

MEDICAL IMAGE SEGMENTATION WITH



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What is image segmentation?

- Simplifying an image to meaningful pixel groups.
- Partitioning an image into parts for deriving meaning or further analysis based on some homogenous visual characteristics

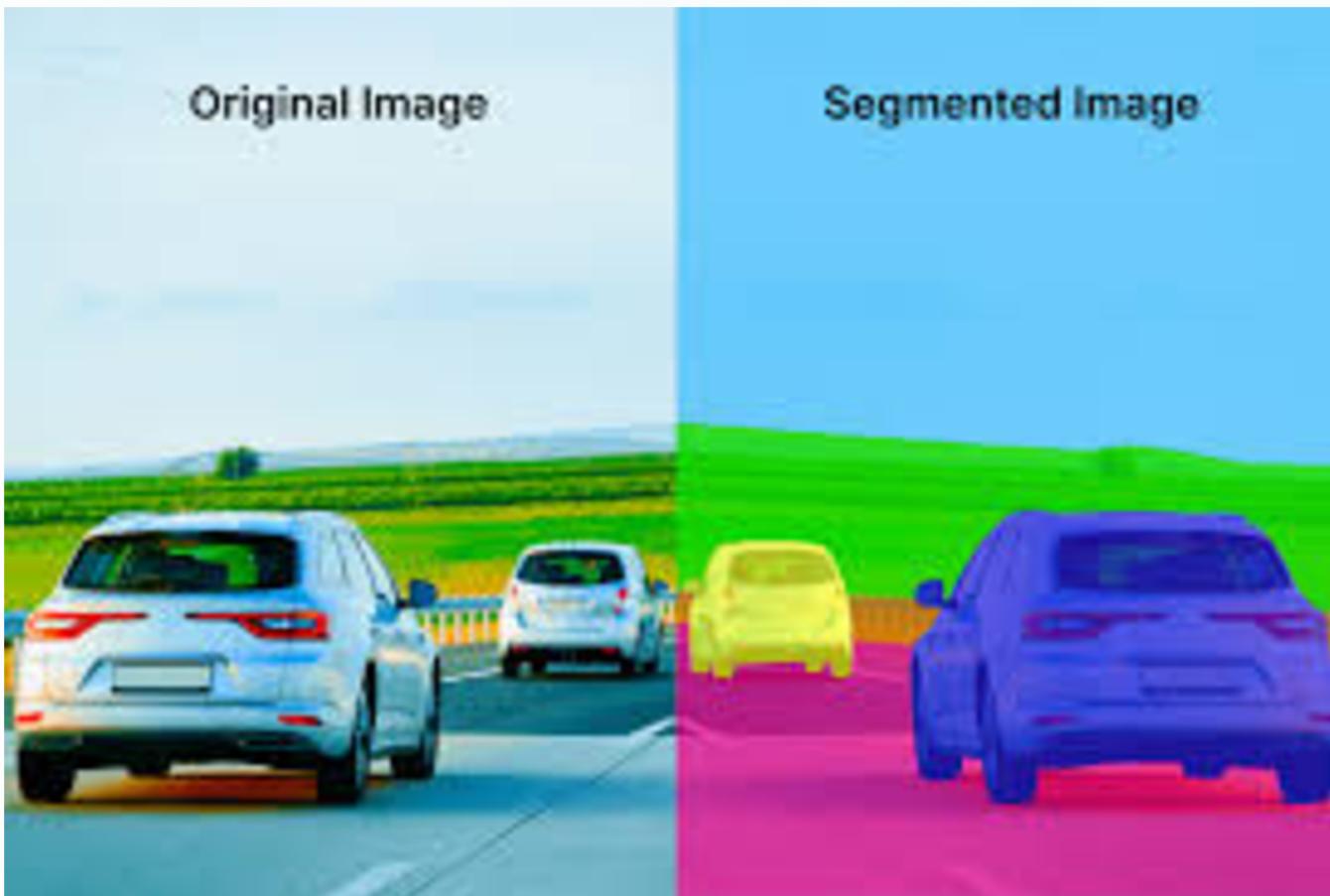


Image segmentation techniques

1. Thresholding
2. Edge-Based Segmentation
3. Region-Based Segmentation
4. Clustering-Based Segmentation
5. Machine Learning / Deep Learning - Based Segmentation



Region-Based Segmentation

- 1. Region Growing**
- 2. Watershed Algorithm**

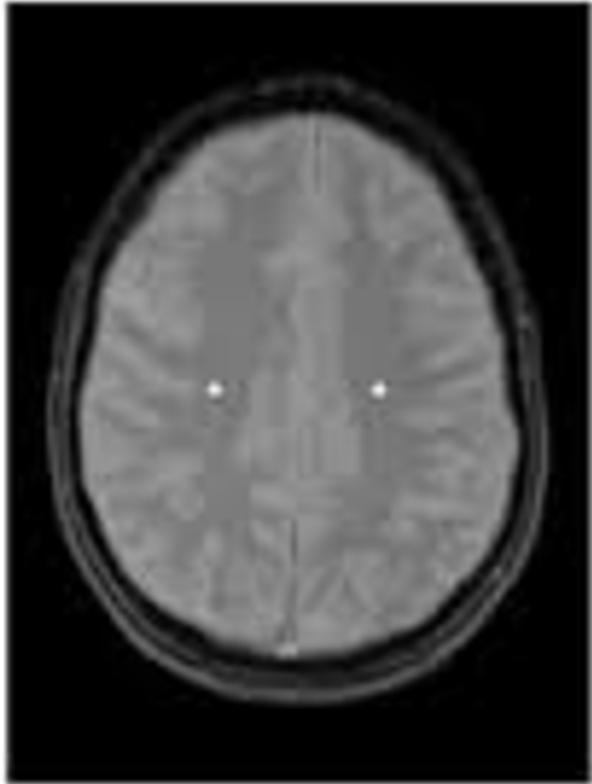


Region Growing



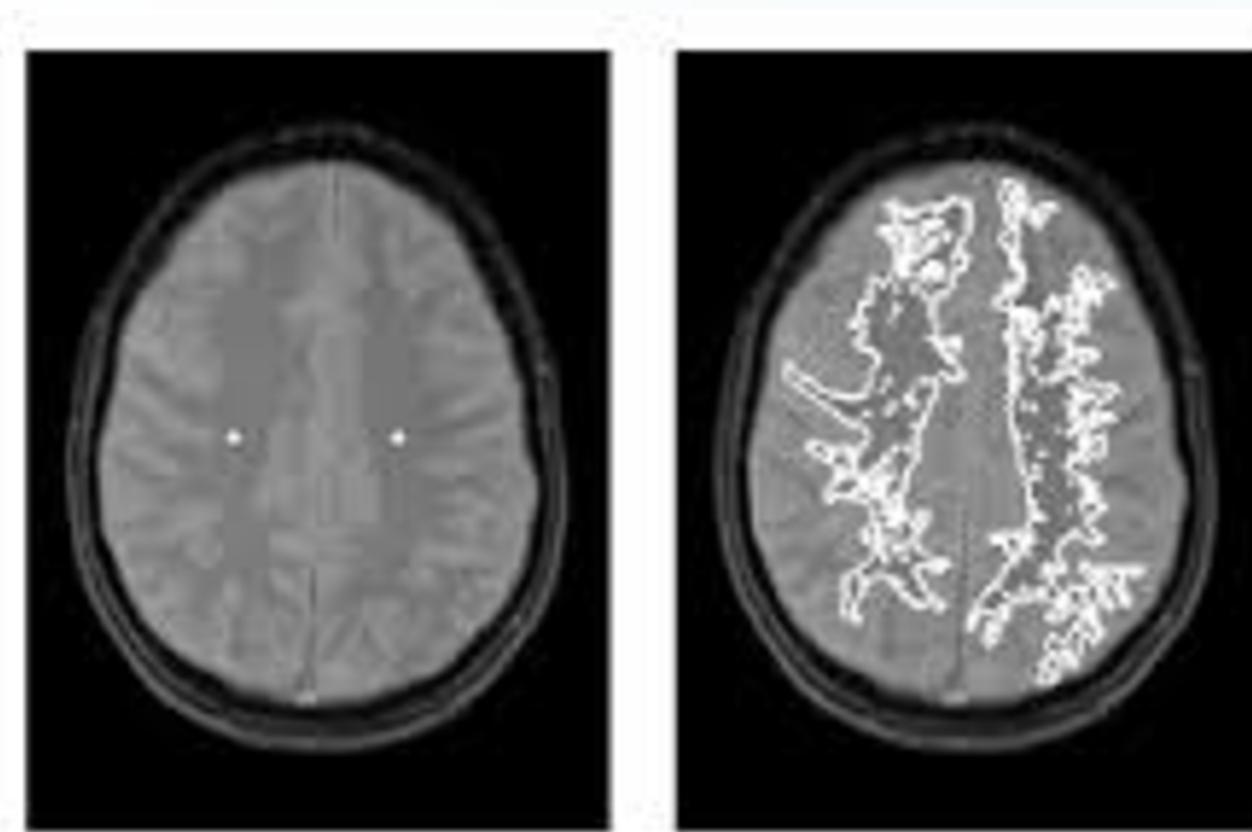
Region Growing

Starts with a seed point and grows the region by adding neighboring pixels that satisfy a inclusion criteria.



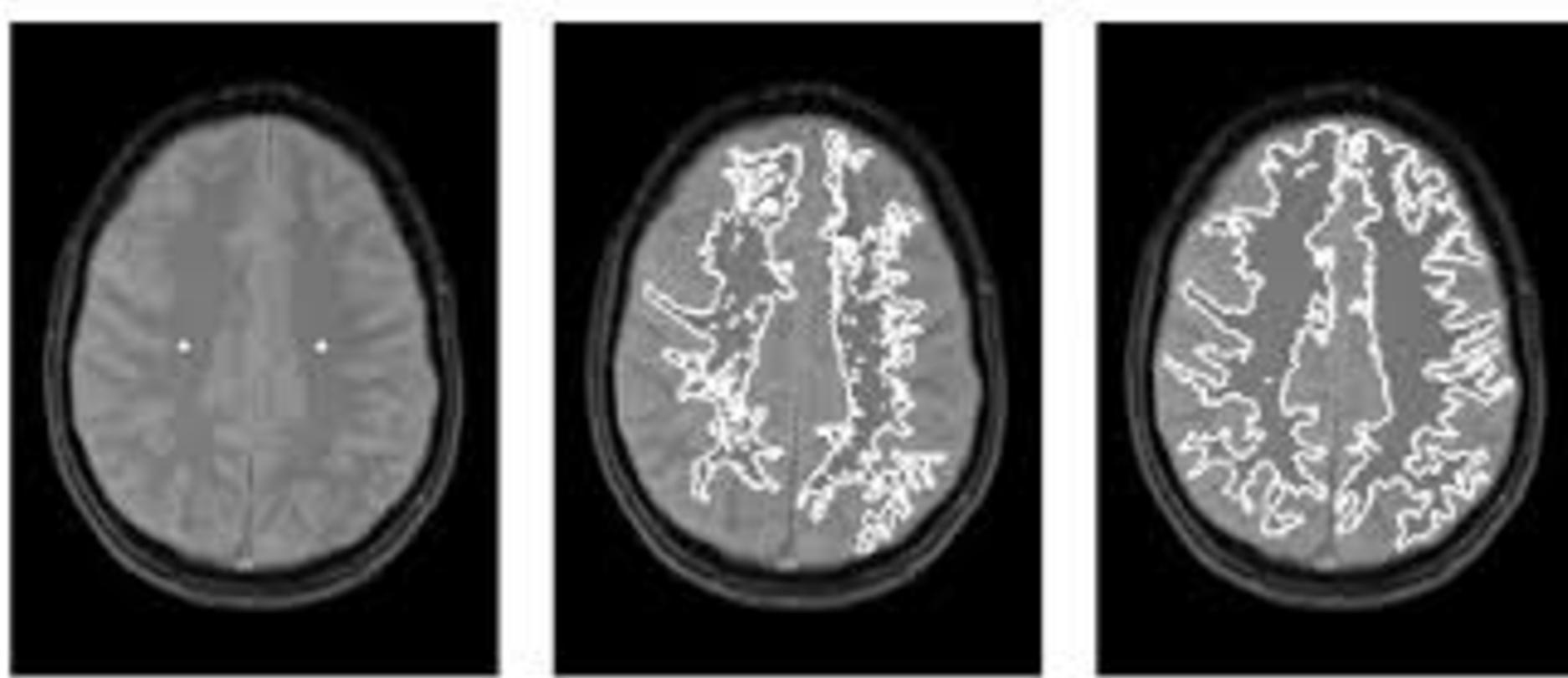
Region Growing

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Region Growing

1. Connected Threshold
2. Otsu Segmentation
3. Neighborhood Connected
4. Confidence Connected
5. Isolated Connected
6. Vector Confidence Connected

