Práctica 1 Aprendizaje Automático

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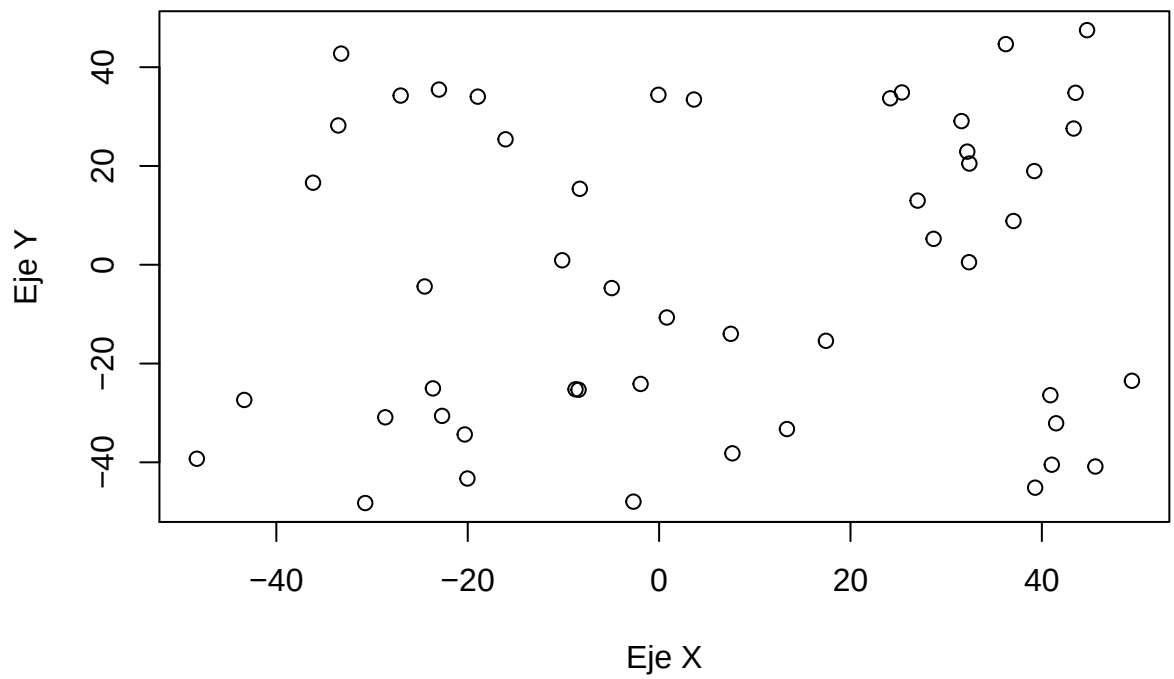
Generación y visualización de datos

```
set.seed(3141592)
simula_unif <- function(N, dim, rango){
  lista <- matrix(runif(N*dim, min =  rango[1], max = rango[2]), dim, N)
  return(lista)
}
```

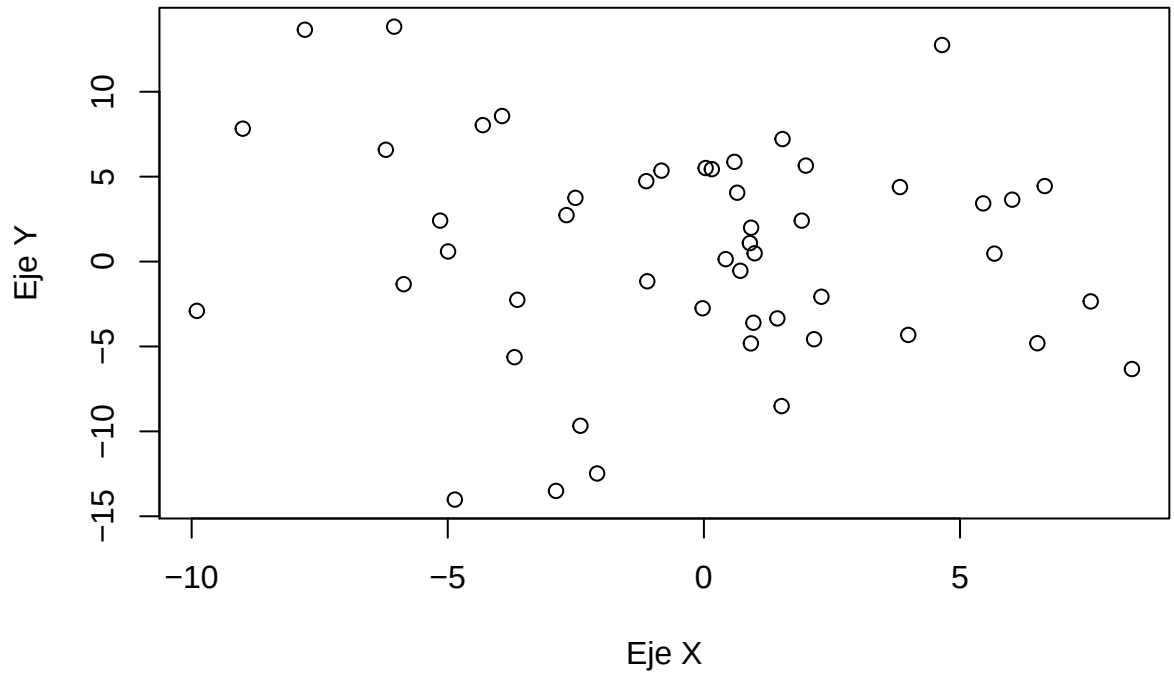
```
simula_gauss <- function(N, dim, sigma){
  lista <- matrix(rnorm(N*dim, sd = sigma), dim, N)
  return(lista)
}
```

```
lista_unif <- simula_unif(50, 2, c(-50, 50))
lista_gauss <- simula_gauss(50, 2, c(5,7))
```

