Particle Swarm Optimizer

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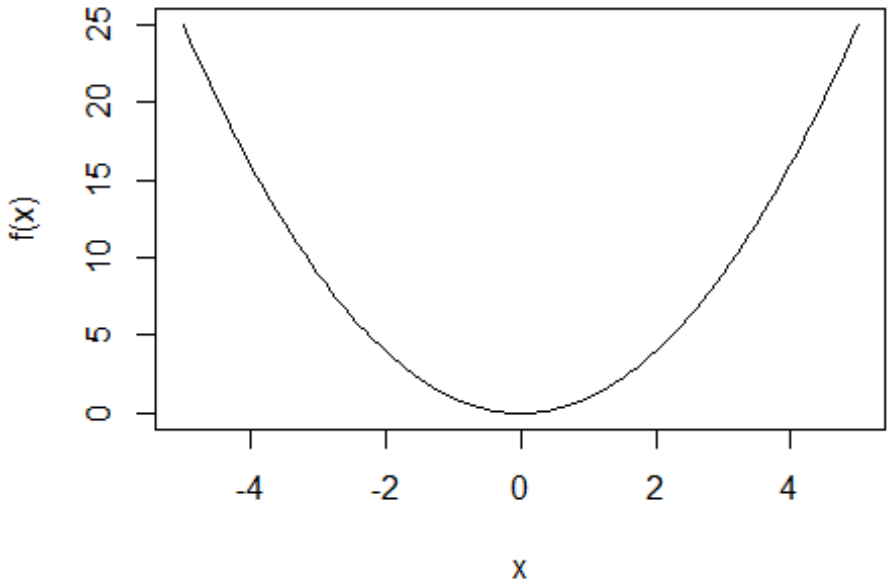
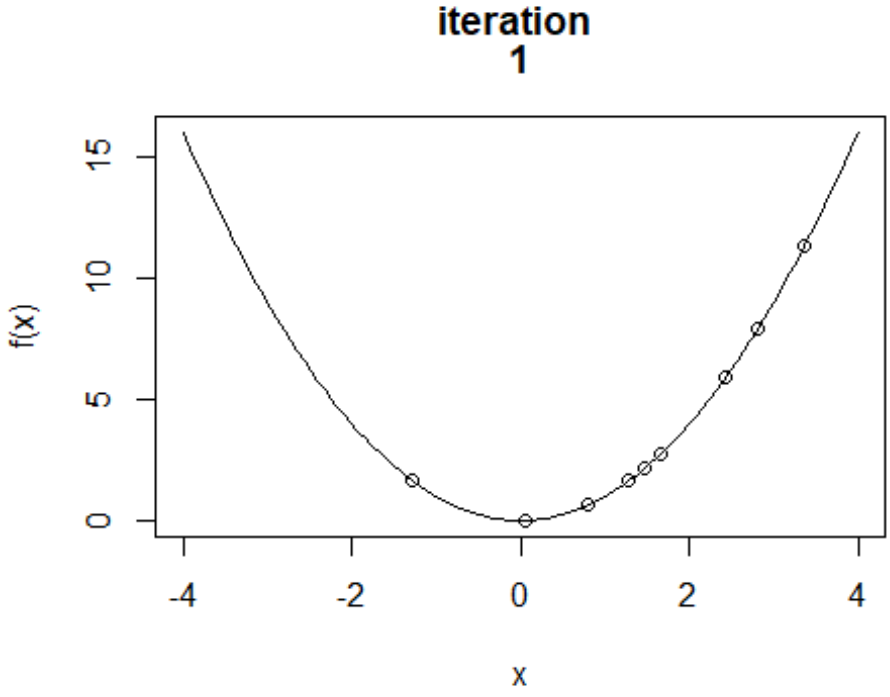
Trying out 2D first

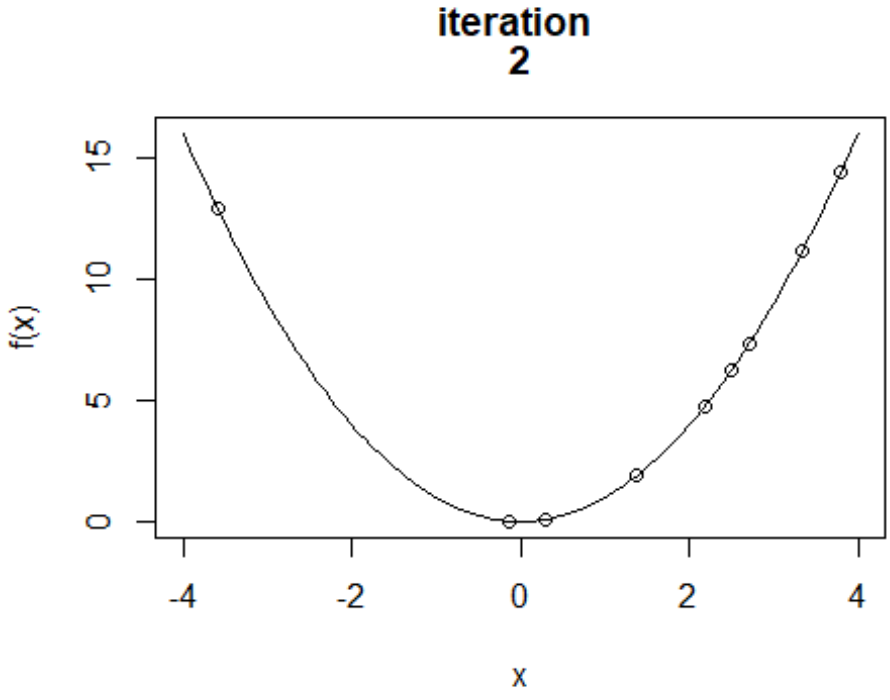
```
set.seed(123)
#Simple function
f <- function(x){
  return(x^2)
}

curve(f(x),-5,5)
```

