

1. Out put images `q1_Superpixels.png` and `q1_result.png` are shown in Figure 1 and 2 correspondingly. This super-pixel covers a part of two yellow peppers of the lower middle of the input image.



Figure 1: Superpixels of Question 1

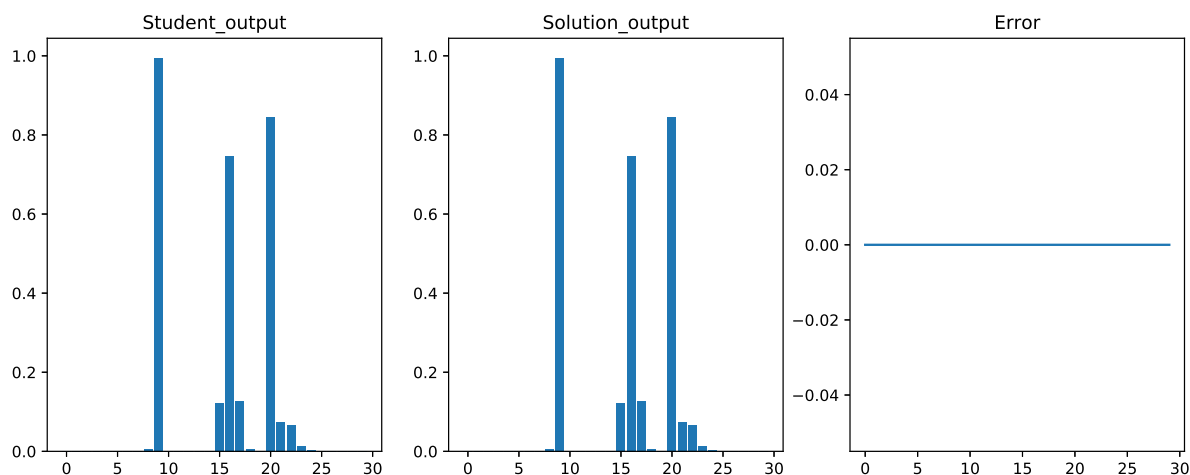


Figure 2: Results of Question 1

2. Out put images `q2_Superpixels.png` and `q2_result.png` are shown in Figure 3 and 4 correspondingly. We find the average node degree is 5.33766 for the adjacency matrix in this problem. The adjacency graph is not perfectly banded diagonal matrix because superpixels in images have various sizes. We can see that some superpixels are cover a lot of space along the y direction, while narrow along x direction. In this way, it is able to adjunct to some superpixel, whose centroid is far from its centroid. Moreover, some superpixel are relatively small and only adjunct to four superpixels around it.