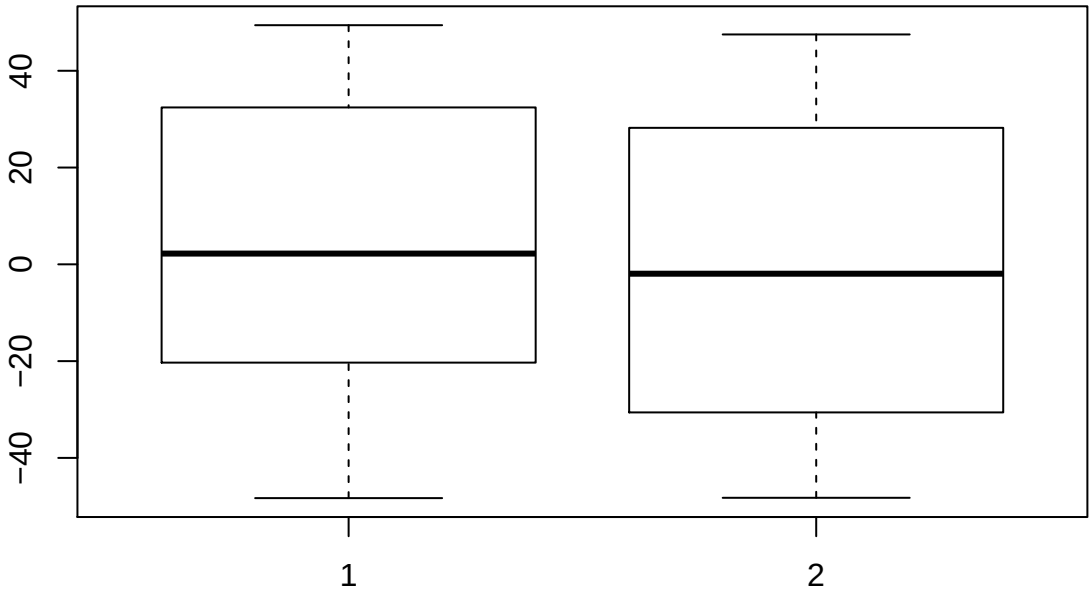
```
plot(lista_unif[1,], lista_unif[2,], xlab="Eje X", ylab="Eje Y")
```



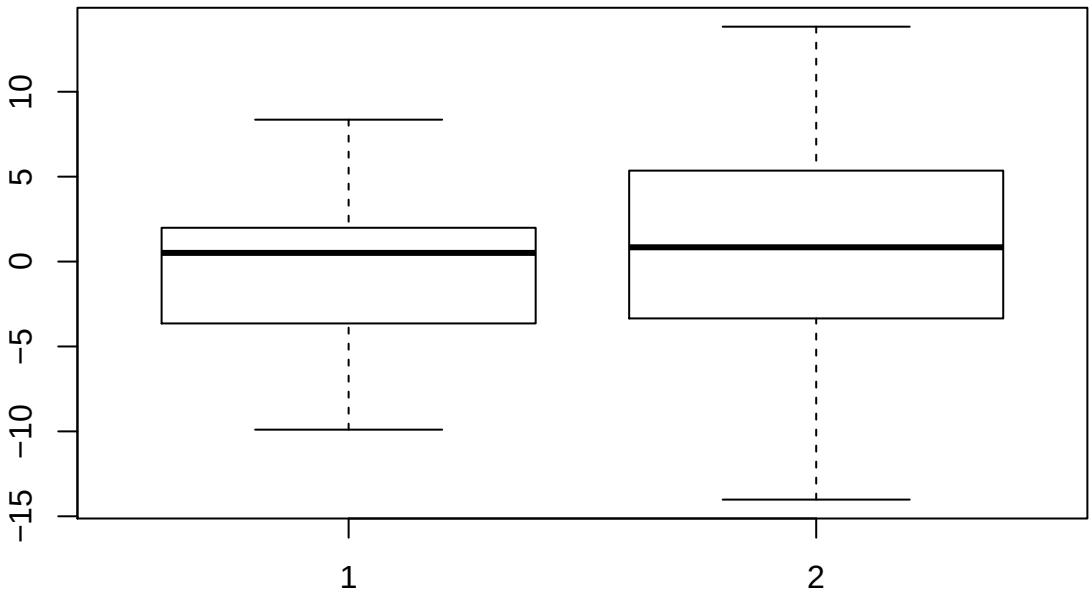

```
plot(lista_gauss[1,],lista_gauss[2,], xlab="Eje X", ylab="Eje Y")
```




```
boxplot(lista_unif[1,],lista_unif[2,])
```

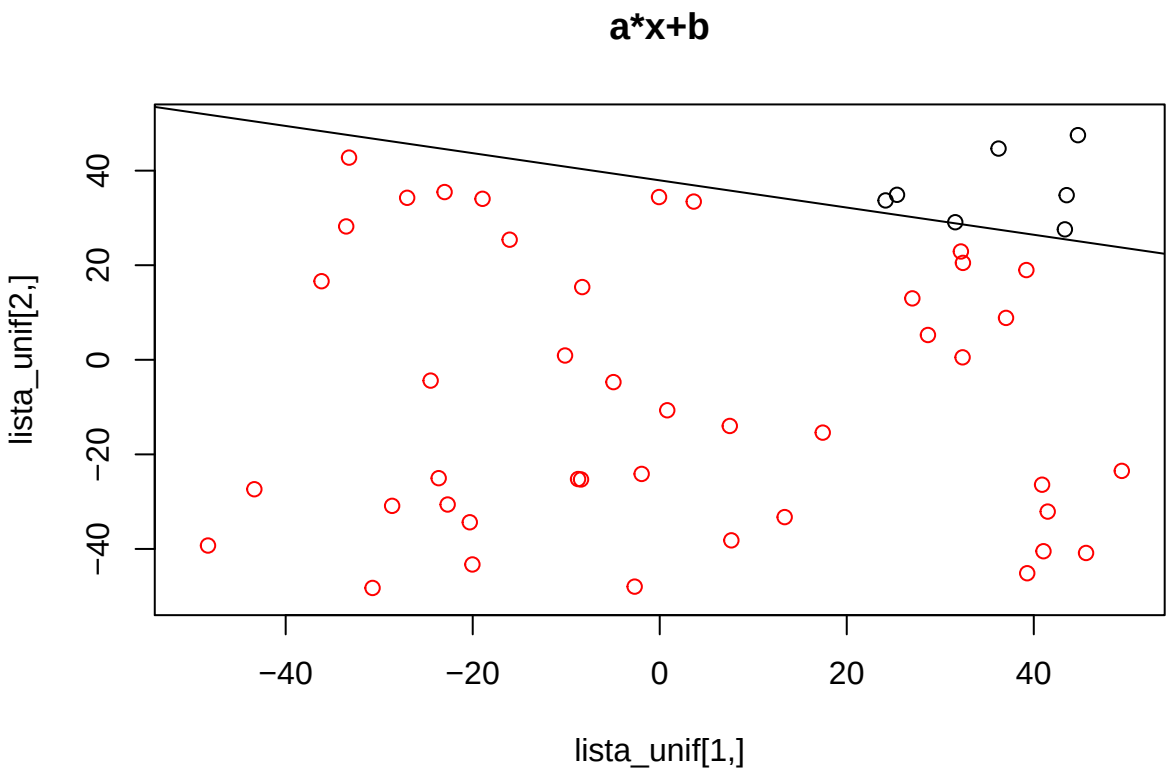



```
boxplot(lista_gauss[1,],lista_gauss[2,])
```