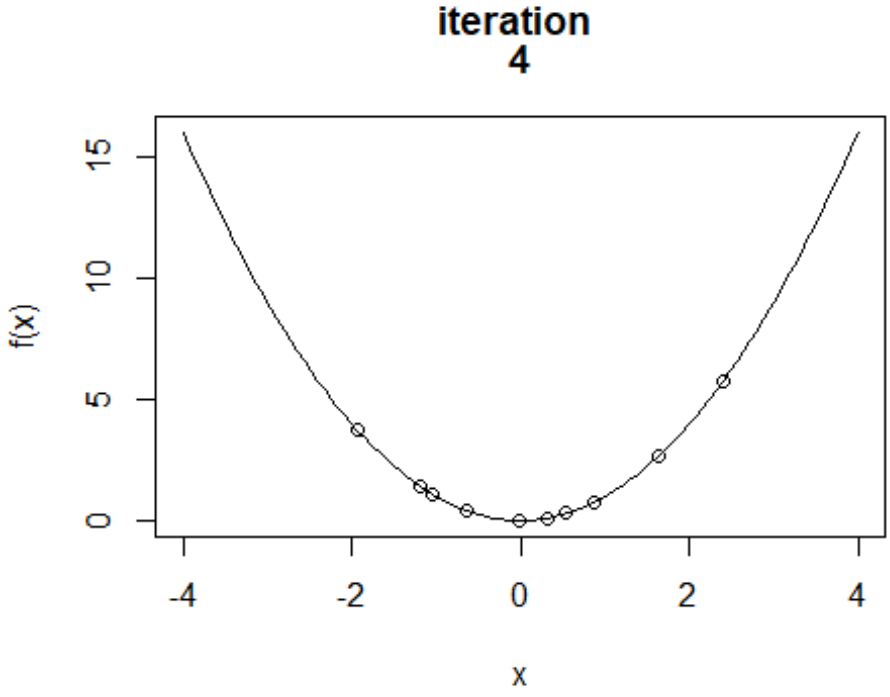


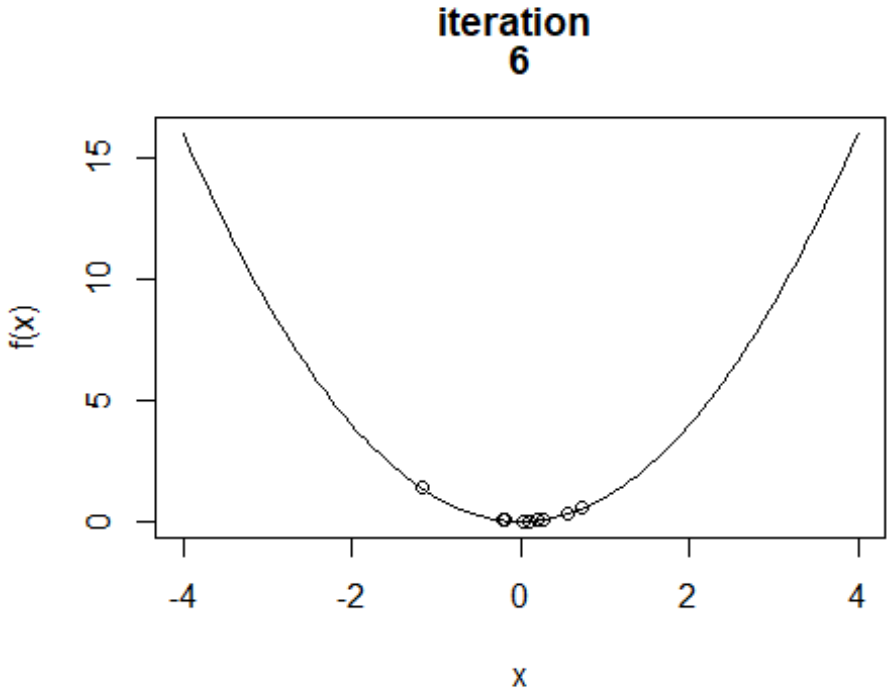

```
swarm <- function(S,lower, upper,omega,phiP,phiG){
  iterations <- 100
  best_swarm <- lower
  #particle positions
  x <- rep(0,S)
  #particle best positions
  p <- rep(0,S)
  #particle velocities
  v <- rep(0,S)
```

