INTRODUCING MULTIVARIATE CONNECTED OPENINGS AND CLOSINGS

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At a Glance

Problem:

- the morphological trees (Min-tree, Max-tree, ToS) are great structures and support connected filters (see right)
- ... but they are not well-defined for color images

Common Solution:

- Imposing an *arbitrary* total ordering relation between colors [2, 3]

→ false color when reconstructing

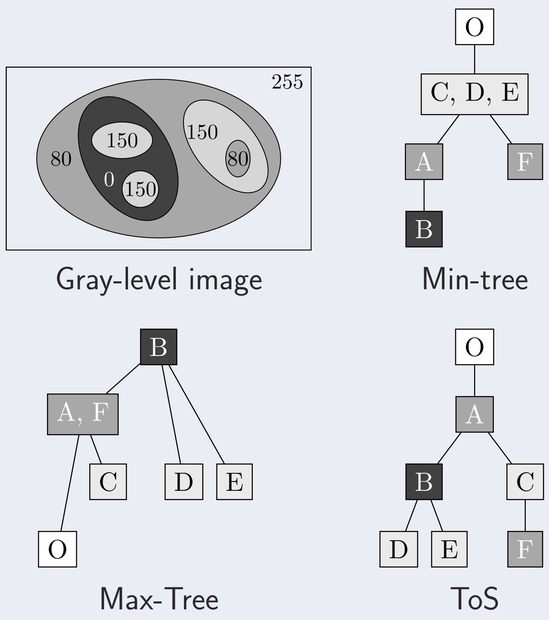
→ ordering requires an apriori about the data (background/foreground)

Our approach:

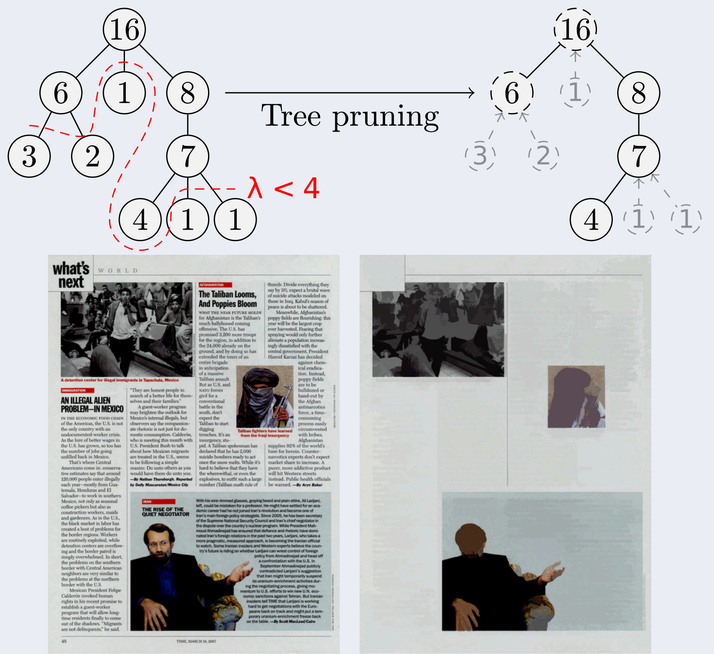
- Merging marginal trees based on the *inclusion relation only*

→ **The level of inclusion defines the order**

Some great morphological structures... ...used for connected filtering [5]

