Homework 3

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CS 527
Fall 2014

Problem 1

(a) gauss.m:

```
function [w1, u] = gauss(sigma)
  h = ceil(2.5 * sigma);
  u = [-h:h];
  w1 = exp(- (u.^2) / (2*sigma^2) );
  w1 = (w1/sum(w1))';
end
```

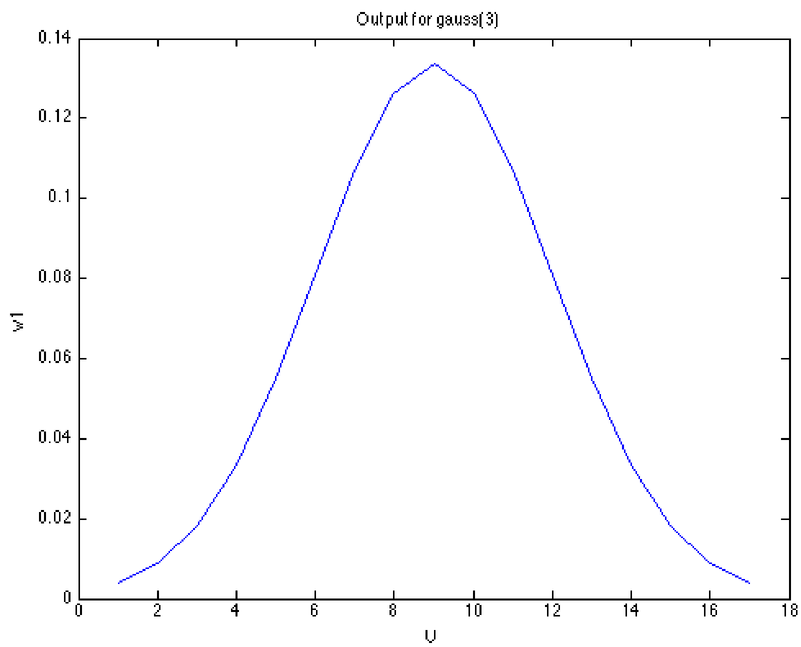

Figure 1: `w1` versus `u` for $\sigma = 3$

(b) dissimilarity.m:

```
function D = dissimilarity(I, x, y, sigma)
  % todo: error message if x or y is too near boundary
  I = double(I);
  [w1, u] = gauss(sigma);
  h = ceil(size(u, 2)/2);
  w = w1 * w1'; % todo: see if I can do this in a linearly separable way
  D = 0;
  for i=u % todo: vectorize
    for j=u
      z = [i j]';
      wz =  w(i+h, j+h)  ;
      tmp = (I(z + y) - I(z + x))' * (I(z + y) - I(z + x))  ;
      D = D + ( tmp);
    end
  end
end
```

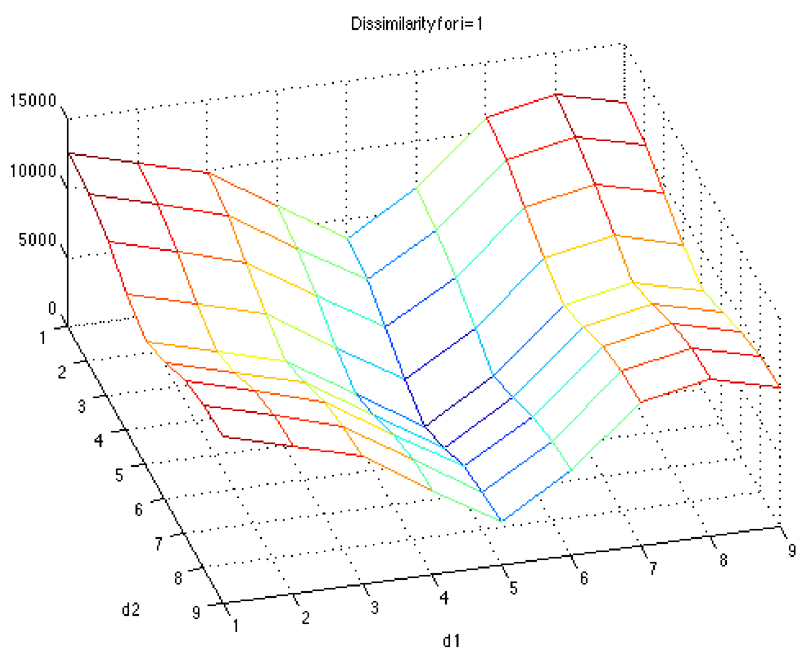

Figure 2: Meshplot of `dissimilarity` output for $i = 1$

1: flat 2: edge 3: corner

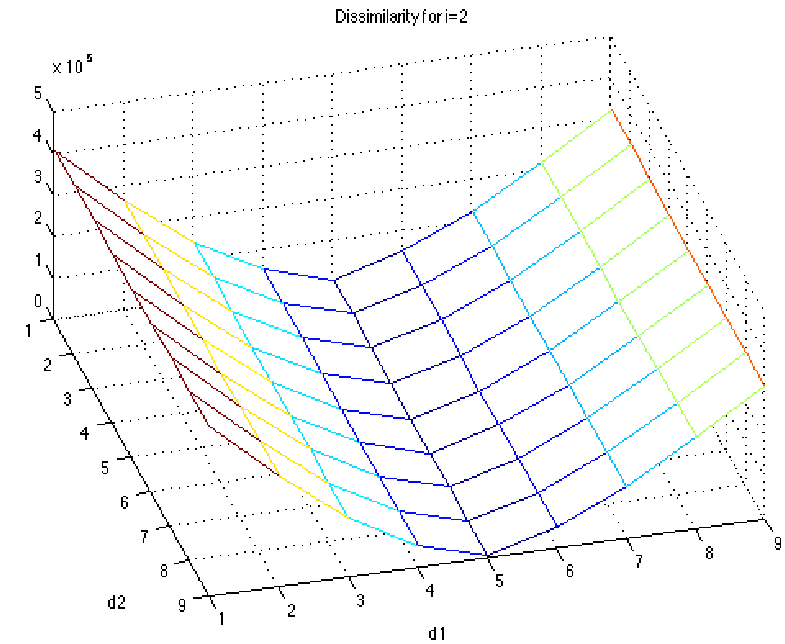

Figure 3: Meshplot of `dissimilarity` output for $i = 2$

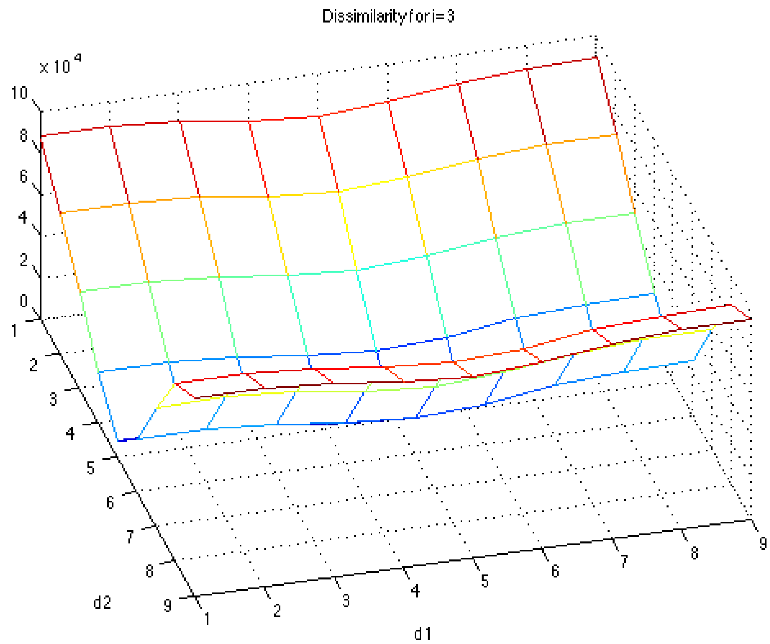

Figure 4: Meshplot of `dissimilarity` output for $i = 3$

(c) The dissimilarity output for $i = 1$ is relatively flat, especially compared to the other two plots. There is a slight v-shape in the d_1 and d_2 directions, but given the magnitude of the values this is likely due to image noise.

In the second window ($i = 2$), the dissimilarity values are flat in the d_2 direction and u-shaped in the d_1 direction. The corresponds to an edge in the image, which is qualitatively more interesting than the flat window when $i = 1$ but not as interesting as the bowl shape ($i = 3$).

The third window is the most interesting of the three: although its maximum D values are slightly lower than the maxima in the second window, the bowl shape is much more apparent. This tells us that points slightly away from x in each direction are very different, and identifies x as an interesting point in the image.

Problem 3

(a) **smallEigenvalue.m**:

```
function lambdaMin = smallEigenvalue(I, sigma)
  g = grad(I);
  w1 = gauss(sigma);
  a = g{1}.^2;
  b = g{2}.^2;
  d = g{1} .* g{2};
  p = conv2(w1, w1, a);
  q = conv2(w1, w1, b);
  r = conv2(w1, w1, d);
  lambdaMin = p + q - ((p - q).^2 + 4 * r.^2).^0.5;
end
```

The image produced by running this function on `shadow.jpg` is:

(b) The interesting windows in `shadow.jpg` correspond to high values of `lambdaMin` in the image above. Many of the interesting windows identified above corresponed to the joints of the marionette in `shadow.jpg`. Looking at the original image, these are areas with noticeable light-dark differences in both the horizontal and vertical directions.

The shadow of the marionette does not contain interesting windows (as identified by this algorithm), likely because the shadow has much more gradual color changes and the joints are less identifiable. A few other minor interesting windows appear where the base of the lamp overlaps the edge of the paper and where the background behind the strings suspending the marionette transitions from dark (table) to light (paper).

Figure 5: Interesting windows in `shadow.jpg` identified by `smallEigenvalue`