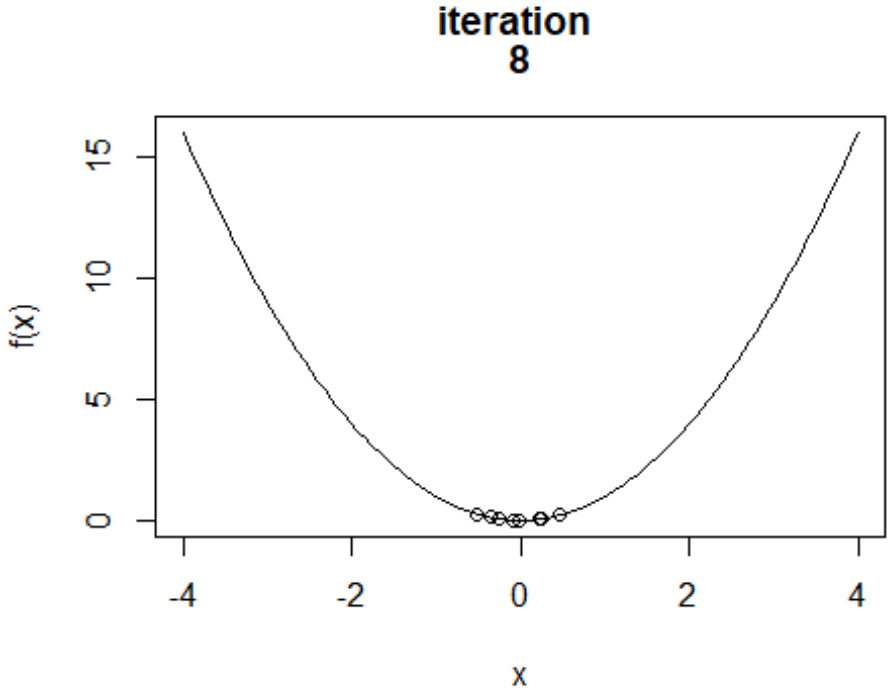
```
  #for each particle i
  for (i in 1:S){
    #initial position
    x[i] <- runif(1,lower,upper)
    p[i] <- x[i]

    if(f(p[i]) < f(best_swarm)){
      best_swarm <- p[i]
    }

    #initial velocity
    v[i] <- runif(1,-abs(upper-lower),abs(upper-lower))
  }
  #print(x)
  #print(p)
  #print(v)
  #print(best_swarm)
  for(j in 1:iterations){

    for (i in 1:S){
      rp <- runif(1,0,1)
      rg <- runif(1,0,1)

      v[i] <- omega*v[i] + phiP*rp*(p[i]-x[i]) + phiG*rg*(best_swarm-x[i])

      x[i] <- x[i] + v[i]

      if (f(x[i]) < f(p[i])){
        p[i] <- x[i]

        #update best position in the swarm
        if (f(p[i]) < f(best_swarm)){
          best_swarm <- p[i]
        }
      }
    }
    if((j%%2 == 0 && j < 20) || j == 1){
      curve(f,lower,upper,main = c("iteration ",j))
      points(x,f(x))
    }

  }
  cat("best x value: ",best_swarm,"\n")
  cat("minimum: ",f(best_swarm),"\n")
  cat("\n")
}

swarm(10,-4,4,.5,.5,.5)
```

