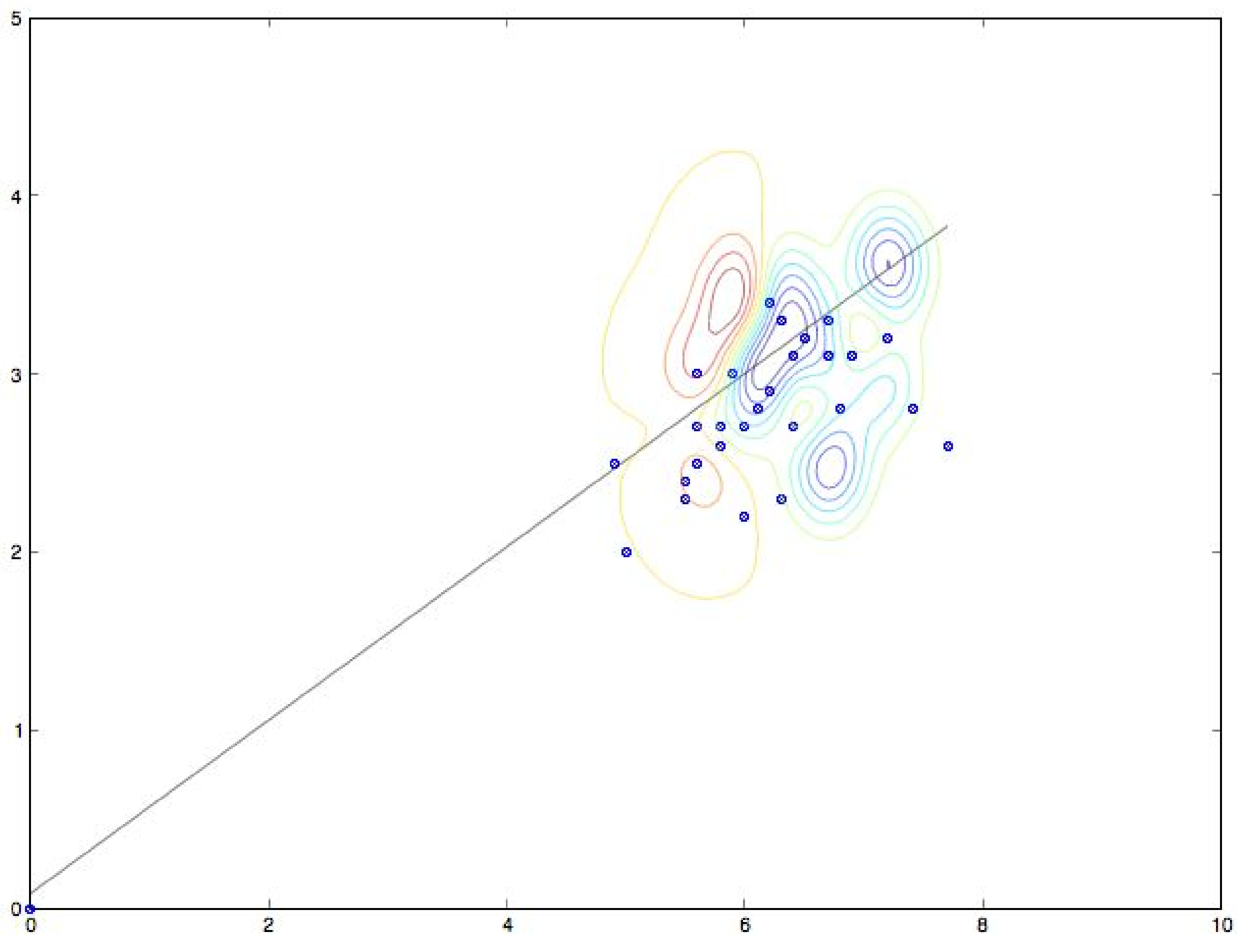
Problem 3

Now you are going to analyze the differences between the models you have created, and perform a brief summary on what you found.

1. plot that combines the scatter plot of testing dataset and the boundaries you obtained in the perceptron algorithm(s).



2. Comparison on precision of the two (or three, if you choose to do the optional perceptron) classifiers, and summarization of what you find.

The linear perceptron decision boundary goes straight through the points in the feature space and classifies the test vectors as one class on one side of the line and another class on the other side.

The decision boundary for the linear perceptron is:
$\langle \mathbf{w}, \mathbf{x} \rangle = 0$

The kernel perceptron maps the two dimensional feature space to a three dimensional gaussian. Shown here is the contours of the Gaussian with the red and orange representing one class and the blue and green representing another class.

The kernel I used for the kernel perceptron is:

$$\mathrm{k}\left(\mathbf{x},\mathbf{x}'\right) = \exp\left(\frac{-\left\|\mathbf{x}-\mathbf{x}'\right\|^2}{2\sigma^2}\right)$$

The precision for the linear perceptron was found to be about 0.4 while the precision for the kernel perceptron was found to be about 0.6.

For most cases, a linear perceptron will not be very effective at classifying data that is not linearly separable. This is shown in the figure and in the precision for the linear perceptron. The decision boundary will never converge, and so the linear perceptron, as shown, does not have good precision.

The Gaussian kernel perceptron performs better by mapping the two dimensional feature space to a three dimensional space using a Gaussian kernel as shown above. As you can see, the Gaussians are able to wrap around the test points in the feature space in a nonlinear way. This allows the kernel perceptron to get a better classification than the linear perceptron.