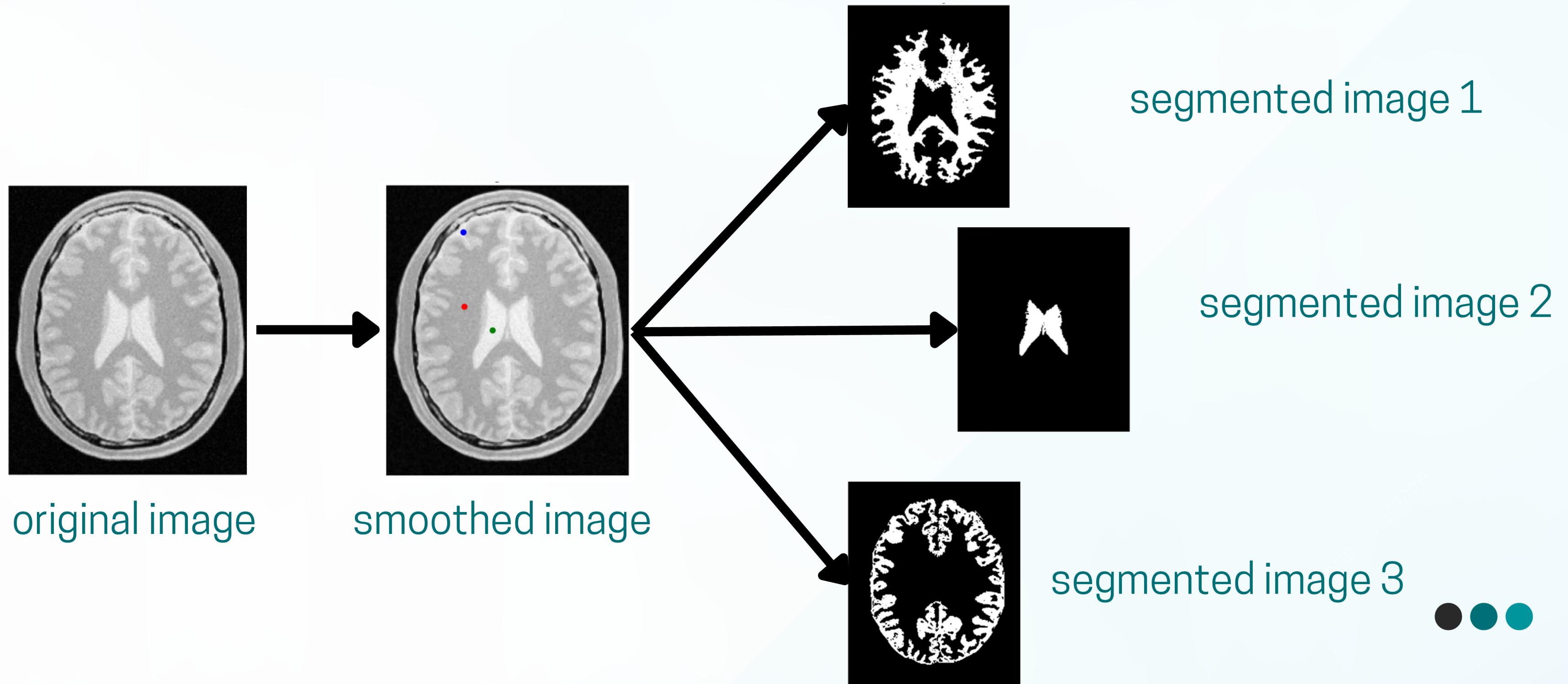


Region Growing : Connected Threshold

1. Input Preparation: CurvatureFlowImageFilter to reduce noise while preserving edges
2. Threshold Setting: Lower and upper intensity thresholds.
3. Region Growing: All connected pixels within the threshold range, starting from the seed point.
4. Binary Output: A binary image