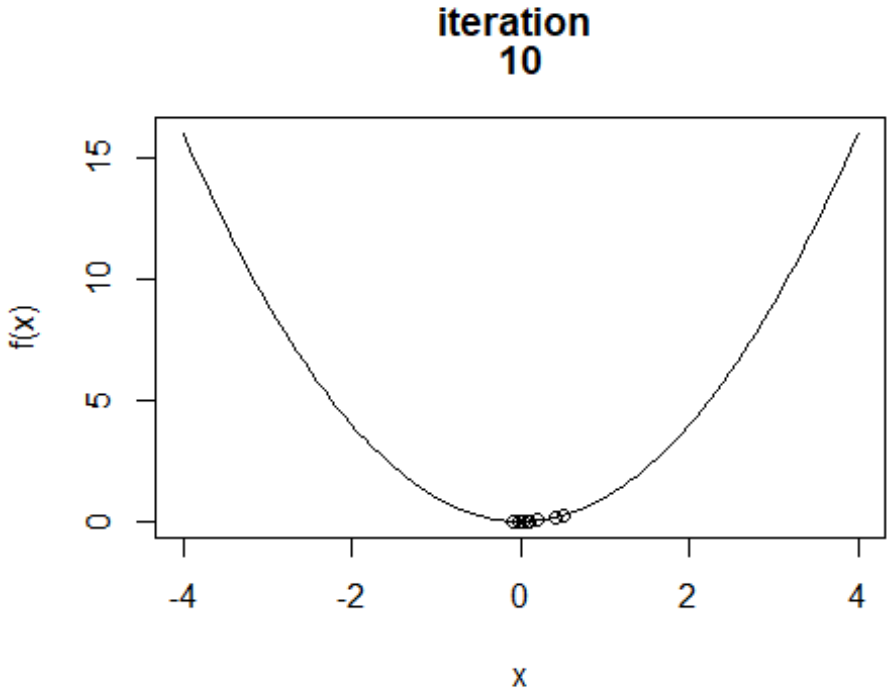

iteration
1
f(x)
0
5
10
15
-4
-2
0
2
4
x

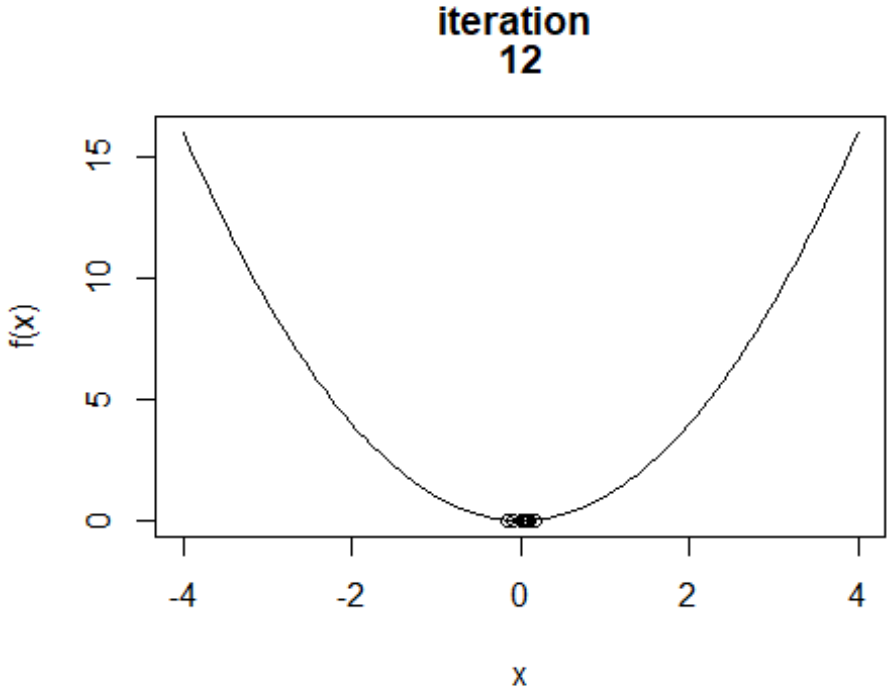

iteration
2
f(x)
0
5
10
15
-4
-2
0
2
4
x

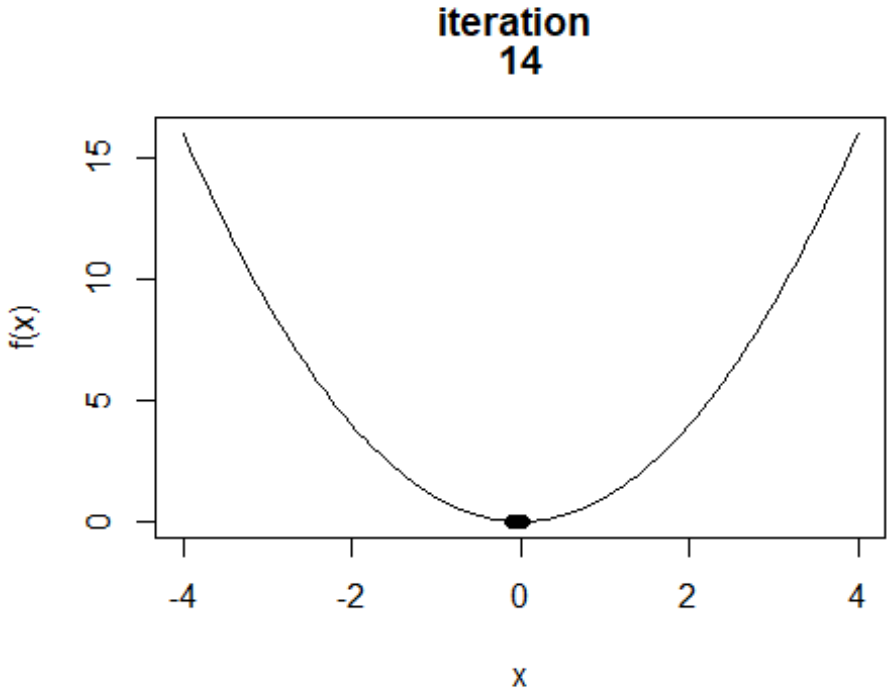

iteration
4
f(x)
0
5
10
15
-4
-2
0
2
4
x

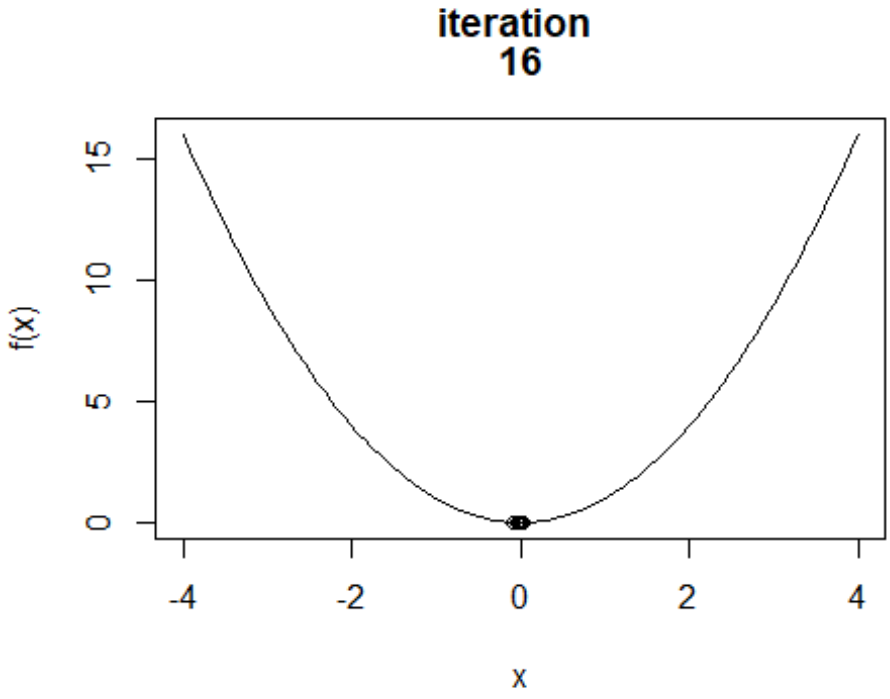

