



Intervertebral Disc Segmentation **in less than 3s** Using Mathematical Morphology

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At a glance

Problem:

- we want to segment intervertebral discs **without using CNN...**
- ...and we want our method to be fast!

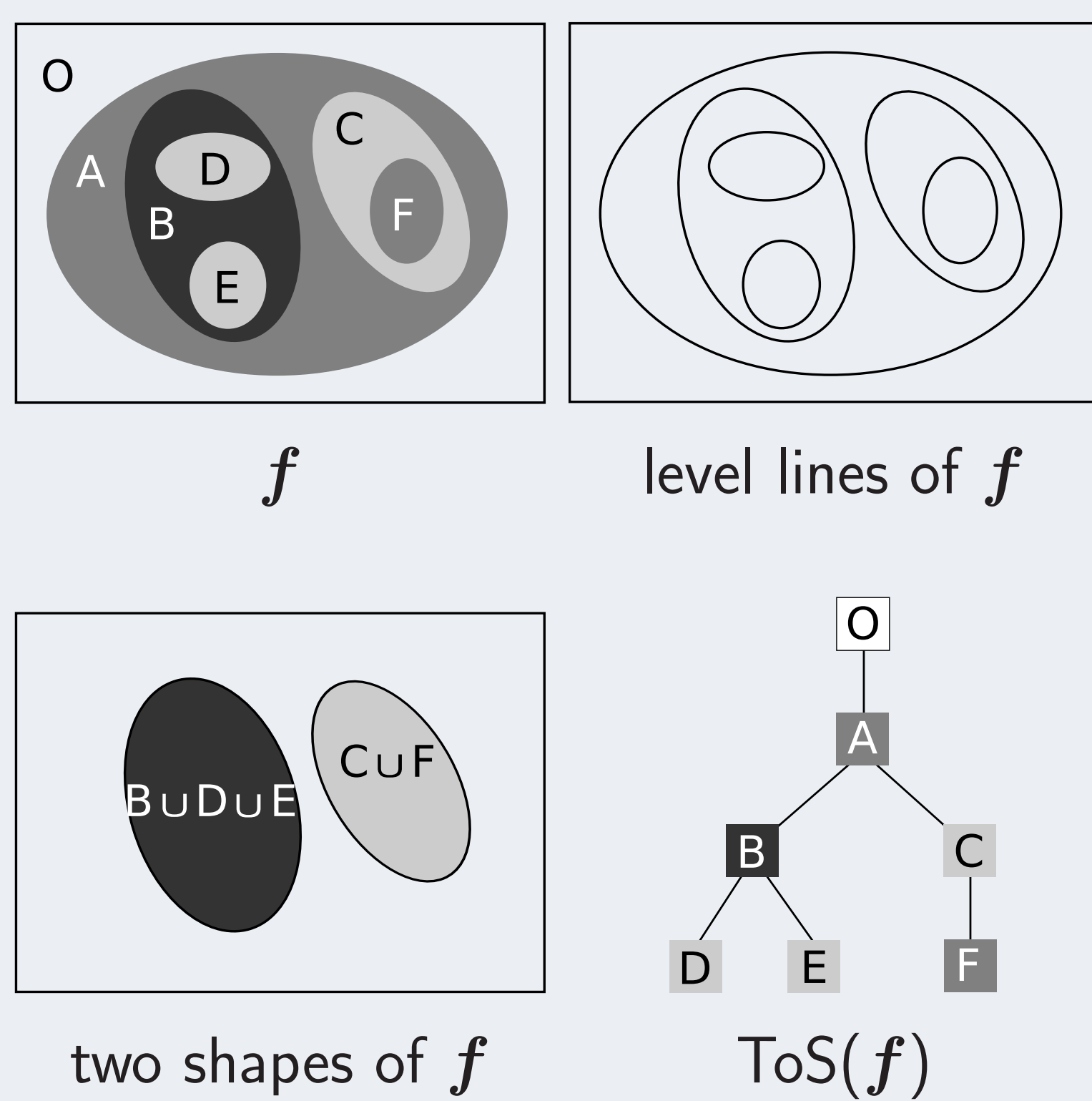
Why our approach is interesting:

- it is lightweight and simple

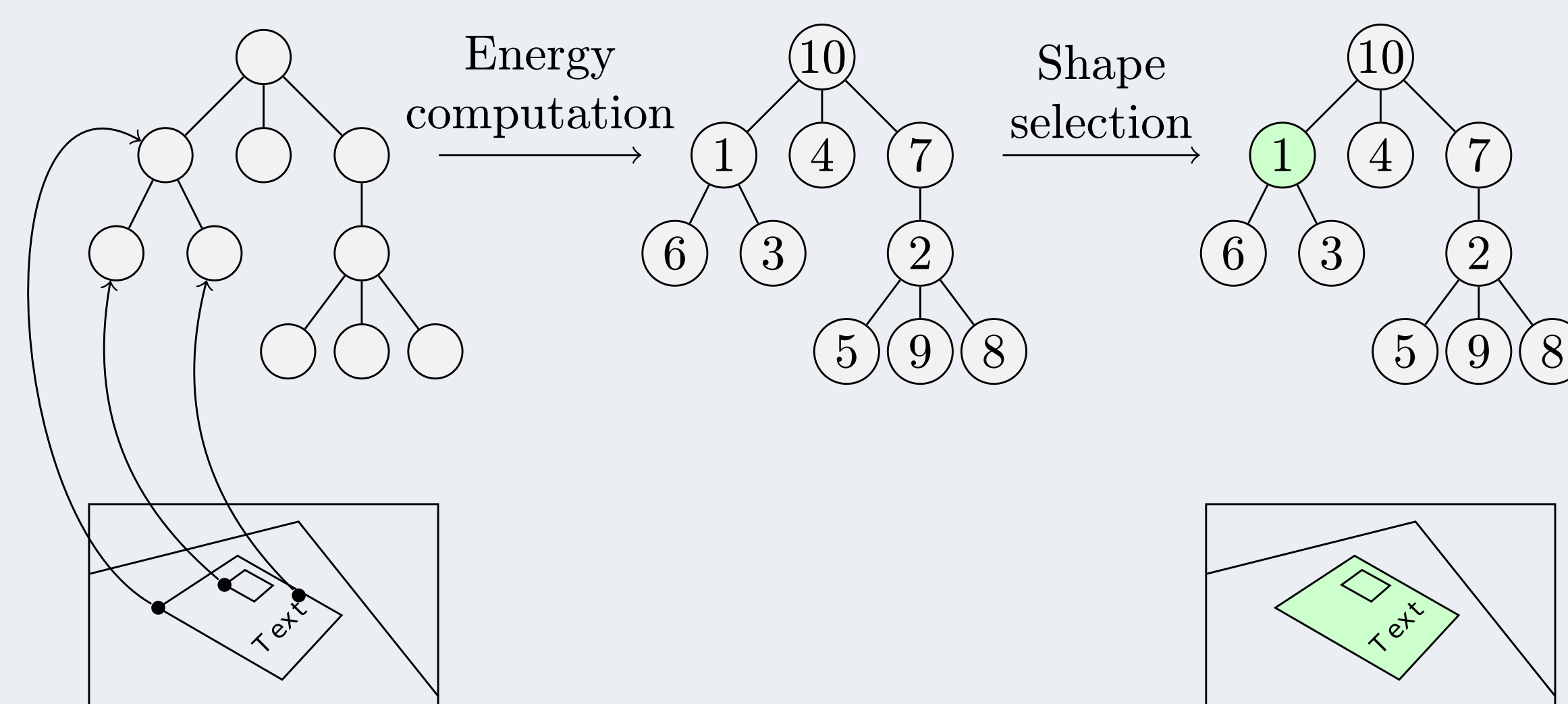
Conclusion:

- the morphological tree of shapes is a very useful structure [1, 2]
- mathematical morphology rocks [3, 4]
- we do not rely on parallelization [5]... think about .5s per volume
- perspective: use the *multivariate tree of shapes* [6]

Morphological tree of shapes (ToS)



