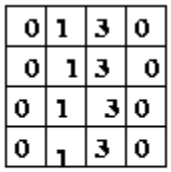
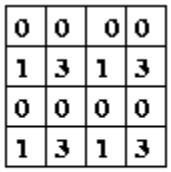
Solutions to Midterm Practice Problem Set

1.



(a) 4 regions

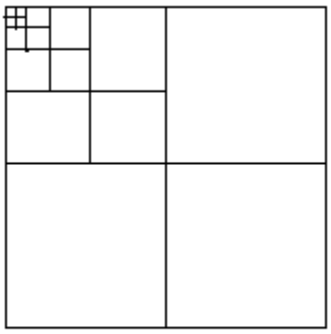


(b) 10 regions

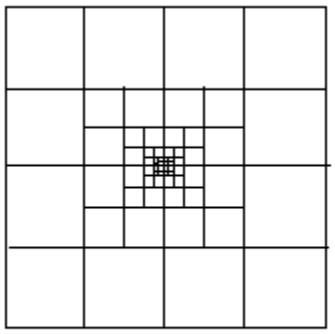
(c) If (i,j) and (n,m) are NS-connected they are also 4-connected since they are north-south neighbors. But if they are 4-connected EW they are not NS-connected. So NS-connectivity is sufficient but not necessary for 4-connectivity.

2. (a) $2^{12}+2^{10}+2^8+2^6+2^4+2^2+1=2^{12}(1-2^{-14})/(1-2^{-2})=5461$

(b) Minimum: set the 2x2 square in the ULHC. Then have 16 leaf nodes plus 5 other nodes = 21 nodes. Maximum: set the 2x2 square right in the middle. Then for each quarter have 21 nodes plus one at the top=4x21+1=85 nodes in the quadtree.



Minimum: smallest sqate is 2x2



Maximum: smallest squate is 1x1

3. (a) Mask I: each pixel stores an estimate to the directional deriv in the SE-to-NW direction. So uniform areas become ~0. Edges enhanced and salt-pepper noise enhanced.

Mask II: nine-point average. Edges and noise both blurred out.

Mask III: Brightness is doubled and image is shifted two pixels up and one pixel to the left.

(b) In order for median to be unaffected by the MxM noise cluster, there must be at least one more good pixel than M^2, ie. M^2+1. So entire mask must have at least $2*M^2+1$ pixels. Thus mask size must be at least M'xM', where M' is next integer larger than $\text{sqrt}(2*M^2+1)$.

(c) The larger the mask, the more pixels are involved

in the calculation. As the mask grows, pixels far away can bias the filter losing local features and increasing the computational load.

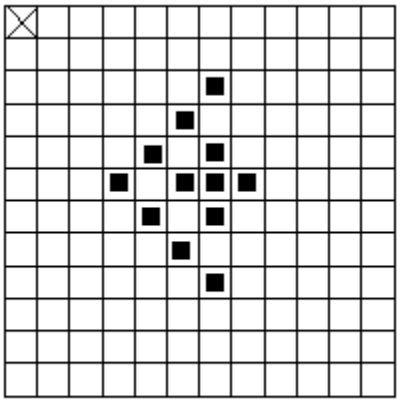
4. Optimal threshold will be where b(x)=o(x), if such exists. Set 1/80=(1/5000)*(x-50), get x=112.5. So consider T such that the area under o(x) to the left of T plus that under b(x) to the right is min. This clearly occurs at T=90.

5. (a) Preprocessing: begin with histogram equalization. If lens geometrically distorts, do the inverse geometric transformation. A method for smoothing with low edge blurring may be used (rotating masks, median filter). Segmentation: edge based methods don't work well on noisy, highly textured images. Best bet might be split-merge, consider also watershed segmentation.

   (b) Buildings seen from above tend to have rectangular boundaries, or in the case of some silos, circular. So can run Hough transform set to detect rectangles, do another pass to detect circles. Or can do match based segmentation with circles and rectangles. In this case must run many masks, each matched to a

rectangle of a specific size and pose.

6.



X eroded by B

7. (a) Yes. Do a top-bottom left-right sweep of B across X to produce Y. The first X point you hit adds two points to Y. Each subsequent X point adds at least one point (due to the (0,2) point in B). Conclude: at least one more point in Y than X.

(b) Yes. Only points in X are candidate points for Y since (0,0) is in B. The rightmost point in each row of X will not be in Y. Since there is at least one rightmost point (X is non-null), Y has at least one less point than X.