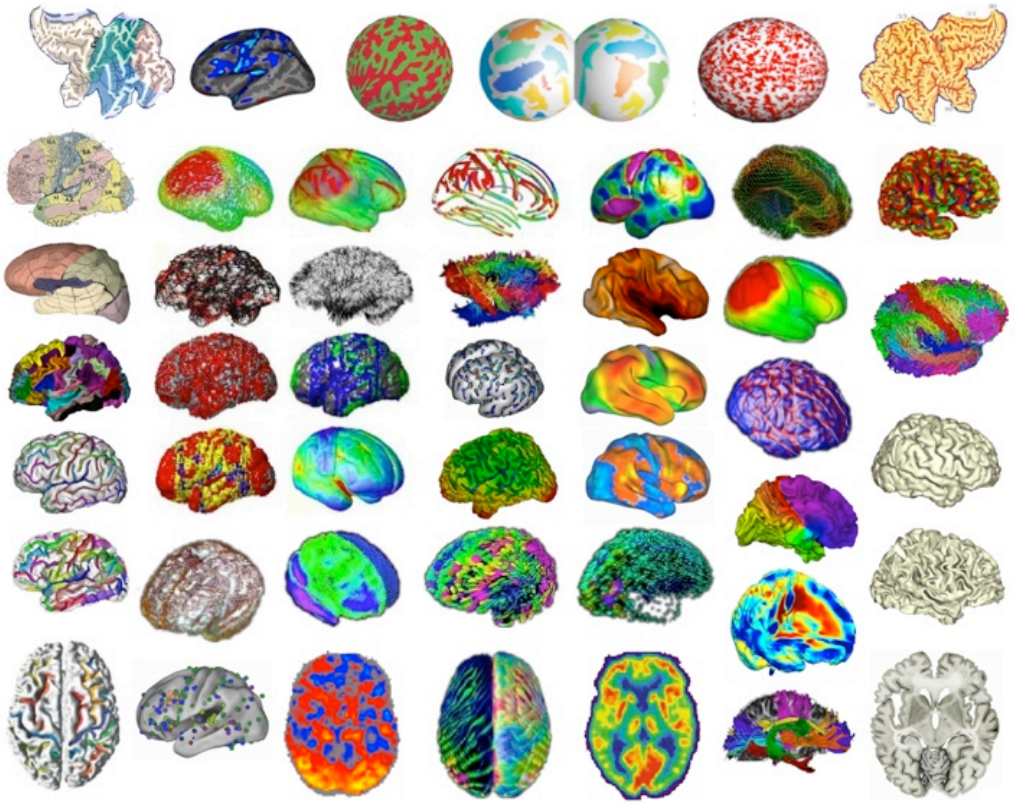
Introduction to Image Processing



— registration, filtering, and segmentation —

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http://binarybottle.com

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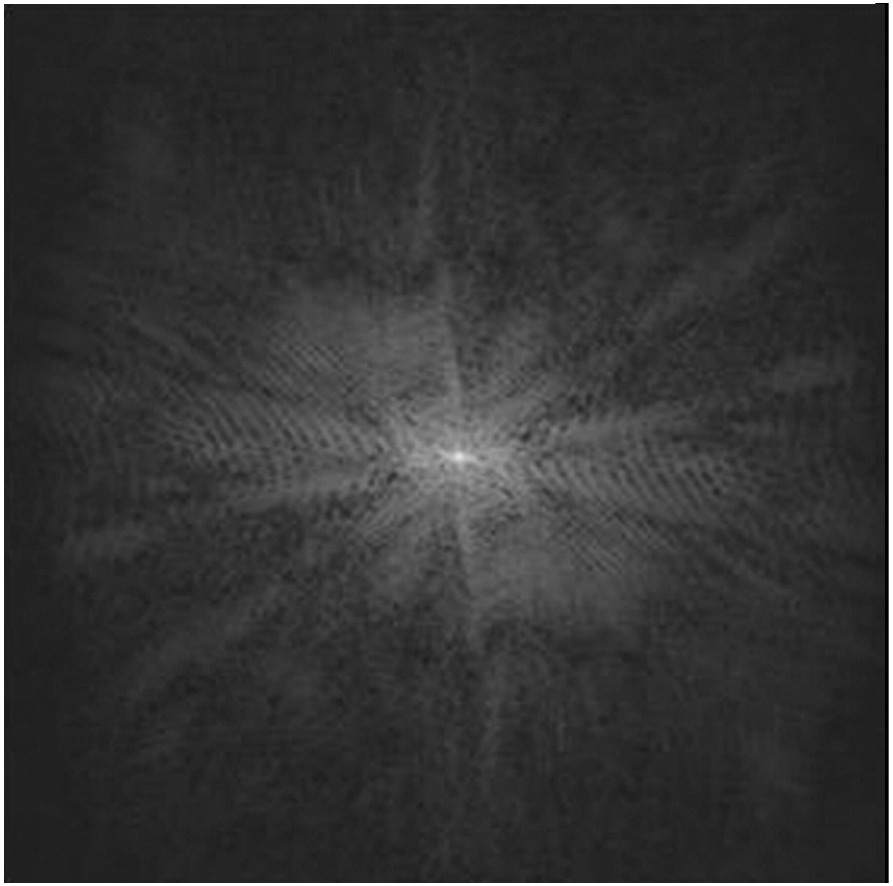
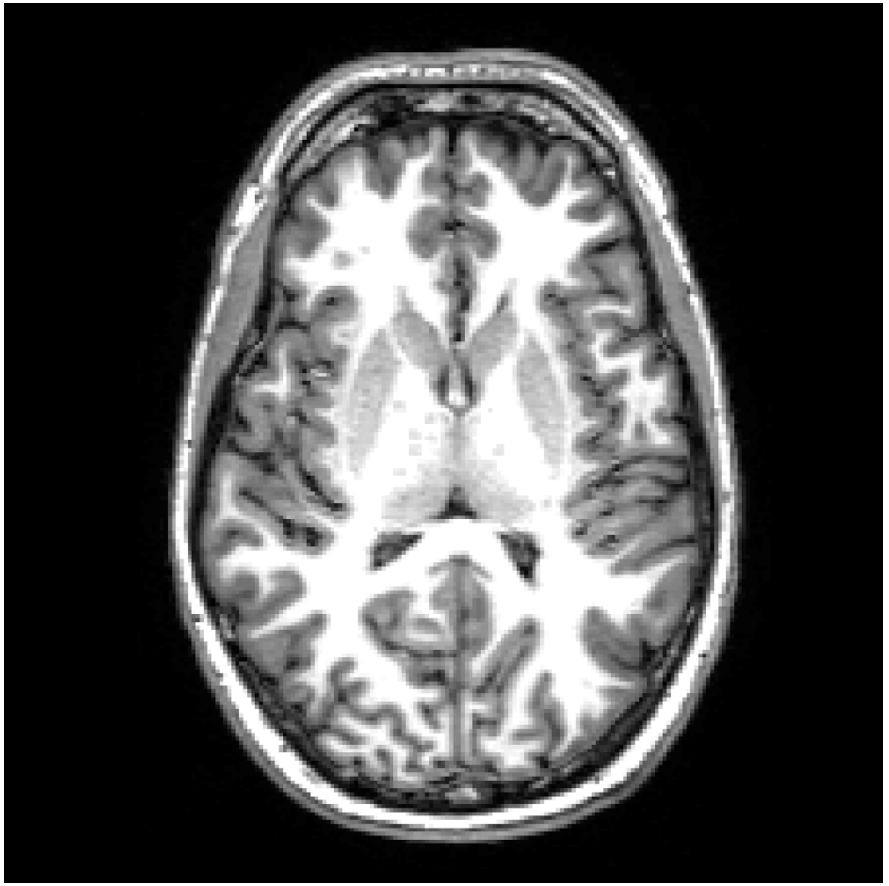
Re: image acquisition





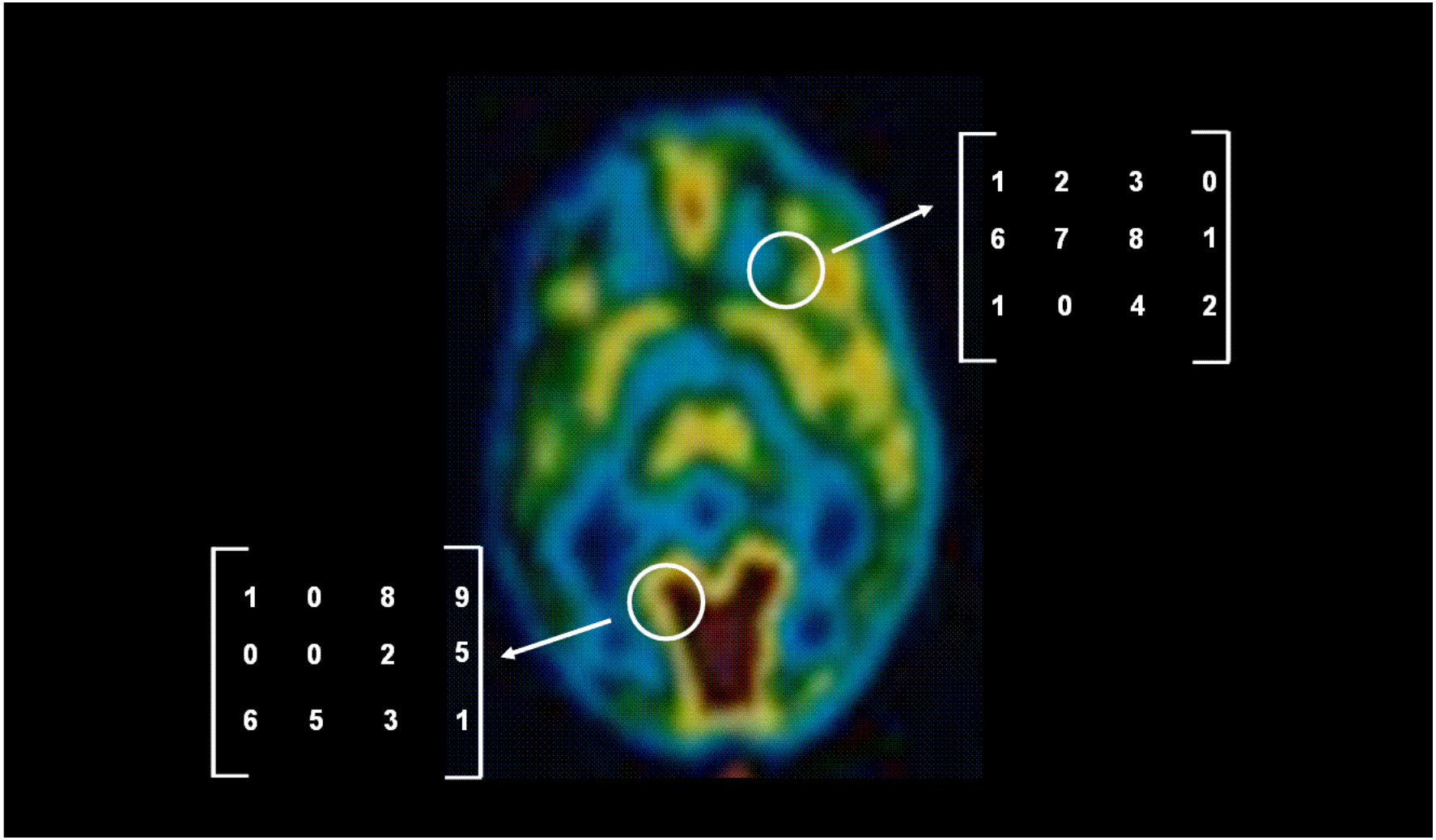
Hargreaves B A et al. AJR 2011;197:547-555

images as matrices

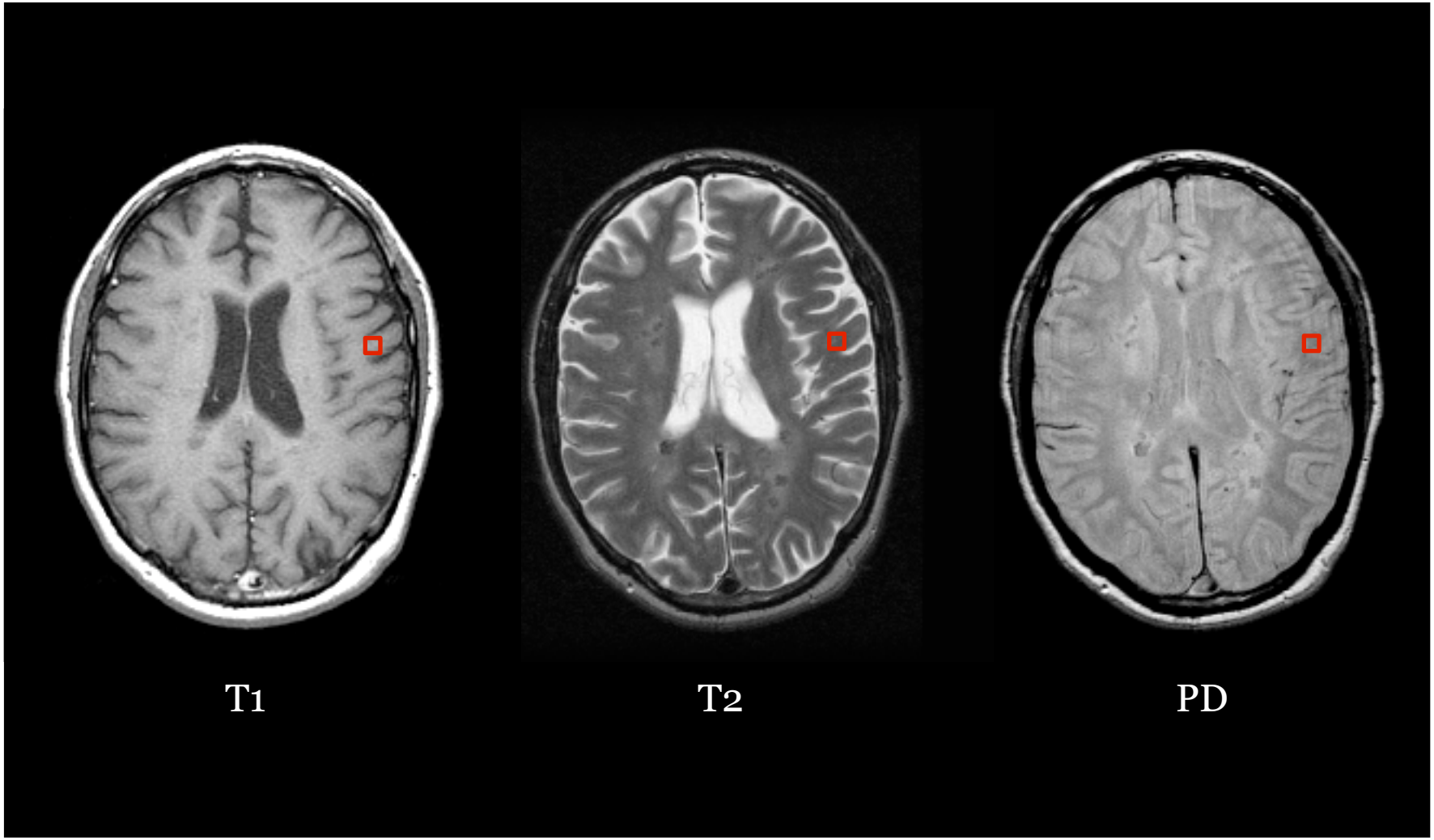
Hargreaves B A et al. AJR 2011;197:547-555