iteration
6
f(x)
0
5
10
15
-4
-2
0
2
4
x

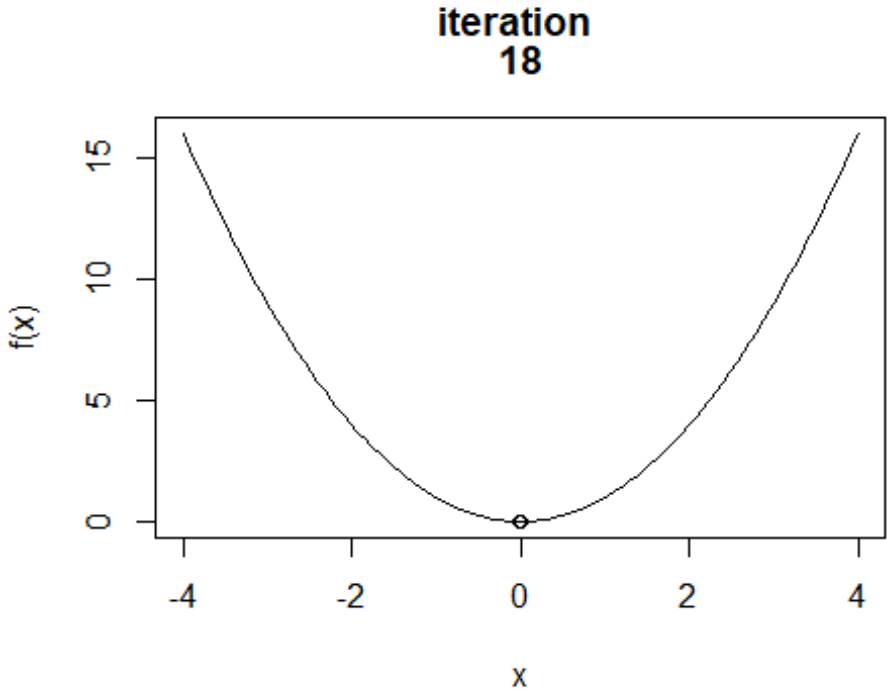

iteration
8
f(x)
0
5
10
15
-4
-2
0
2
4
x


iteration
10
f(x)
0
5
10
15
-4
-2
0
2
4
x


iteration
12
f(x)
0
5
10
15
-4
-2
0
2
4
x

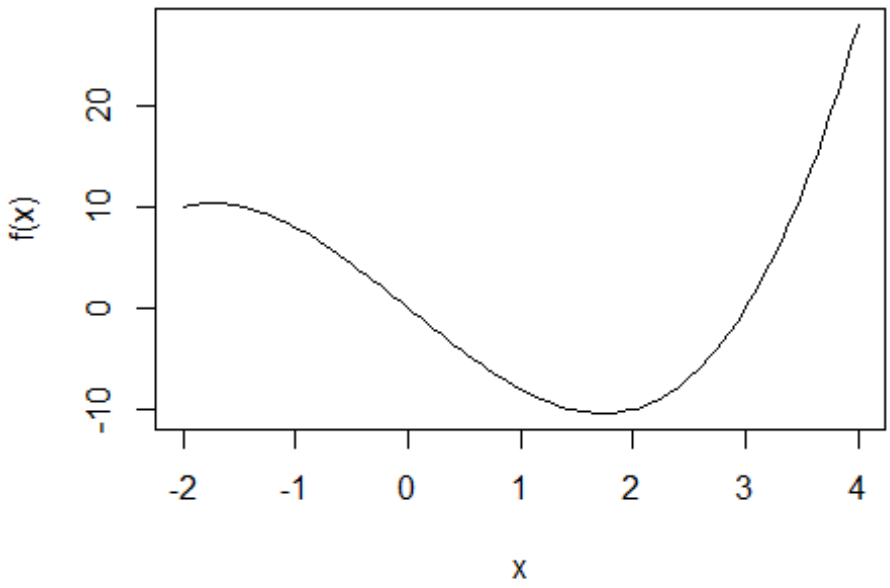

iteration
14
f(x)
0
5
10
15
-4
-2
