Region-based Segmentation

基于区域的图像分割

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Region-based Methods

1. **Region**
2. **Region Growing**
3. **Region Splitting and Merging**
4. **Watershed**

Region

Definition:

- A group of connected pixels with **similar properties**

Idea:

- Similarity
- Spatial Proximity

Region Growing

(A) **Idea:**

- Seed: The regions are growing from seeds points.
  The corresponding regions grow by appending those neighboring pixels to each seed points.
- Pre-defined Criterion: It groups pixels or sub-regions into larger regions based on pre-defined criterion.
- End Condition: The regions keep growing until meeting the end condition.

Region Growing

(B) **Algorithm:**

step1 Initially, the region R needs to be extracted. The region R only contains its seed point p.

step2 Initially, a queue Q contains the boundary points of R. Q contains the 8-neighborhood or 4-neighborhood of the seed point p.

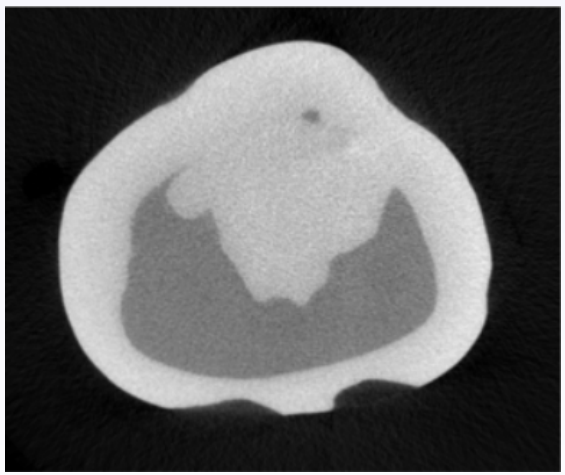
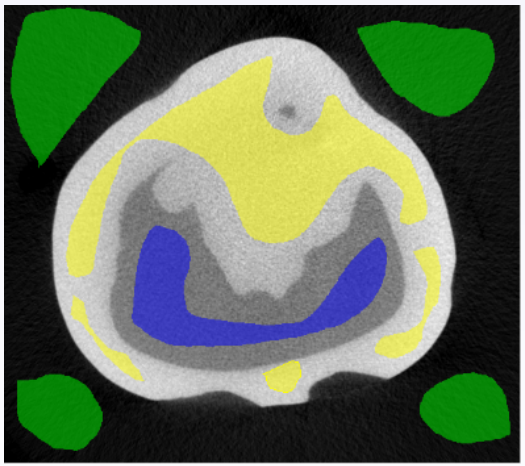
step3 While Q is not empty:

- for each neighboring pixel $p*$ of p in Q :
  - *if* $p*$ is similar to p :
    - $p*$ is added to R, $p*$ is marked with a label.
    - neighboring pixels of $p*$ (not in R) are added to Q.
  - *else* set $p*$ as non-similar.

Region Growing

$$\begin{bmatrix} 1 & 0 & 4 & 7 & 5 \\ 1 & 0 & 4 & 7 & 7 \\ 0 & 1 & 5 & 5 & 5 \\ 2 & 0 & 5 & 6 & 5 \\ 2 & 2 & 5 & 6 & 4 \end{bmatrix}$$

Region Growing


Region Growing

(C) **Advantages:**

- Fast
- Simple conceptually

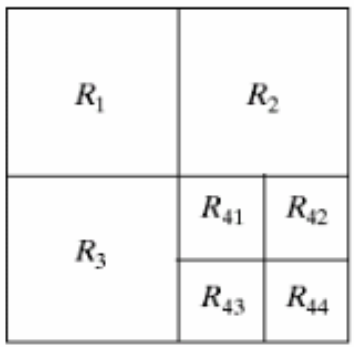
Disadvantages:

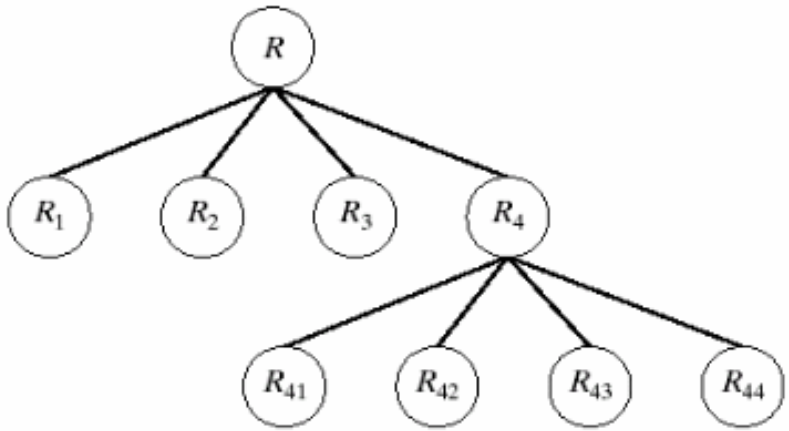
- Dependent on seed point and pre-defined criterion
- Sensitive to noise

Region Splitting and Merging

(A) **Idea:**

- Splitting: Subdivide the whole image into subsidiary regions recursively while a condition of homogeneity is not satisfied.
- Merging: It starts with small regions and merges the regions that have similar characteristics to avoid over-segmentation.





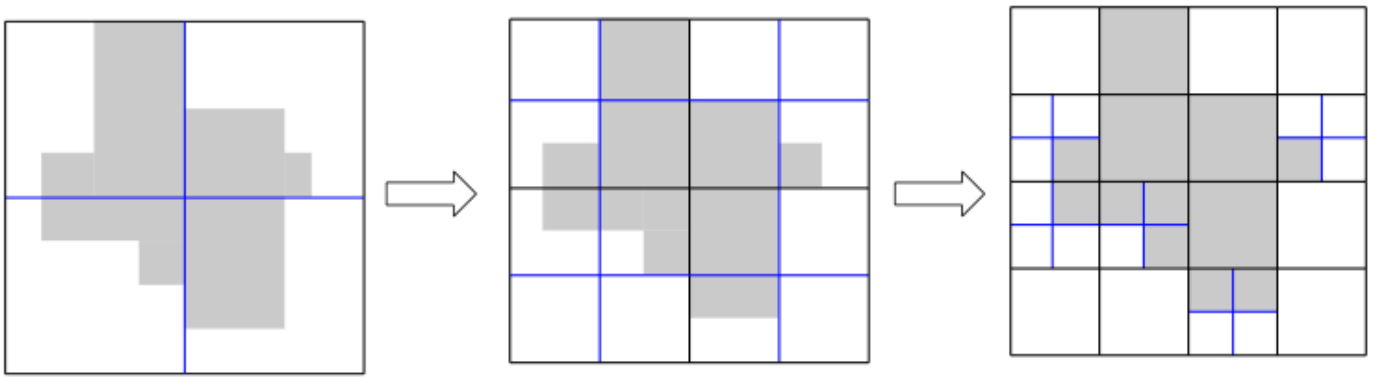
Region Splitting and Merging

(B) **Algorithm:**

step1 *If* a region R is inhomogeneous ($P_1(R) = FALSE$), *then* R is split into four sub-regions.

step2 *If* two adjacent regions R_i and R_j are homogeneous ($P_2(R_i \cup R_j) = TRUE$), *then* they are merged.

step3 The algorithm stops when no further splitting or merging is possible.