images as matrices

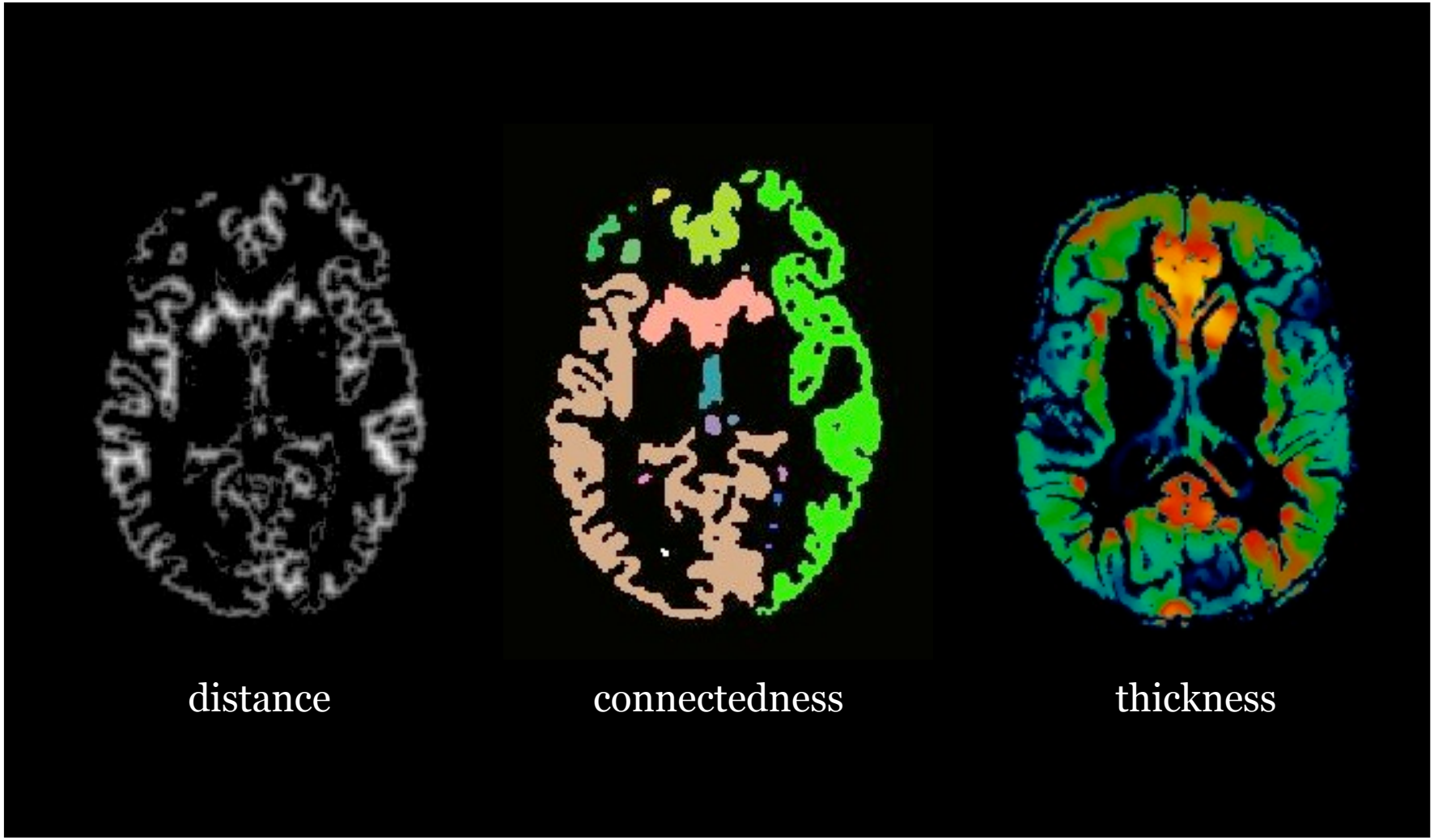
images as matrices



intensity values

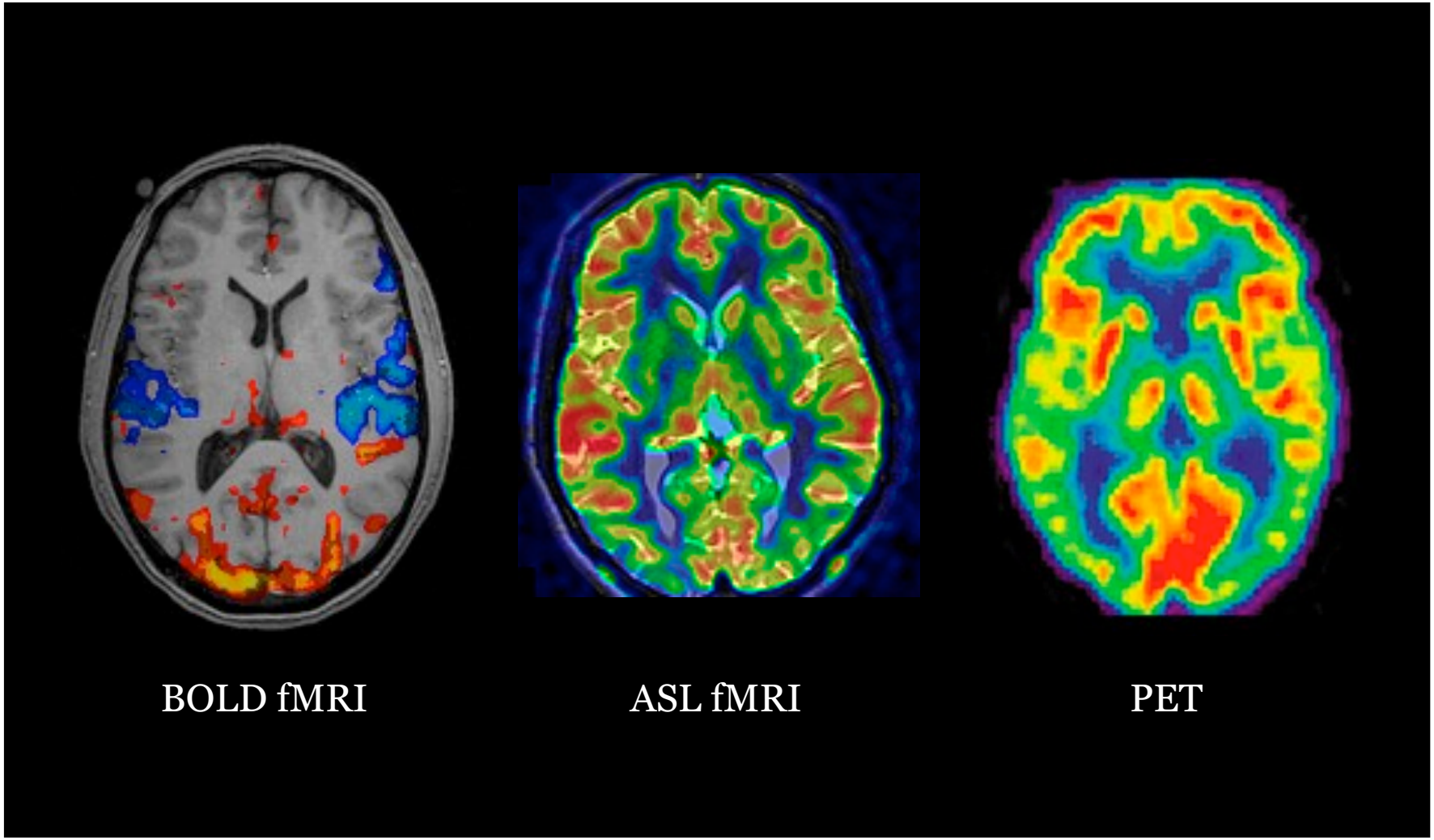


morphological values



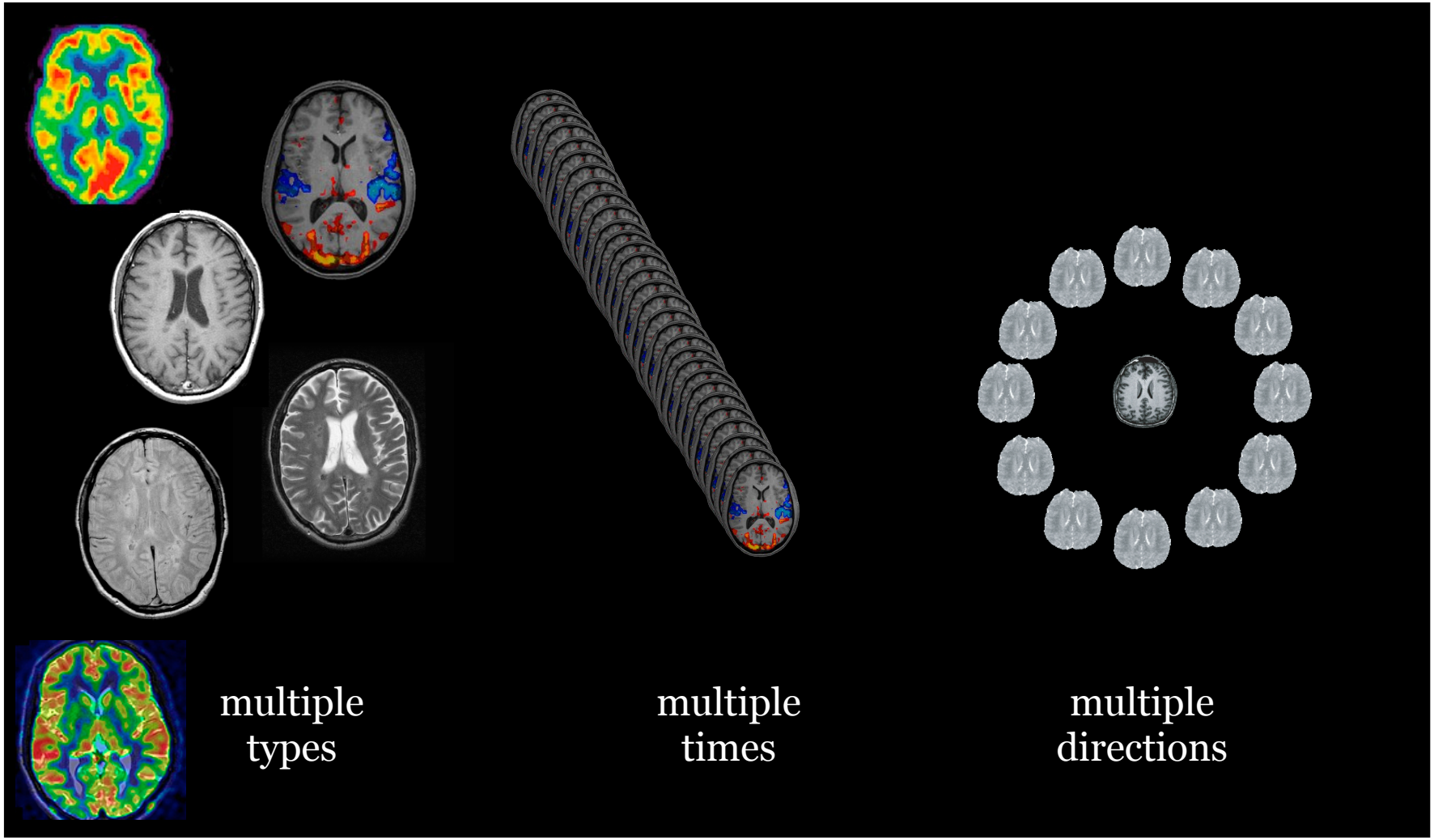
http://picsl.upenn.edu/Project/Thickness

statistical values

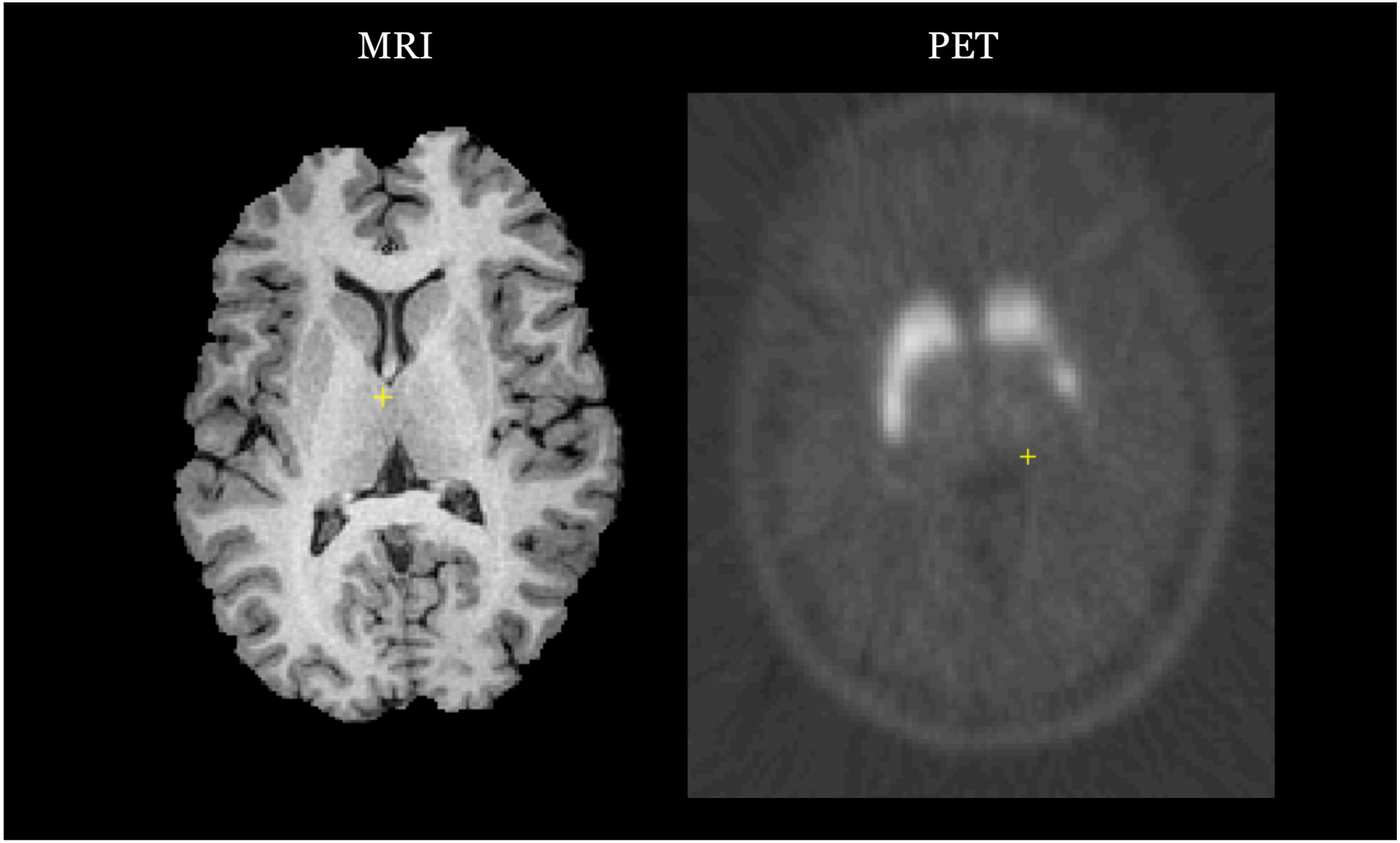


http://psychcentral.com/blog/archives/2008/01/29/the-pretty-compelling-pictures-of-fmri/
http://www.gehealthcare.com/euen/mri/products/Signa_HDxt_1.5T/signa-hdxt-1.5t_optimaedition.html
http://www.cam.ac.uk/research/news/what-do-drugs-do-to-the-brain/

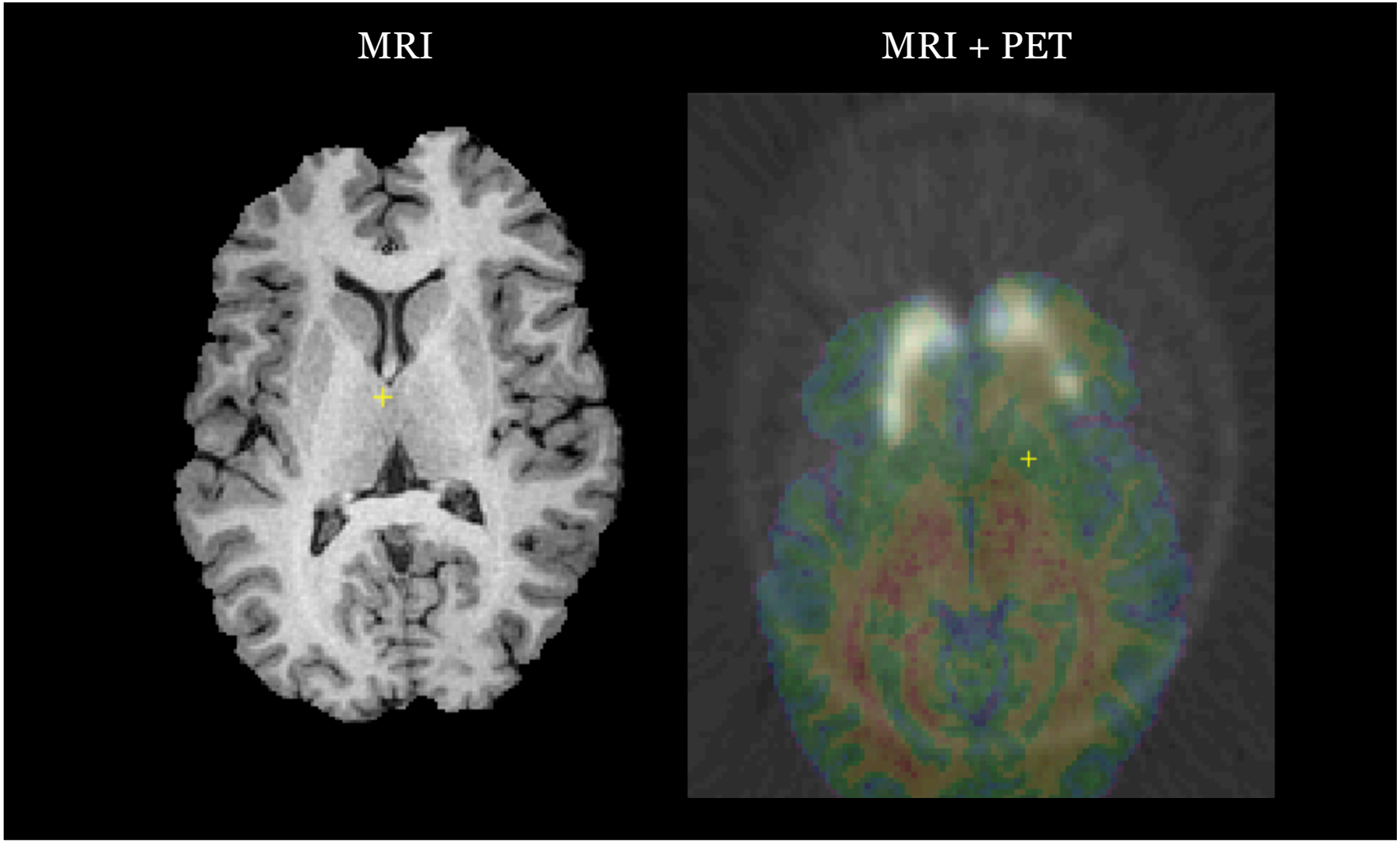
for multiple images!