0
2
4
x



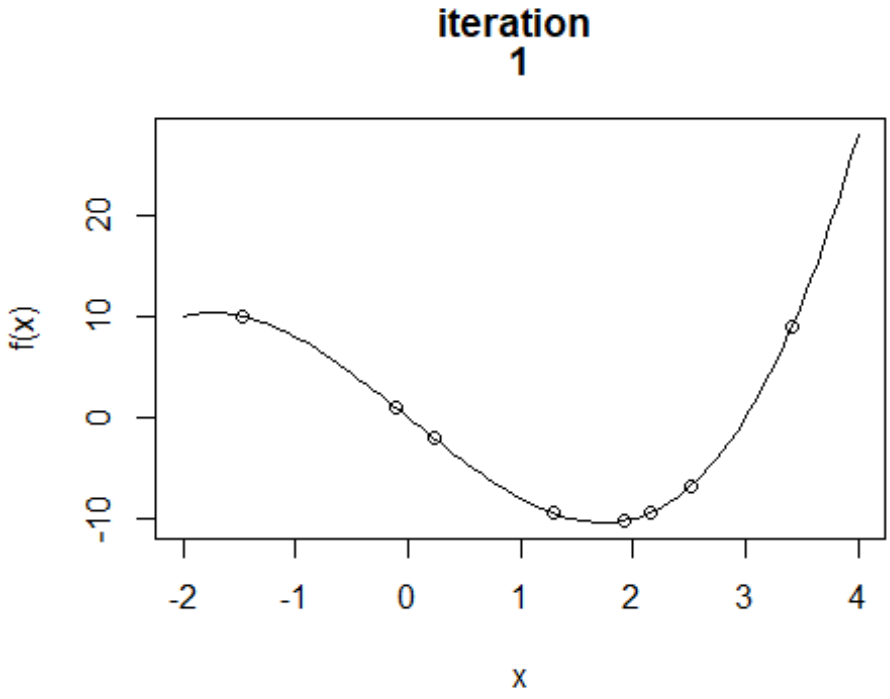


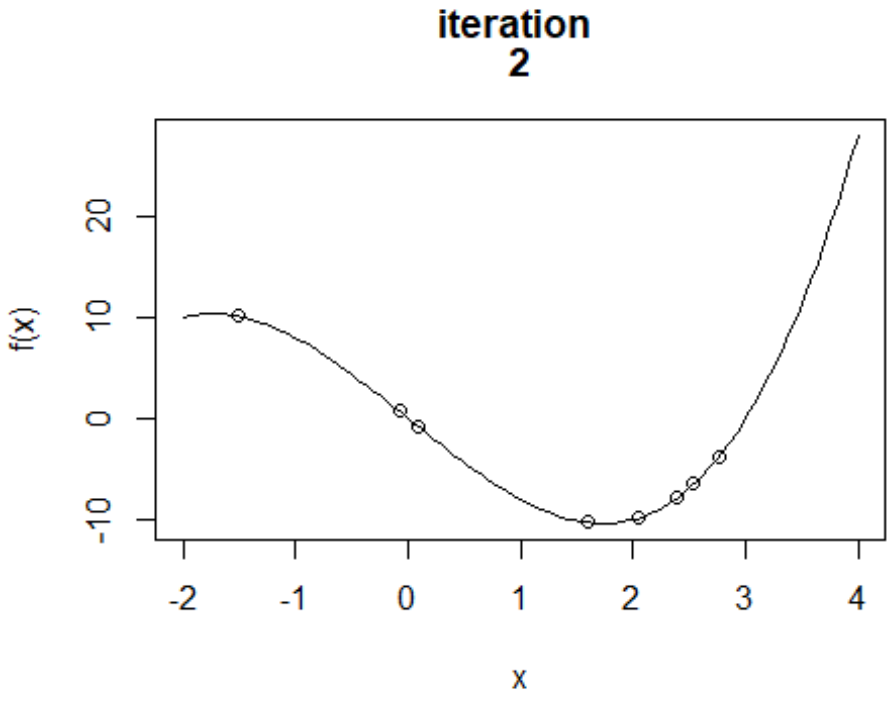

```
## best x value:  -8.493187e-17
## minimum:  7.213423e-33
```

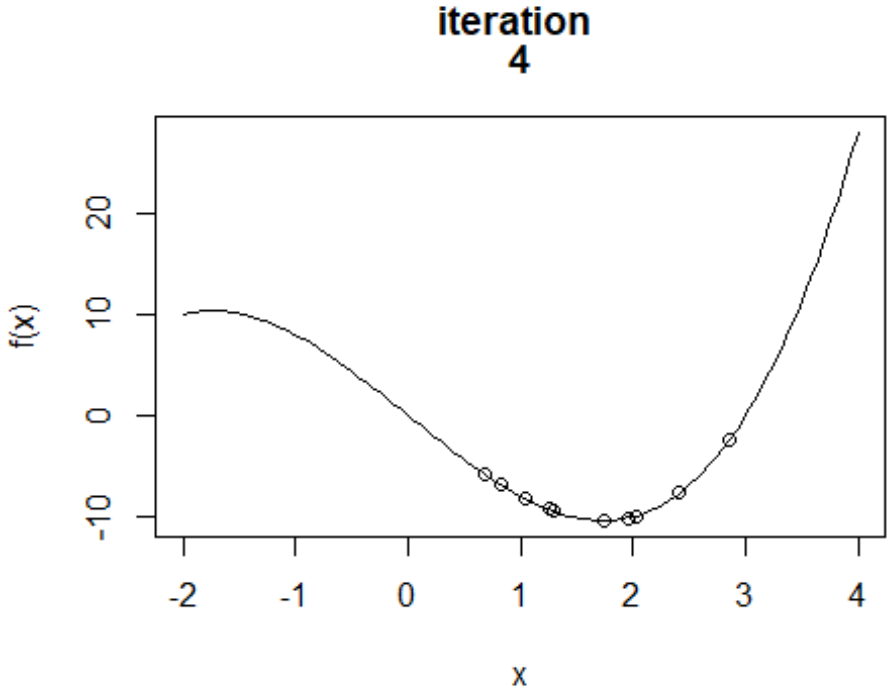
```r
#more complex function
f <- function(x){
  return(x^3 - 9*x)
}
curve(f,-2,4)
```

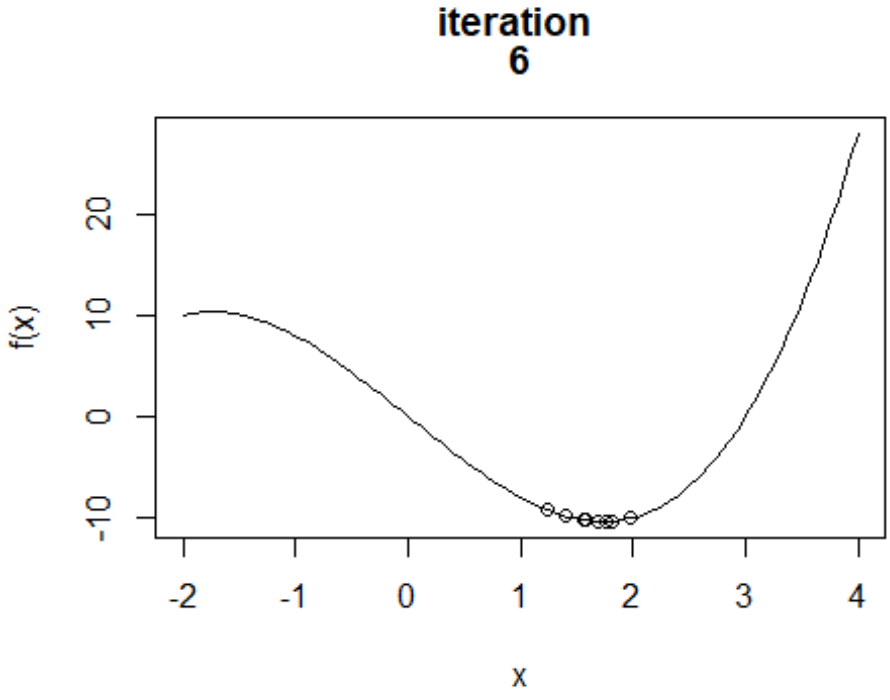


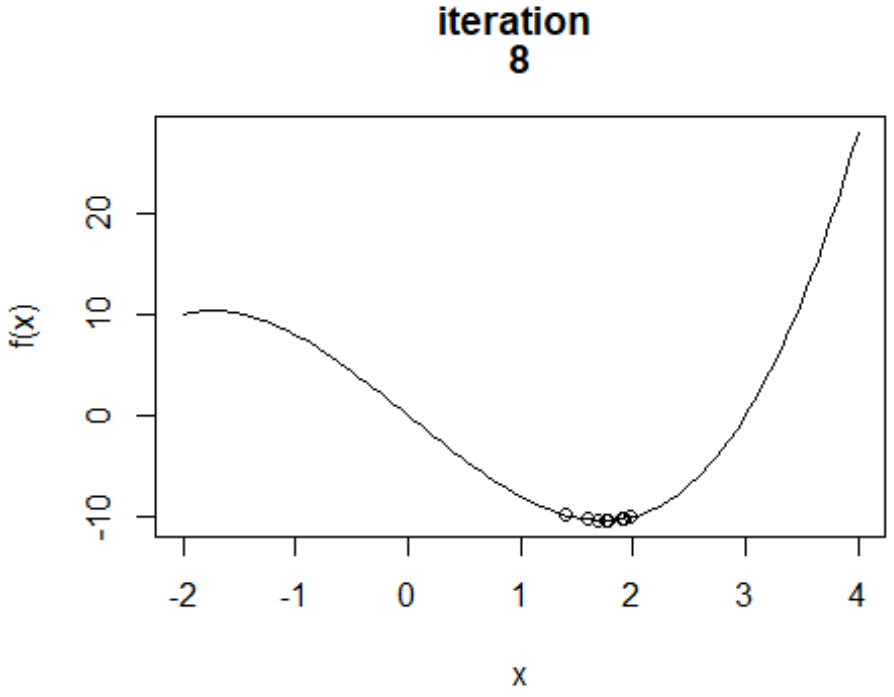

```r
swarm(10,-2,4,.5,.5,.5)
```

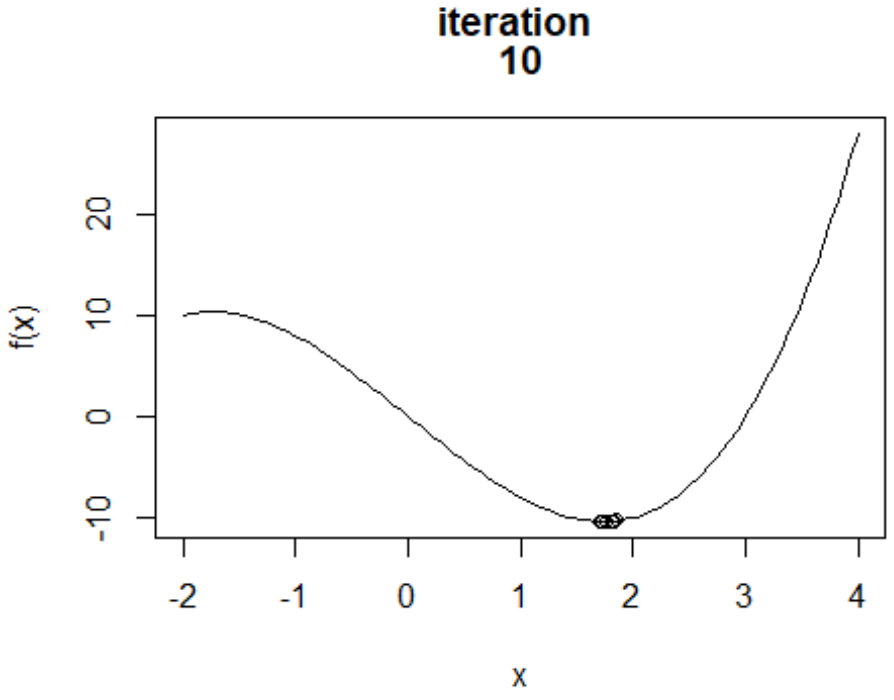

iteration
1
f(x)
20
10
0
-10
-2
-1
0
1
2
3
4
x

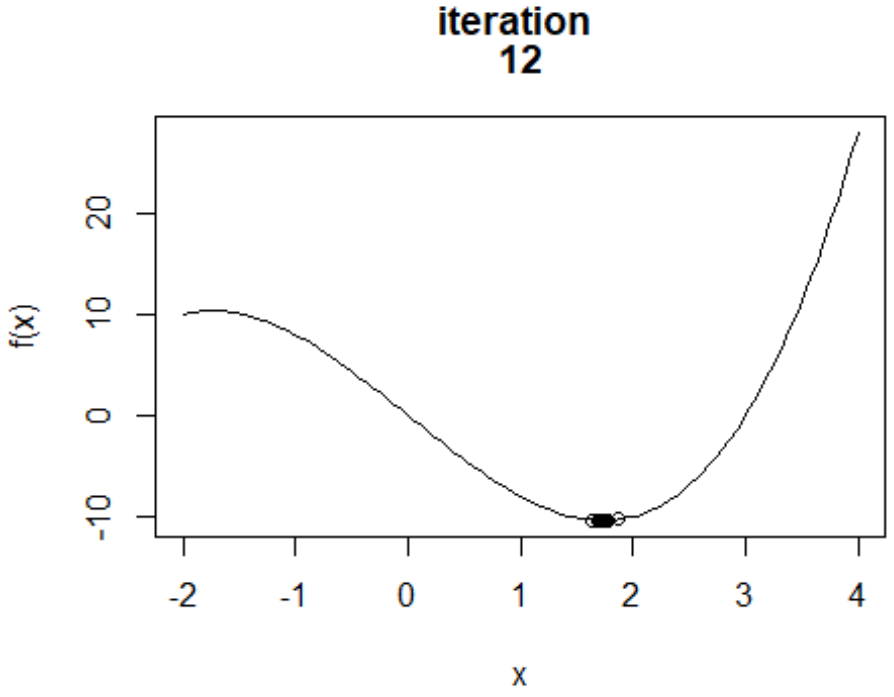

