Assignment 3

For Gradient ascent algorithm with hinge loss and C = 10 & ϵ = 0.0001 for Database "irisslwc.txt", results are shown below.

Linear Kernel:

The optimal hyper plane h_l depicted in figure 1with margin planes on both side. For linear kernel hyper plane equation is given as:

$$h_l : W^T \phi(X) = 0$$

$$(-2.74806971, 3.75194245, 3.08387655)(x1,x2,1)^T = 0$$

$$-2.748069710360916 * x1 + 3.7519424506153598 * x2 + 3.0838765539811797 = 0$$

For margin hyper plan add & subtract 1 from left side of the equation.

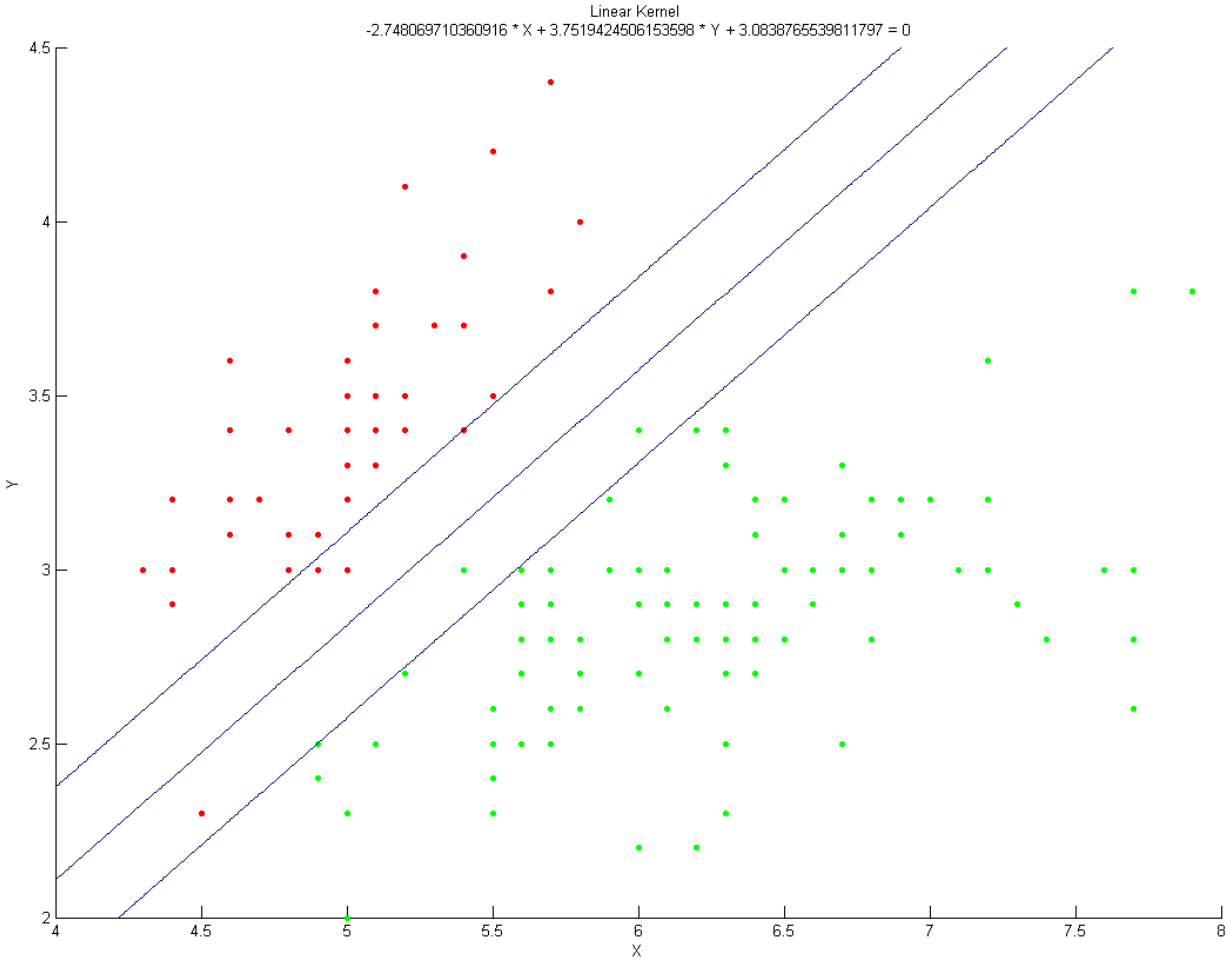


Figure 1

Homogeneous Quadratic Kernel:

