

Medical Image Analysis Homework I

You can find source code in the ipynb file for all parts.

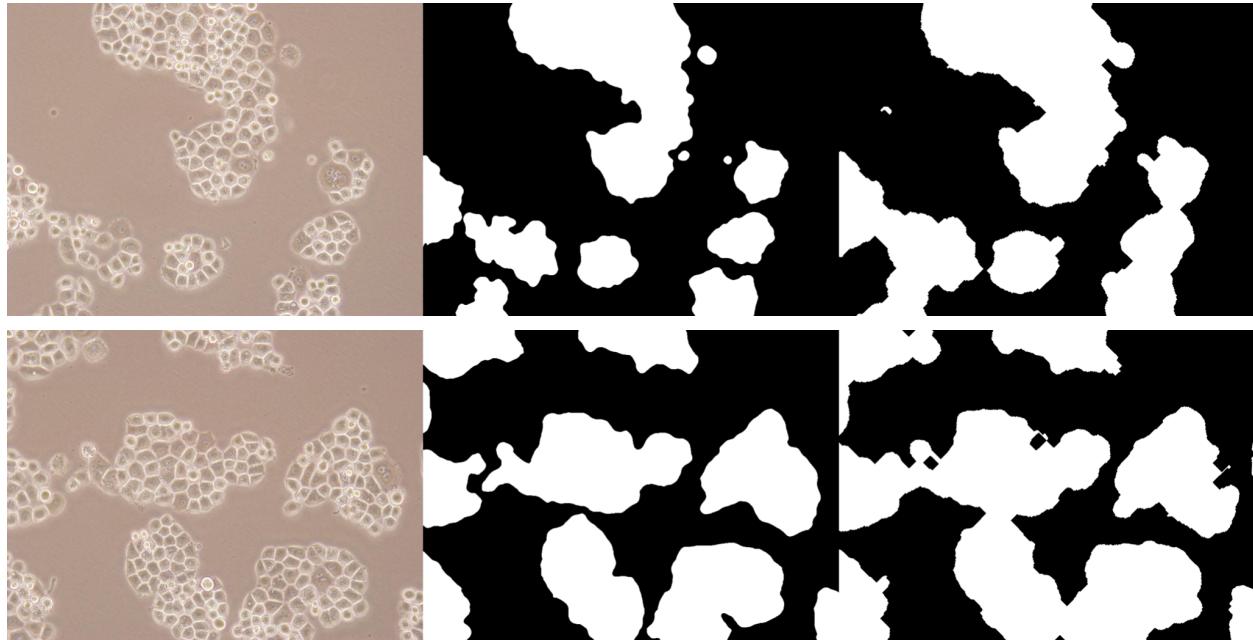
1) Obtain Foreground Mask

ObtainForegroundMask method takes one parameter, which is the image itself and returns a foreground mask, indicating foreground parts with 1, and background with 0.

In order to find the foreground mask, cell edges need to be clarified. For this purpose, LoG filter is applied to the R channel of the image after evaluation seeing that the edge values are much higher than the background. Foreground edges are sharpened by adding LoG filter result to the R channel. After sharpening the image, binary threshold is applied. Threshold value is picked by manually and selected as 150.

For post processing, 3x3 elliptic kernel is selected and two different morphological operations are applied. Opening is applied three times first to clear out the noises, and closing operation is applied 15 times in order to fill the holes in foreground masks.

In order to visually compare the image, ground truth and the predicted mask they are horizontally appended.





	Recall	Precision	F-Score
Image I	1.0	0.7889750713243721	0.8820414369891656
Image II	0.9854691177785061	0.8844206996686962	0.9322145920206537
Image III	0.9578179304356257	0.9647311316649224	0.9612621016272286

