Multivariate Image Processing with the Tree of Shapes

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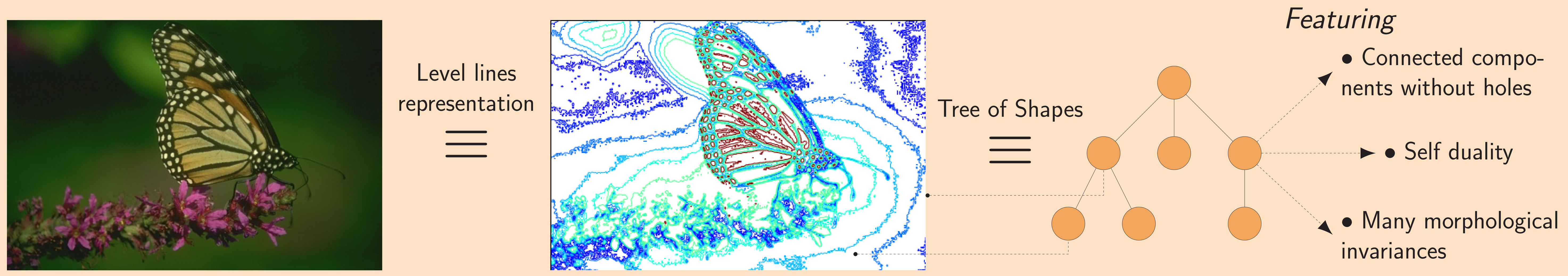
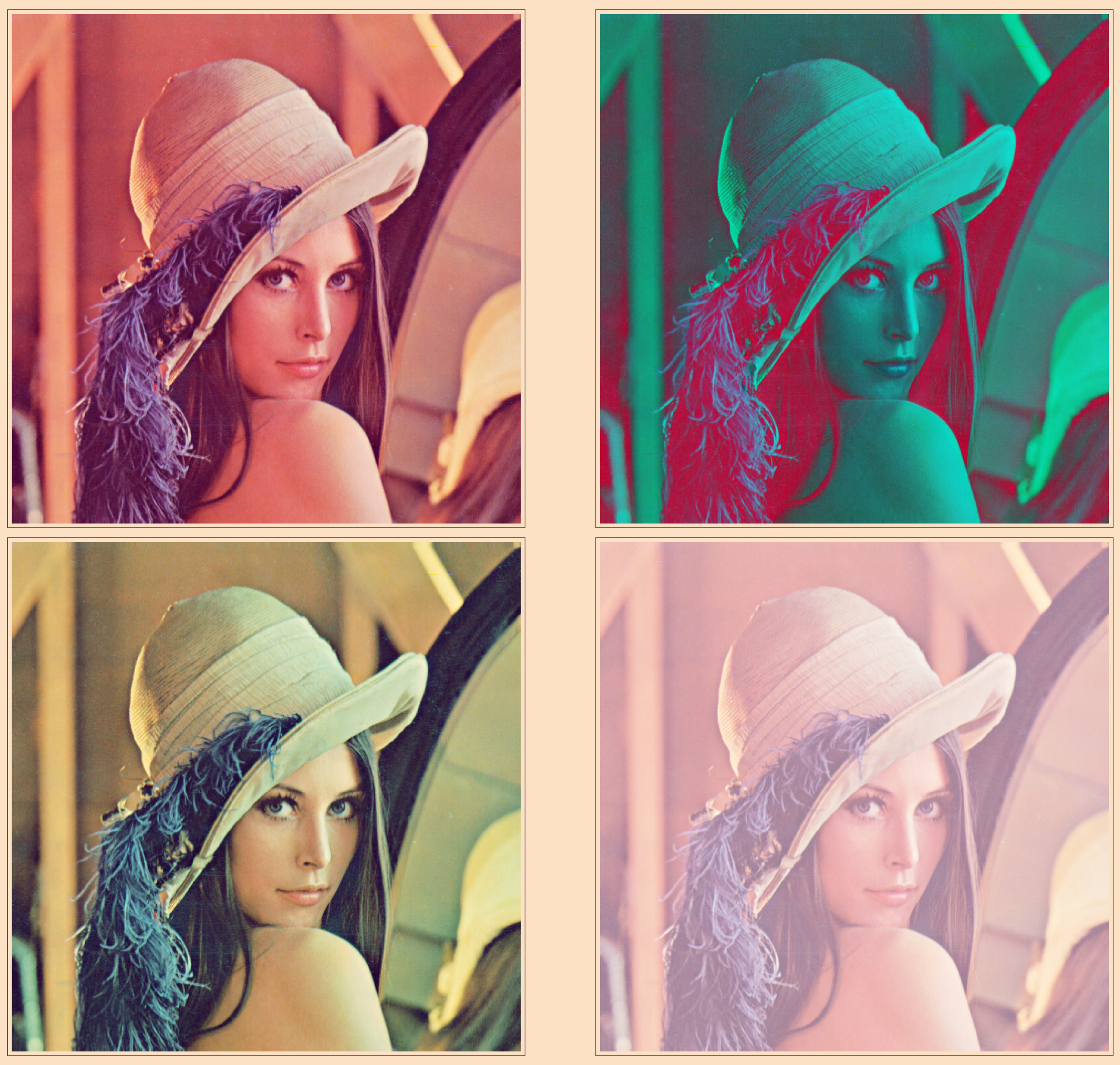


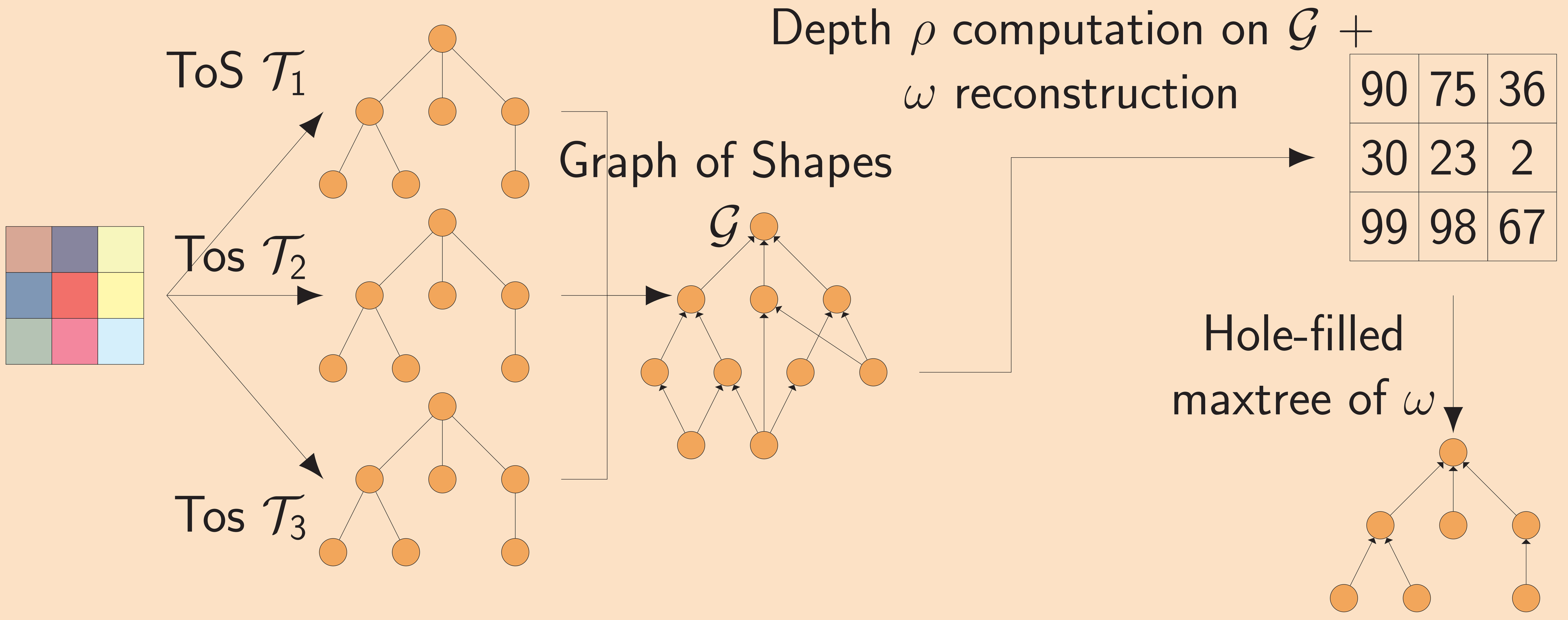
At a Glance

- **Motivation.** The Tree of Shapes (ToS) provides a *high-level representation of the image structure* and has *many applications*.
- **Objective.** Extend the ToS computation on color images.
- **Problem.** A natural tree **does not** exist for color images, "standard" approaches are not satisfactory.
- **Contribution.** A method that:
  - does **not** rely on any total ordering of colors,
  - is invariant by any marginal change of contrast,
  - is invariant by any marginal inversion of contrast,
  - is equivalent to the "normal" ToS in the gray level case.

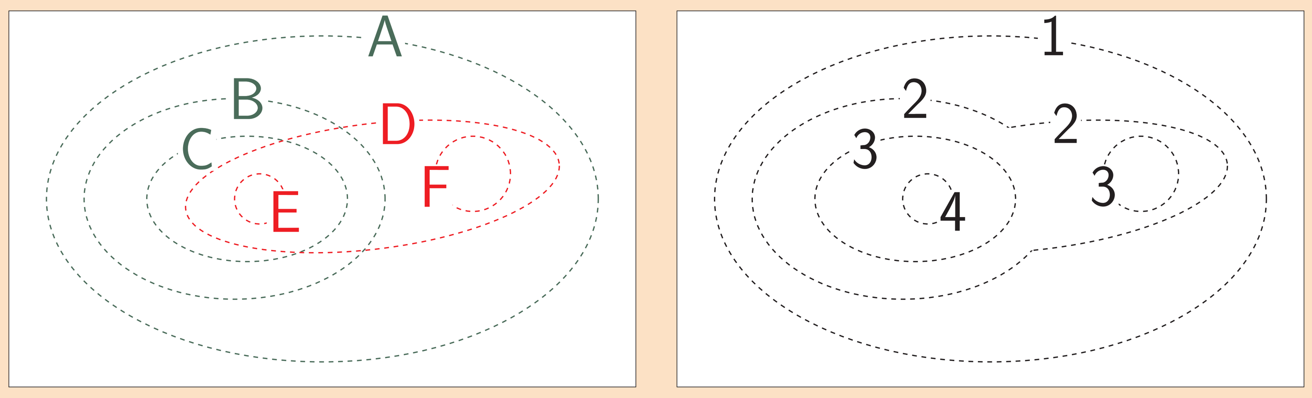


The ToS is invariant by contrast and inversion change of contrast → these images have the same tree