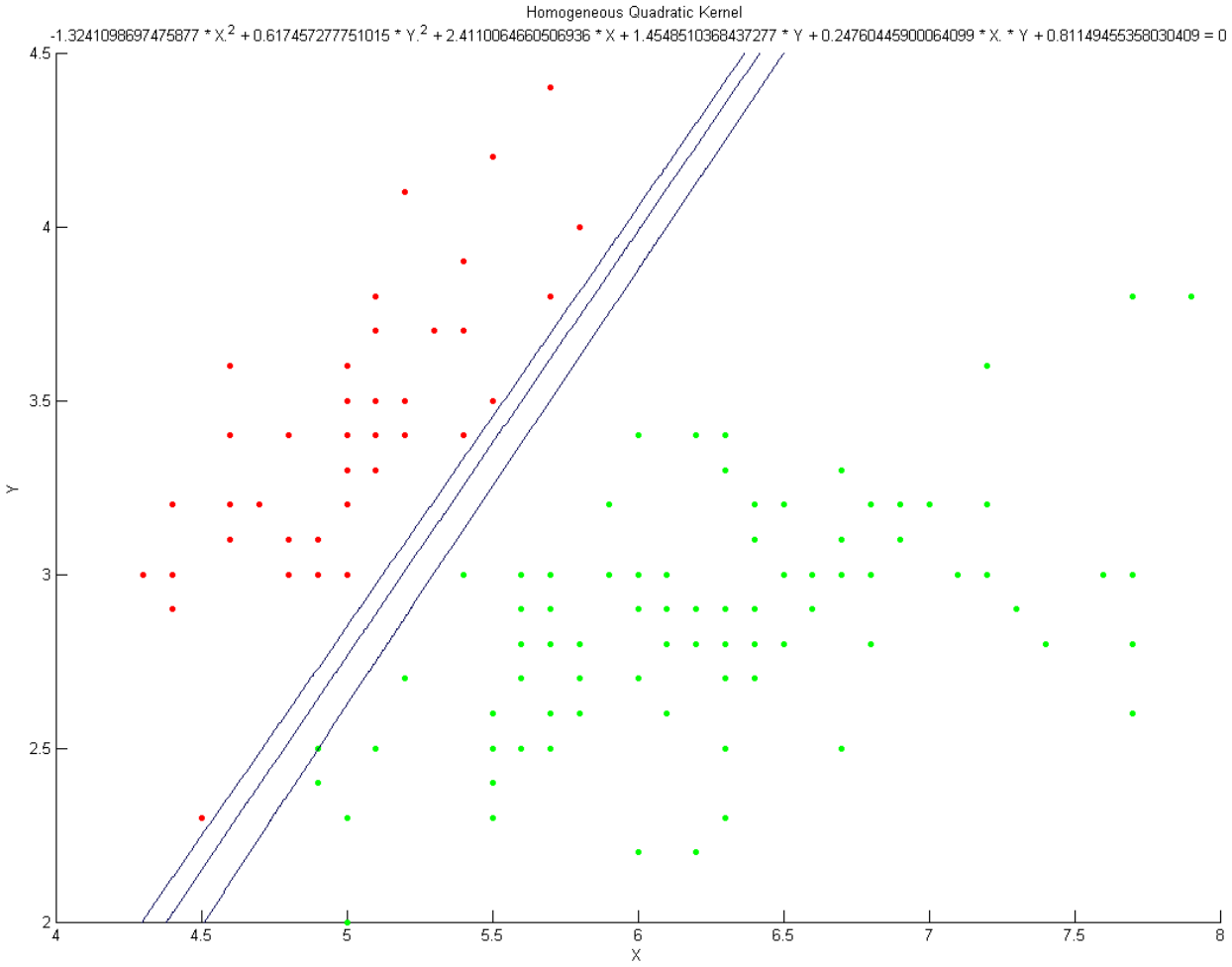
The optimal hyper plane h_d depicted in figure 2 with margin planes on both side. For Quadratic kernel hyper plane equation is given as:

$$h_d : W^T \phi(X) = 0$$

$$(-1.3241, 0.6175, 2.4110, 1.4549, 0.2476, 0.8115)\ (x1^2, x2^2, \sqrt{2}x1, \sqrt{2}x2, \sqrt{2} * x1*x2, 1)^T = 0$$

$$-1.3241098697475877 * x1^2 + 0.617457277751015 * x2^2 + 3.4096780432581184 * x1 + 2.0574700675369595 * x2 + 0.35016558402275949 * x1*x2 + 0.81149455358030409 = 0$$

For margin hyper plan add & subtract 1 from left side of the equation.



Discussion:

Here, we can see in linear kernel case there is one data point on the other side of boundary and few within the margin. On the other hand Homogeneous Quadratic kernel is quite easily able to separate without any outlier or wrongly classified points.

Bonus Question

For this question, Gradient ascent algorithm is used with again hinge loss and C = 10 & ϵ = 0.0001 for Database "irisPC.txt", results are shown below.