2) Find Cell Locations

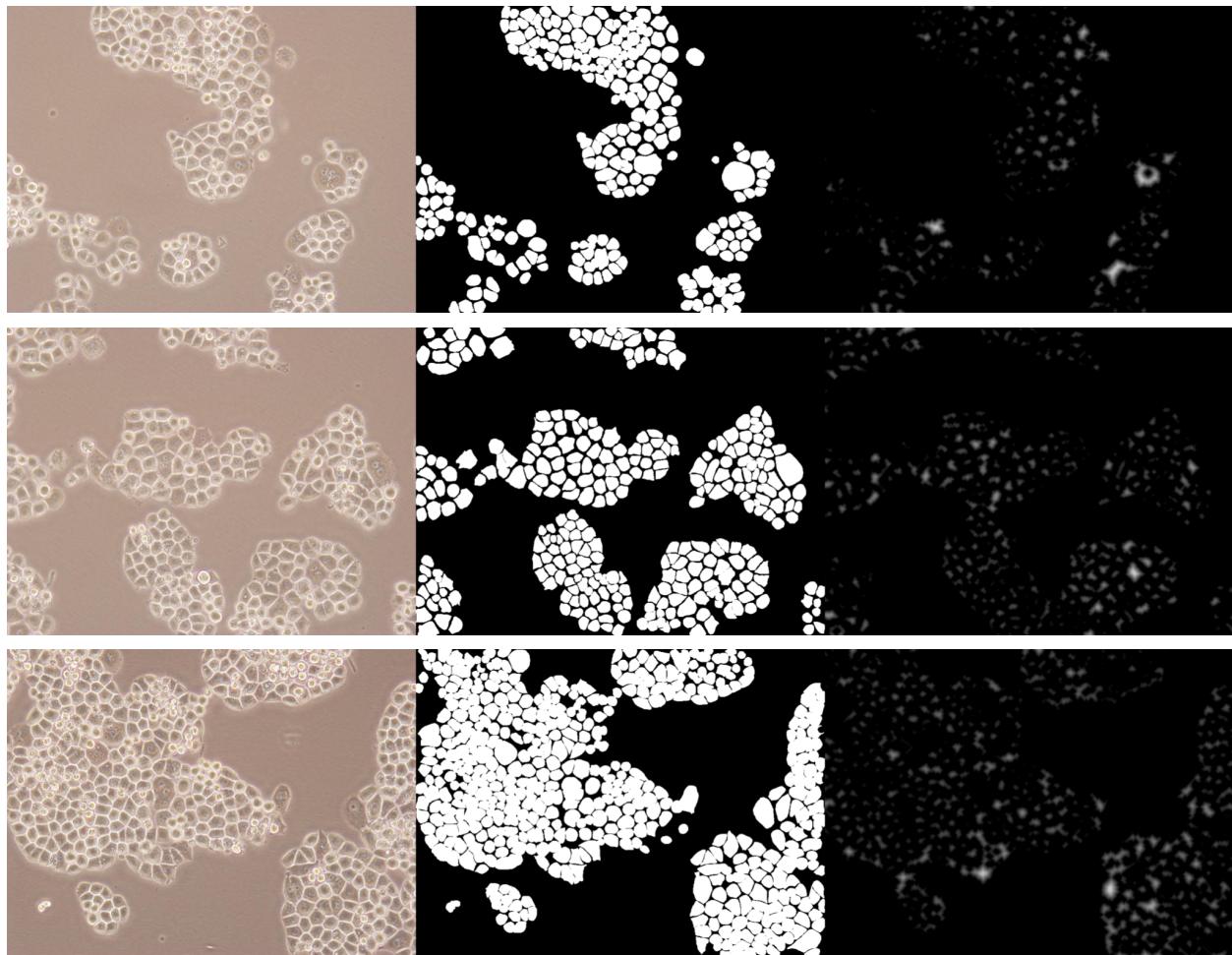
FindCellLocations method takes two parameters, which are the image itself and the foreground mask, and returns cell locations as a list of x and y coordinate pairs and regional maxima image for visualization.

First, the foreground mask is applied to the image. LoG filter is applied to the R channel of the image as in the first part. However, LoG filter result is not used for sharpening the image, instead it is used for finding the details of the cells to find the exact position of cell centers.

After having the details of the image, a binary threshold with 150 is applied and its binary negation is taken to have the distinct shapes which include a center of a cell. Distance transform is applied to the end image to make the cell centers more distinct from other parts.

As the final part, binary threshold with 0 is applied and the centers of each shape are calculated by moments of a shape.

In order to visually compare the image, ground truth and the regional maxima image, they are horizontally appended.



	Recall	Precision	F-Score
Image I	0.7892561983471075	0.880184331797235	0.8322440087145969
Image II	0.8231511254019293	0.8797250859106529	0.8504983388704318
Image III	0.6070726915520629	0.8879310344827587	0.7211201866977829