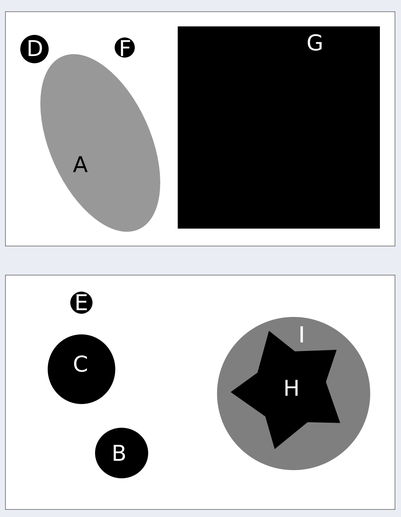


Gray-level image — Min-tree — Max-Tree — ToS

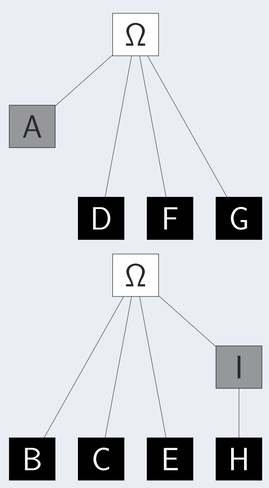


The Multivariate Component Tree that we want

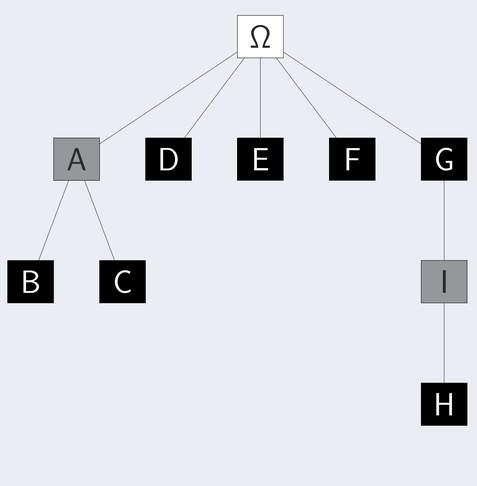
A structure that follows the intuition:



Channels u_1 and u_2



Min-Trees of u_1 and u_2



Multivariate Min-Tree for $u = \langle u_1, u_2 \rangle$

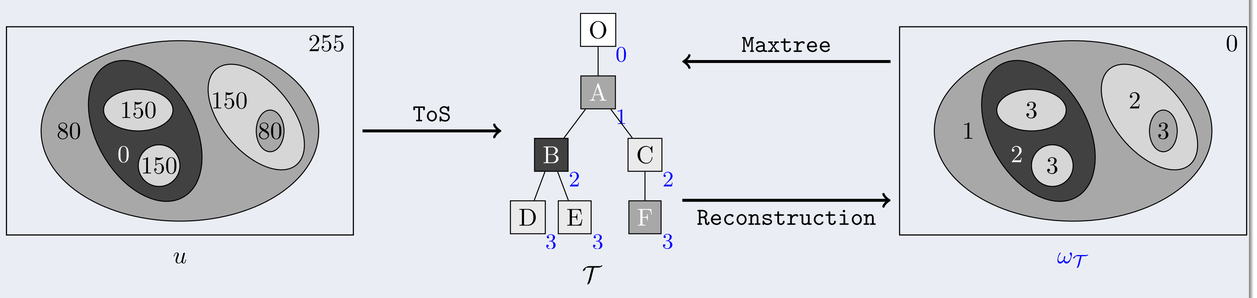
More formally; a transformation that:

- is invariant to any marginal change of contrast
- is equivalent to the *regular* Component Tree for a single channel image
- preserves the maximum number of shapes (all of them, if there are not conflicting)