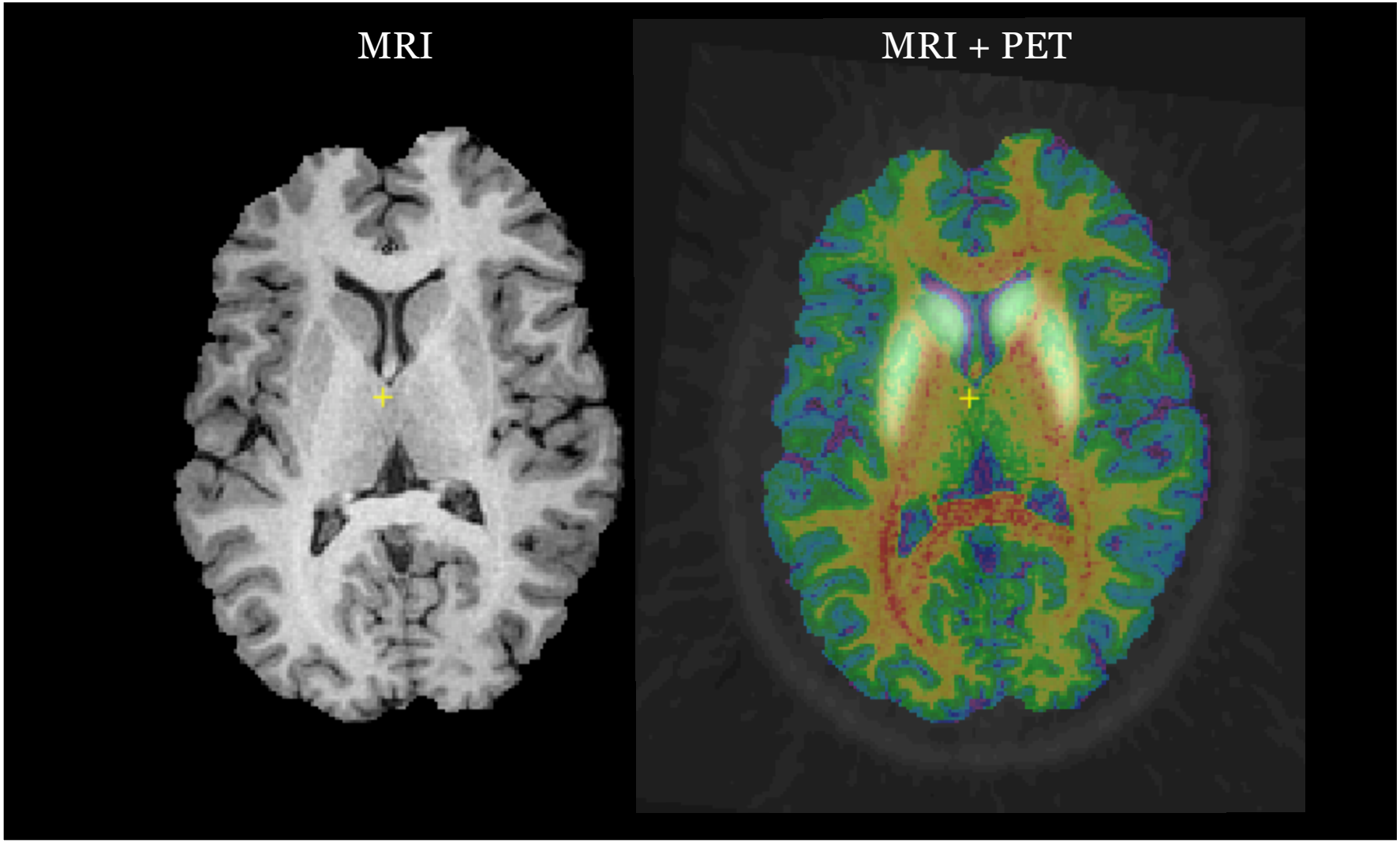
registration

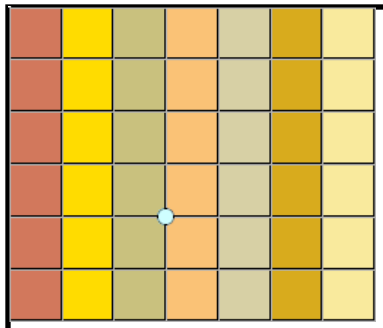


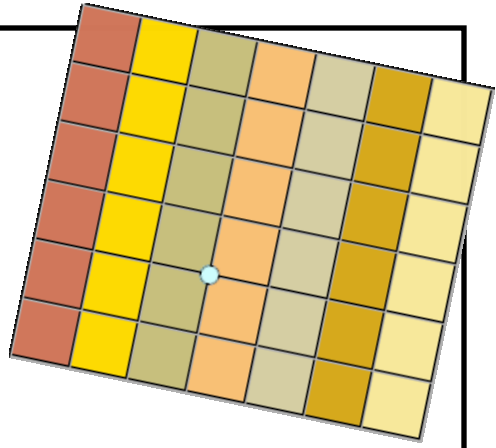
registration



registration







registration

degrees of freedom

6: 3 translations, 3 rotations (x,y,z) “rigid-body”

7: 3 translations, 3 rotations, 1 global scale

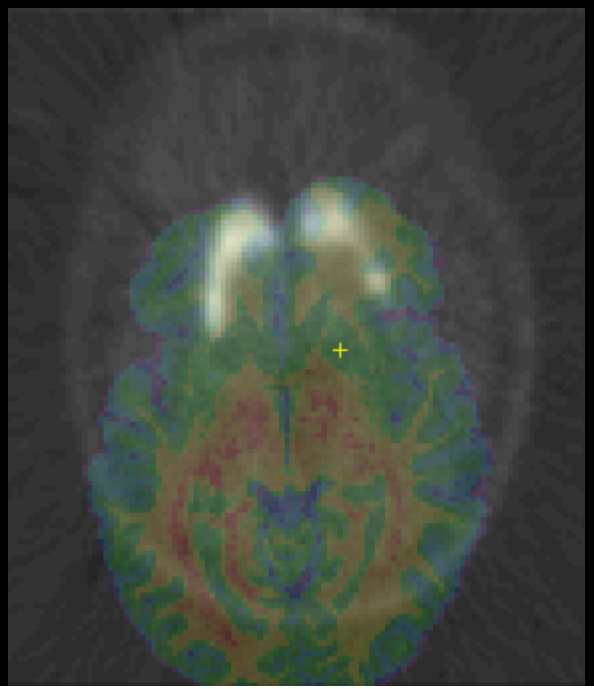
9: 3 translations, 3 rotations, 3 scales

12: 3 translations, 3 rotations, 3 scales, 3 shears

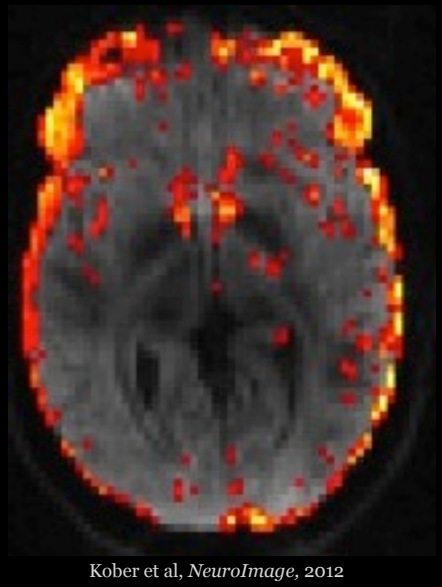
>12: nonlinear deformation (warp)

applications of registration

multiple scan co-registration



motion correction

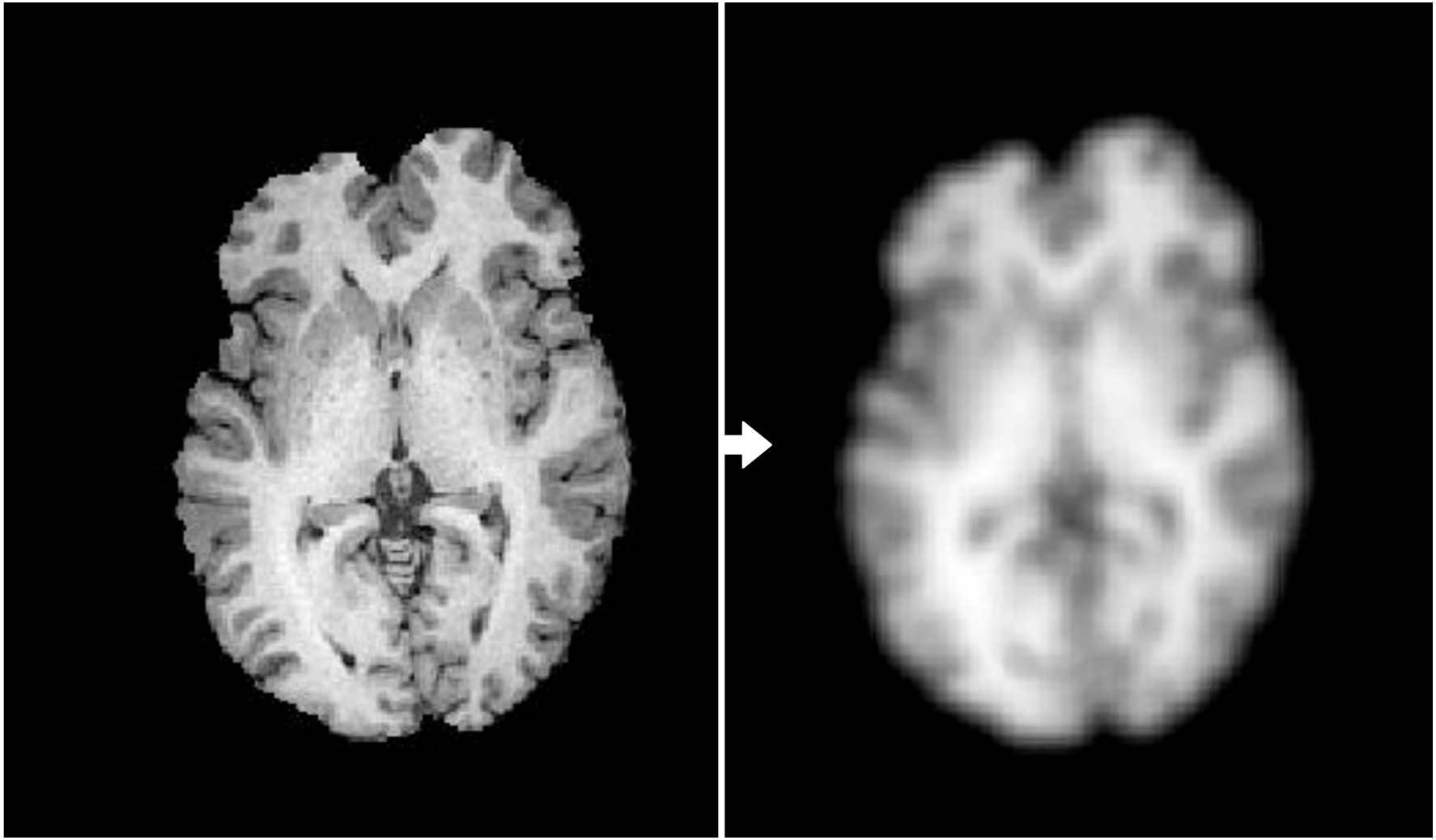


Kober et al, *NeuroImage*, 2012

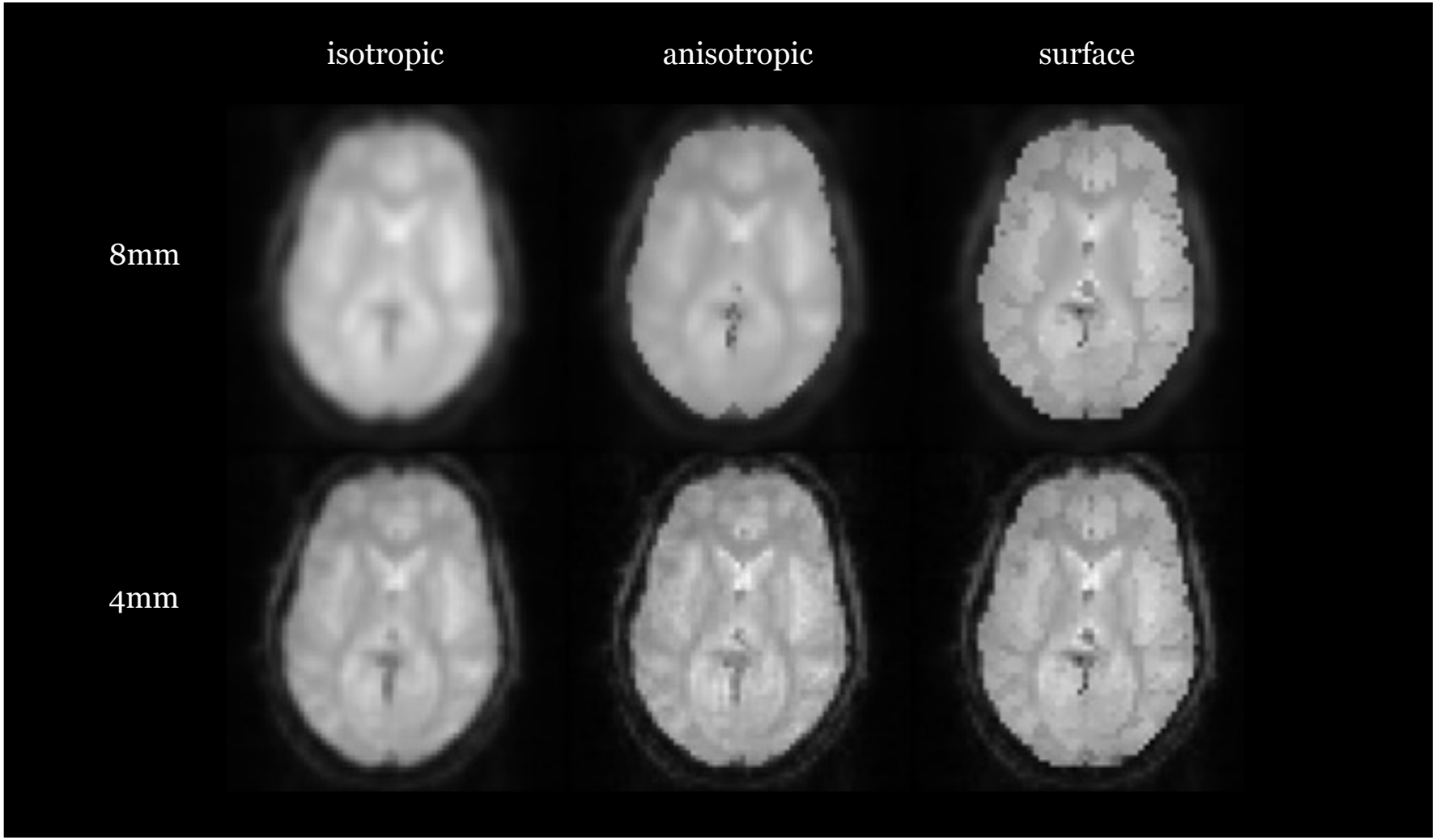
distortion correction

Combine or compare images for:
group analysis, morphometry, multispectral analysis, segmentation, labeling,...