Region Growing : Connected Threshold

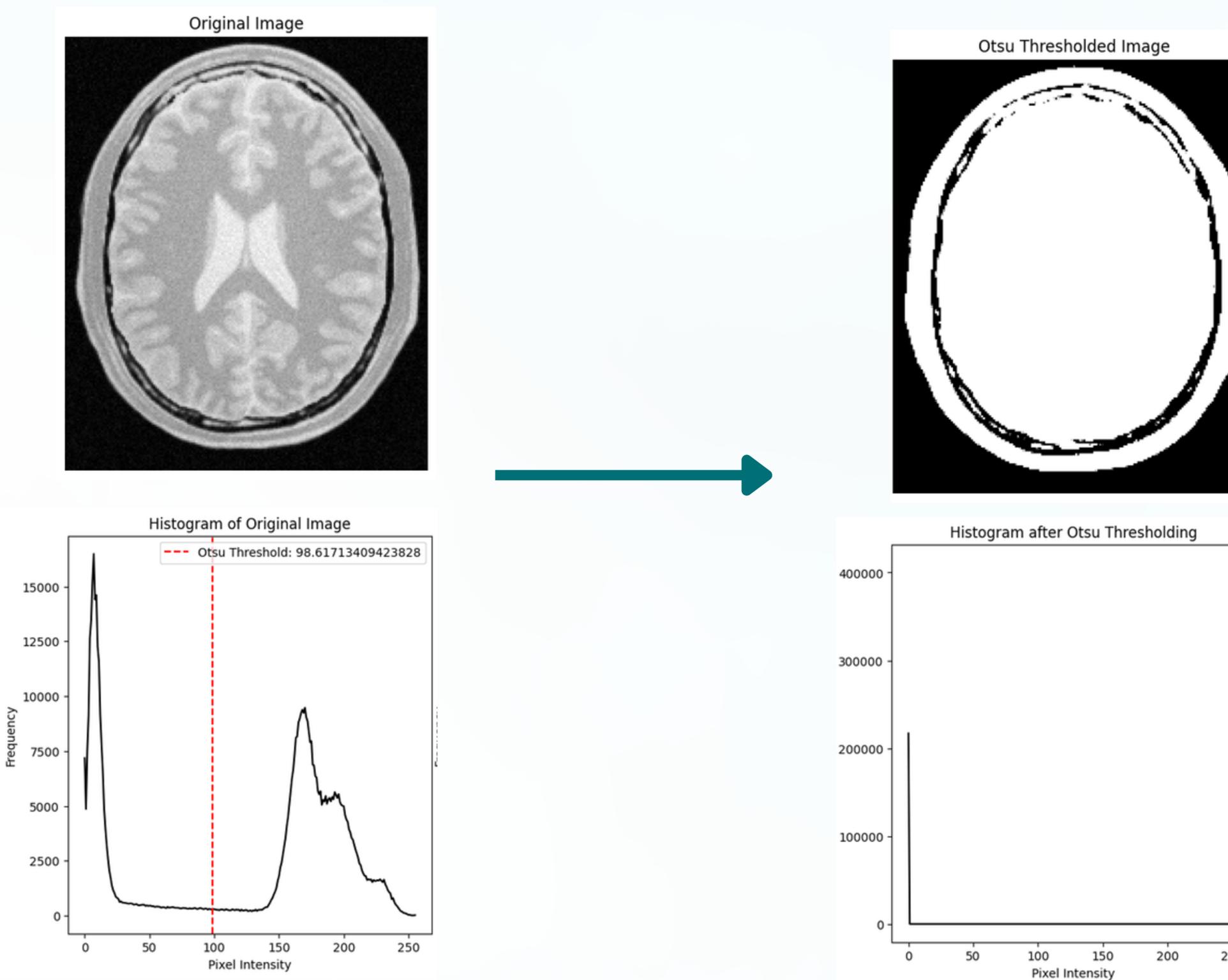


Region Growing : Otsu Segmentation

1. Histogram Generation: Determines the distribution of pixel intensities in the image.
2. Otsu's Method: Otsu's method to determine the optimal threshold values that maximize inter-class variance.
3. Binary Thresholding: Thresholding is applied to segment the image into different regions based on these thresholds.



Region Growing : Otsu Segmentation

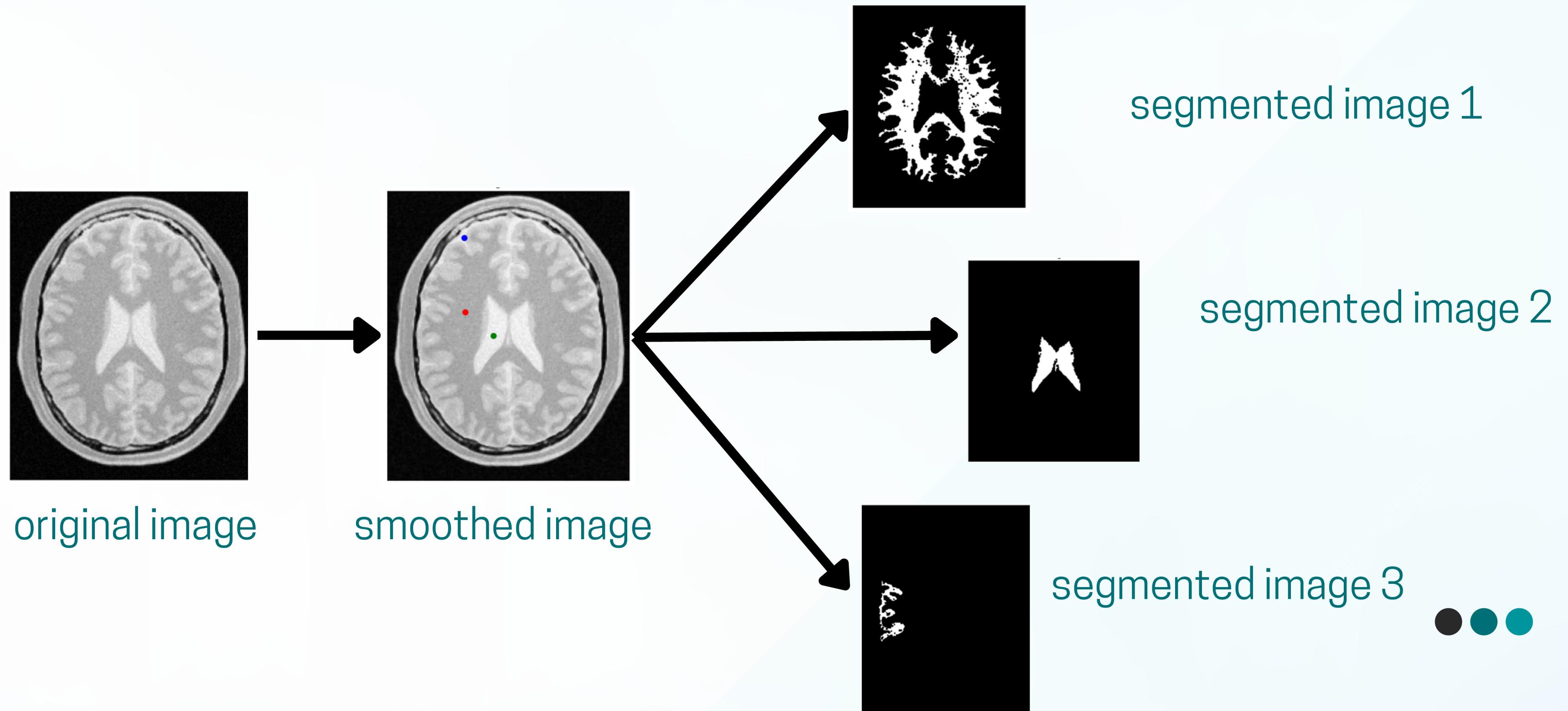


Region Growing : Neighborhood Connected

1. Edge-Preserving Smoothing: Smoothing the image while preserving important edges
2. Neighborhood Radius: Size of the region around each pixel that will be evaluated
3. Segmentation Process: reduces the chances of including small, isolated structures.