From a depth map to the Multivariate Component Tree

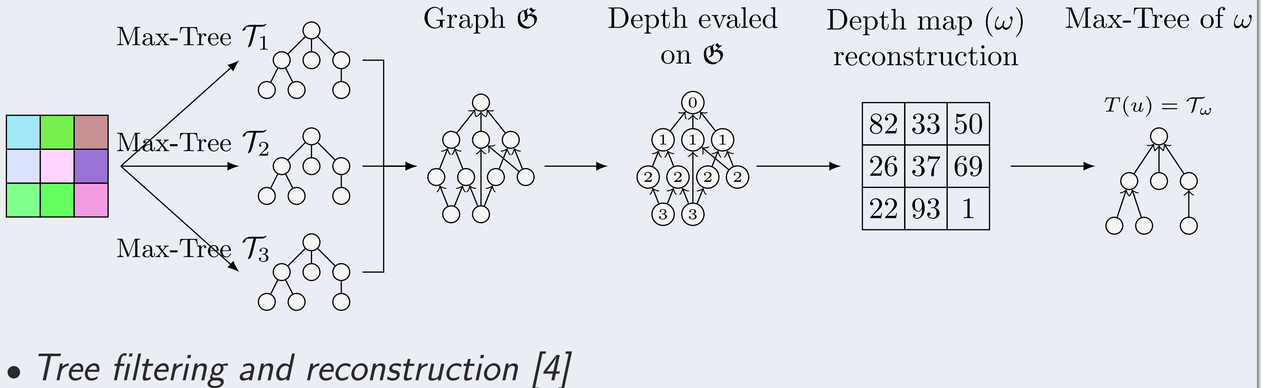
- *The starting point*

Max-Tree of $\omega_{\mathcal{T}} \equiv \mathcal{T}$



- *Multivariate Component Tree construction process* *(inspired from MToS [1])*

1. Marginal tree construction
2. Inclusion graph $\mathcal{G}$ of every component
3. $\mathcal{G}$ nodes *depth* → *depth* map ω
4. Max-tree of ω

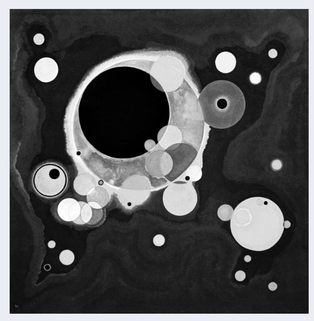


- *Tree filtering and reconstruction [4]*

When a node is removed, the pixels are affected with the nearest color from the node boundary.

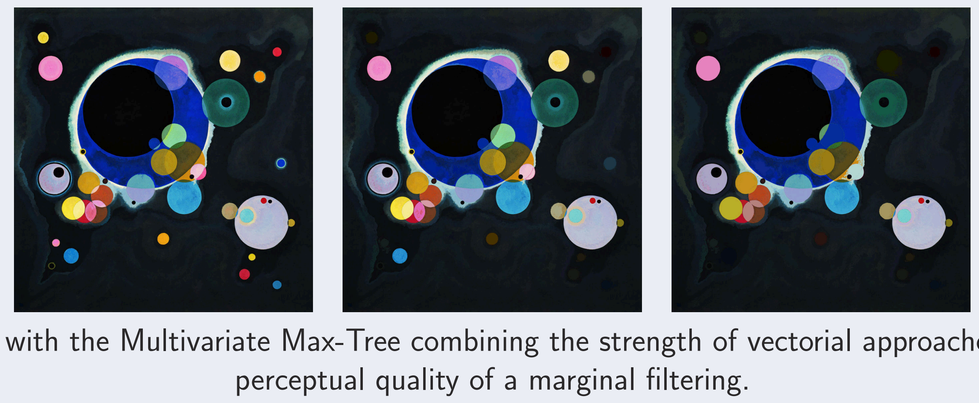
Experiments

Original image



depth map

Marginal openings leading to *false colors*, *fake flat-zones*, and blurry boundaries.



Openings with the Multivariate Max-Tree combining the strength of vectorial approaches and the perceptual quality of a marginal filtering.

Selected bibliography

[1] E. Carlinet and T. Géraud, "**MToS: A tree of shapes for multivariate images**" In *IEEE Transactions on Image Processing*, vol. 24, num. 12, pp. 5330–5342, 2015.

[2] B. Perret, S. Lefèvre, C. Collet, and E. Slezak, "**Connected component trees for multivariate image processing and applications in astronomy.**" In *Proc. of the Intl. Conf. on Pattern Recognition (ICPR)*, pp. 4089–4092, Aug. 2010.

[3] B. Naegel and N. Passat, "**Component-trees and multi-value images: A comparative study.**" In *Proc. of ISMM*, vol. 5720 of *LNCS*, po. 261–271. Springer, 2009.

[4] F. Tushabe and M. Wilkinson, "**Color processing using max-trees: A comparison on image compression.**" In *Proceedings of the International Conference on Systems and Informatics (ICSAI)*, pp. 1374–1380, 2012.

[5] L. Vincent., "**Morphological area openings and closings for grey-scale images.**" In *Shape in Picture: Mathematical Description of Shape in Grey-level Images*, pp. 197–208. Springer, 1994.