smoothing

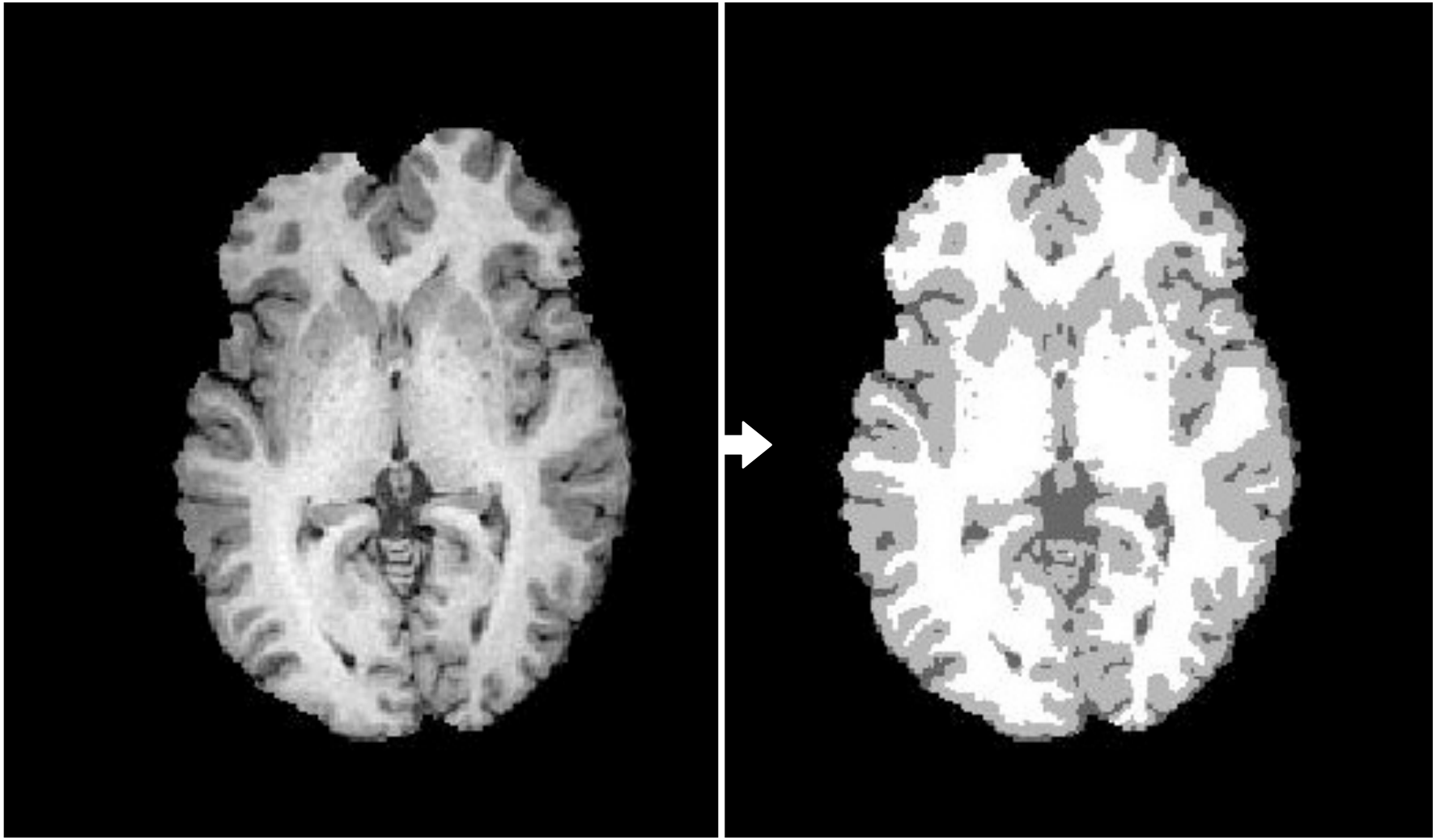


smoothing

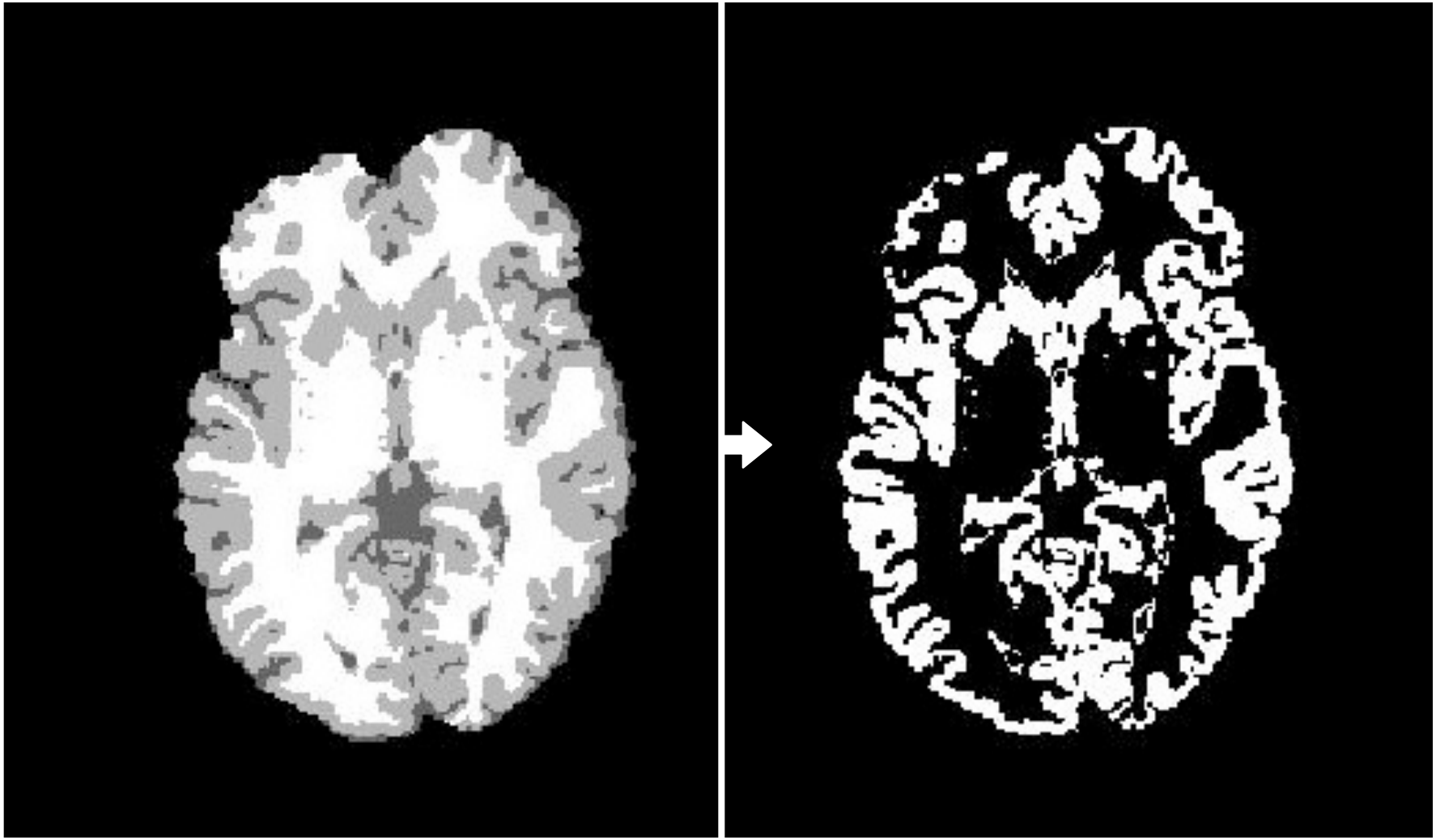


http://www.frontiersin.org/Neuroinformatics/10.3389/fninf.2011.00013/abstract

segmentation



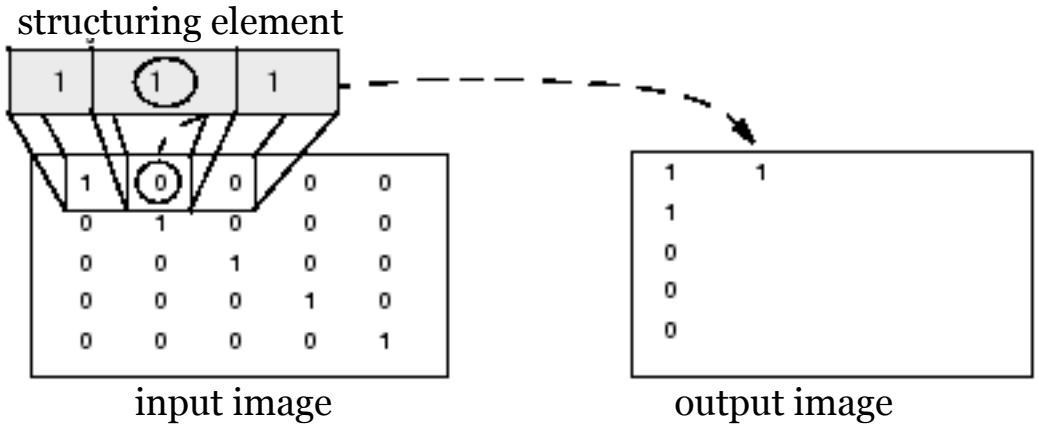
thresholding

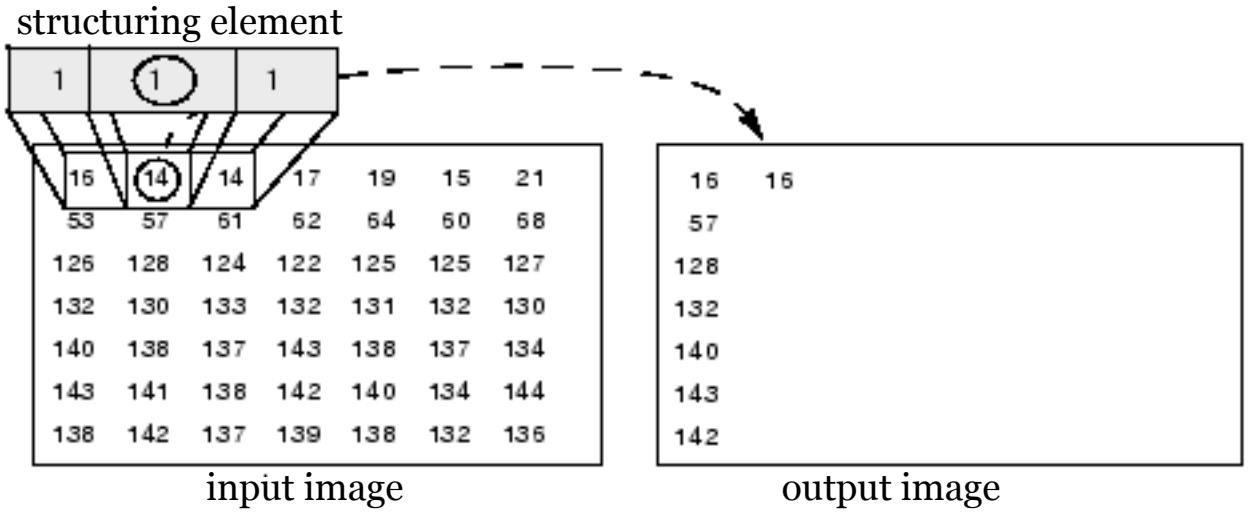


morphological image processing

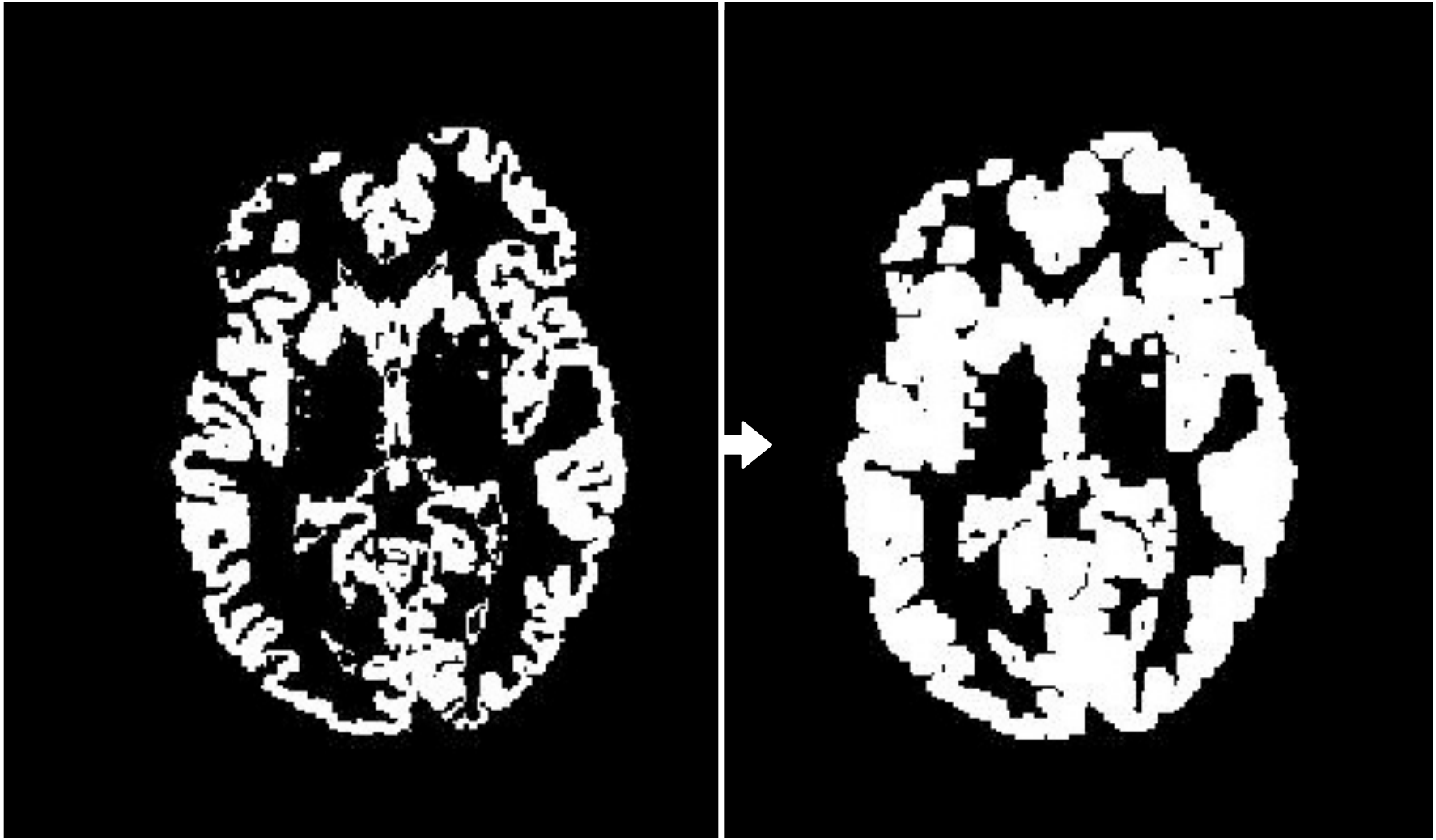
Dilation example

maximum value in neighborhood

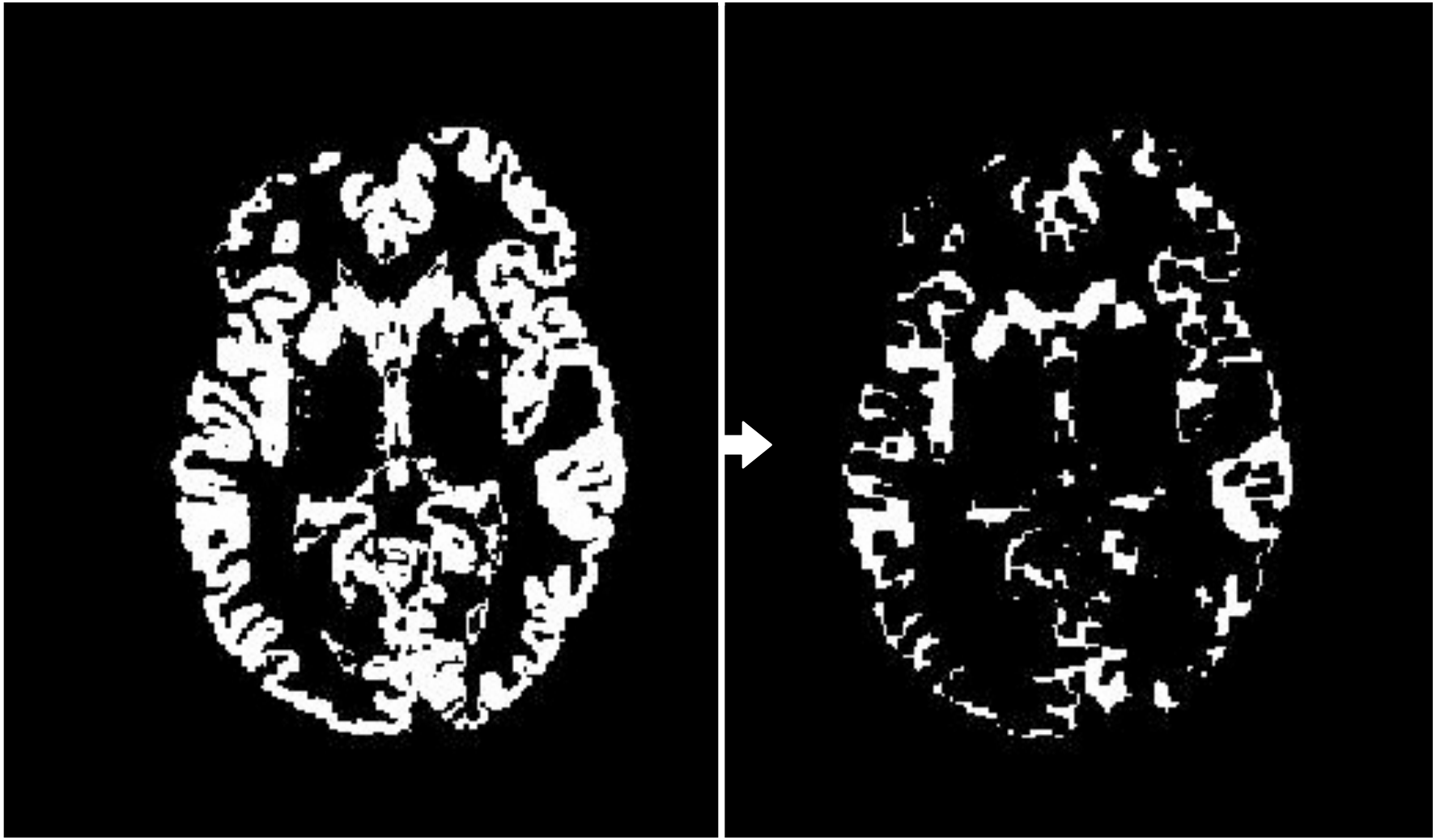




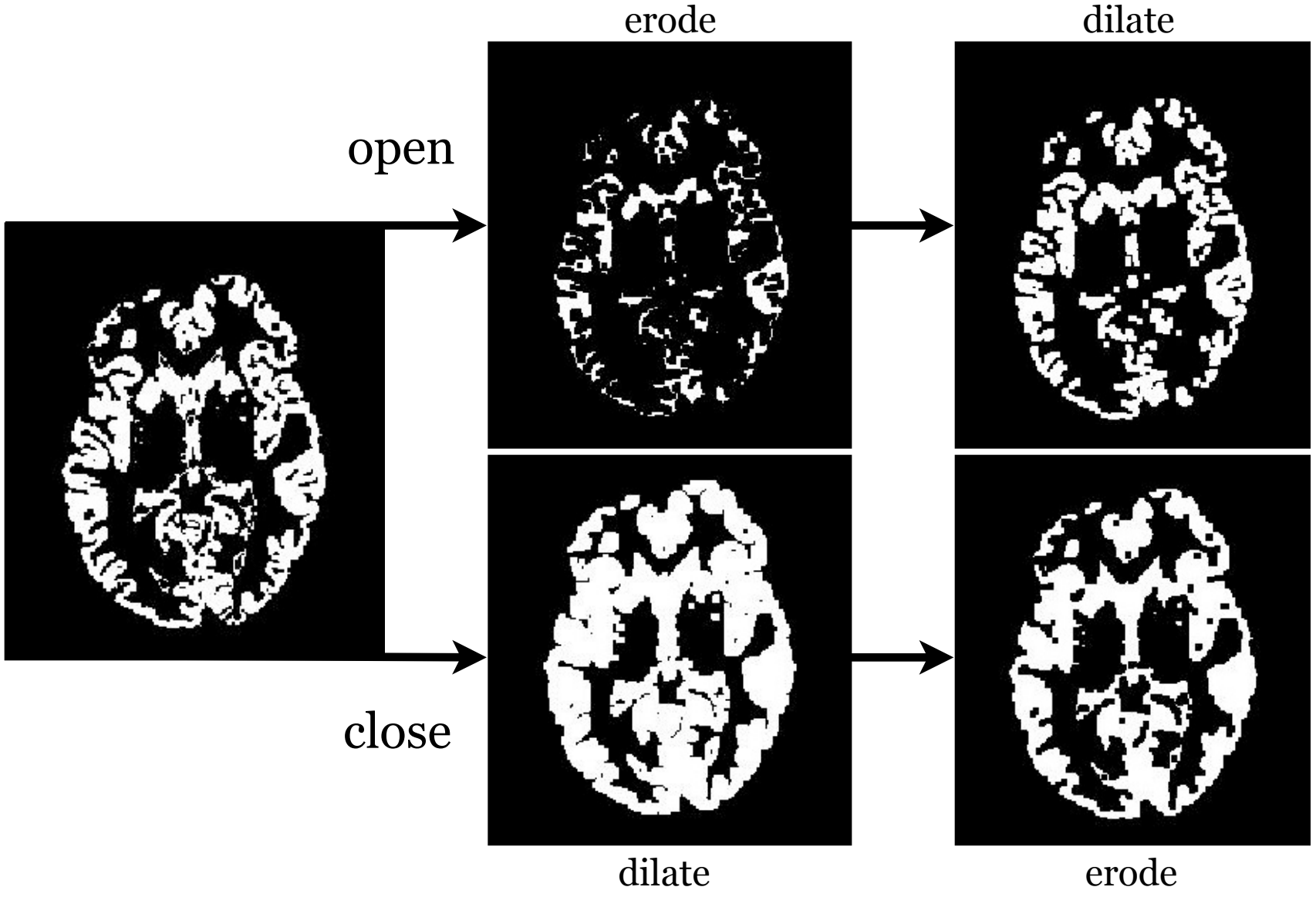
dilation



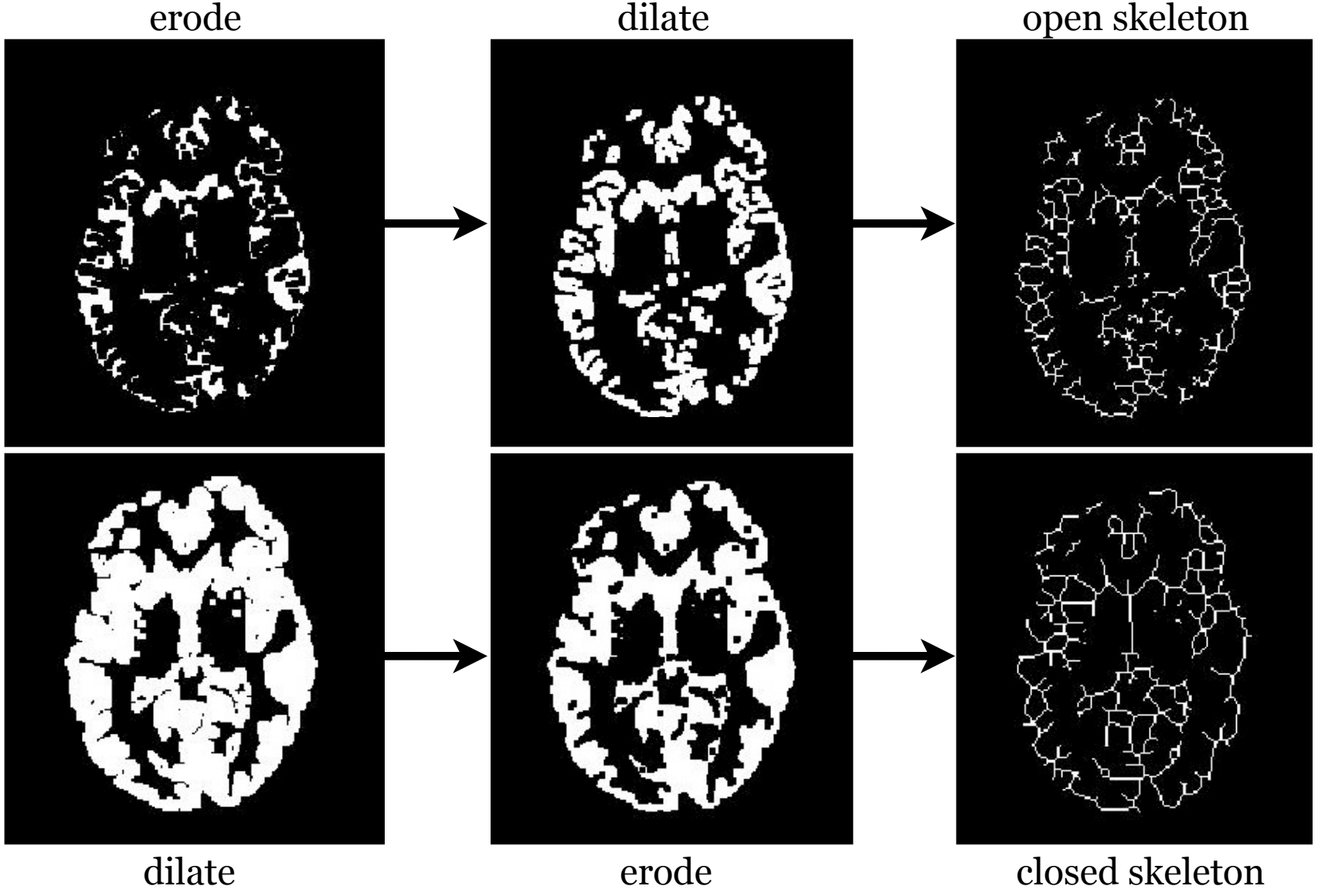
erosion



combining processing steps



combining processing steps



connectivity

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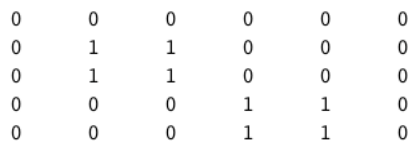
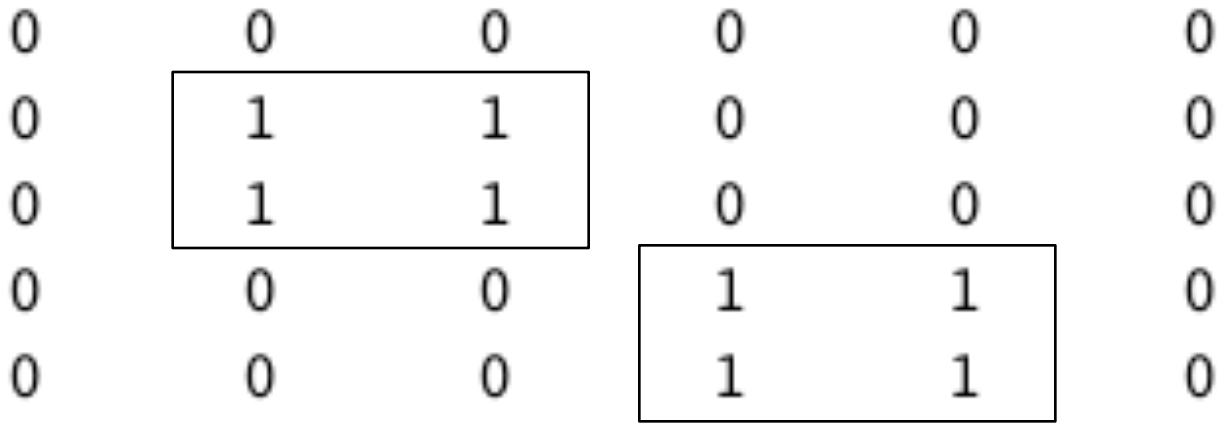
0	1	1	0	0	0
0	0	0	1	1	0
0	0	0	1	1	0

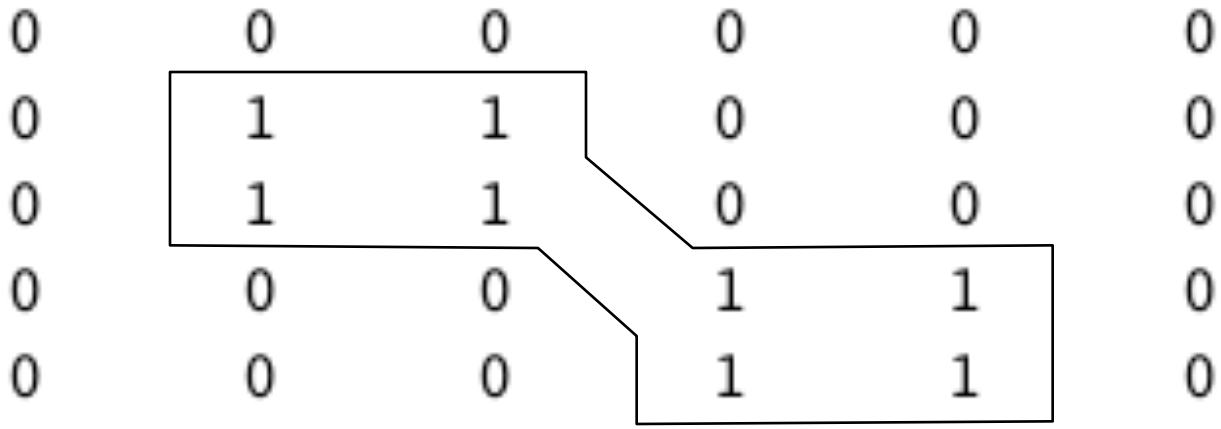
0	0	0	0	0	0
0	1	1	0	0	0
0	1	1	0	0	0
0	0	0	1	1	0
0	0	0	1	1	0

connectivity





connectivity



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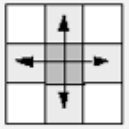
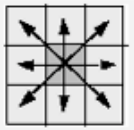
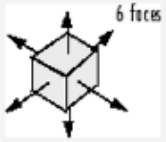
0	1	1	0	0	0
0	1	1	0	0	0
0	0	0	1	1	0
0	0	0	1	1	0

connectivity

0	0	0	0	0	0
0	1	1	0	0	0
0	1	1	0	0	0
0	0	0	1	1	0
0	0	0	1	1	0

Two-Dimensional Connectivities		
4-connected	Pixels are connected if their edges touch. This means that a pair of adjoining pixels are part of the same object only if they are both on and are connected along the horizontal or vertical direction.	
8-connected	Pixels are connected if their edges or corners touch. This means that if two adjoining pixels are on, they are part of the same object, regardless of whether they are connected along the horizontal, vertical, or diagonal direction.	
Three-Dimensional Connectivities		
6-connected	Pixels are connected if their faces touch.	
18-connected	Pixels are connected if their faces or edges touch.	
26-connected	Pixels are connected if their faces, edges, or corners touch.	