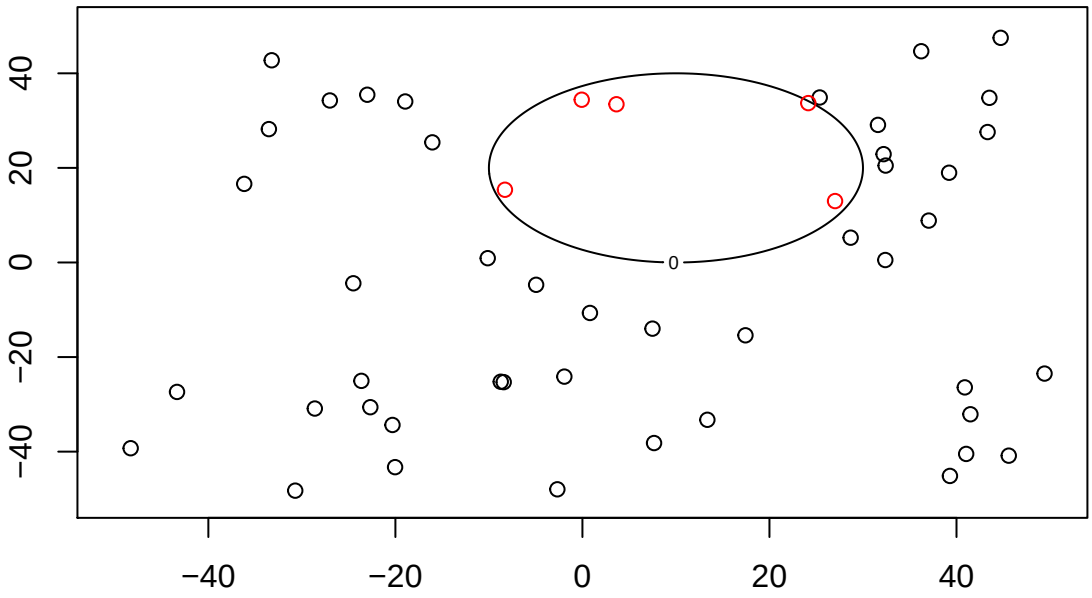

```
simula_recta <- function(intervalo){
  puntos <- simula_unif(2,2,intervalo)
  a <- (puntos[2,2]-puntos[2,1])/(puntos[1,2]-puntos[1,1])
  b <- puntos[2,1] - a * puntos[1,1]
  return(c(a,b))
}
```

```
intervalo = c(-50, 50)
coefs <- simula_recta(intervalo)
a <- coefs[1]
b <- coefs[2]

f <- function(X){
  return(X[2] - a*X[1] -b)
}


etiqueta = apply(lista_unif, 2, function(X) sign(f(X)))

plot.new()
plot.window(xlim=c(-50,50), ylim=c(-50,50))
axis(1)
axis(2)
box()
title(main="a*x+b", ylab = "lista_unif[2,]", xlab = "lista_unif[1,]")
points(lista_unif[1,etiqueta==-1], lista_unif[2,etiqueta==-1], col = 2)
points(lista_unif[1,etiqueta==1], lista_unif[2,etiqueta==1])
abline(b,a)
```



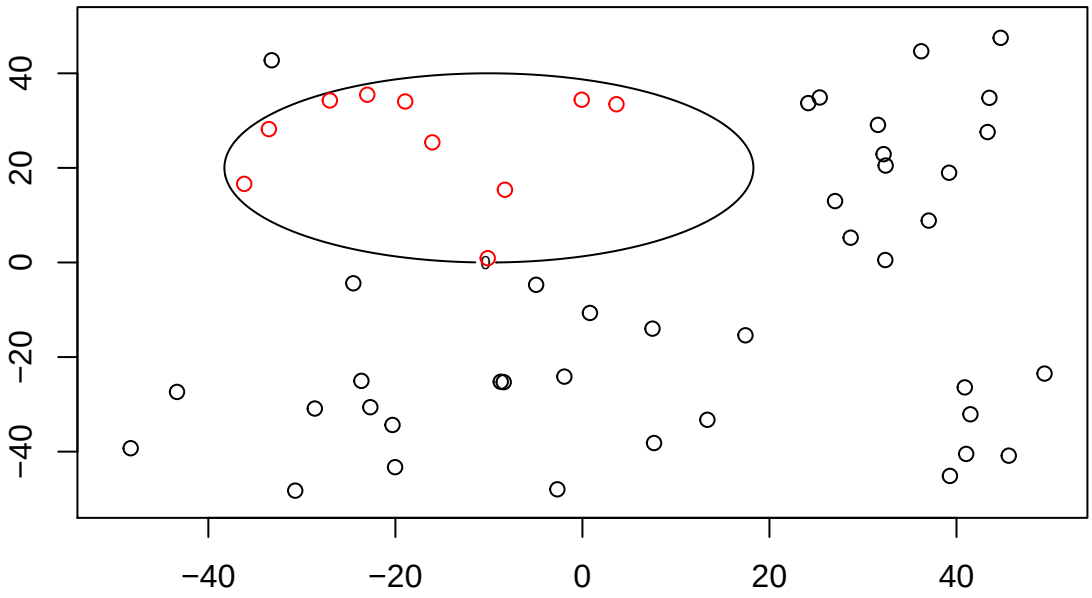

```
f_1 <- function(X){
  return((X[1] - 10)^2 + (X[2] - 20)^2 - 400)
}

etiqueta_1 = apply(lista_unif, 2, function(X) sign(f_1(X)))

x <- seq(-50,50,length=1000)
y <- seq(-50,50,length=1000)
z <- outer(x,y,function(x,y) (x - 10)^2 + (y - 20)^2 - 400)

contour(x,y,z, levels=0, main=expression((x-10)^2 + (y-20)^2 - 400))
points(lista_unif[1,etiqueta_1==1], lista_unif[2,etiqueta_1==1])
points(lista_unif[1,etiqueta_1==-1], lista_unif[2,etiqueta_1==-1],col=2)
```