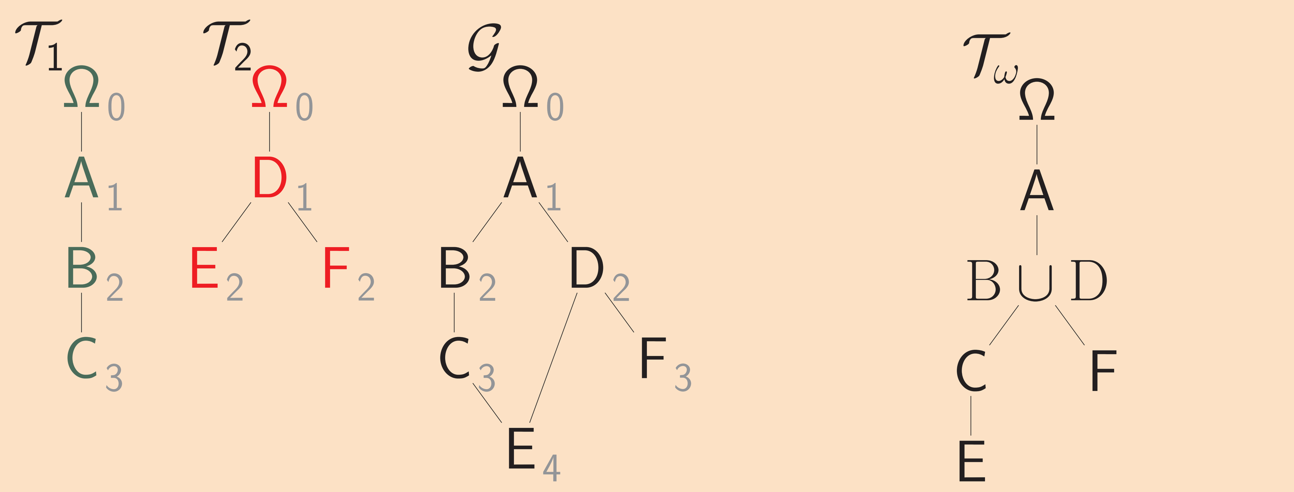
Method Description



1. Compute the marginal ToS $\mathcal{T}_1$, $\mathcal{T}_2$ and $\mathcal{T}_3$.
2. Merge them into a single graph structure $\mathcal{G}$ (the Graph of Shapes (GoS)).
3. Compute the depth ρ of each shape S in $\mathcal{G}$. The depth is the longest path from the root to that shape.
4. Reconstrust $\omega(x) = \max_{S | x \in S} \rho(S)$
5. Compute the hole-filled maxtree of ω to get the final tree $\mathcal{T}_\omega$.