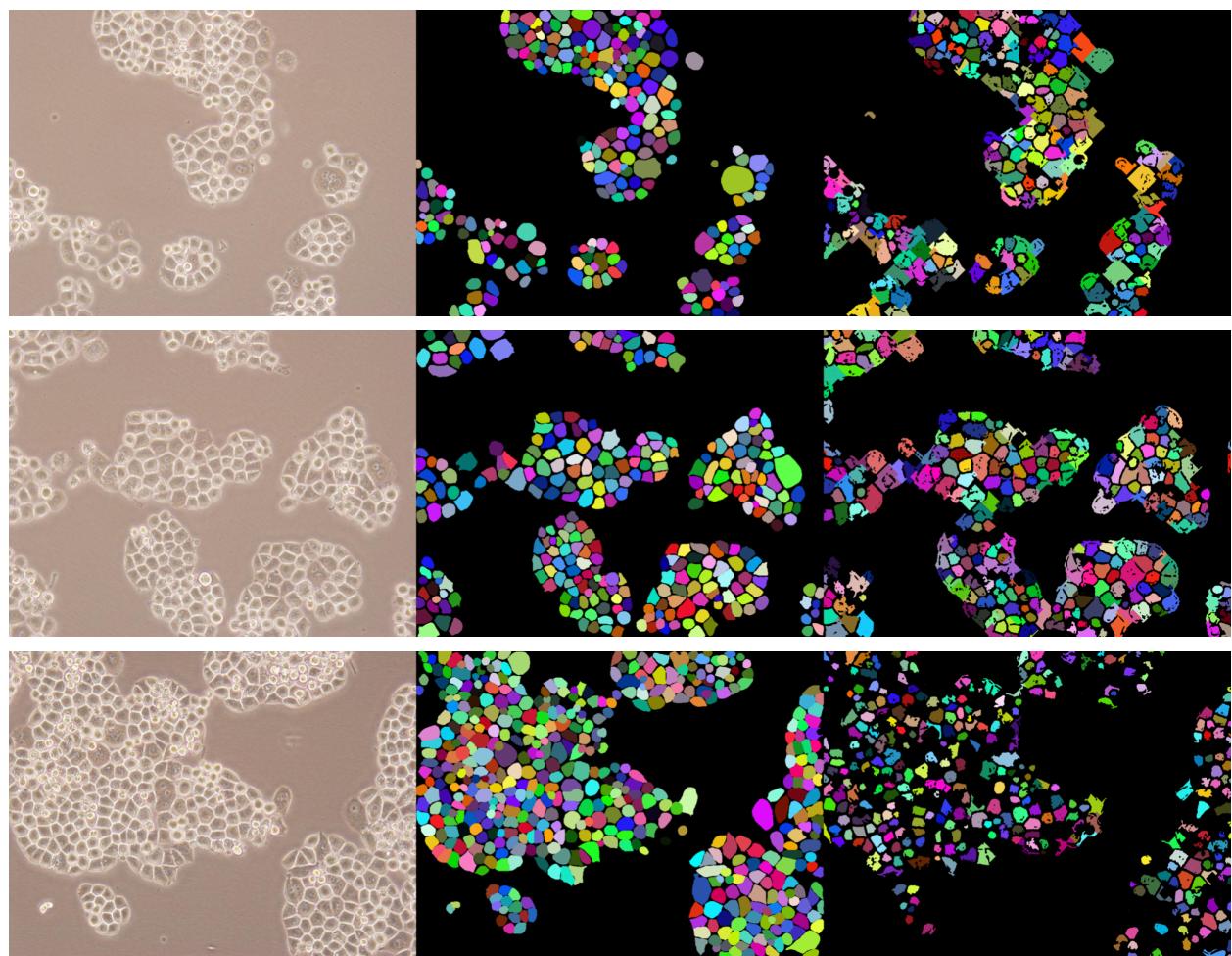
3) Find Cell Boundaries

FindCellBoundaries method takes three parameters, which are the image itself, the foreground mask, and a list of cell centers with x and y coordinate pairs, and returns an estimated set of cell locations labeled between 1 and N for each different cell.

First, the foreground mask is applied to the image. LoG filter is applied to the R channel of the image as in the first part in order to sharpen the cell edges.

Region growing algorithm starts with a cell center position and assigns a label to the cell. Region grows until the algorithm hits a cell boundary, or background or another cell or the current location is 40 pixels away from the starting position, the cell center.

In order to visually compare the image, ground truth and the segmentation image, they are horizontally appended.



Ratio : 0.5

	Recall	Precision	F-Score
Image I	0.5068493150684932	0.45867768595041325	0.48156182212581344
Image II	0.5808580858085809	0.5659163987138264	0.5732899022801303
Image III	0.5428571428571428	0.37328094302554027	0.44237485448195574

Ratio : 0.75

	Recall	Precision	F-Score
Image I	0.1506849315068493	0.13636363636363635	0.14316702819956617
Image II	0.21782178217821782	0.21221864951768488	0.21498371335504884
Image III	0.04571428571428571	0.03143418467583497	0.03725261932479627

Ratio : 0.9

	Recall	Precision	F-Score
Image I	0	0	0
Image II	0.00660066006600660	0.00643086816720257	0.00651465798045602
Image III	0	0	0

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Image I	0.6247203255581232
Image II	0.6826737198194843
Image III	0.5550989508592267