flood filling

0	0	0	0	0	0	0	0
0	1	1	1	1	1	0	0
0	1	0	0	0	1	0	0
0	1	0	0	0	1	0	0
0	1	0	0	0	1	0	0
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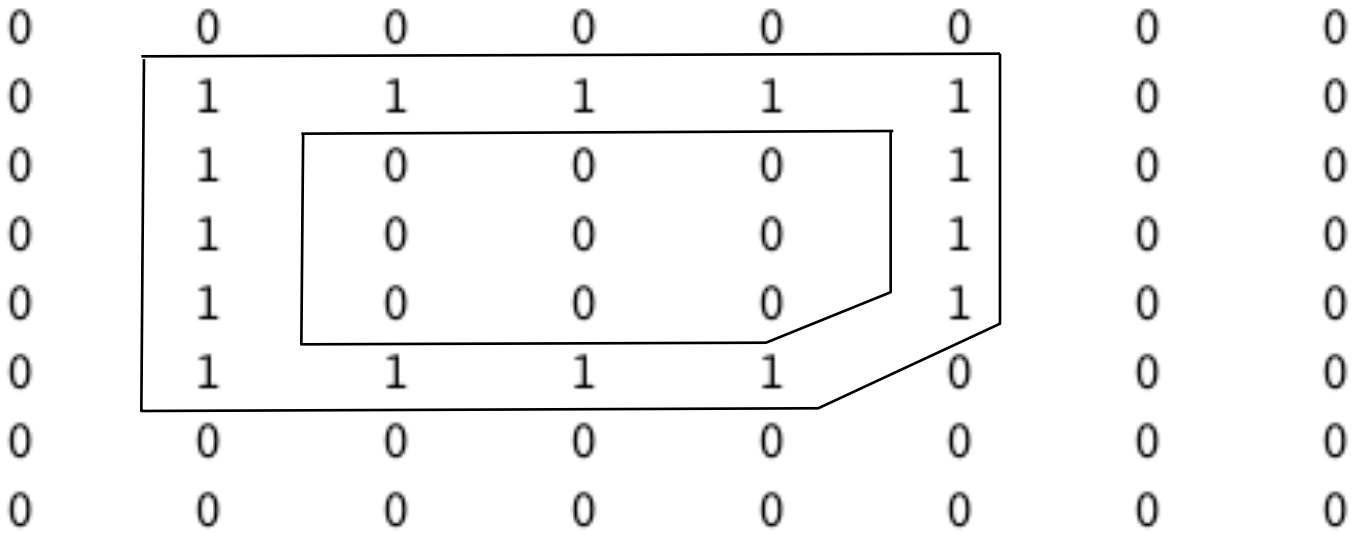
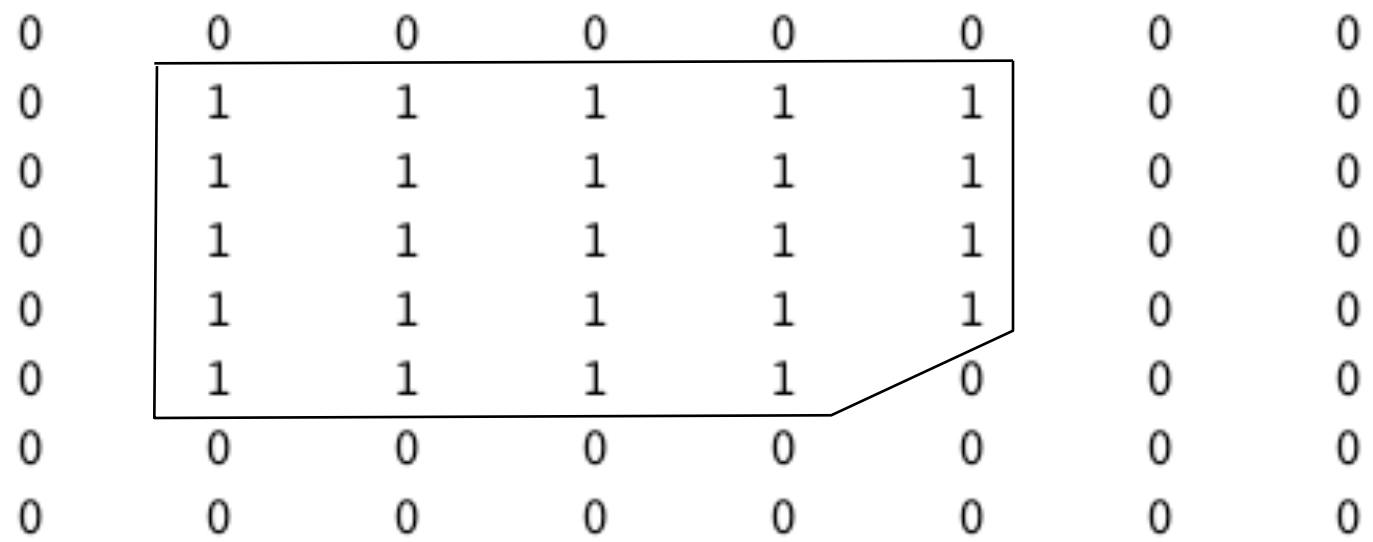
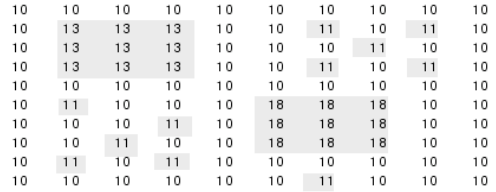
flood filling

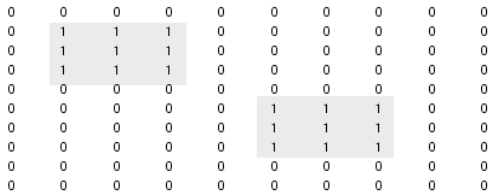


flood filling



peaks & valleys





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10	10	10	10	10	10	10	10	10	10
10	11	10	10	10	18	18	18	10	10
10	10	10	11	10	18	18	18	10	10
10	10	11	10	10	18	18	18	10	10
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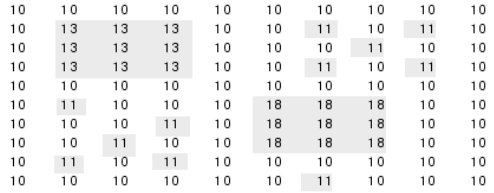
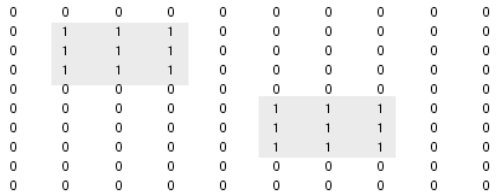
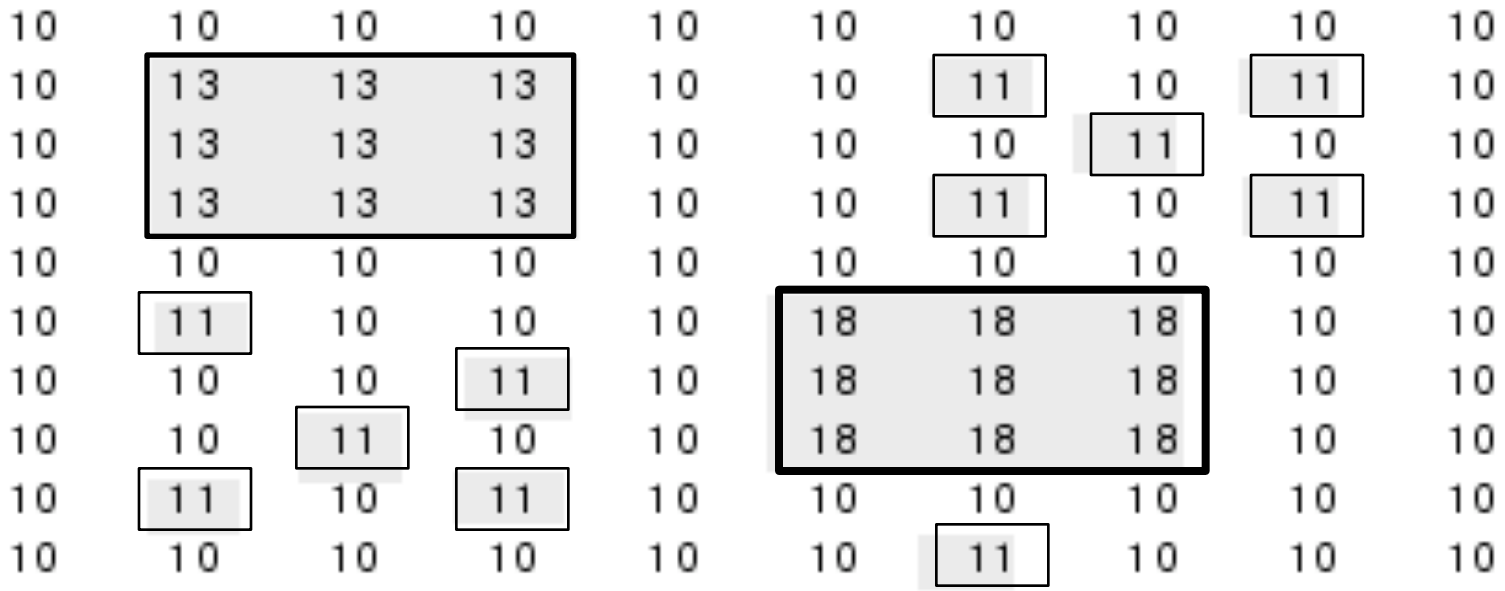
10	10	10	10	10	10	11	10	10	10

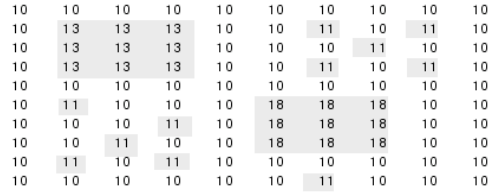
peaks & valleys

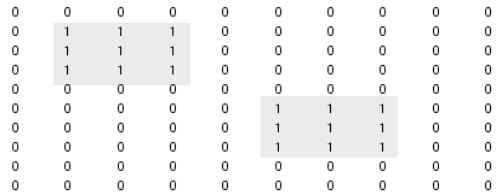


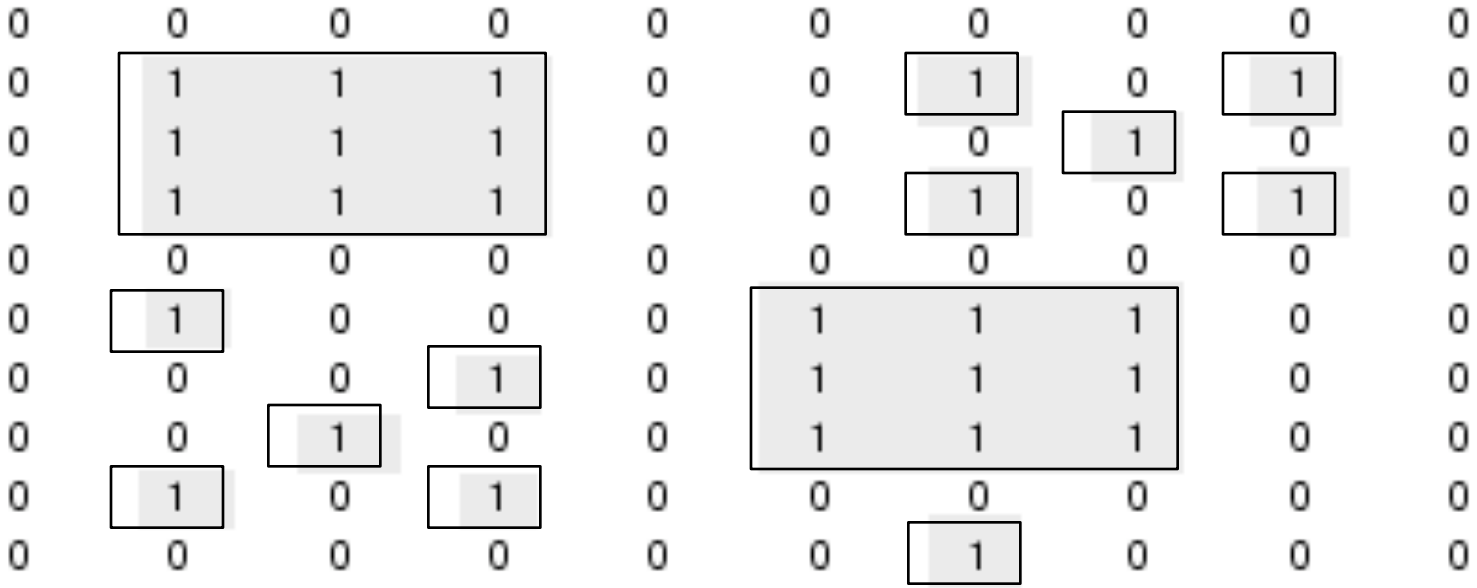


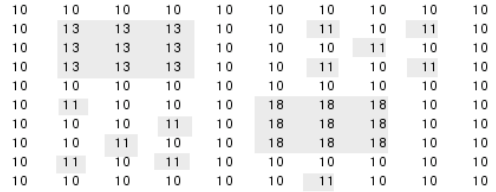


peaks & valleys

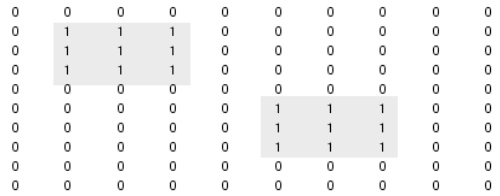








peaks & valleys



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0	1	1	1	0	0	0	0	0	0
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0	0	0	0	0	1	1	1	0	0
0	0	0	0	0	1	1	1	0	0
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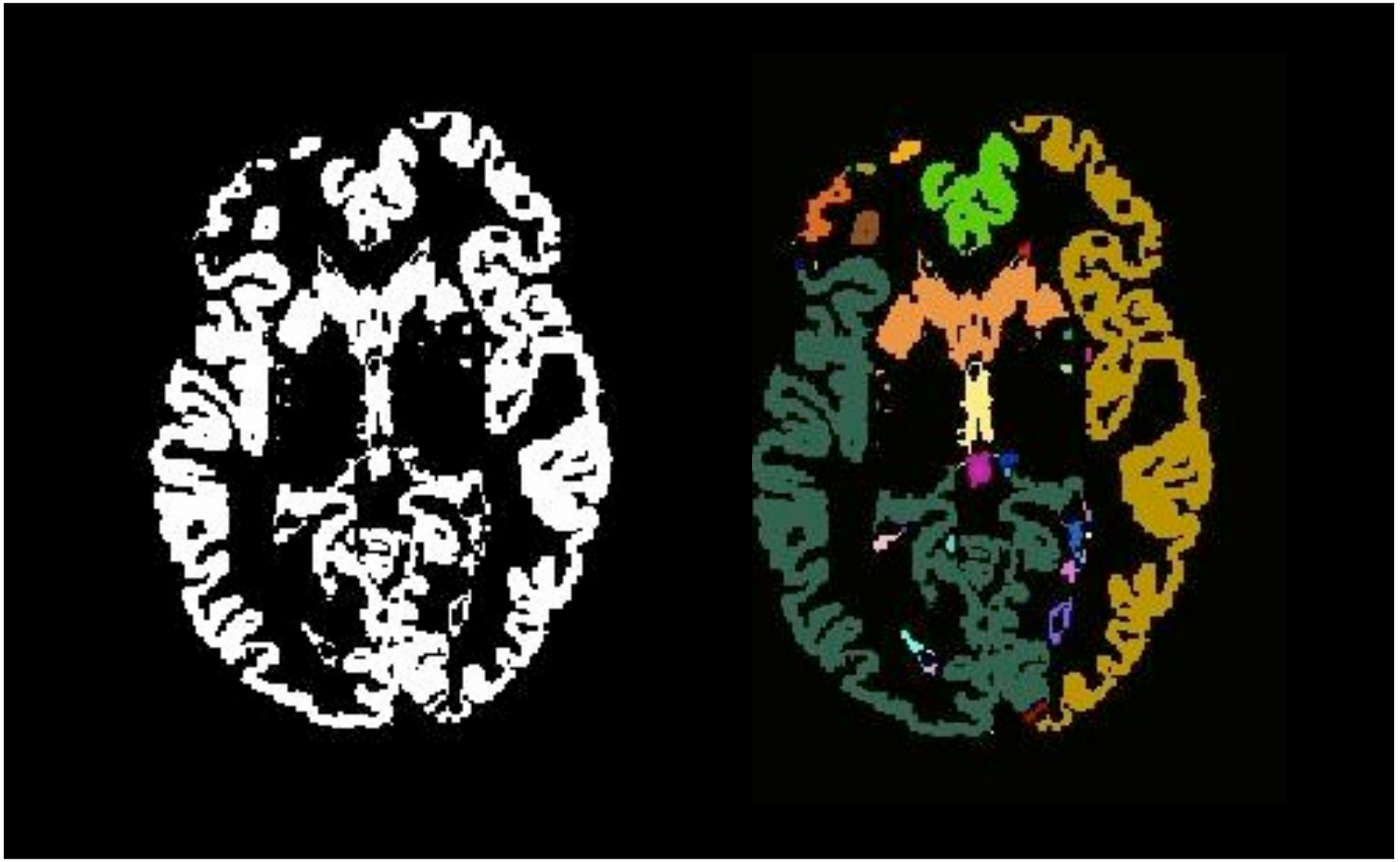
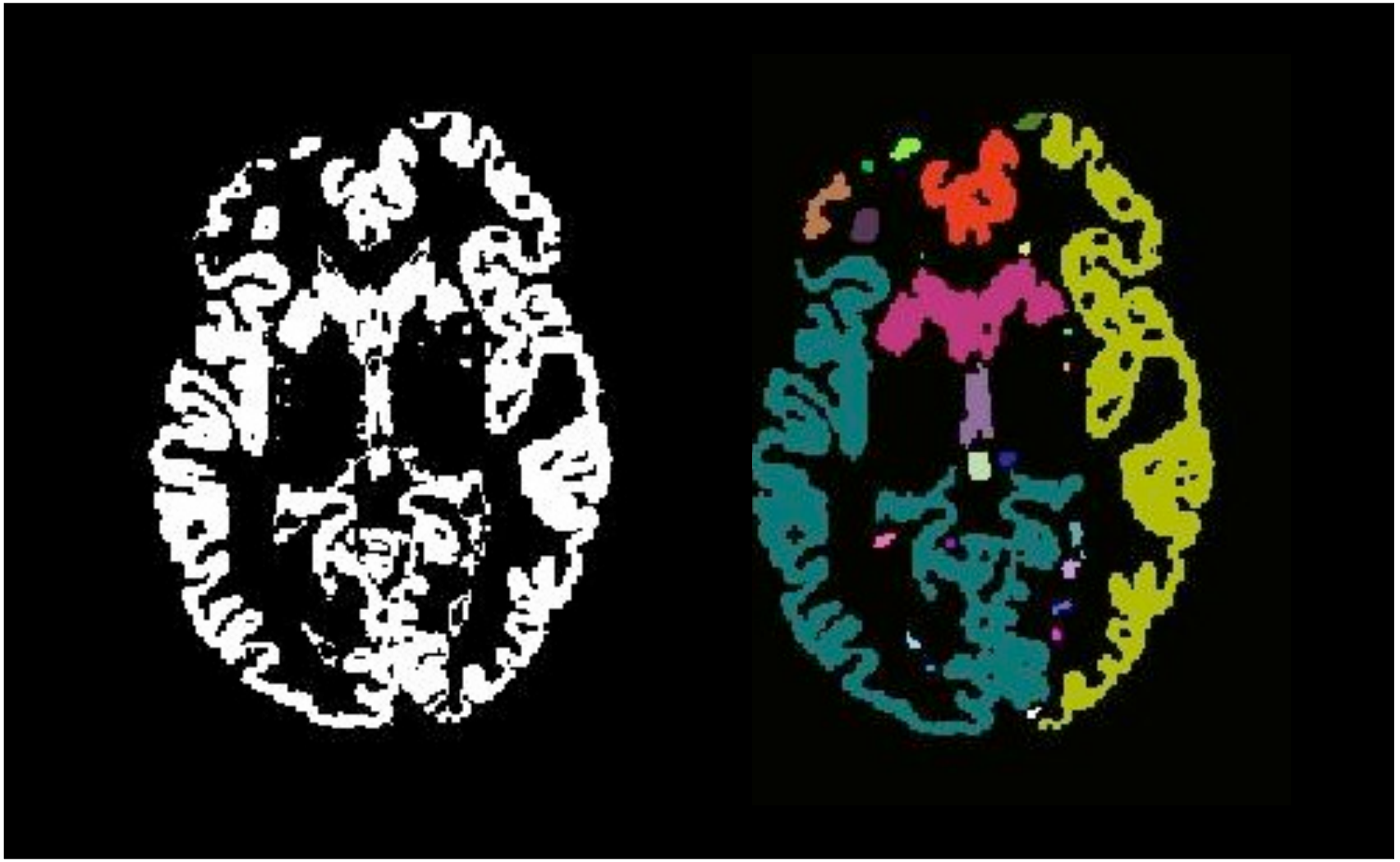
segmenting connected objects

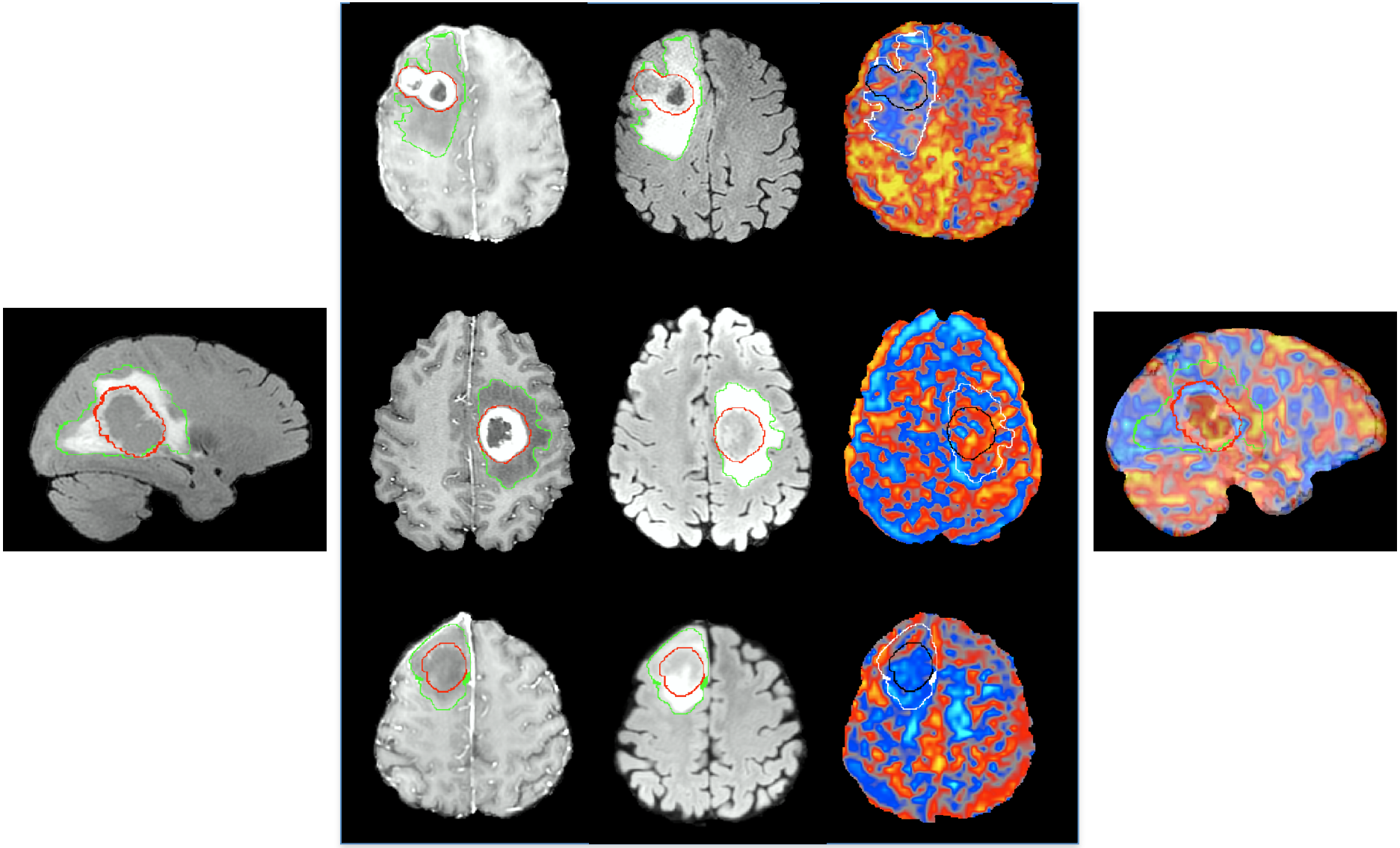


segmenting connected objects



segmenting connected objects

example clinical application



Tumor segmentation thanks to Jack Grinband

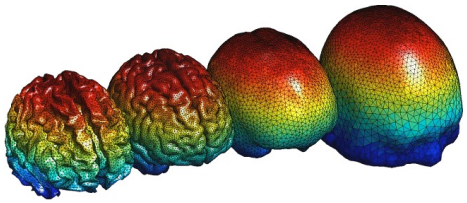


image processing of surfaces

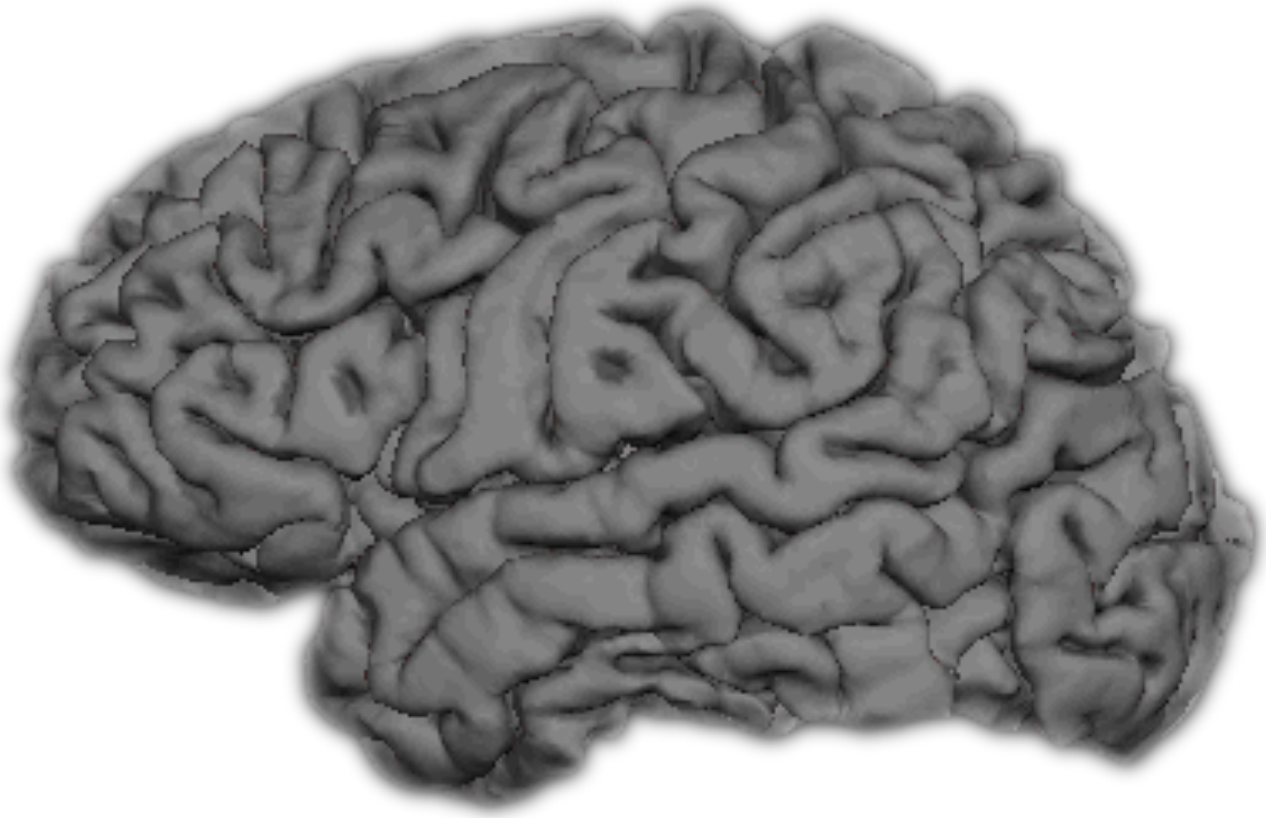
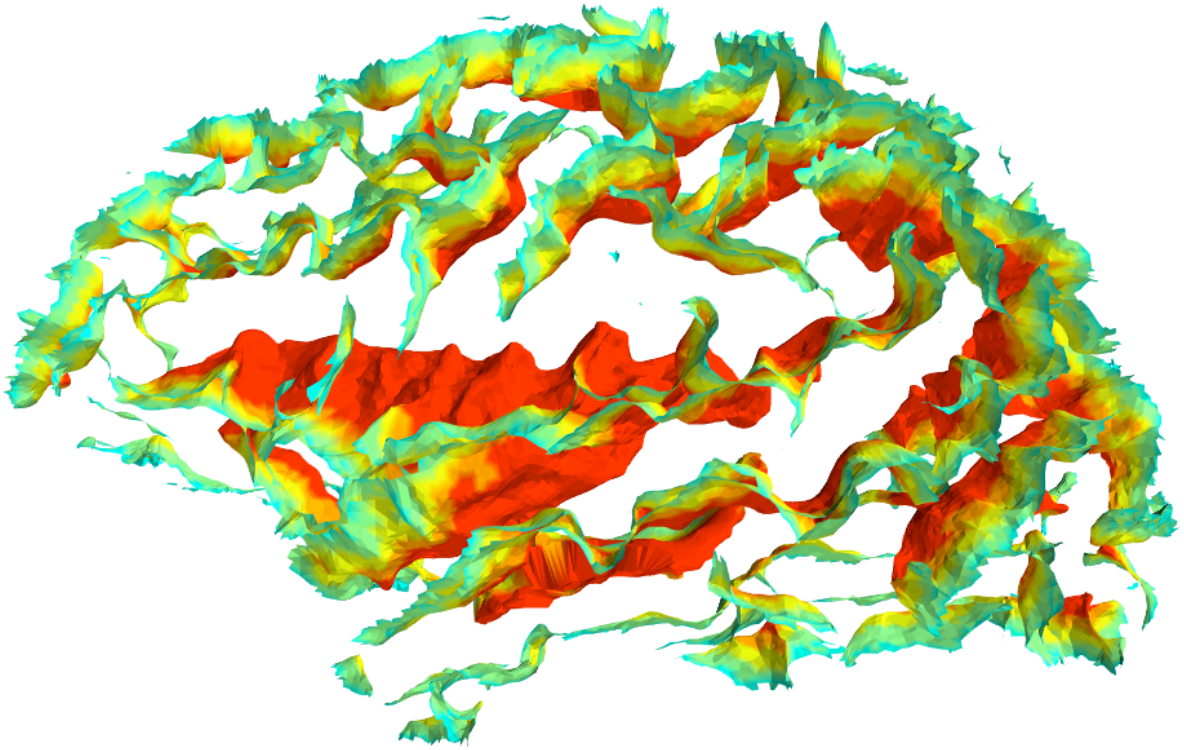
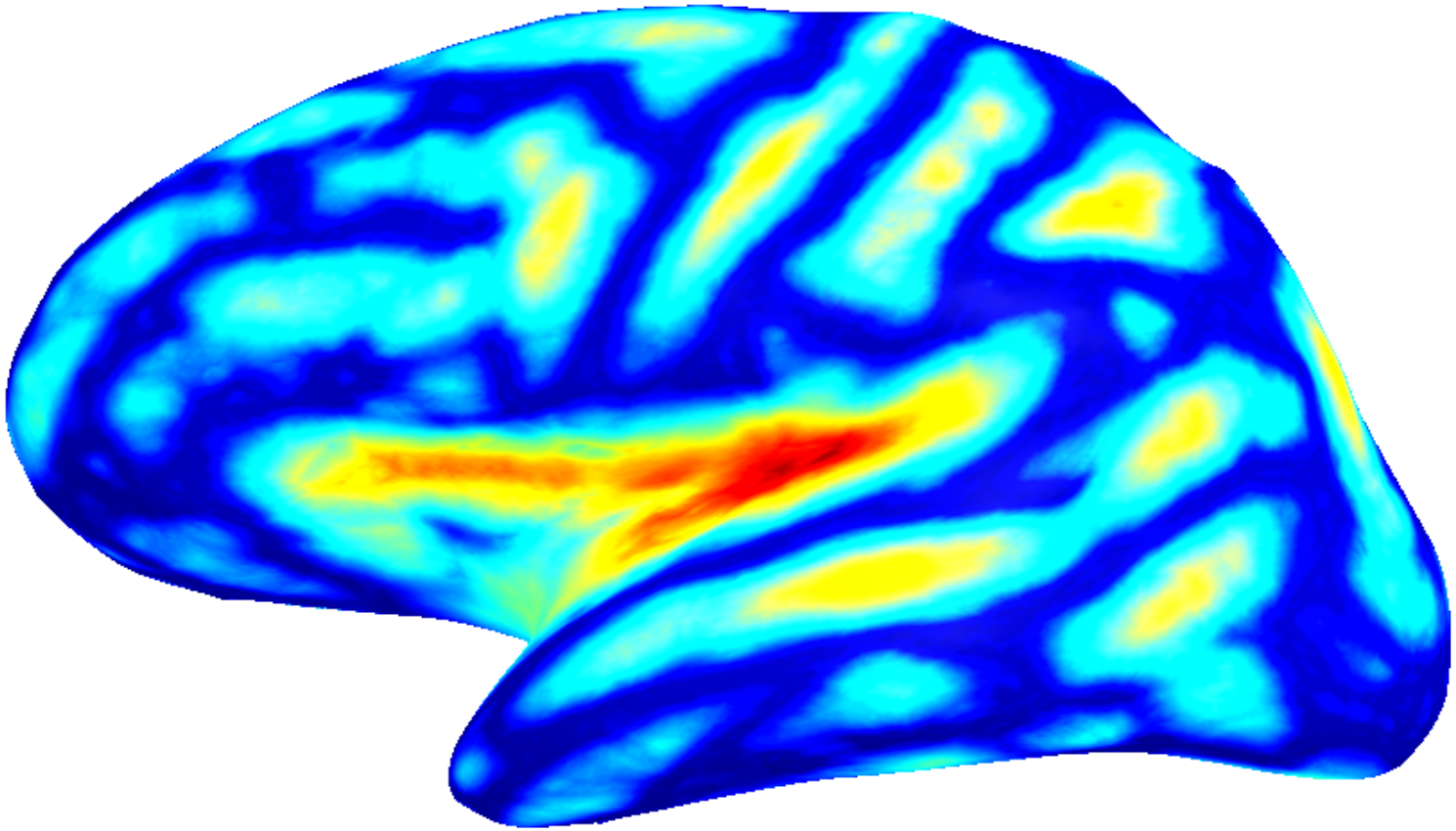


image processing of surfaces



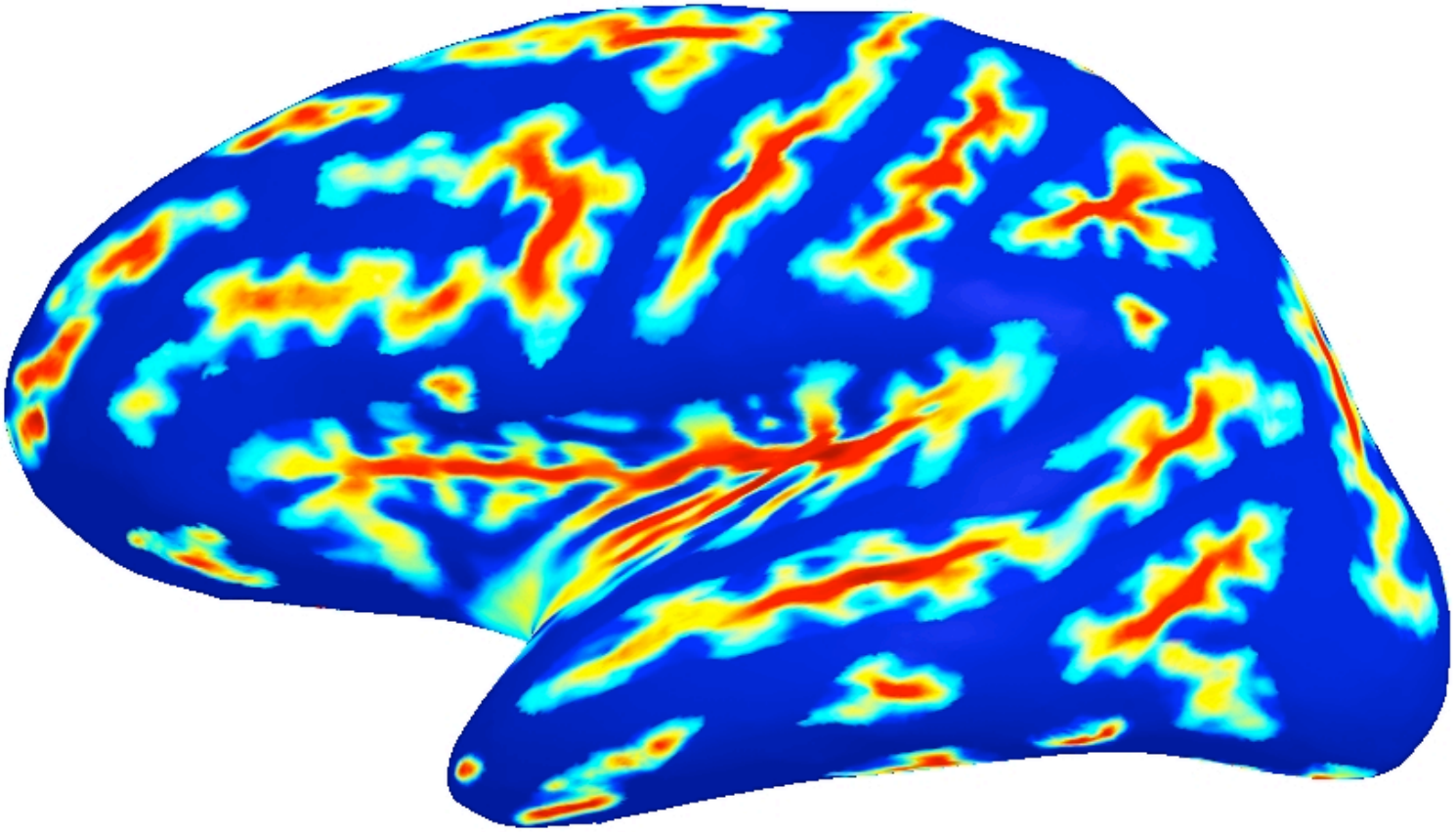
depth (folds)

image processing of surfaces



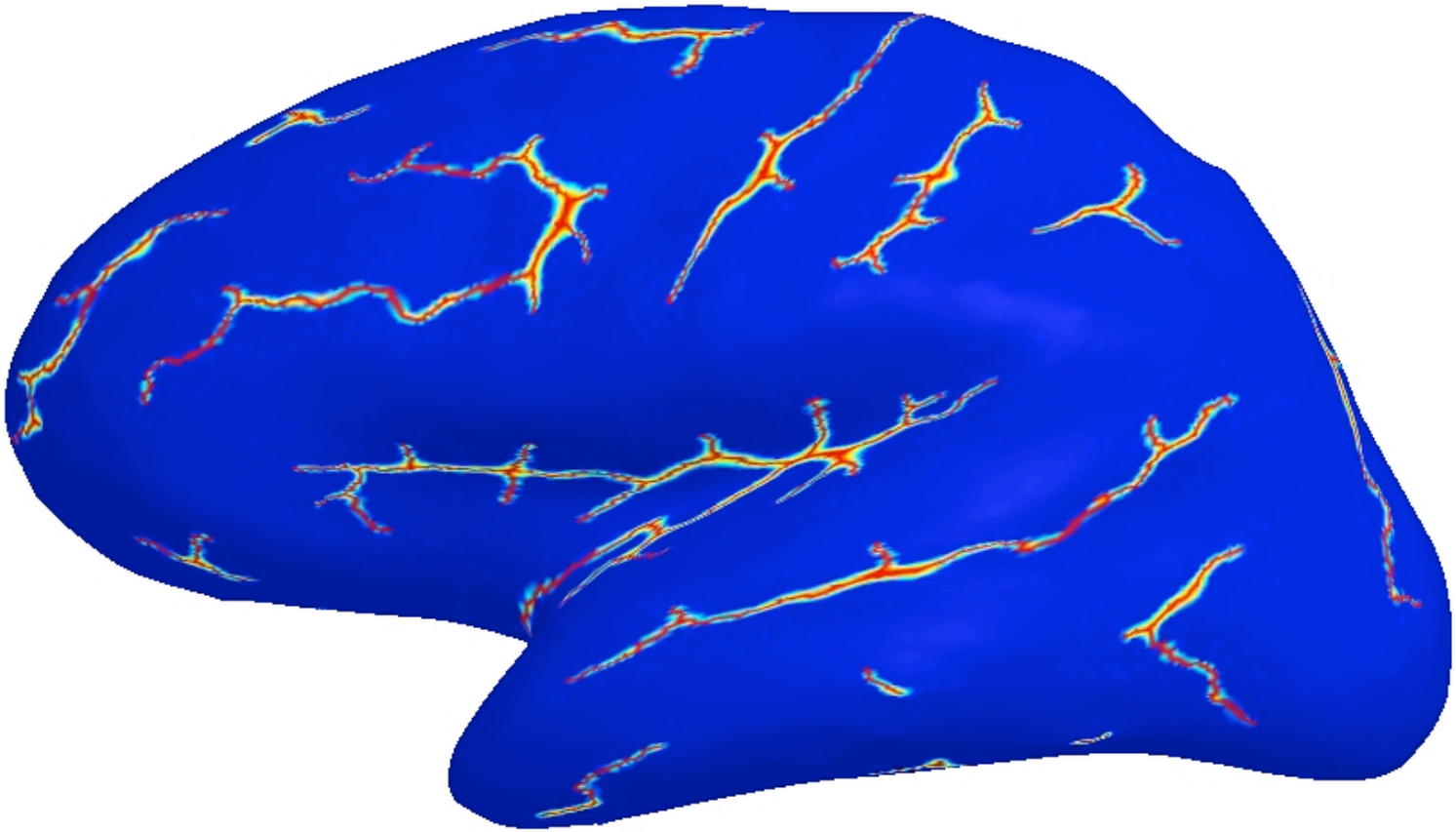
depth (inflated surface)

surface feature extraction



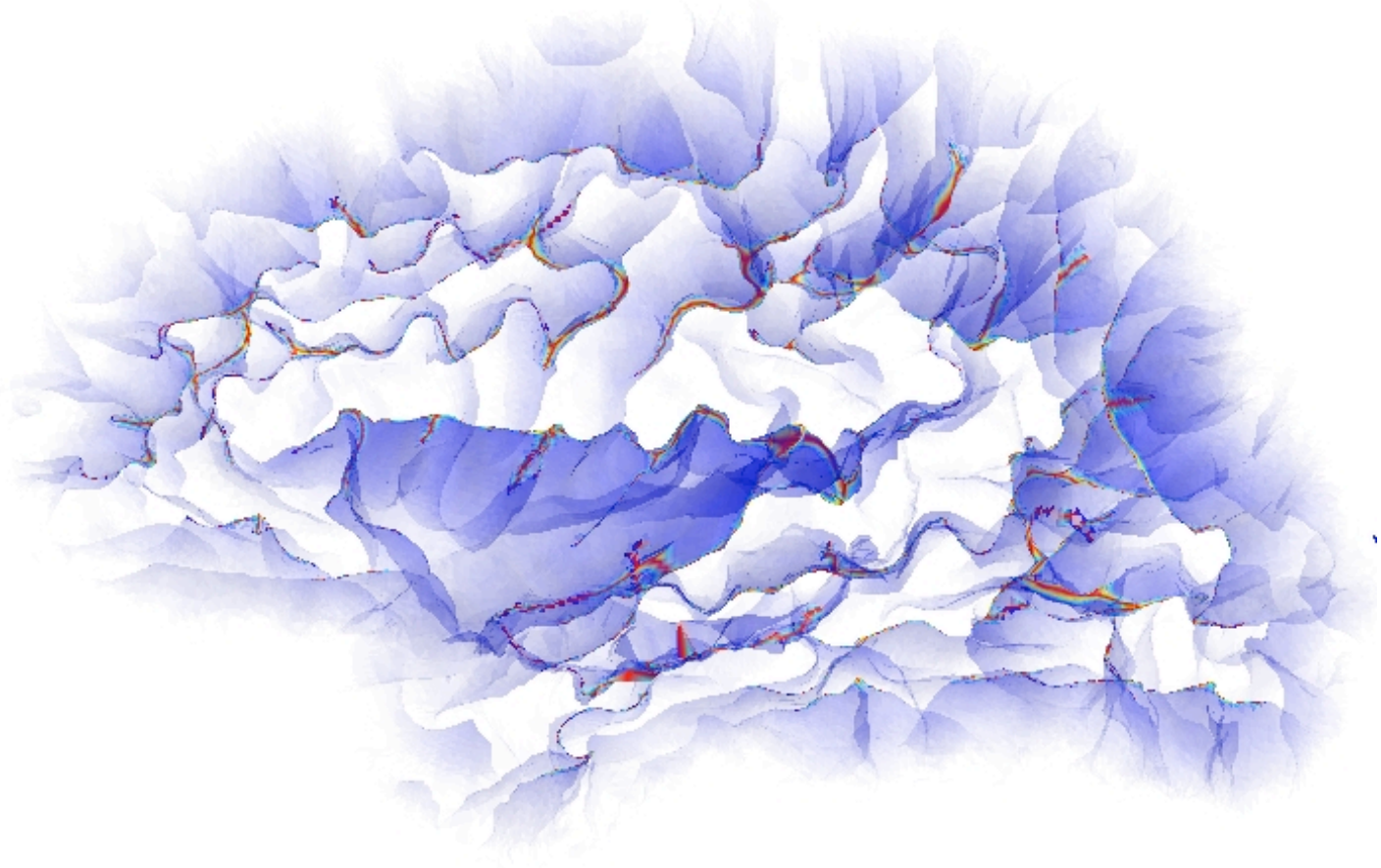
fundus regions

surface feature extraction

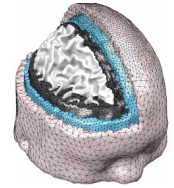


fundus curves

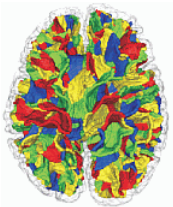
surface feature extraction

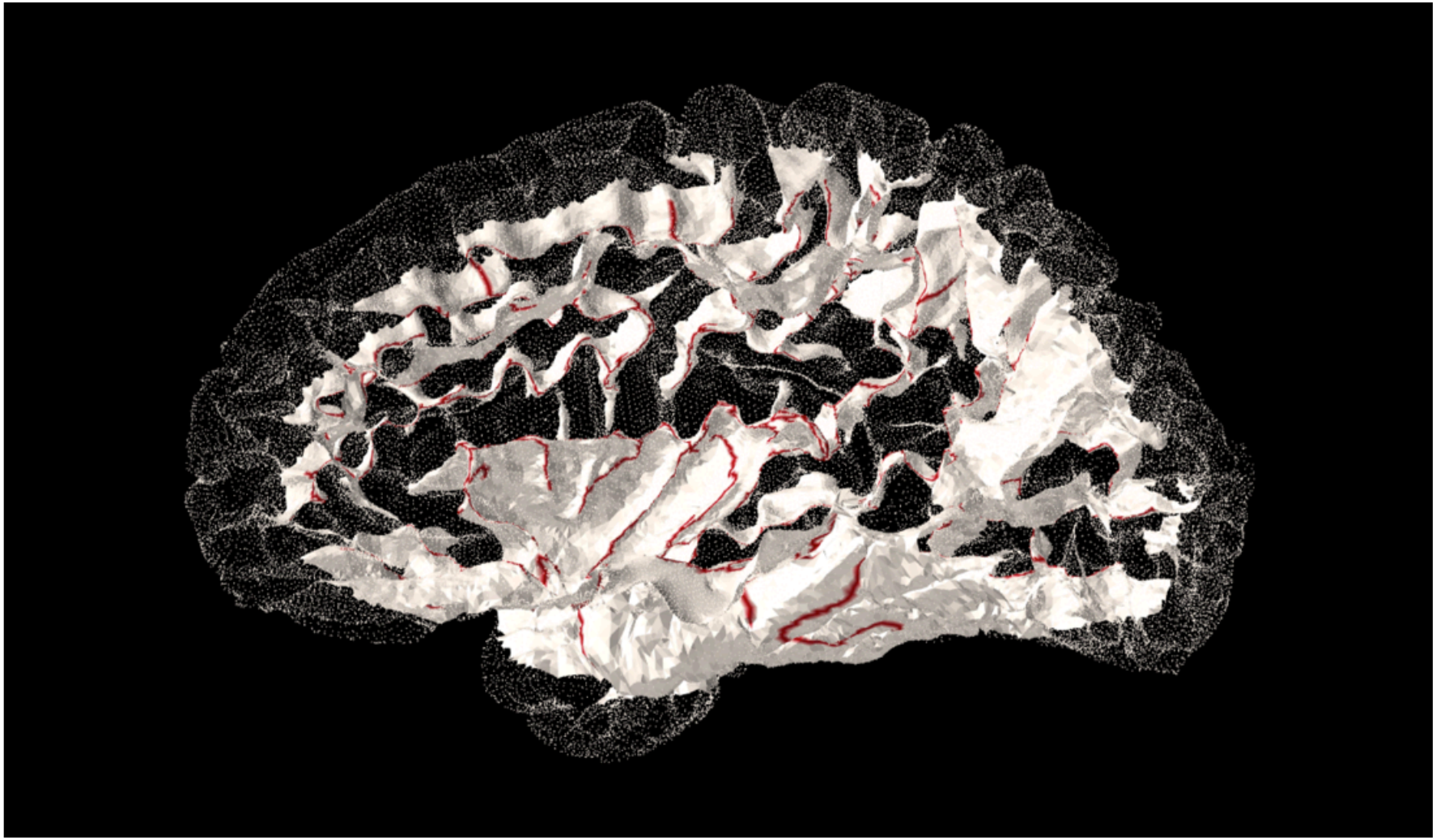


fundus curves



surface feature extraction





fundus curves

References

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