Region Growing : Neighborhood Connected



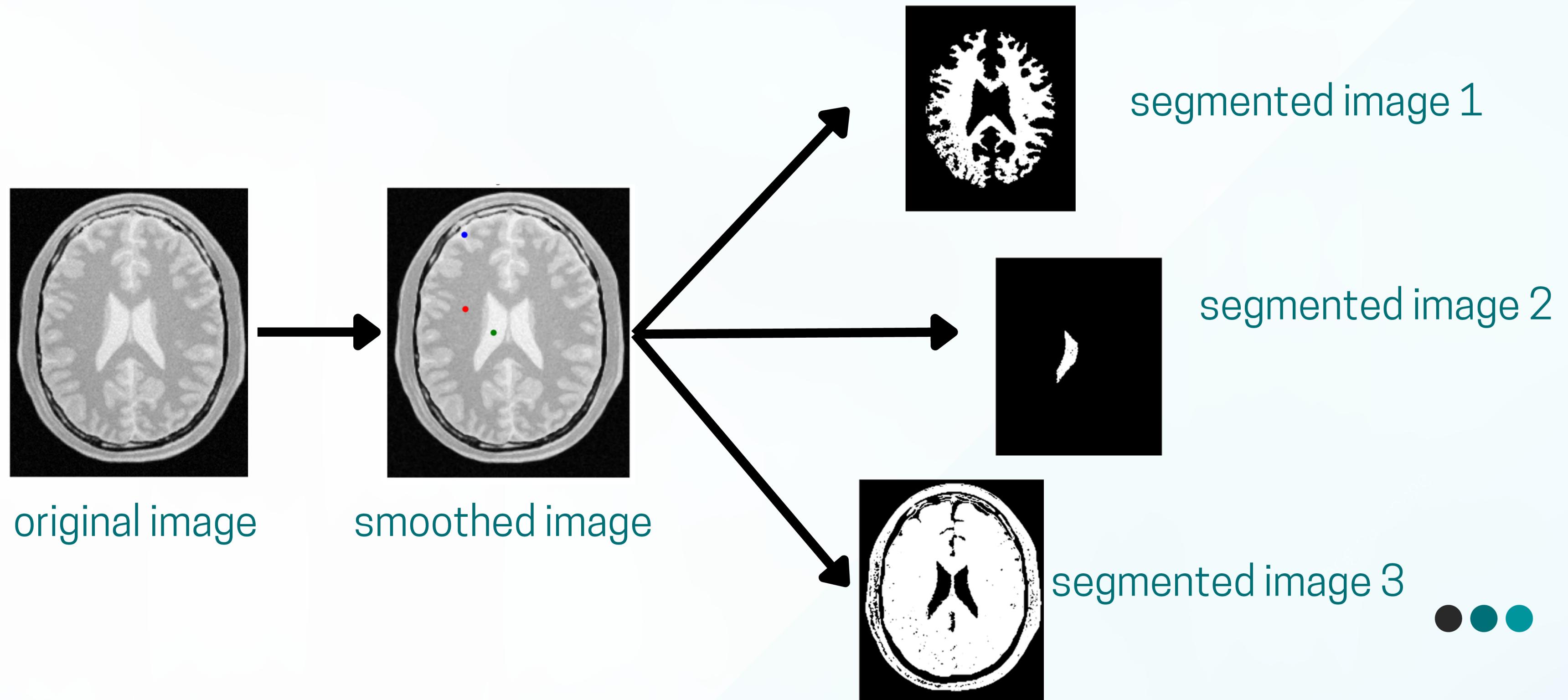
Region Growing : Confidence Connected

1. Edge-Preserving Smoothing: Smoothing the image while preserving important edges
2. Statistical Criterion: Compute the mean and standard deviation of the intensity values for all the pixels included in the region
3. Parameters:
 - Multiplier (f): Controls the size of the intensity range.
 - Number of Iterations: The number of times the mean and standard deviation are recalculated.
 - Initial Neighborhood Radius:

$$I(\mathbf{X}) \in [m - f\sigma, m + f\sigma]$$



Region Growing : Confidence Connected

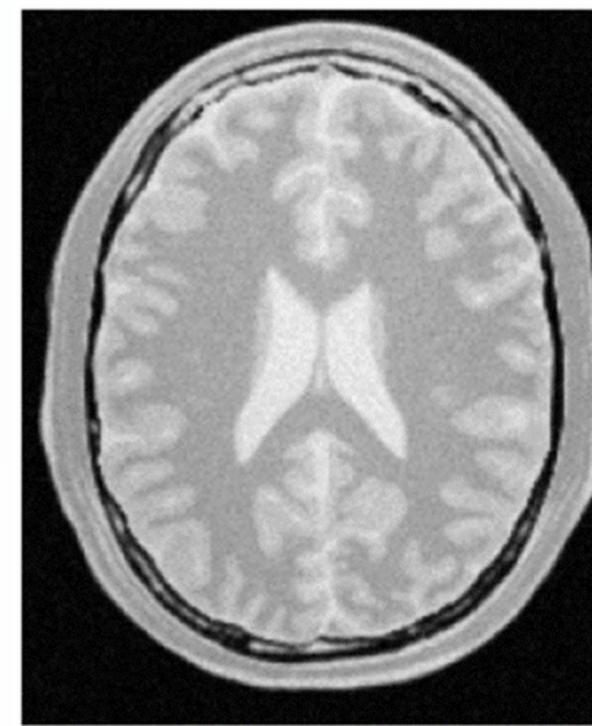


Region Growing : Isolated Connected

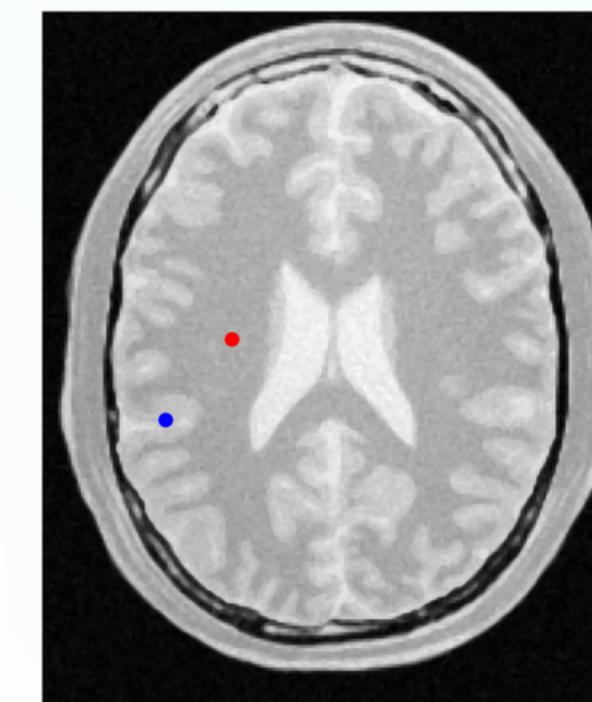
1. Edge-Preserving Smoothing: Smoothing the image while preserving important edges
2. Two Seed Points: One seed (Seed1) is used to grow a region, and the other seed (Seed2) is used to define a region that should not be connected to the first region.
3. Binary Search for Upper Threshold