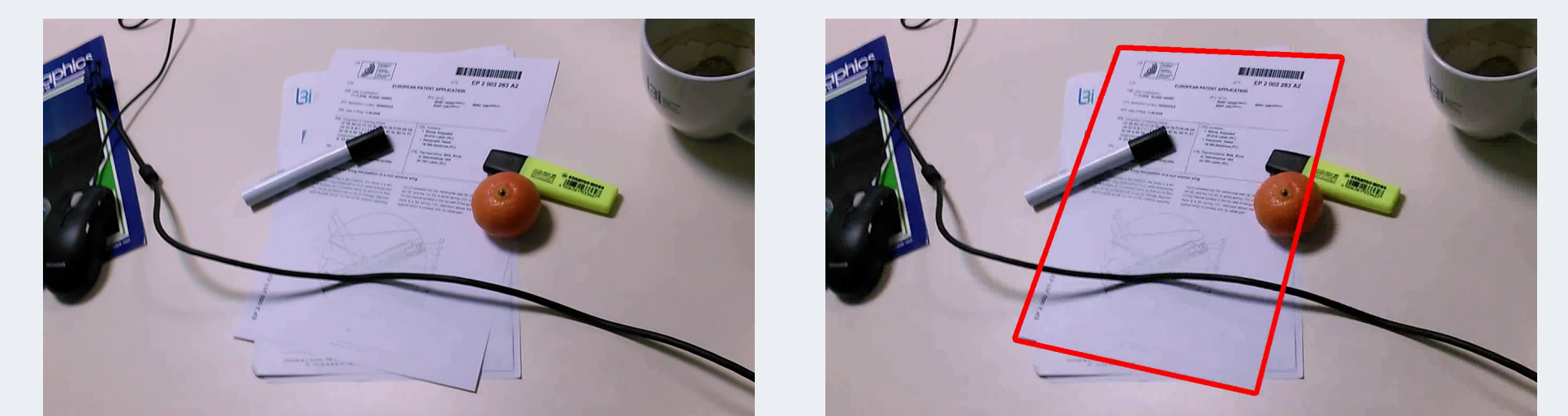
Tree-based object detection



1. Compute the tree of shapes
2. Valuate an energy adapted to the object(s) to detect
3. Retrieve the shape(s) with minimal energy

Illustration:

Smartphone document capture competition (SmartDoc) at the Intl. Conf. on Document Analysis and Recognition (ICDAR) 2015