$$(x-10)^2+(y-20)^2-400$$



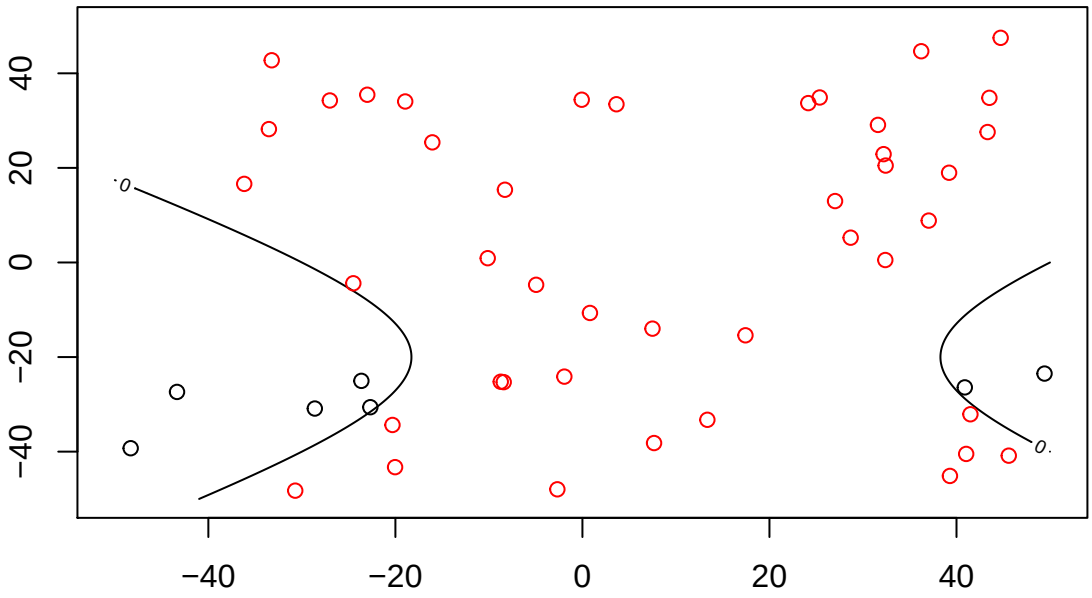

```
f_2 <- function(X){
  return(0.5*(X[1] + 10)^2 + (X[2] - 20)^2 - 400)
}

etiqueta_2 = apply(lista_unif, 2, function(X) sign(f_2(X)))

x <- seq(-50,50,length=1000)
y <- seq(-50,50,length=1000)
z <- outer(x,y,function(x,y) 0.5*(x + 10)^2 + (y - 20)^2 - 400)

contour(x,y,z, levels=0, main=expression(0.5(x + 10)^2 + (y - 20)^2 - 400))
points(lista_unif[1,etiqueta_2==1], lista_unif[2,etiqueta_2==1])
points(lista_unif[1,etiqueta_2==-1], lista_unif[2,etiqueta_2==-1],col=2)
```

$$0.5(x+10)^2+(y-20)^2-400$$

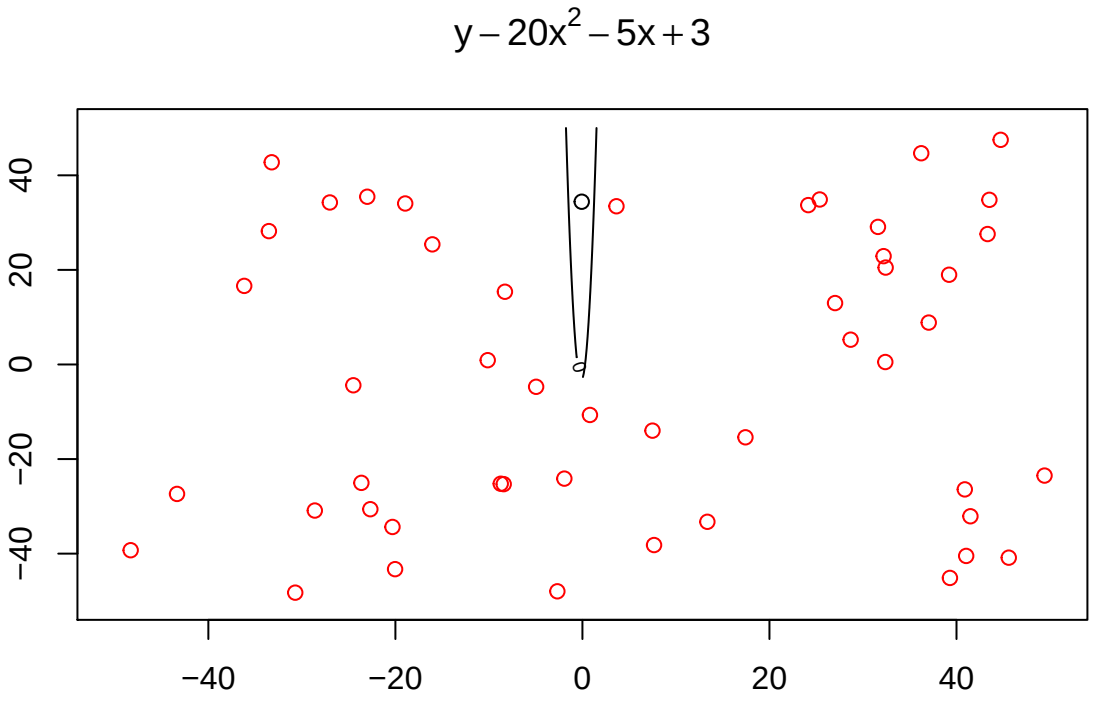



```
f_3 <- function(X){
  return(0.5*(X[1] - 10)^2 - (X[2] + 20)^2 - 400)
}

etiqueta_3 = apply(lista_unif, 2, function(X) sign(f_3(X)))

x <- seq(-50,50,length=1000)
y <- seq(-50,50,length=1000)
z <- outer(x,y,function(x,y) 0.5*(x - 10)^2 - (y + 20)^2 - 400)

contour(x,y,z, levels=0, main=expression( 0.5*(x - 10)^2 - (y + 20)^2 - 400))
points(lista_unif[1,etiqueta_3==1], lista_unif[2,etiqueta_3==1])
points(lista_unif[1,etiqueta_3==-1], lista_unif[2,etiqueta_3==-1],col=2)
```