Non-Homogeneous Quadratic Kernel:

The optimal hyper plane h_d depicted in figure 3 with margin planes on both side. For Non-Homogeneous Quadratic Kernel hyper plane equation is given as:

$h_d : W^T \phi(X) = 0$

$$(1.69991, 0.8171, 0.5735, -1.2305, -0.6274, -4.6945)\ (x1^2, x2^2, 2*x1, 2*x2, \sqrt{2}*x1*x2, 1)^T = 0$$

$$1.6990962595739809 * x1^2 + 0.81711982601874567 * x2^2 + 1.1469942025230679 * x1 - 2.4609101043949488 * x2 + -0.88727187259809204 * x1 * x2 - 4.6944578069124789 = 0$$

For margin hyper plan add & subtract 1 from left side of the equation.

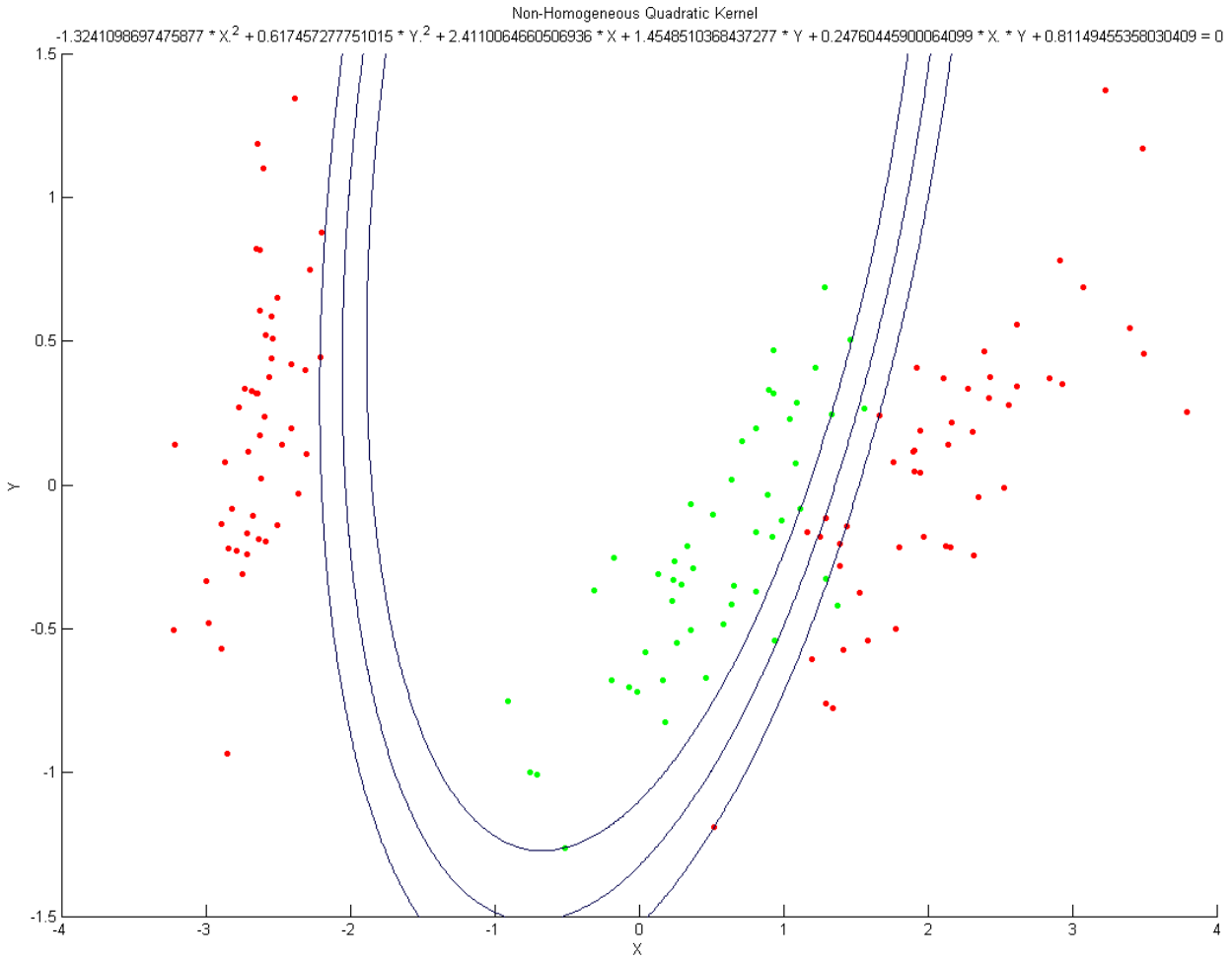


Figure 3

Discussion:

Here we can easy observe that linear kernel cannot work in this case. However Non homogeneous quadratic kernel work quite good and give almost clear boundary with few outliers.