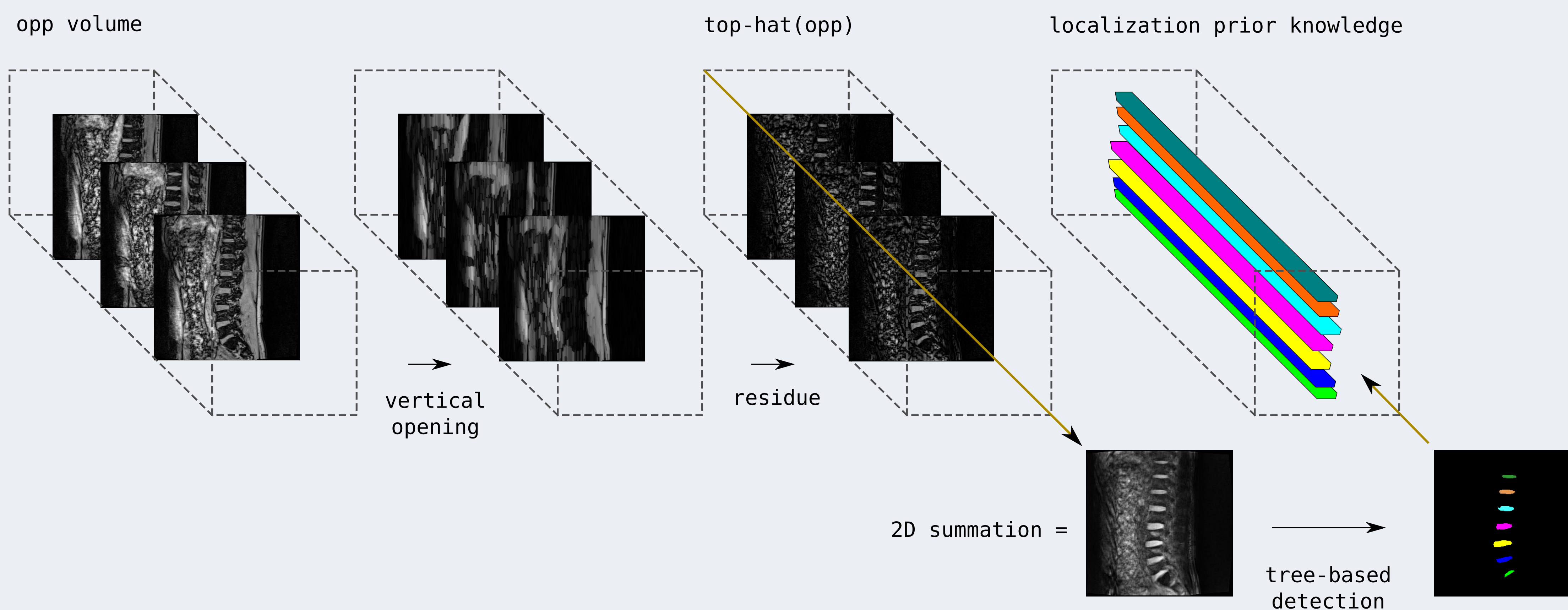


input

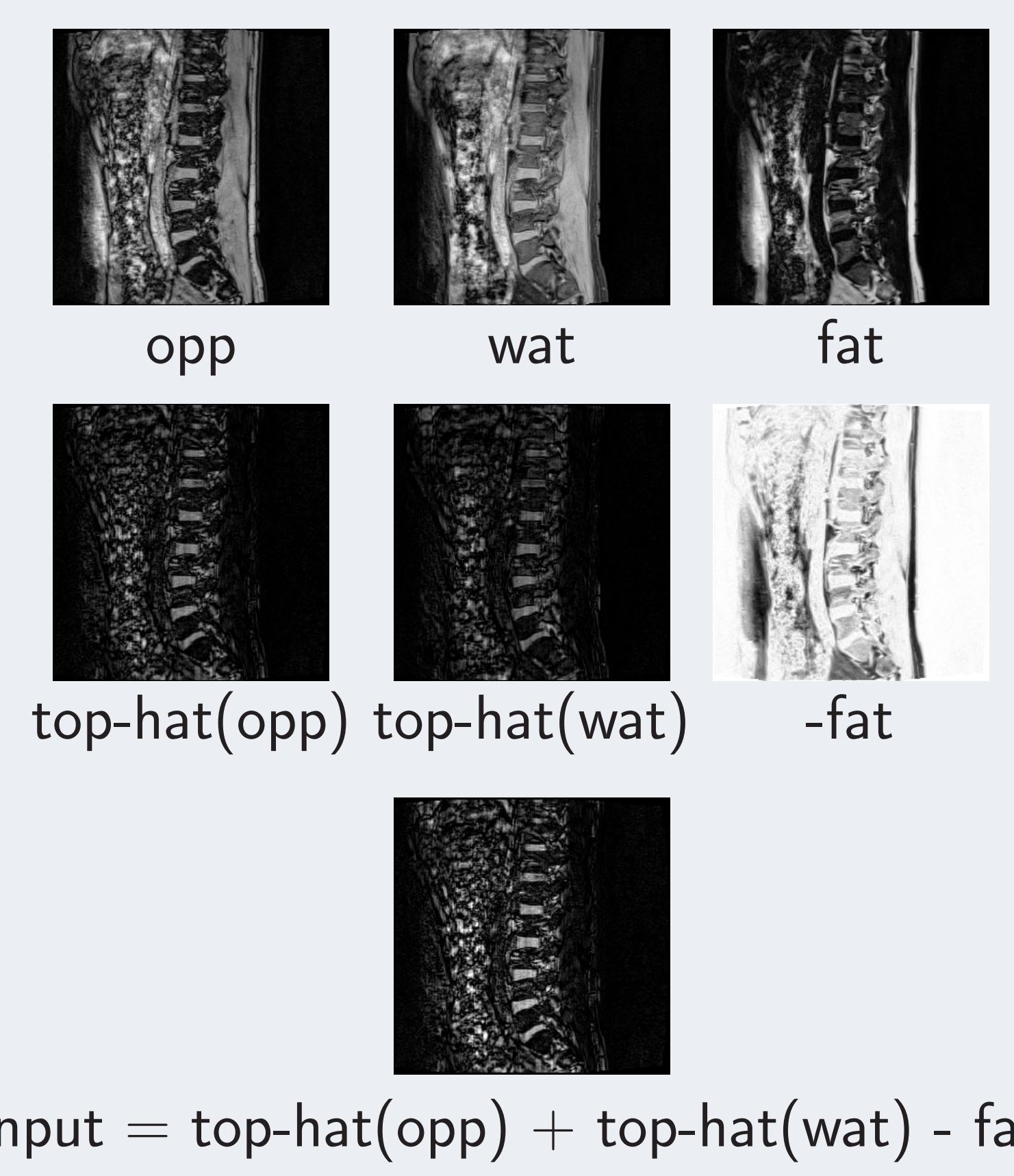
selection

(winning method!)