$$0.5(x-10)^2-(y+20)^2-400$$

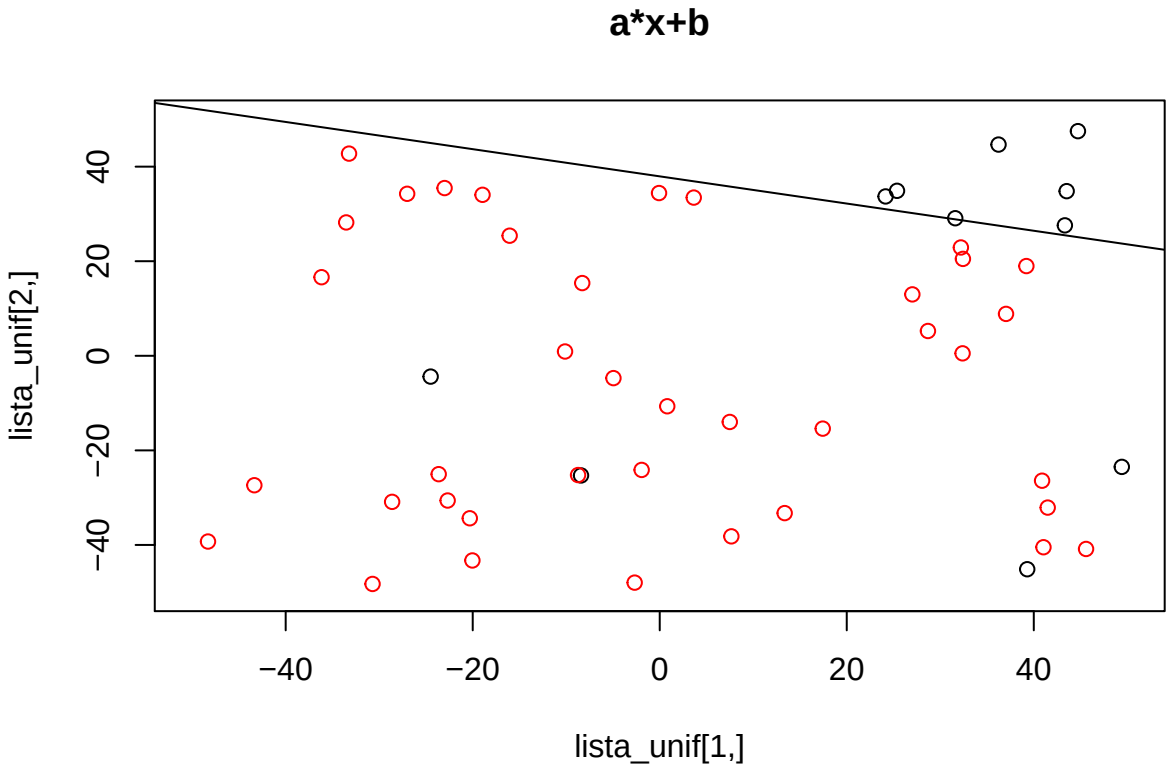



```
f_4 <- function(X){
  return(X[2] - 20*X[1]^2- 5*X[1] + 3)
}

etiqueta_4 = apply(lista_unif, 2, function(X) sign(f_4(X)))

x <- seq(-50,50,length=1000)
y <- seq(-50,50,length=1000)
z <- outer(x,y,function(x,y) y - 20*x^2 - 5*x + 3)

contour(x,y,z, levels=0, main=expression(y - 20*x^2 - 5*x + 3))
points(lista_unif[1,etiqueta_4==1], lista_unif[2,etiqueta_4==1])
points(lista_unif[1,etiqueta_4==-1], lista_unif[2,etiqueta_4==-1],col=2)
```



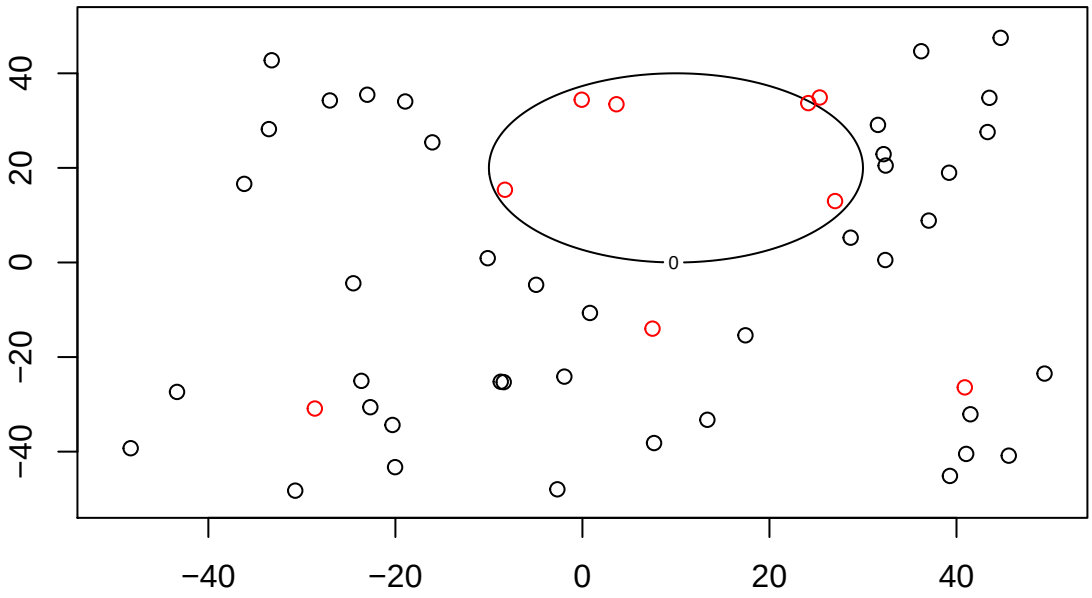

```
modify_rnd_bool_subvector <- function(v, perc = 0.1){
  mod_v <- v

  if( length(which(v == 1)) >= 10){
    to_change <- sample(which(v == 1), 0.1*length(which(v == 1)) )
    mod_v[to_change] = -1
  }

  if( length(which(v == -1)) >= 10){
    to_change <- sample(which(v == -1), 0.1*length(which(v == -1)) )
    mod_v[to_change] = 1
  }

  return(mod_v)
}
```

```
etiqueta_mod <- modify_rnd_bool_subvector(etiqueta)

plot.new()
plot.window(xlim=c(-50,50), ylim=c(-50,50))
axis(1)
axis(2)
box()
title(main="a*x+b", ylab = "lista_unif[2,]", xlab = "lista_unif[1,]")
points(lista_unif[1,etiqueta_mod==1], lista_unif[2,etiqueta_mod==1])
points(lista_unif[1,etiqueta_mod==-1], lista_unif[2,etiqueta_mod==-1],col=2)
abline(b,a)
```



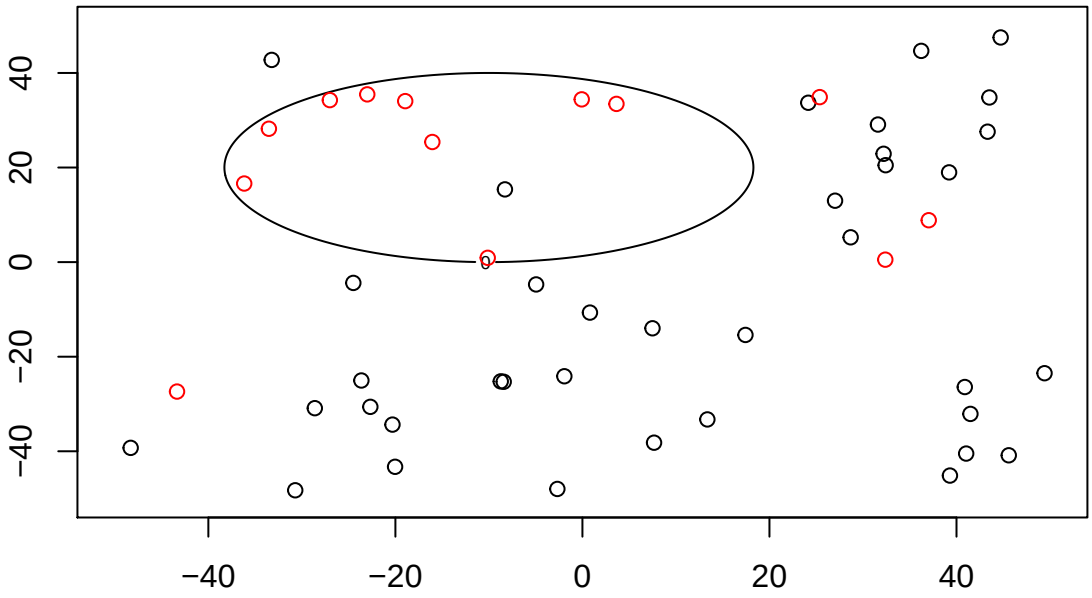

```
etiqueta_mod_1 <- modify_rnd_bool_subvector(etiqueta_1)

x <- seq(-50,50,length=1000)
y <- seq(-50,50,length=1000)
z <- outer(x,y,function(x,y) (x - 10)^2 + (y - 20)^2 - 400)

contour(x,y,z, levels=0, main=expression((x-10)^2 + (y-20)^2 - 400))
points(lista_unif[1,etiqueta_mod_1==1], lista_unif[2,etiqueta_mod_1==1])
points(lista_unif[1,etiqueta_mod_1==-1], lista_unif[2,etiqueta_mod_1==-1],col=2)
```

$$(x-10)^2+(y-20)^2-400$$



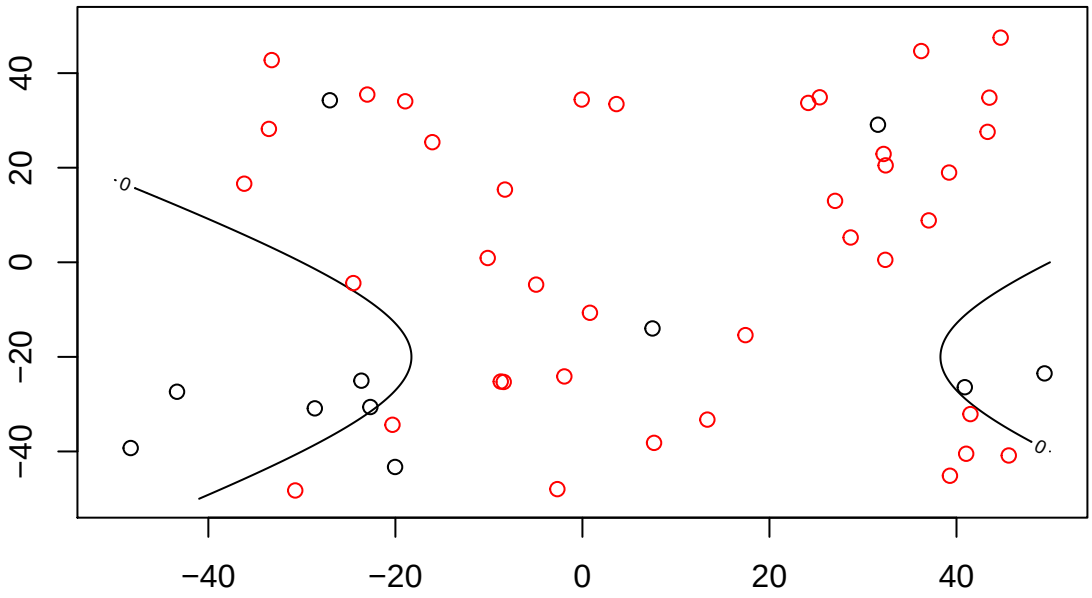

```
etiqueta_mod_2 <- modify_rnd_bool_subvector(etiqueta_2)

x <- seq(-50,50,length=1000)
y <- seq(-50,50,length=1000)
z <- outer(x,y,function(x,y) 0.5*(x + 10)^2 + (y - 20)^2 - 400)

contour(x,y,z, levels=0, main=expression(0.5(x + 10)^2 + (y - 20)^2 - 400))
points(lista_unif[1,etiqueta_mod_2==1], lista_unif[2,etiqueta_mod_2==1])
points(lista_unif[1,etiqueta_mod_2==-1], lista_unif[2,etiqueta_mod_2==-1],col=2)
```

$$0.5(x+10)^2+(y-20)^2-400$$

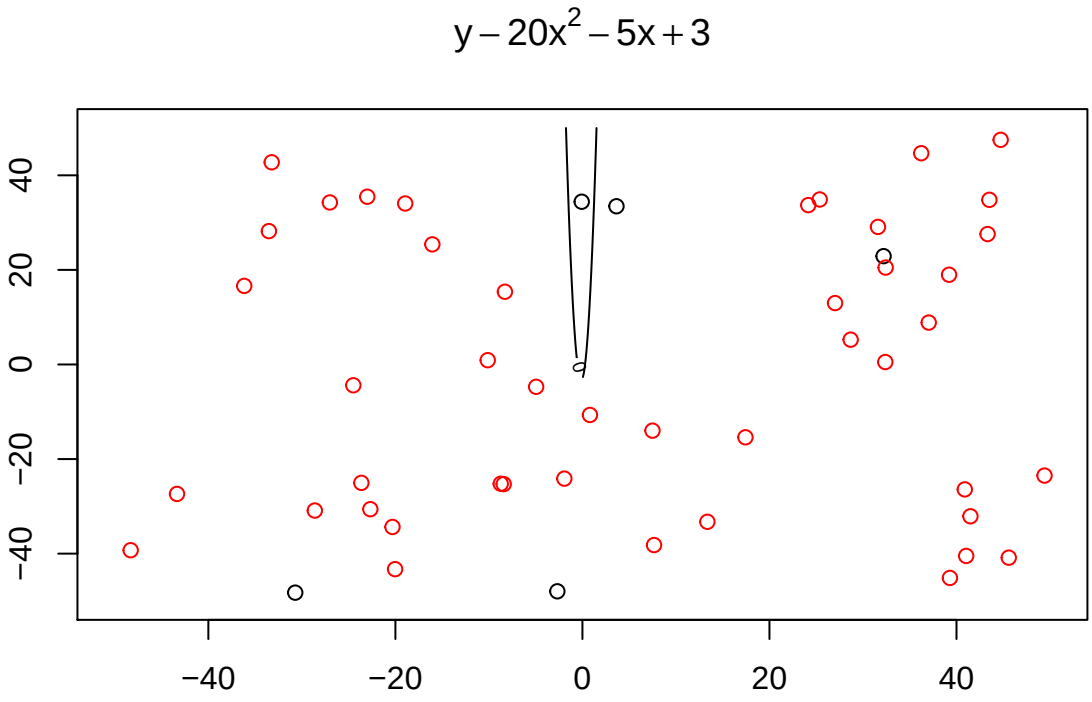


```
etiqueta_mod_3 <- modify_rnd_bool_subvector(etiqueta_3)

x <- seq(-50,50,length=1000)
y <- seq(-50,50,length=1000)
z <- outer(x,y,function(x,y) 0.5*(x - 10)^2 - (y + 20)^2 - 400)

contour(x,y,z, levels=0, main=expression( 0.5*(x - 10)^2 - (y + 20)^2 - 400))
points(lista_unif[1,etiqueta_mod_3==1], lista_unif[2,etiqueta_mod_3==1])
points(lista_unif[1,etiqueta_mod_3==-1], lista_unif[2,etiqueta_mod_3==-1],col=2)
```

$$0.5(x-10)^2-(y+20)^2-400$$




```
etiqueta_mod_4 <- modify_rnd_bool_subvector(etiqueta_4)

x <- seq(-50,50,length=1000)
y <- seq(-50,50,length=1000)
z <- outer(x,y,function(x,y) y - 20*x^2 - 5*x + 3)

contour(x,y,z, levels=0, main=expression(y - 20*x^2 - 5*x + 3))
points(lista_unif[1,etiqueta_mod_4==1], lista_unif[2,etiqueta_mod_4==1])
points(lista_unif[1,etiqueta_mod_4==-1], lista_unif[2,etiqueta_mod_4==-1],col=2)
```



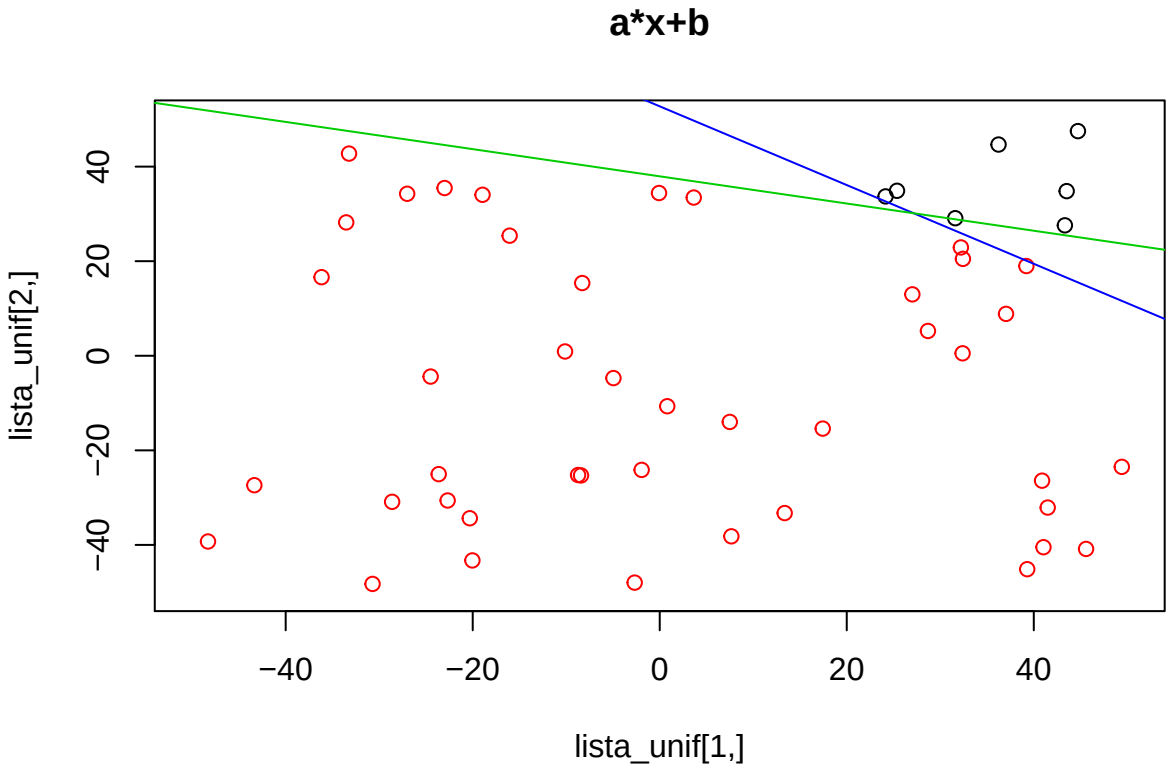
Ajuste del algoritmo Perceptron

```
ajusta_PLA <- function(datos, label, max_iter, vini){
  sol <- vini
  iter <- 0
  finished <- FALSE
  last_change <- -1

  while ( iter < max_iter && !finished){
    i <- iter%%length(label) +1
    x <- c(datos[,i],1)
    if( sign( crossprod(x,sol)) != label[i]){
      sol <- sol + label[i] * x
      last_change <- i
    }
    else{
      finished <- (i == last_change)
    }

    iter <- iter+1
  }

  sol <- sol/sol[2]

  if(finished){
    errors <- 0
  }
  else{
    signes <- apply(datos, 2, function(x){
```

```
      x <- c(x,1)
      return(sign(crossprod(x,sol)))})
    v <- signes != label
    errors <- length(v[v])
  }
  return(c(sol,errors, iter))
}

sol_pla <- ajusta_PLA(lista_unif,etiqueta, 7000,rep(0,3))
```

Representación de ejecución del algoritmo PLA

```
plot.new()
plot.window(xlim=c(-50,50), ylim=c(-50,50))
axis(1)
axis(2)
box()
title(main="a*x+b", ylab = "lista_unif[2,]", xlab = "lista_unif[1,]")
points(lista_unif[1,etiqueta==-1], lista_unif[2,etiqueta==-1], col = 2)
points(lista_unif[1,etiqueta==1], lista_unif[2,etiqueta==1])

abline(-sol_pla[3], -sol_pla[1], col = 4)
abline(b, a, col=3)
```



Cálculo de la media para 10 ejecuciones del PLA con el vector (0,0,0) y vectores aleatorios:

```
iterations <- numeric()
length(iterations) <- 10
```

```
iterations[1] <- ajusta_PLA(lista_unif,etiqueta, 10000,rep(0,3))[5]

for(i in 2:10){
  v_ini <- runif(3)
  print(v_ini)
  iterations[i] <- ajusta_PLA(lista_unif,etiqueta, 10000, v_ini)[5]
}
```

```
## [1] 0.6155947 0.6837588 0.1597617
## [1] 0.5615201 0.9476890 0.7015599
## [1] 0.8325838 0.8381125 0.6139540
## [1] 0.4954858 0.3251657 0.2211903
## [1] 0.6669954 0.7690558 0.2719020
## [1] 0.2419385 0.3997260 0.9621263
## [1] 0.8532034 0.9938891 0.3760681
## [1] 0.6769181 0.4364411 0.2389027
## [1] 0.06685798 0.25910080 0.18731783
```

```
print(c("Media de iteraciones ", mean(iterations)))
```

```
## [1] "Media de iteraciones " "3217.8"
```

Conteo de errores

```
errores_10 <- ajusta_PLA(lista_unif,etiqueta_mod, 10,rep(0,3))[4]
print(errores_10)
```

```
## [1] 29
```

```
errores_100 <- ajusta_PLA(lista_unif,etiqueta_mod, 100,rep(0,3))[4]
print(errores_100)
```

```
## [1] 19
```

```
errores_1000 <- ajusta_PLA(lista_unif,etiqueta_mod, 1000,rep(0,3))[4]
print(errores_1000)
```

```
## [1] 18
```