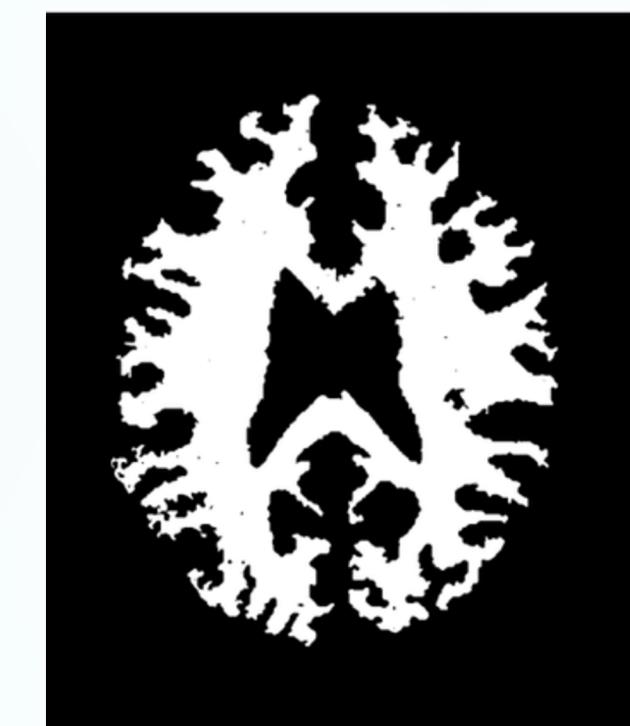
Region Growing : Isolated Connected



original image



smoothed image



segmented image

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Region Growing : Vector Confidence Connected

1. Vector Pixel Data Types: RGB
2. Covariance and Mean: Relationships between different components of the pixel vectors
3. Mahalanobis Distance : Measure how far a pixel's vector is from the region's mean.



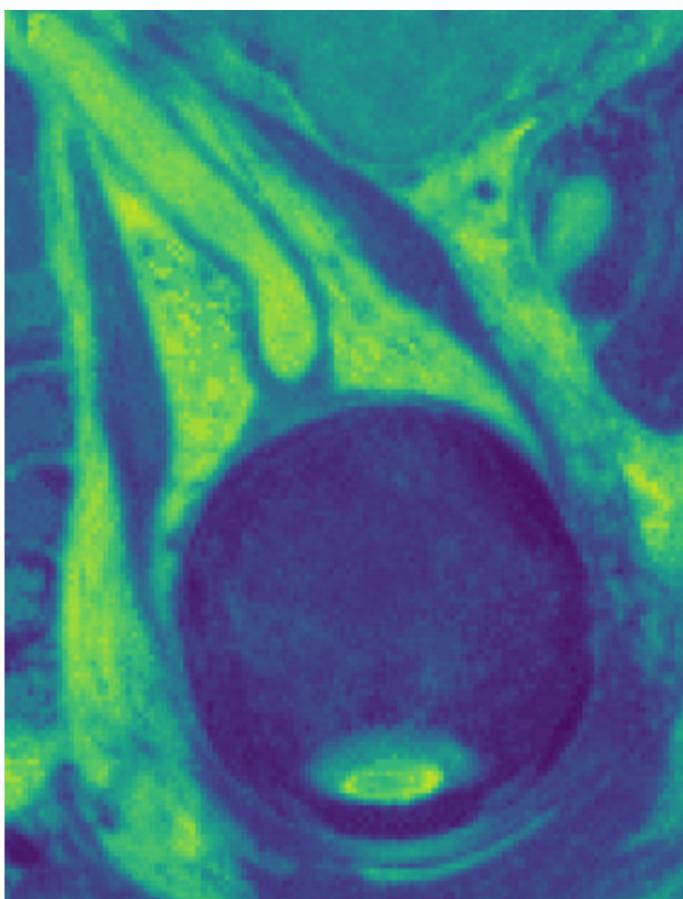
Region Growing : Vector Confidence Connected

Segmentation Approach:

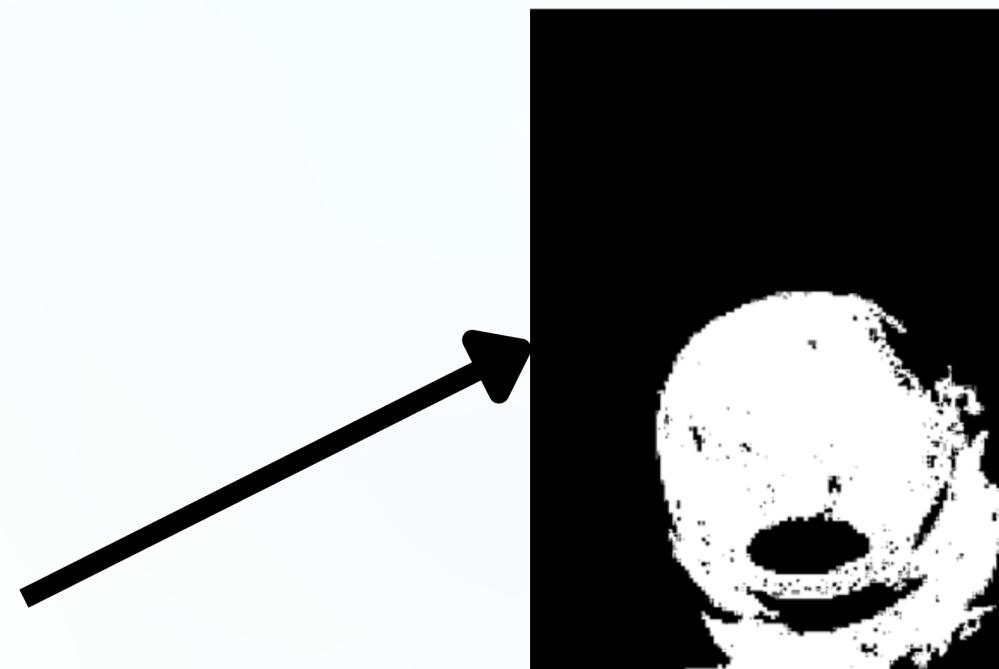
- a. Segments an image by iteratively expanding a region starting from an initial seed point.
- b. mean vector and covariance matrix of the pixel values within the region.
- c. A pixel is included in the region if its Mahalanobis distance from the region's mean is within a user-defined threshold.