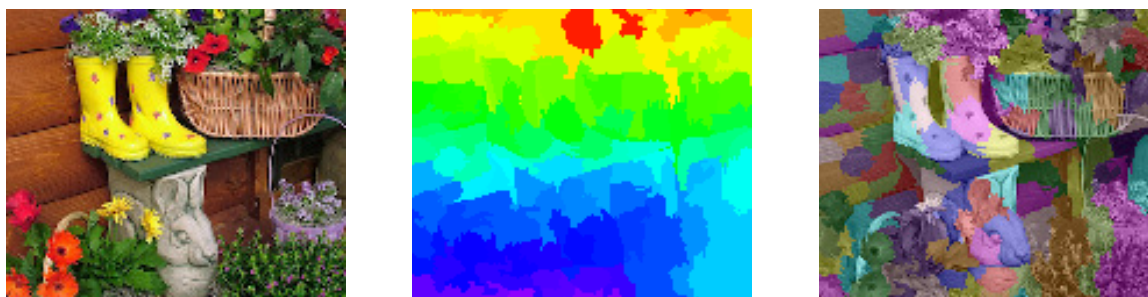


Figure 3: Superpixels of Question 2

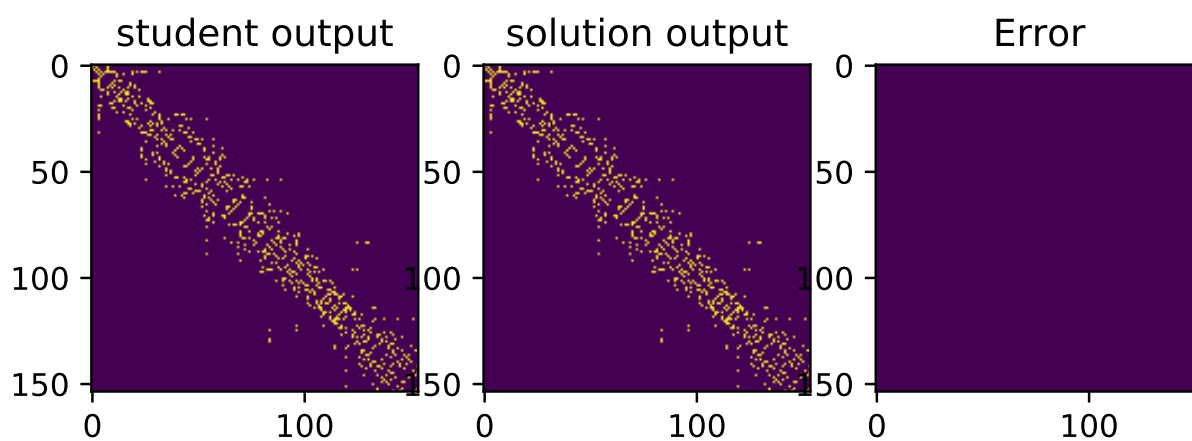


Figure 4: Results of Question 2

3. Out put images `q3_Superpixels.png` and `q3_result.png` are shown in Figure 5 and 6 correspondingly.



Figure 5: Superpixels of Question 3

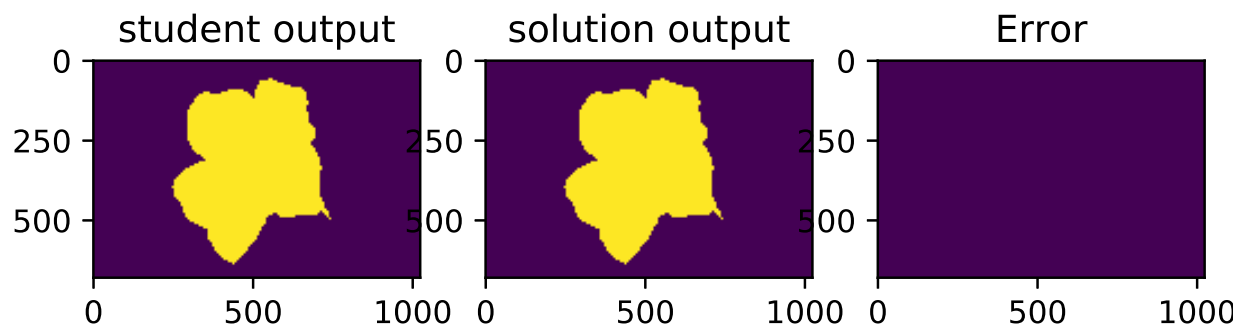


Figure 6: Results of Question 3

Appendix

Q1:

```
1 def histvec(img,mask,b):
2     '''
3     Function to find the color histogram of the image.
4
5     Args:
6     -----
7     img: input image
8     mask: Super pixel mask. Each pixel location will have the
9           superpixel label corresponding to it
10    b: number of bins in the histogram
11    Return:
12    -----
13    hist_vector: 1-D vector having the histogram of all three
14                  channels appended
15    '''
16
17    img_in_SP = img[mask,:].astype(dtype=np.int64)
18    total_location = img_in_SP.shape[0]
19
20    hist_vector = np.zeros(3*b)
21    ub_unit = 256.0/b
22
23    '''loop through all bins'''
24    for i in range(b):
25        ub_cur = ((i+1)*ub_unit)
26        '''loop through rgb channels'''
27        for j in range(3):
28            cur_idx = np.argwhere(img_in_SP[:,j]<=ub_cur)
29            hist_vector[j*b+i]+=len(cur_idx)
30            img_in_SP[cur_idx,j] = 300
31
32    '''Normalize Histogram'''
33    hist_vector=hist_vector/total_location
34    return hist_vector
```

Q2:

```
1 def seg_neighbor(svMap):
2     '''
3     Function to find adjacency matrix
4     Args:
5     ----
6     svMap: Super pixel mask. Each pixel location will have the
7           superpixel label corresponding to it.
8
9     Return:
10    -----
11    Bmap: a binary adjacency matrix NxN (N being the number of
12          superpixels in svMap).
13    '''
14    segmentList = np.unique(svMap)
15    segmentNum = segmentList.shape[0]
16    # FILL IN THE CODE HERE to calculate the adjacency
17    Bmap = np.zeros([segmentNum, segmentNum])
18    height,width = svMap.shape
19    for i in range(height):
20        for j in range(width):
21            '''check eight connectivity'''
22            y_u = min(i+1, height-1)
23            x_u = min(j+1, width-1)
24            x_l = max(j-1, 0)
25            ''' check lower'''
26            if svMap[i,j] != svMap[y_u,j]:
27                Bmap[svMap[i,j],svMap[y_u,j]] = 1
28                Bmap[svMap[y_u,j],svMap[i,j]] = 1
29            ''' check left'''
30            if svMap[i,j] != svMap[i,x_u]:
31                Bmap[svMap[i,j],svMap[i,x_u]] = 1
32                Bmap[svMap[i,x_u],svMap[i,j]] = 1
33            ''' check lower left'''
34            if svMap[i,j] != svMap[y_u,x_u]:
35                Bmap[svMap[i,j],svMap[y_u,x_u]] = 1
36                Bmap[svMap[y_u,x_u],svMap[i,j]] = 1
37            ''' check lower right'''
38            if svMap[i,j] != svMap[y_u,x_l]:
39                Bmap[svMap[i,j],svMap[y_u,x_l]] = 1
40                Bmap[svMap[y_u,x_l],svMap[i,j]] = 1
41
42    return Bmap
```

```
1 def ave_deg(adj_mat):  
2     '''  
3     Calculate average node of an adj_mat  
4     '''  
5     total_deg = np.sum(adj_mat)  
6     num_nodes = adj_mat.shape[0]  
7     return total_deg/num_nodes
```

Q3: