Redes Neurais Artificiais

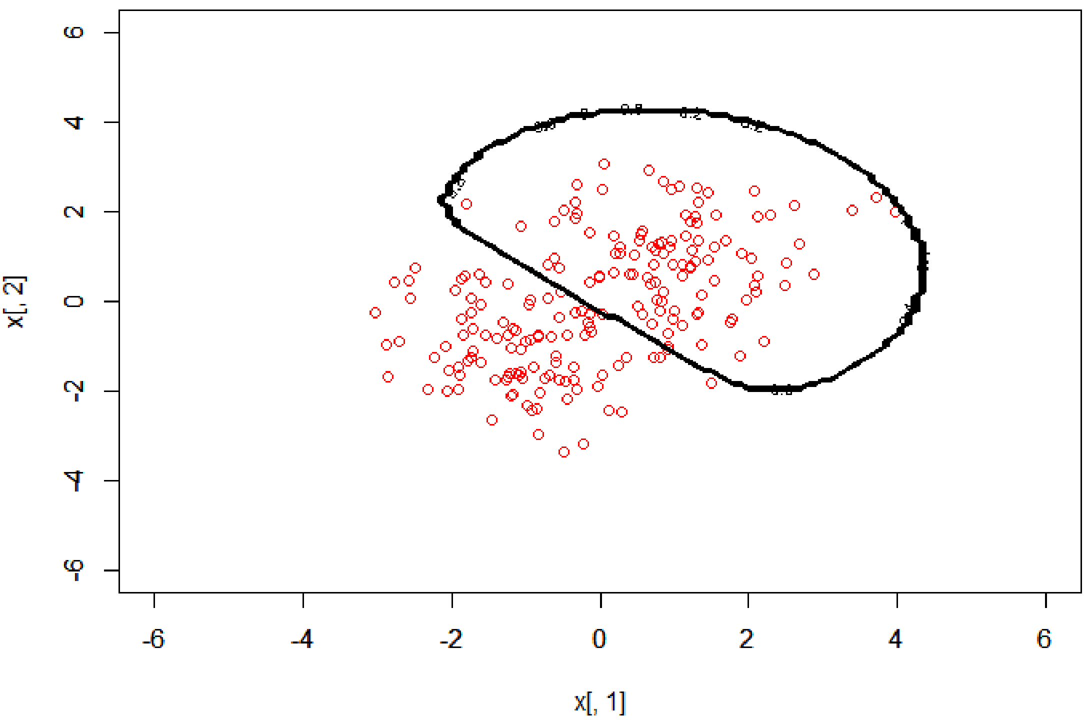
André Costa Werneck, Matrícula: 2017088140

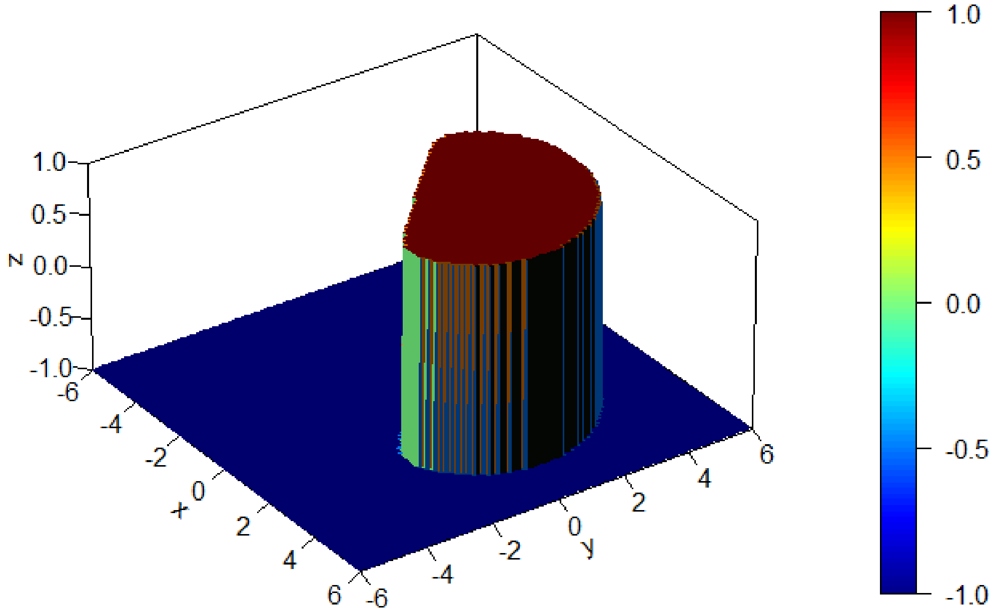
LISTA 7

31/05/2022

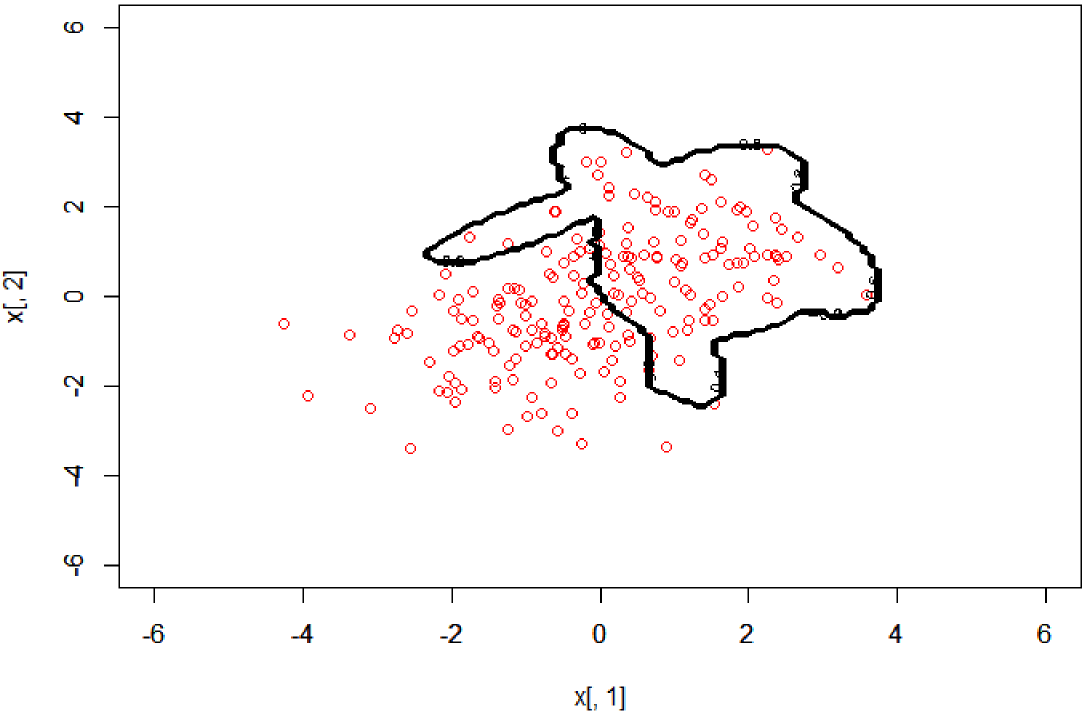
1) *Base 2dnormals e:*

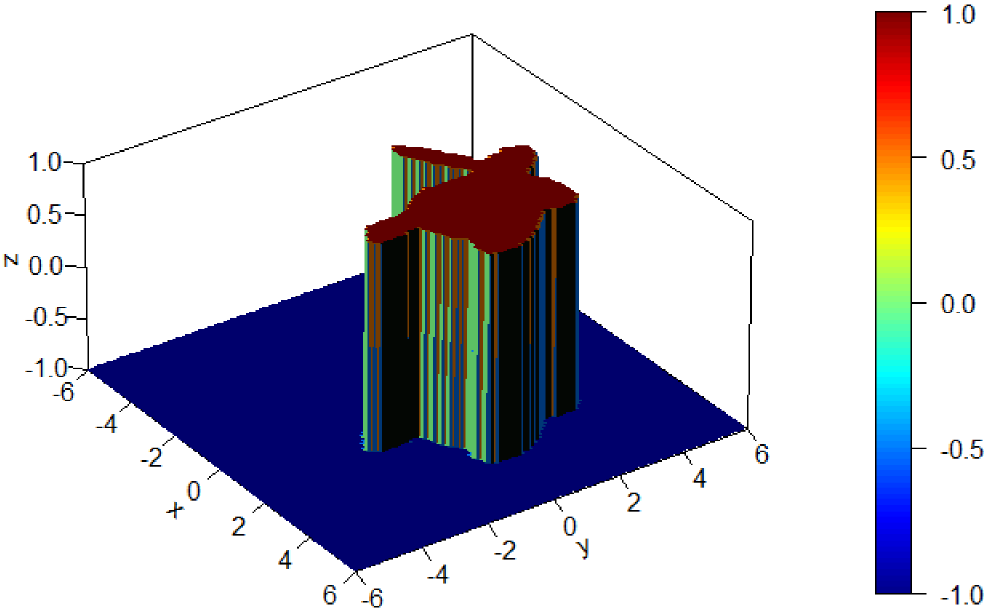
- *P = 2 centros*





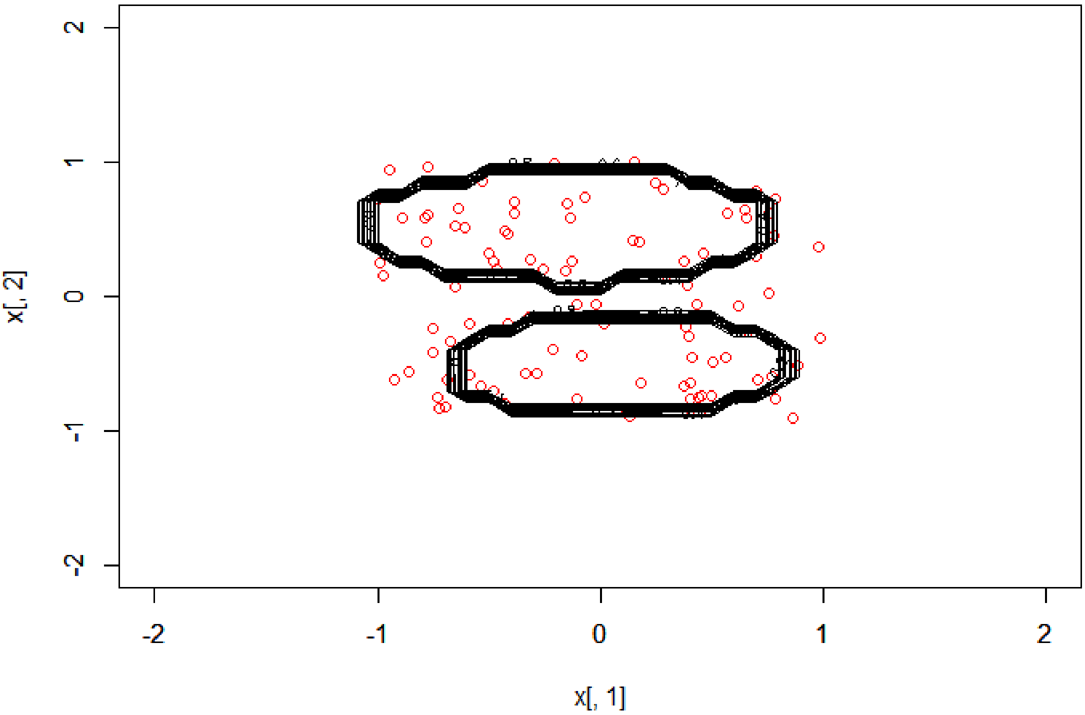
P = 20

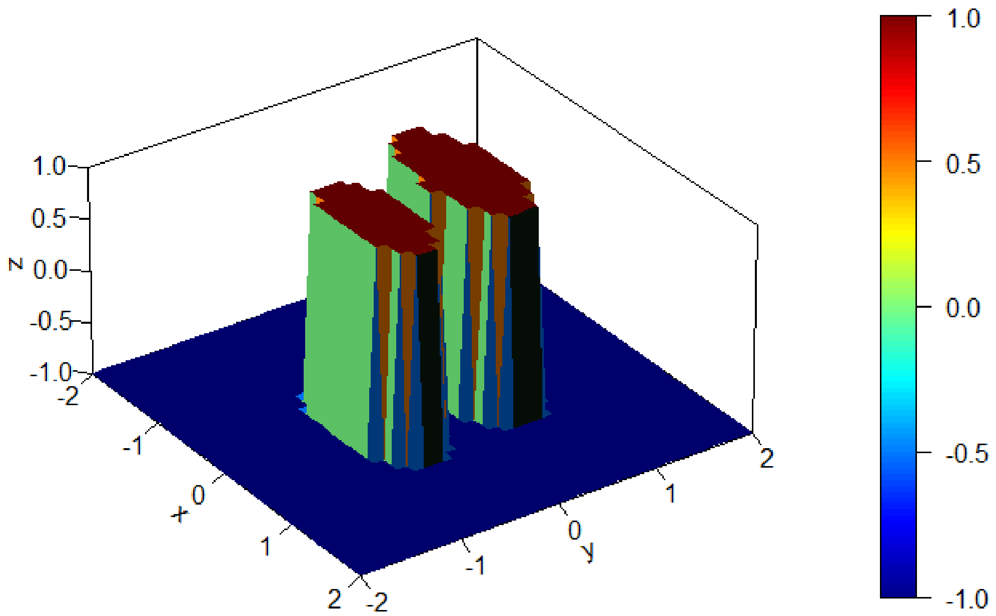




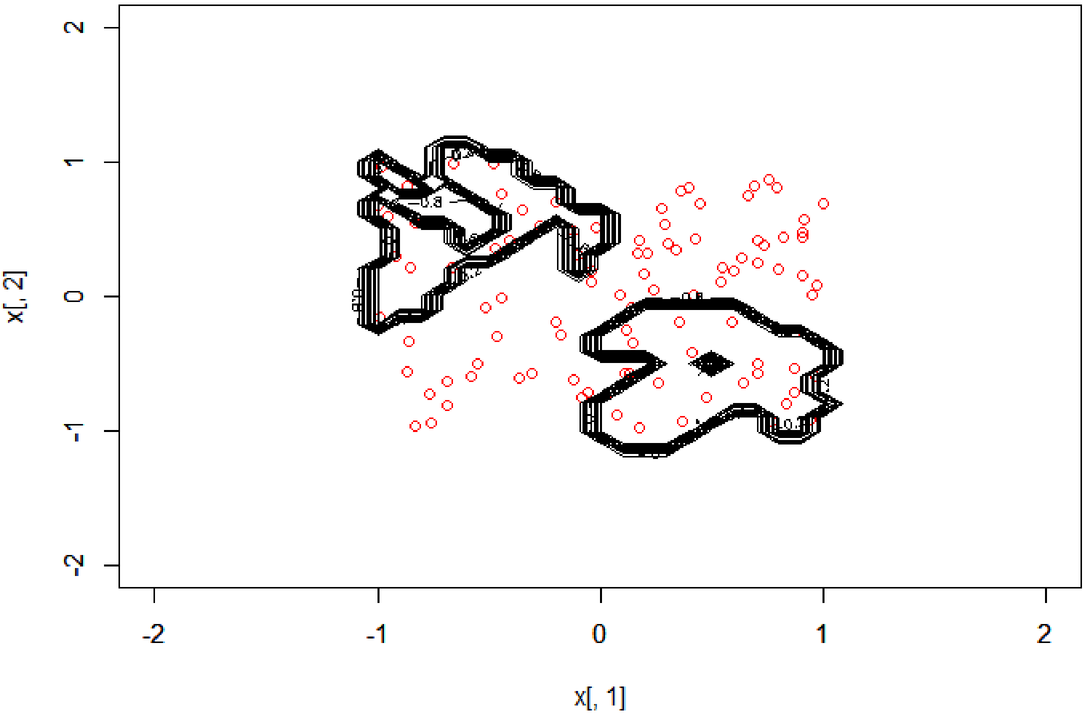
2) *Base xor e:*

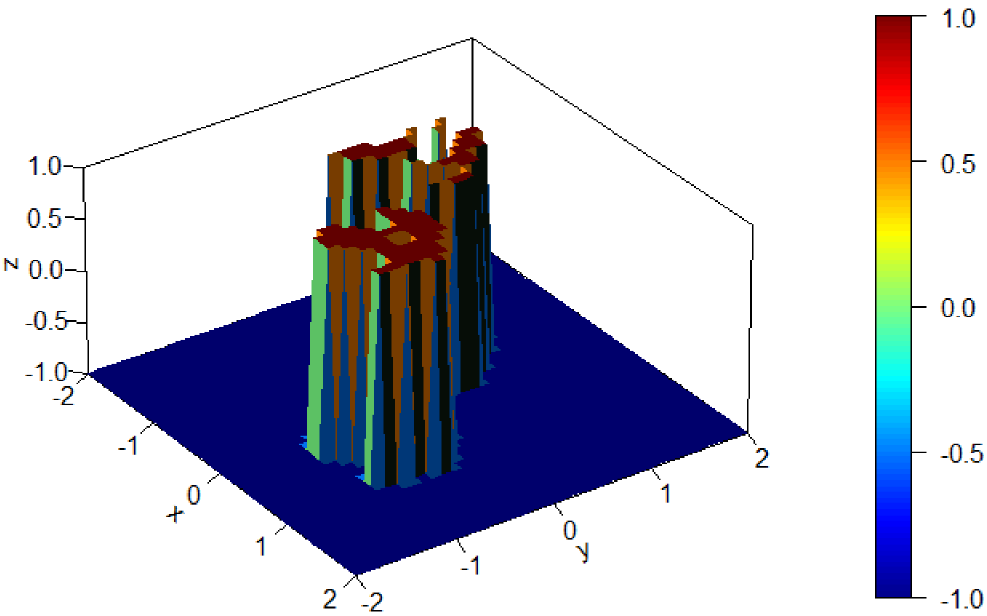
- *P = 2 centros*





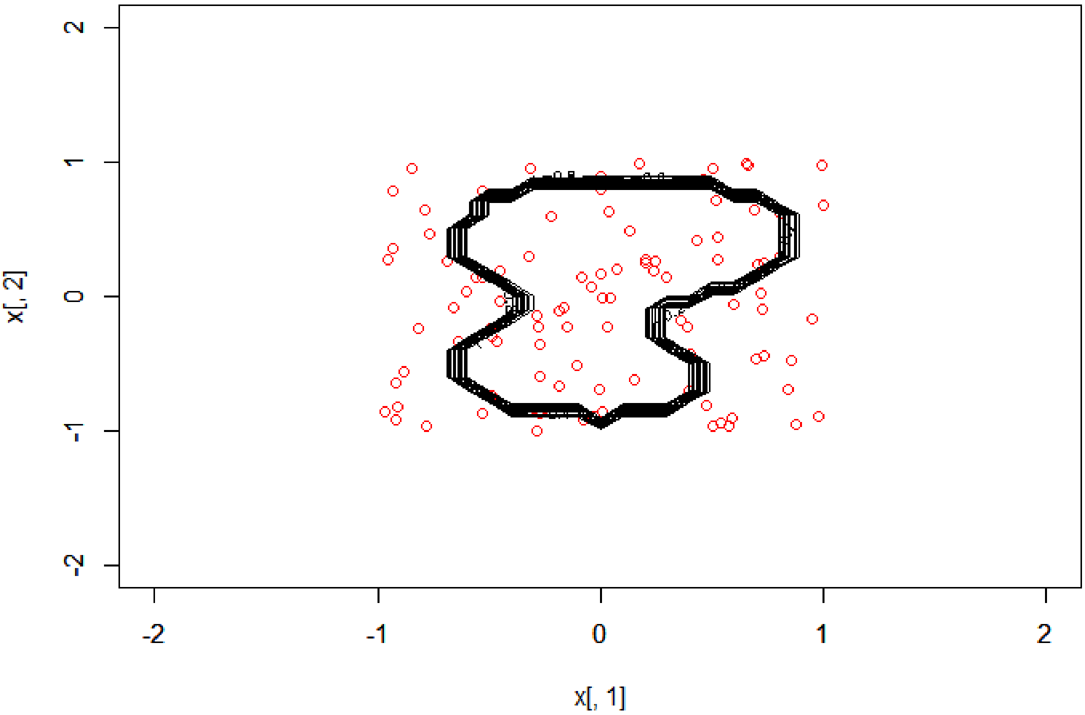
P = 20

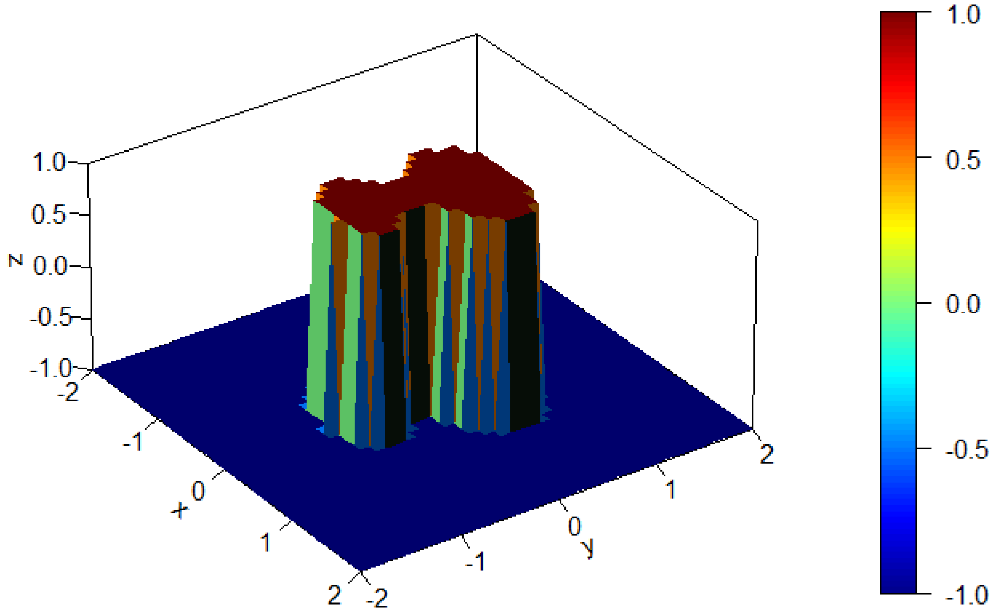




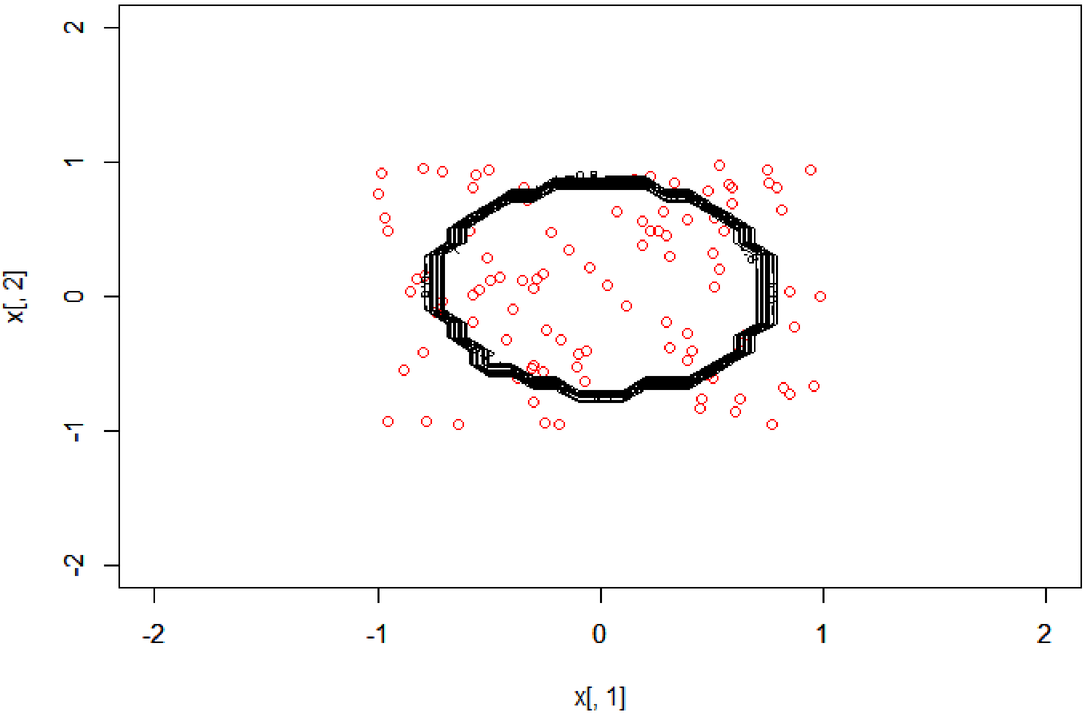
3) *Base circle e:*

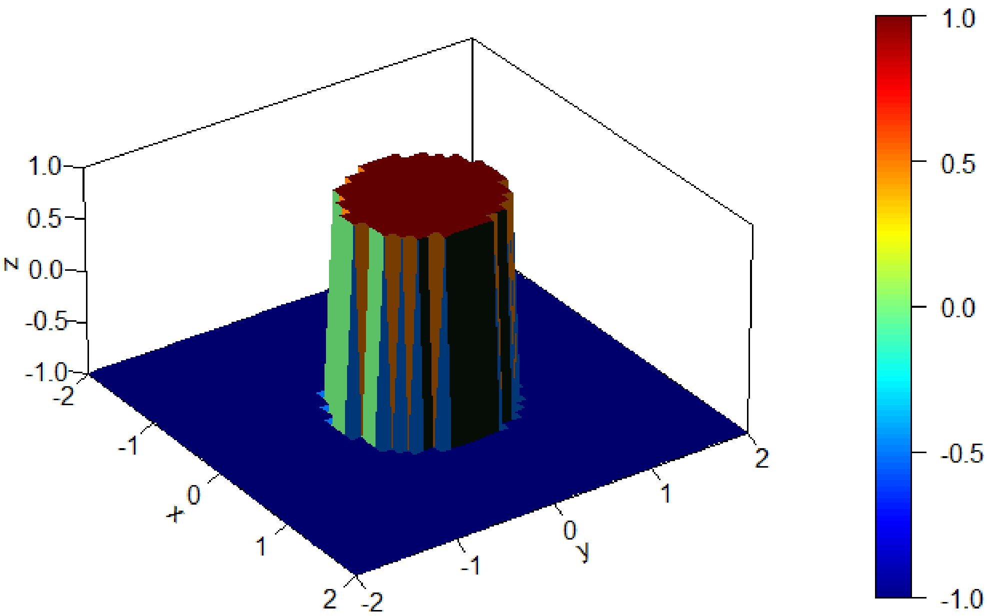
- *P = 2 centros*





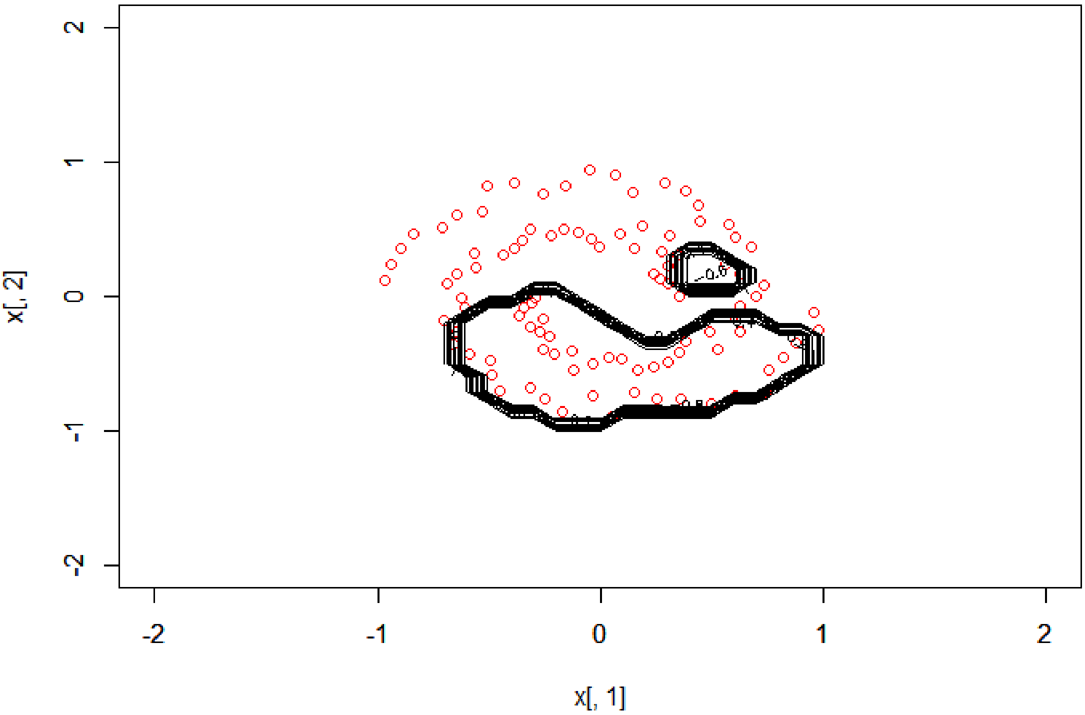
P = 1

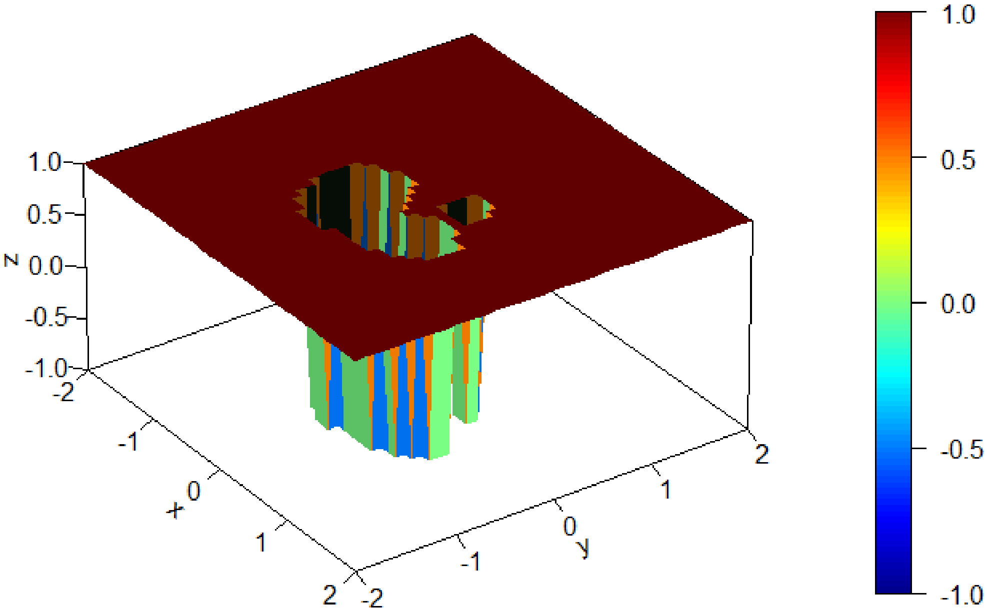




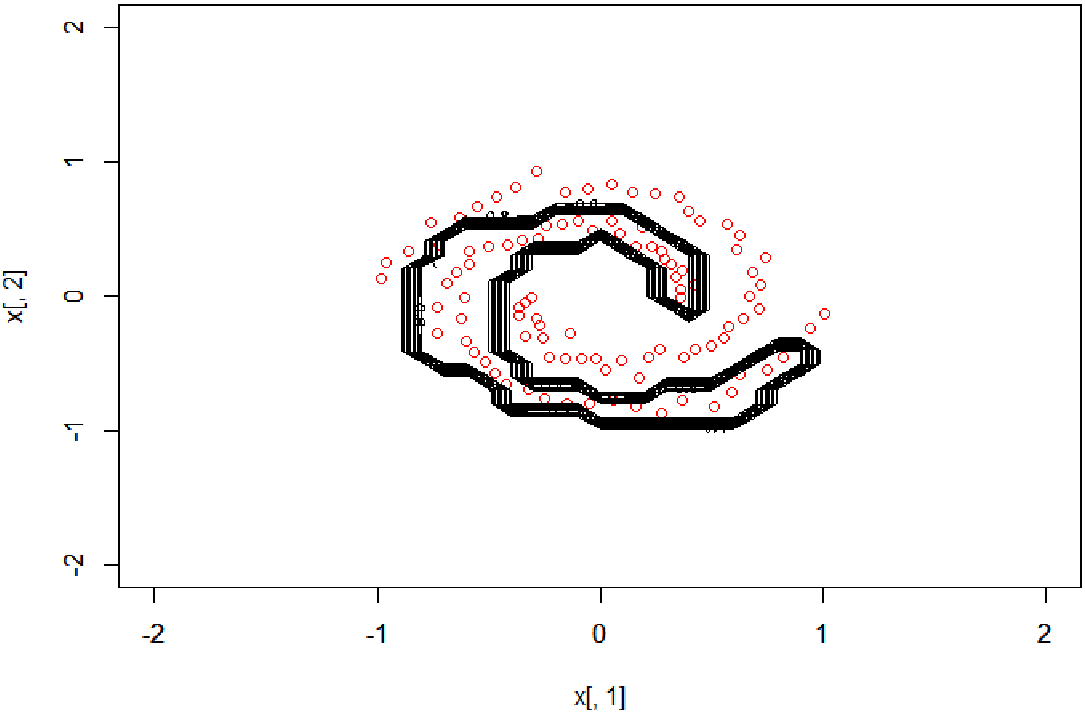
1) *Base spirals e:*

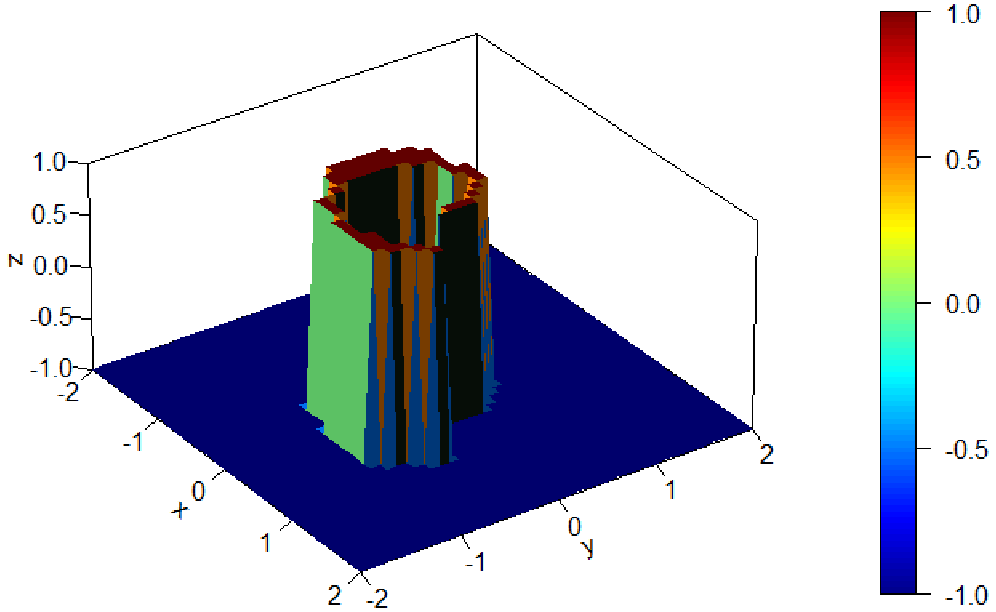
- *P = 5 centros*





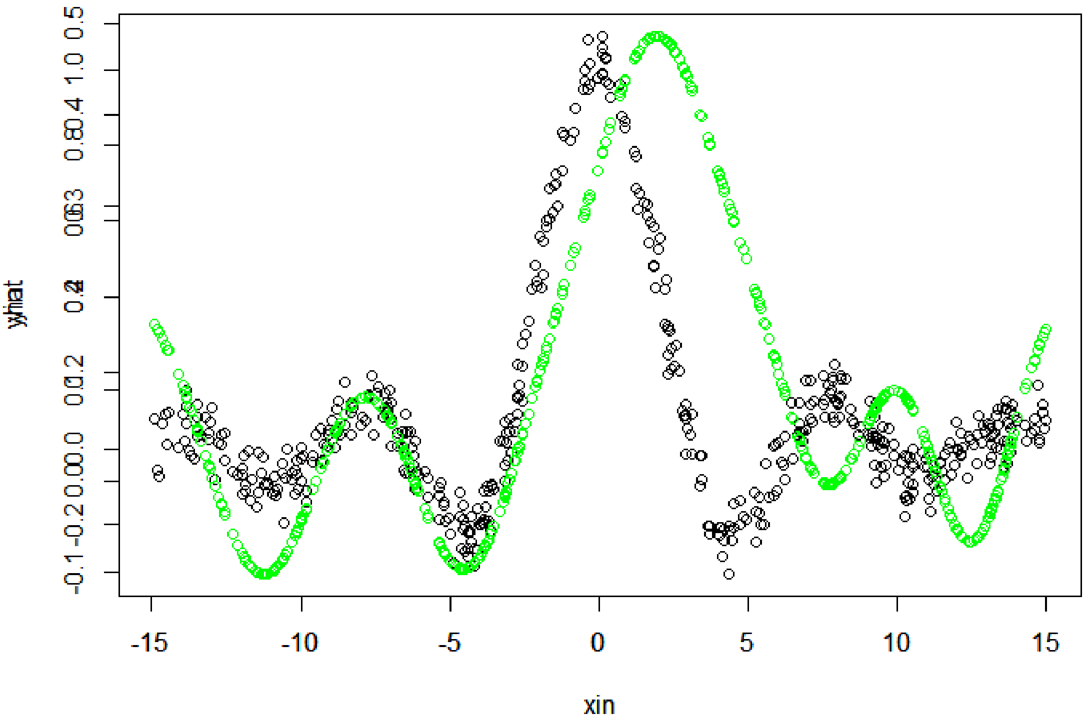
P=20





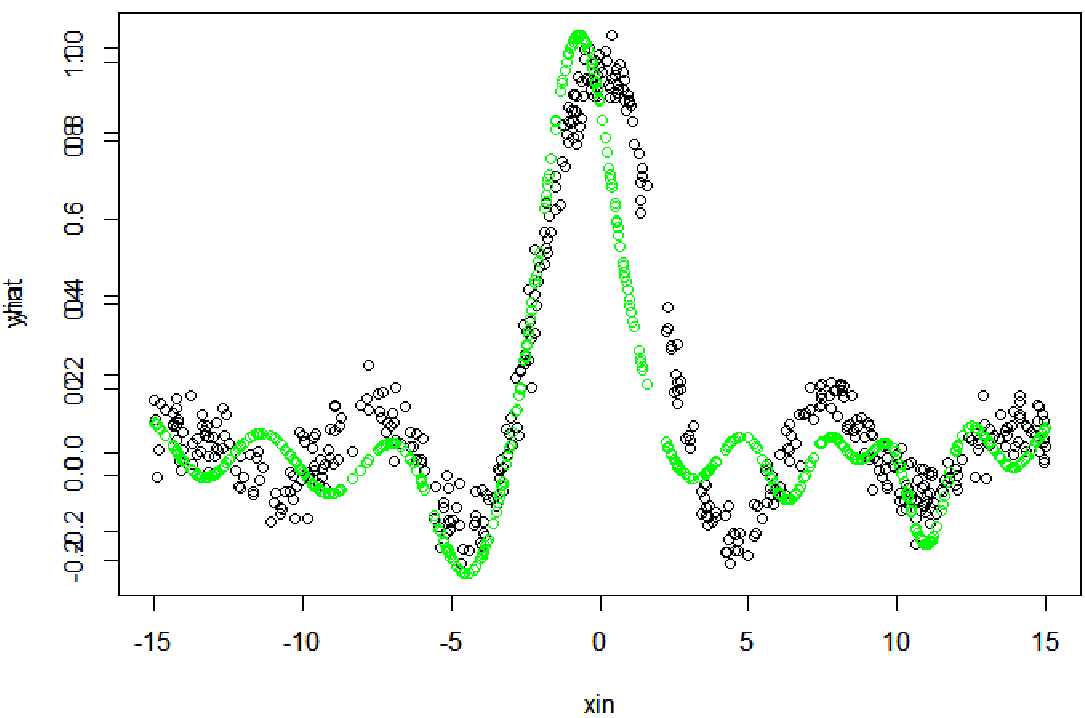
FUNÇAO SINC

P= 5



MSE [,1]
[1,] 0.05515065

P = 9



MSE [,1]
[1,] 0.02184937

ANEXOS

O código para realização dos exercícios 1, 2, 3 e 4 se encontra devidamente documentado, através dos comentários, em anexo:

```
rm(list=ls())

library('mlbench')
library('plot3D')


cd0 <- mlbench.spirals(100,sd = 0.05)

#pdfnvar<-function(x,m,K,n) ((1/(sqrt((2*pi)^n*(det(K)))))*exp(-0.5*(t(x-m) %*% (solve(K)) %*% (x-m))))

trainRBF <- function(xin,yin,p){

  # aplica a PDF nos dados -> OBRENÇAO DA MATRIX H
  pdfnvar<-function(x,m,K,n) ((1/(sqrt((2*pi)^n*(det(K)))))*exp(-0.5*(t(x-m) %*% (solve(K)) %*% (x-m))))

  # pega as dimensoes de entrada
  N <- dim(xin)[1]
  n <- dim(xin)[2]
  xin <- as.matrix(xin)
  yin <- as.matrix(yin)

  # aplica clustering nos dados com k-means nativo do R
  dataclustering <- kmeans(xin,p)

  centers <- as.matrix(dataclustering$centers) # armazena os centros encontrados
  covlist <- list()

  # estima matriz de covariancia para cada um dos centros
```

```
  for(i in 1:p){
    ici <- which(dataclustering$cluster == i)
    xci <- xin[ici,]
    if (n == 1)
      covi <- var(xci)
    else
      covi<-cov(xci)
    covlist[[i]] <- covi
  }

  #determina matriz H
  H <- matrix(nrow = N,ncol = p)
  for (j in 1:N) {
    for(i in 1:p){
      mi<-centers[i,]
      covi <- covlist[i]
      covi<-matrix(unlist(covlist[i]),ncol = n,byrow=T) + 0.001 * diag(n)
      H[j,i] <- pdfnvar(xin[j,],mi,covi,n)
    }
  }

  Haug <- cbind(H,1)
  # calcula W usando a pseudoinversa de Haug e sem regularizacao
  W <- (solve(t(Haug)%*%Haug) %*% t(Haug)) %*% yin

  return(list(centers,covlist,W,H))

}

YRBF <- function(xin,modelRBF,binary){
  # declara a funcao gaussiana radial
  pdfnvar<-function(x,m,K,n)      ((1/(sqrt((2*pi)^n*(det(K)))))*exp(-0.5*(t(x-m)      %*%
(solve(K)) %*% (x-m))))

  # pega as dimensoes de entrada
  N <- dim(xin)[1]
  n <- dim(xin)[2]
  xin <- as.matrix(xin)
```

```
  centers<-as.matrix(modelRBF[[1]])
  covlist <- modelRBF[[2]]
  p <- length(covlist) # numero de funcoes radiais
  W <- modelRBF[[3]]

  #determina matriz H
  H <- matrix(nrow = N,ncol = p)
  for (j in 1:N) {
    for(i in 1:p){
      mi<-centers[i,]
      covi <- covlist[i]
      covi<-matrix(unlist(covlist[i]),ncol = n,byrow=T) + 0.001 * diag(n)
      H[j,i] <- pdfnvar(xin[j,],mi,covi,n)
    }
  }

  Haug <- cbind(H,1)
  Yhat <- Haug %*% W

  if(binary==TRUE)
    return(sign(Yhat))
  else
    return(Yhat)
}



x <- as.matrix(cd0$x)
y <- as.matrix(cd0$classes)
class(y) <- "numeric"
y[y==2]<- (-1)
y[y==1]<- (1)

separeTrainAndTest <- function(x,y,percTrain){

  xin <- x
  yin <- y
```

```
  indexTreino <- sample(dim(xin)[1])

  Xtrain <- xin[indexTreino[1:(dim(xin)[1]*percTrain)],]
  Ytrain <- as.matrix(yin[indexTreino[1:(dim(xin)[1]*percTrain)],])

  Xtest <- xin[indexTreino[((dim(xin)[1]*percTrain)+1):dim(xin)[1]],]
  Ytest <- as.matrix(yin[indexTreino[((dim(xin)[1]*percTrain)+1):dim(xin)[1]],])

  return(list(Xtrain,Ytrain,Xtest,Ytest))
}

# training the model
p <- 20
model <- trainRBF(x,y,p)
yhat <- YRBF(x,model,binary = TRUE)
MSE <- (t(y-yhat) %*% (y-yhat))/dim(y)[1]
acc <- y - yhat
acc <- length(acc[acc==0])/dim(y)[1]

seqi <- seq(-2,2,0.1)
seqj <- seq(-2,2,0.1)

M <- matrix(0,nrow = length(seqi),ncol = length(seqj))

ci <- 0
for (i in seqi) {
  ci<-ci+1
  cj<-0
  for (j in seqj) {
    cj<-cj+1
    X<-as.matrix(cbind(i,j))
    M[ci,cj]<- YRBF(X,model,binary = TRUE)
  }

}

plot(x[,1],x[,2],col = 'red', xlim = c(-2,2), ylim = c(-2,2))
par(new=T)
```

```
contour(seqi,seqj,M,xlim = c(-2,2),ylim = c(-2,2),xlab= '', ylab='')
persp3D(seqi,seqj,M,counter = T,theta=55,phi=30,r=40,d=0.1,expand=0.5,ltheta=90,lphi=180,shade=0.4,ticktype='detailed',nticks=5)

# sinc -----
rm(list=ls())

xin <- runif(500,-15,15)
yin <- sin(xin)/xin + rnorm(500,0,0.05)
plot(xin,yin)

trainRBF <- function(xin,yin,p){

  # aplica a PDF nos dados -> OBRENÇAO DA MATRIX H
  pdfnvar<-function(x,m,K,n) ((1/(sqrt((2*pi)^n*(det(K)))))*exp(-0.5*(t(x-m) %*% (solve(K)) %*% (x-m))))

  # pega as dimensoes de entrada
  N <- dim(xin)[1]
  n <- dim(xin)[2]
  xin <- as.matrix(xin)
  yin <- as.matrix(yin)

  # aplica clustering nos dados com k-means nativo do R
  dataclustering <- kmeans(xin,p)

  centers <- as.matrix(dataclustering$centers) # armazena os centros encontrados
  covlist <- list()

  # estima matriz de covariancia para cada um dos centros
  for(i in 1:p){
    ici <- which(dataclustering$cluster == i)
    xci <- xin[ici,]
    if (n == 1)
      covi <- var(xci)
    else
      covi<-cov(xci)
    covlist[[i]] <- covi
```

```
  }

  #determina matriz H
  H <- matrix(nrow = N,ncol = p)
  for (j in 1:N) {
    for(i in 1:p){
      mi<-centers[i,]
      covi <- covlist[i]
      covi<-matrix(unlist(covlist[i]),ncol = n,byrow=T) + 0.001 * diag(n)
      H[j,i] <- pdfnvar(xin[j,],mi,covi,n)
    }
  }

  Haug <- cbind(H,1)
  # calcula W usando a pseudoinversa de Haug e sem regularizacao
  W <- (solve(t(Haug)%*%Haug) %*% t(Haug)) %*% yin

  return(list(centers,covlist,W,H))

}

YRBF <- function(xin,modelRBF,binary){
  # declara a funcao gaussiana radial
  pdfnvar<-function(x,m,K,n)      ((1/(sqrt((2*pi)^n*(det(K)))))*exp(-0.5*(t(x-m)      %*%
(solve(K)) %*% (x-m))))

  # pega as dimensoes de entrada
  N <- dim(xin)[1]
  n <- dim(xin)[2]
  xin <- as.matrix(xin)

  centers<-as.matrix(modelRBF[[1]])
  covlist <- modelRBF[[2]]
  p <- length(covlist) # numero de funcoes radiais
  W <- modelRBF[[3]]

  #determina matriz H
  H <- matrix(nrow = N,ncol = p)
```

```
  for (j in 1:N) {
    for(i in 1:p){
      mi<-centers[i,]
      covi <- covlist[i]
      covi<-matrix(unlist(covlist[i]),ncol = n,byrow=T) + 0.001 * diag(n)
      H[j,i] <- pdfnvar(xin[j,],mi,covi,n)
    }
  }

  Haug <- cbind(H,1)
  Yhat <- Haug %*% W

  if(binary==TRUE)
    return(sign(Yhat))
  else
    return(Yhat)
}

p <- 30
model <- trainRBF(as.matrix(xin),as.matrix(yin),p)
yhat <- YRBF(as.matrix(xin),model,binary = FALSE)
MSE <- (t(as.matrix(yin)-yhat) %*% (as.matrix(yin)-yhat))/dim(as.matrix(yin))[1]

plot(xin,yin,col = 'black')
par(new=T)
plot(xin,yhat,col = 'green')
```