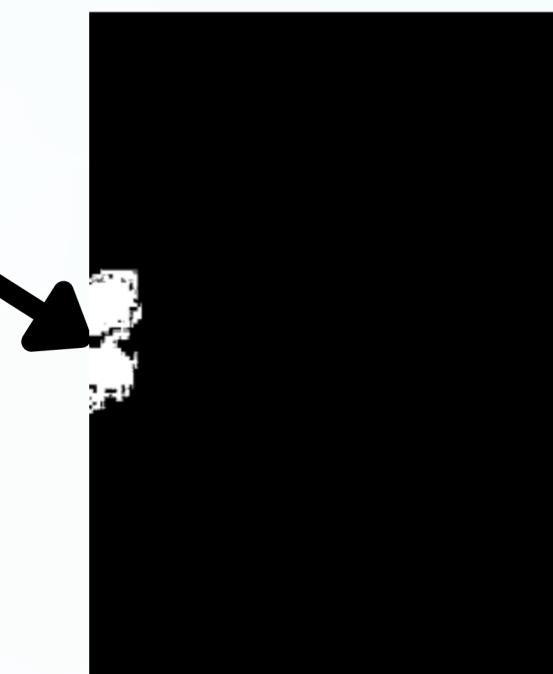
Region Growing : Vector Confidence Connected



original image



segmented image 1



segmented image 2

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Watershed Segmentation



Watershed Segmentation : Key Concepts

Topographic Surface Interpretation:

The image is seen as a landscape, where higher intensity values correspond to peaks and lower values to valleys.



original image



Intensity profile of input image

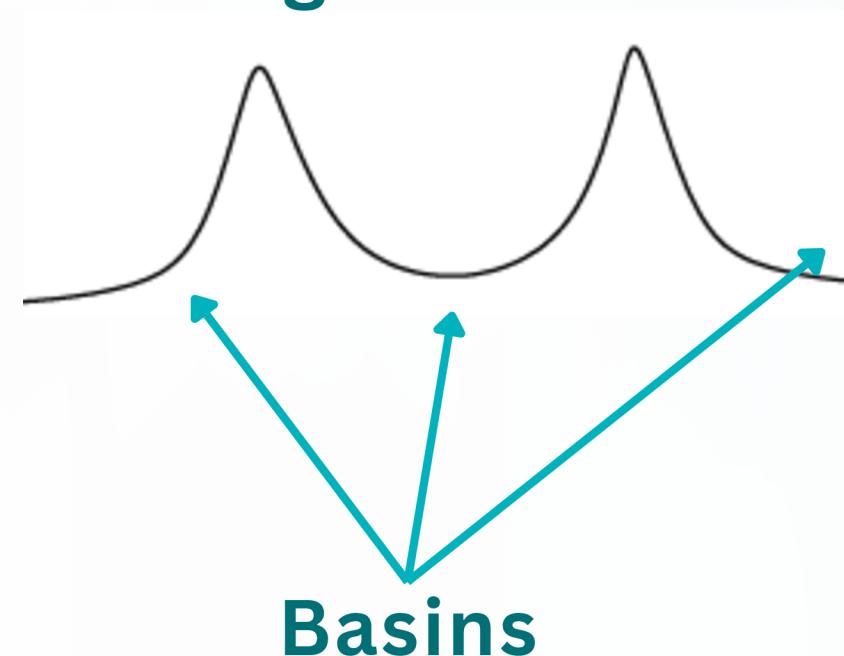


Watershed Segmentation : Key Concepts

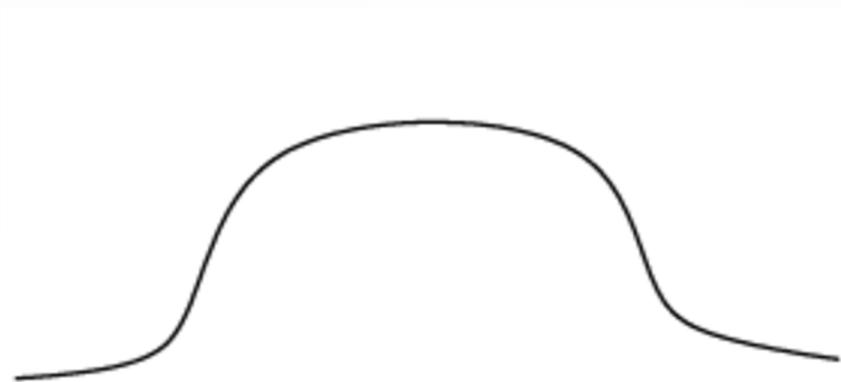
Catchment Basins:

Each local minimum in the image creates a basin, and pixels are classified based on which basin they belong to

Intensity profile of image



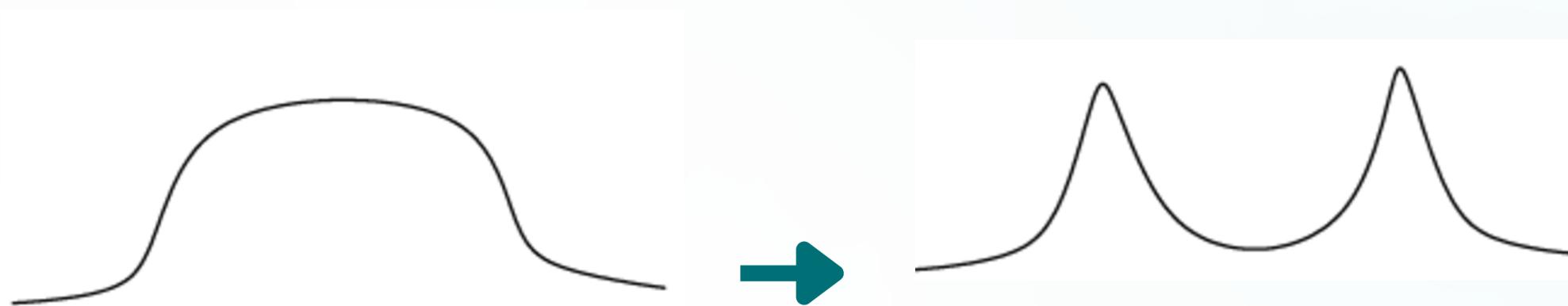
Watershed Segmentation : Intuition



Intensity profile
of input image



Watershed Segmentation : Intuition



Intensity profile
of input image

Intensity profile
of filtered image



Watershed Segmentation : Intuition



Intensity profile
of input image

Intensity profile
of filtered image

Segmented Image

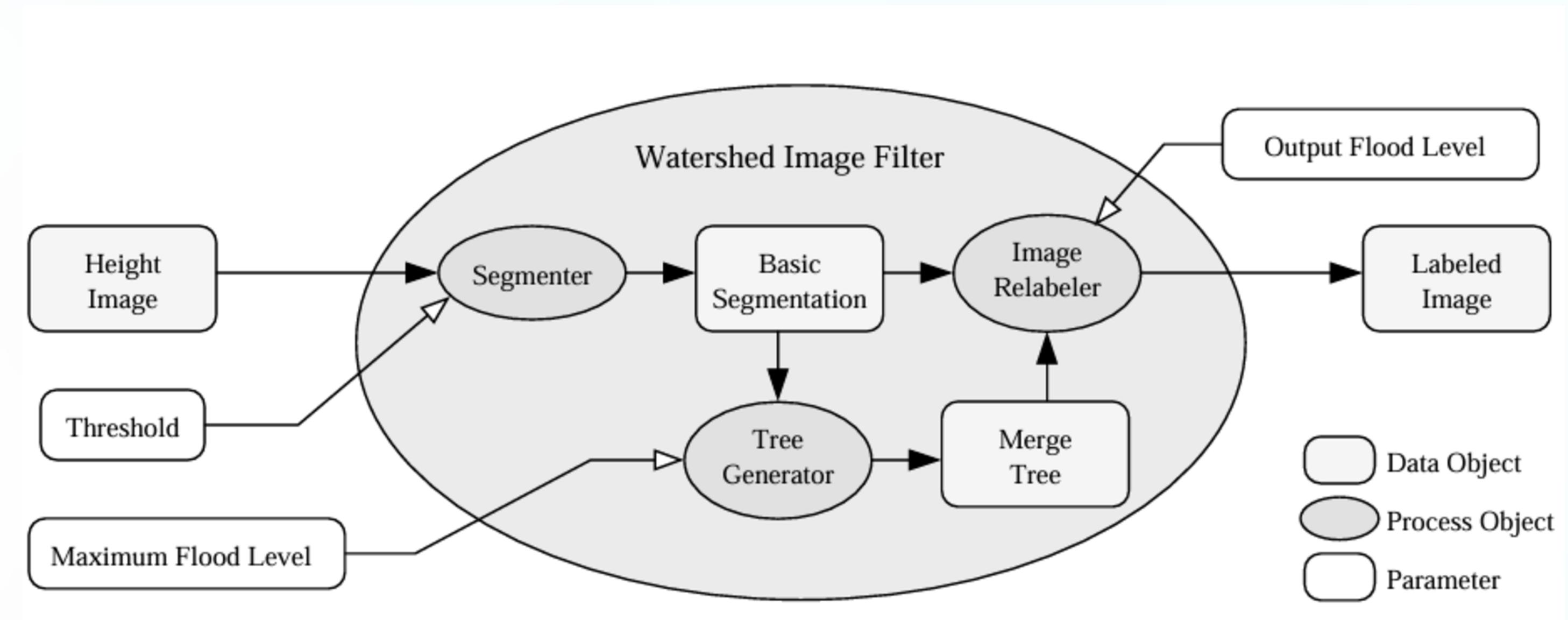


Watershed Segmentation : Key Points

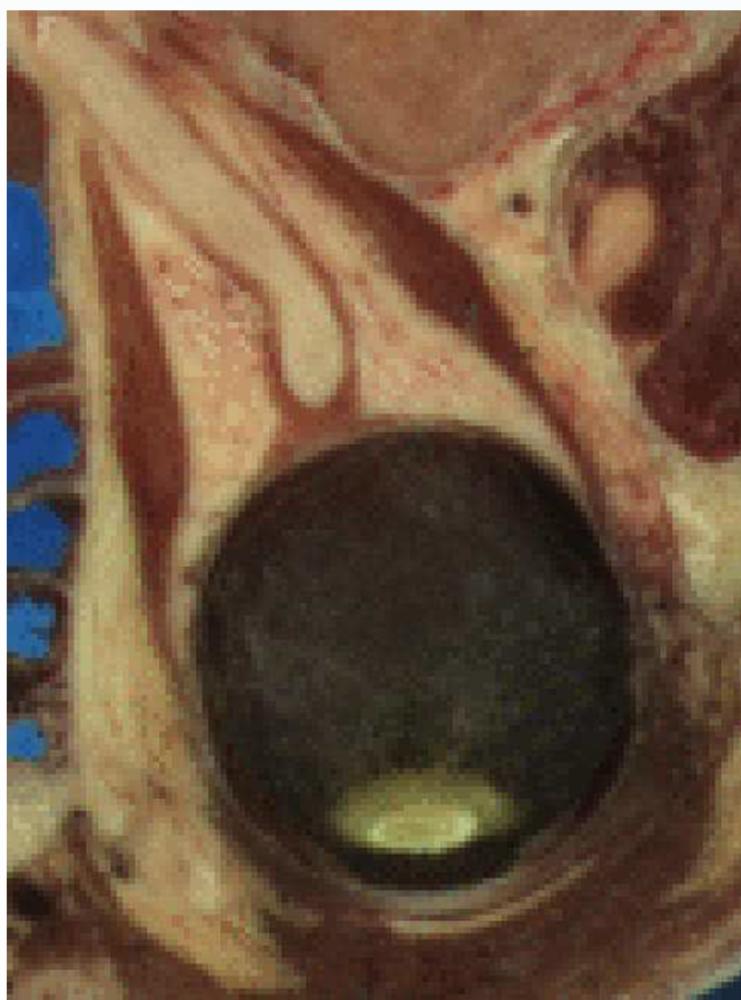
1. Gradient-Based Segmentation: Uses the gradient magnitude of the image
2. Preprocessing with Filters: Edge-preserving smoothing filters(anisotropic diffusion or bilateral filters)
3. Threshold and Level Parameters:
 - a. The threshold parameter controls the minimum height difference between the local minima and their boundaries, merging shallow basins into larger regions.
 - b. The level parameter determines the watershed depth, influencing how the regions are defined.



Watershed Segmentation : Outline



Watershed Segmentation



original image



segmented image





THANK YOU