Step 1: Extracting a prior knowledge about discs localization from a volume



Step 2: Create a 3D input



Detection / selection

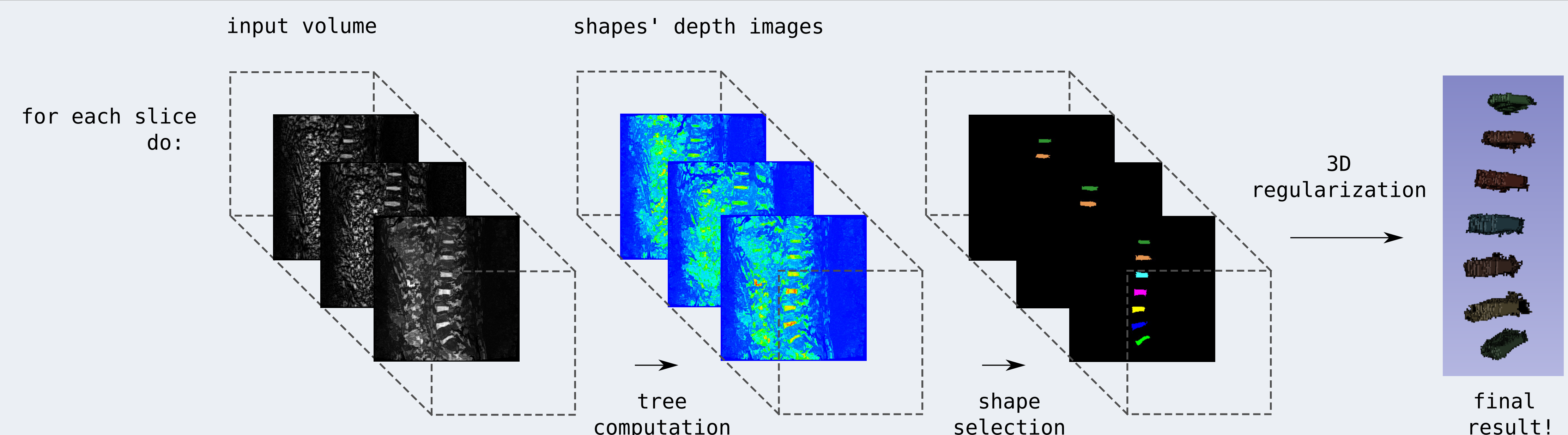
Use of prior knowledge about IVD:

- contrast
- geometry
- in Step 1, approximate localization
- in Step 2, bounding box localization given by Step 1

Bonus

Reproducible research \Rightarrow code available

Step 3: Segmentation slice by slice



Selected bibliography

- [1] T. Géraud, E. Carlinet, S. Crozet, and L. Najman, "A quasi-linear algorithm to compute the tree of shapes of nD images," in *International Symposium on Mathematical Morphology (ISMM)*, pp. 98–110, vol. 7883 of LNCS, Springer, 2013.
- [2] E. Carlinet, T. Géraud, and S. Crozet, "The tree of shapes turned into a max-tree: A simple and efficient linear algorithm," in *IEEE International Conference on Image Processing (ICIP)*, pp. 1488–1492, Oct 2018.
- [3] P. Soille, **Morphological Image Analysis: Principles and Applications**, 2nd ed., Springer, 2004.
- [4] L. Najman and H. Talbot Eds., **Mathematical Morphology—From Theory to Applications**, ISTE Ltd and John Wiley & Sons, 2010.
- [5] S. Crozet and T. Géraud, "A first parallel algorithm to compute the morphological tree of shapes of nD images," in *IEEE International Conference on Image Processing (ICIP)*, pp. 2933–2937, 2014.