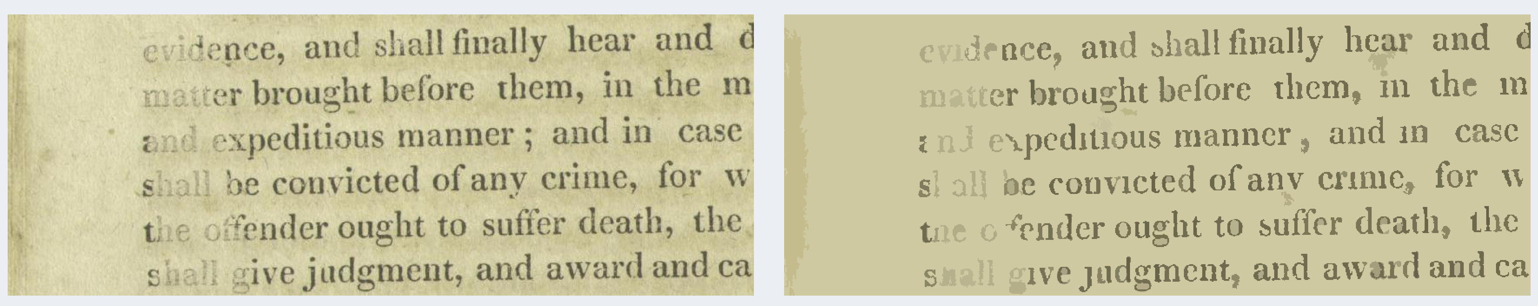


(a) A 2-channel image and its shapes. (c) ω image built from $\mathcal{G}$

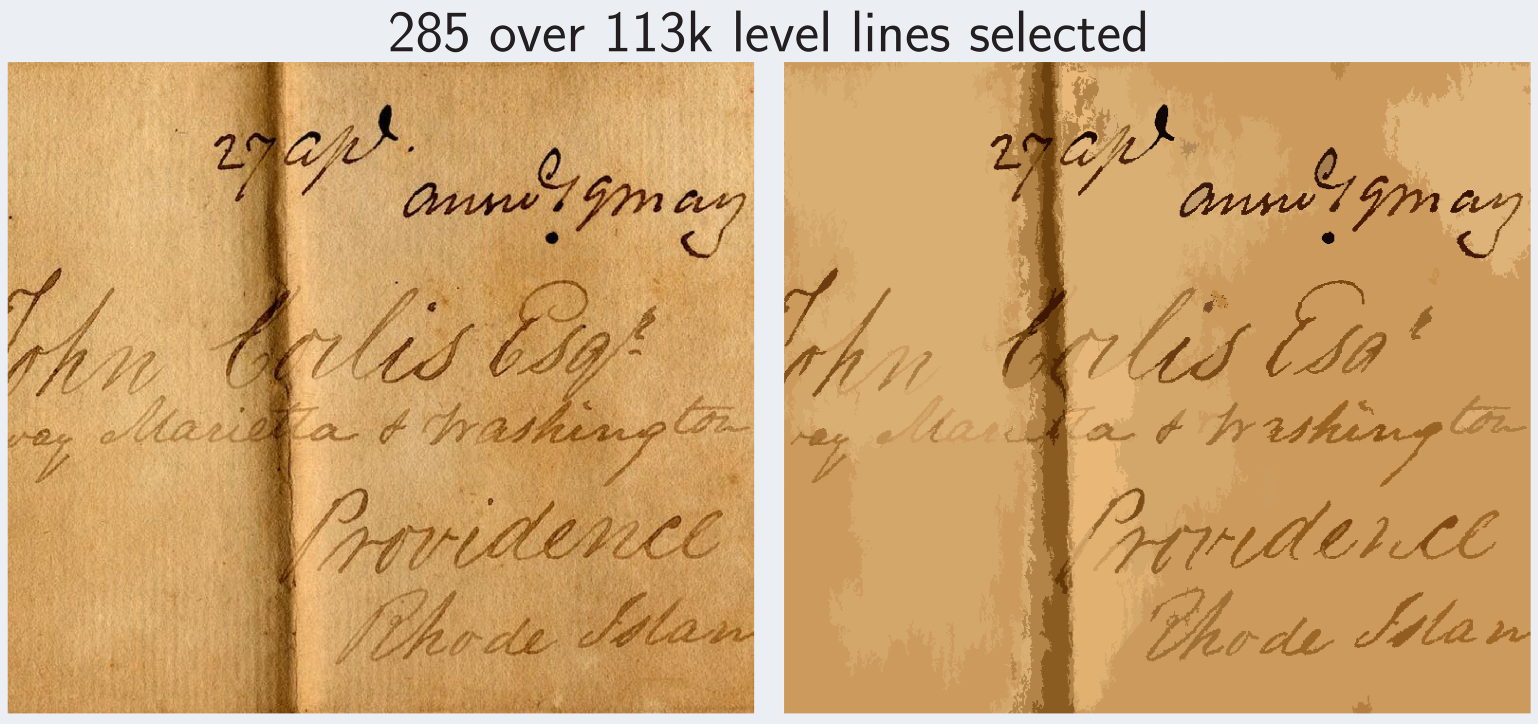


(b) The marginal ToS $\mathcal{T}_1$, $\mathcal{T}_2$ and the GoS (the depth in light gray) (d) The hole-filled max-tree $\mathcal{T}_\omega$ of ω

Applications: Image Simplification (left) and Interactive Segmentation (right)



285 over 113k level lines selected



112 over 288k level lines selected

Markers (top row) and segmented images (bottom row)

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[3] B. Naegel and N. Passat. **Towards connected filtering based on component-graphs.** In *Proc. of ISMM*, volume 7883 of *LNCS*, pages 353–364. Springer, 2013.
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