Region Splitting and Merging

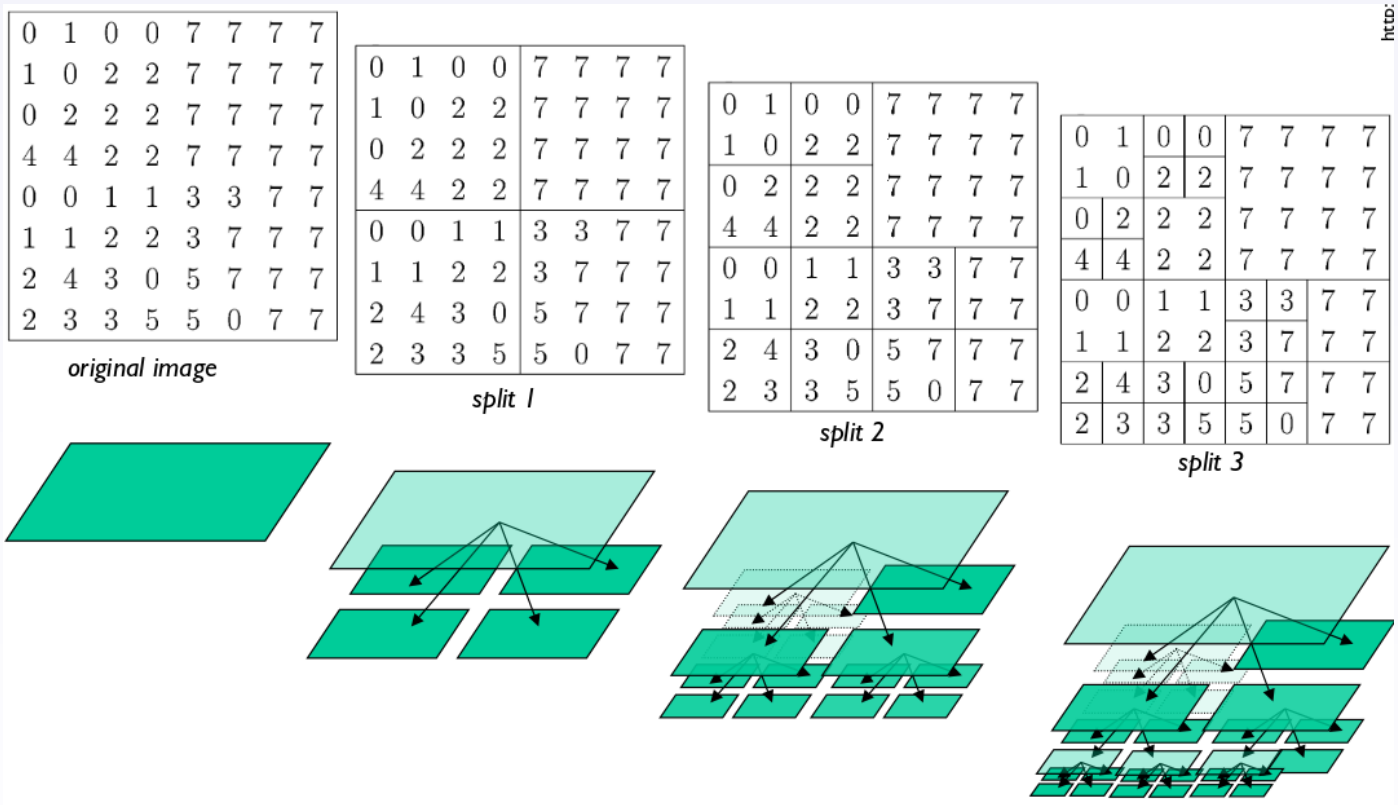


Figure: T=1

Region Splitting and Merging

Region Splitting and Merging

(C) **Advantages:**

- Applicability in complex scenarios

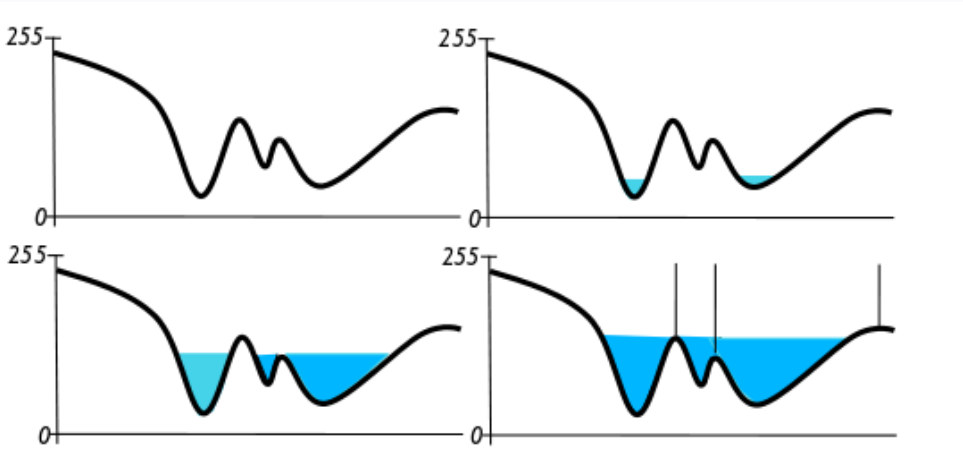
Disadvantages:

- Cost of time and calculation
- Breaking boundaries of regions

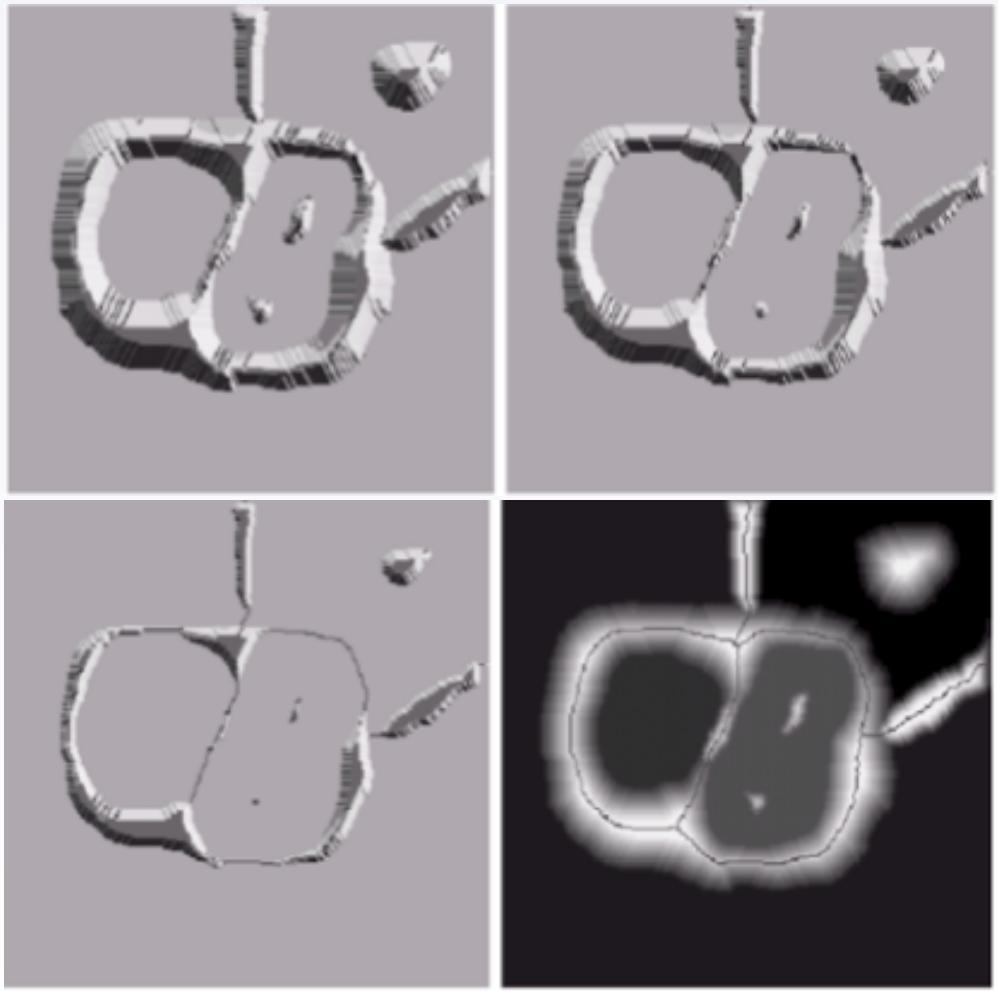
Watershed

(A) **Idea:**

- Hole: Image that a hole is done through each local minimum.
  The entire topography is flooded with water rising through the holes at a uniform rate.
- Dam: When rising water in adjacent catchment basins is about the merge, a dam is built up to prevent merging.
- Lines: These dam boundaries correspond to the watershed lines.



Watershed



Watershed

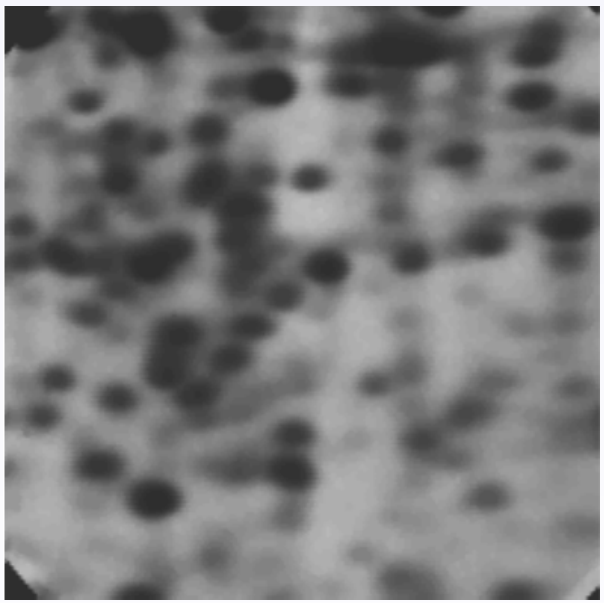
(B) **Algorithm:**

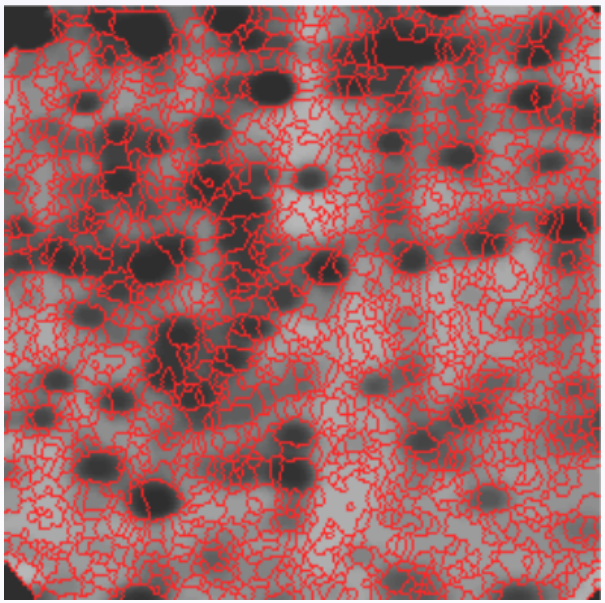
step1 Start with all pixels with the **lowest** possible value. These pixels form the basis for initial watershed.

step2 For each group of pixels of intensity level k :

- *If* the pixels are adjacent to exactly **one** exising region, add these pixels to that region.
- *Else if* the pixels are adjacent to **more than one** existing regions, mark boundary.
  - *Else* start a new region.

Watershed





Watershed

(C) **Improved Algorithm:**

step1 Initially, **label some pixels** in your interested regions manually. Start with 8-neighborhood or 4-neighborhood of the labeled pixels.

step2 For each group of pixels of intensity level k (k means the difference between marked pixels and the neighboring pixels) :

- *If* the pixels are adjacent to exactly **one** exising region, add these pixels to that region.
- *Else if* the pixels are adjacent to **more than one** existing regions, marks boundary.

Watershed