

Exercise. Implement the following function to impose the markers at image imageInMarkers to a gradient image imageIn. The output will be a modified gradient imageOut whose minima are the markers at imageInMarkers.

```
imMinimaImpose (imageIn, imageInMarkers, connectivity, imageOut)
/* imageIn: input image (in principle, a gradient image) whose minima
must be modified; imageInMarkers: binary input image with markers
(markers have an intensity value of 255, and the rest of the image
has a 0 intensity value). The output image imageOut is a modification
of imageIn that has as minima the markers at imageInMarkers. */
```

In order to do that, the following simple minima imposition algorithm should be used. It is a simple and direct algorithm, although not very efficient:

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/*****/
- Let M be a marker image. The markers of M will be 'imposed' as
minima of the gradient. Let I be the original gradient.

- Compute Minv, which is the marker image inverted (in Minv markers
have a 0 value, and the rest of the image has a 255 value).

- Compute I' = I inf Minv.
- Minv_0 is Minv /* init */
- i = 0 /* init */
- DO /* loop */
    Minv_i+1 = erosion_1 (Minv_i) sup I'
    i = i+1
UNTIL idempotence of Minv_i (i.e., Minv_i does not change)
```

erosion_1 is the elementary erosion of size 1 (with a structuring element of size 3x3 in 8-connectivity).

Minv_final is the desired result. Its minima are the markers at M. This can be checked by examining the minima of Minv. (Note: this operation is a geodesic reconstruction.)

This algorithm is simple but slow. (There exists a more efficient algorithm.)

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Associated images:

- (a) micro24.pgm: original image.
- (b) micro24_20060309_grad.pgm: gradient image of micro24.pgm .
- (c) micro24_20060309_grad_min.pgm: regional minima of micro24_20060309_grad.pgm .
- (d) micro24_20060309_markersinsideandfond.pgm: marker image (markers to be imposed as minima).
- (e) micro24_20060309_grad_mod.pgm: modified gradient whose minima are the markers in micro24_20060309_markersinsideandfond.pgm .
- (f) micro24_20060309_grad_mod_min.pgm: minima of the modified gradient (which are the markers in micro24_20060309_markersinsideandfond.pgm).

To check the imMinimaImpose function: the result of calling the imMinimaImpose function with arguments
 -imageIn: micro24_20060309_grad.pgm
 -imageInMarkers: micro24_20060309_markersinsideandfond.pgm
 -conectividad: 8
 should be the modified gradient micro24_20060309_grad_mod.pgm .