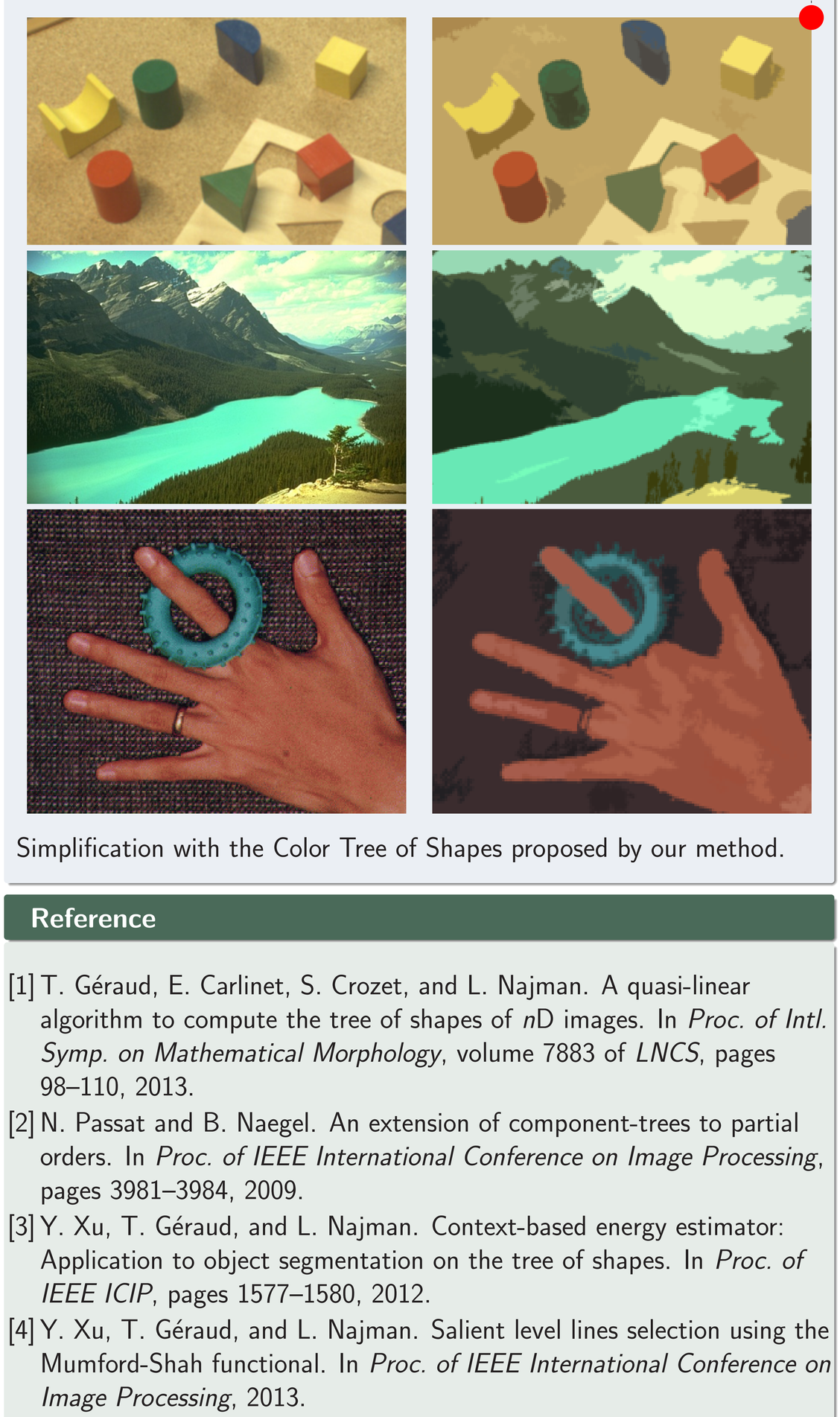
Key ideas:
- Merging the shapes from marginal ToS,
- Merging takes place in an attribute space (does not rely on a total order on colors),
- Given an increasing attribute $\mathcal{A}$ valued on a ToS $\mathcal{T}$ and the min-tree $\mathcal{T}_{\min}$ of the image reconstructed from $\mathcal{A}$, then $\mathcal{T}_{\min} = \mathcal{T}$.



Scheme of the proposed method.

1. Decompose the channels of the image and compute independently their ToS $\mathcal{T}_r, \mathcal{T}_g, \mathcal{T}_b$.
2. Compute the size of each node (attribute) and put the values back in the image space.
3. Merge the attribute images point-wise (w.r.t. the gradient) giving $\mathcal{A}_{\text{merge}}$.
4. Compute the ToS of $\mathcal{A}_{\text{merge}}$ to obtain the final tree structure.

A sample use of the ToS: simplification



Simplification with the Color Tree of Shapes proposed by our method.

Reference

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