iteration
2
f(x)
20
10
0
-10
-2
-1
0
1
2
3
4
x

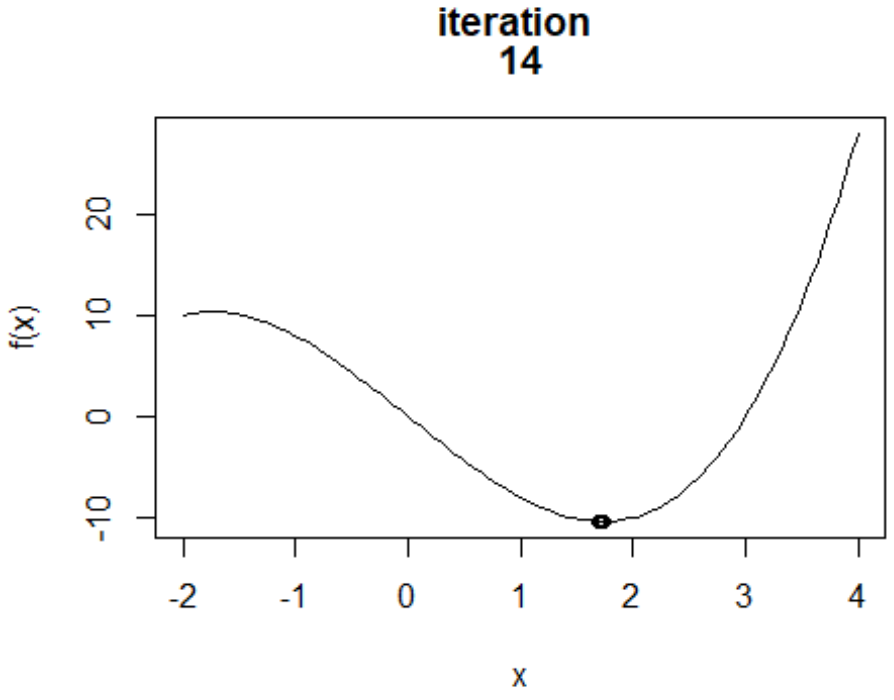

iteration
4
f(x)
20
10
0
-10
-2
-1
0
1
2
3
4
x

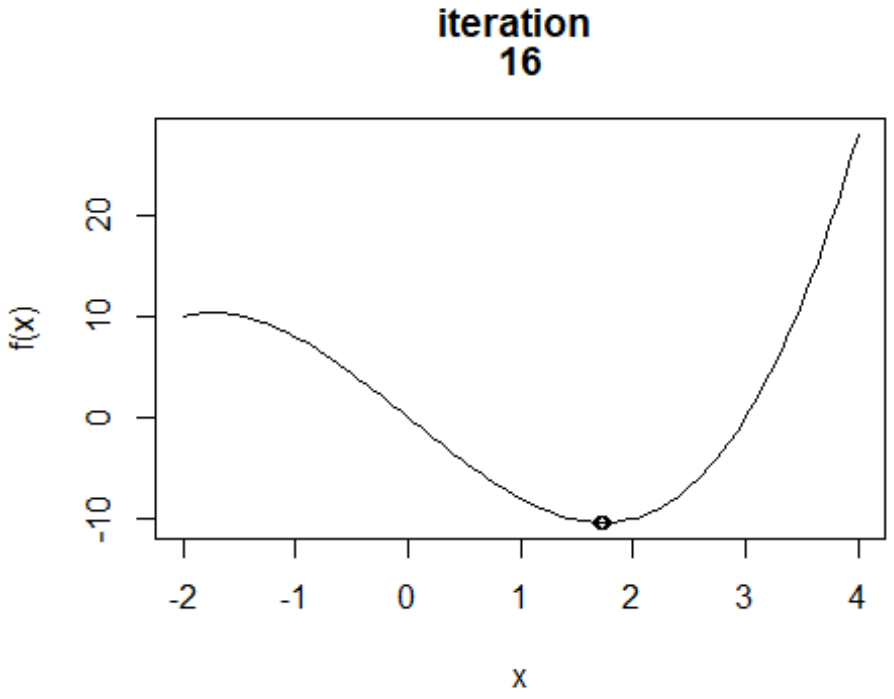

iteration
6
f(x)
20
10
0
-10
-2
-1
0
1
2
3
4
x

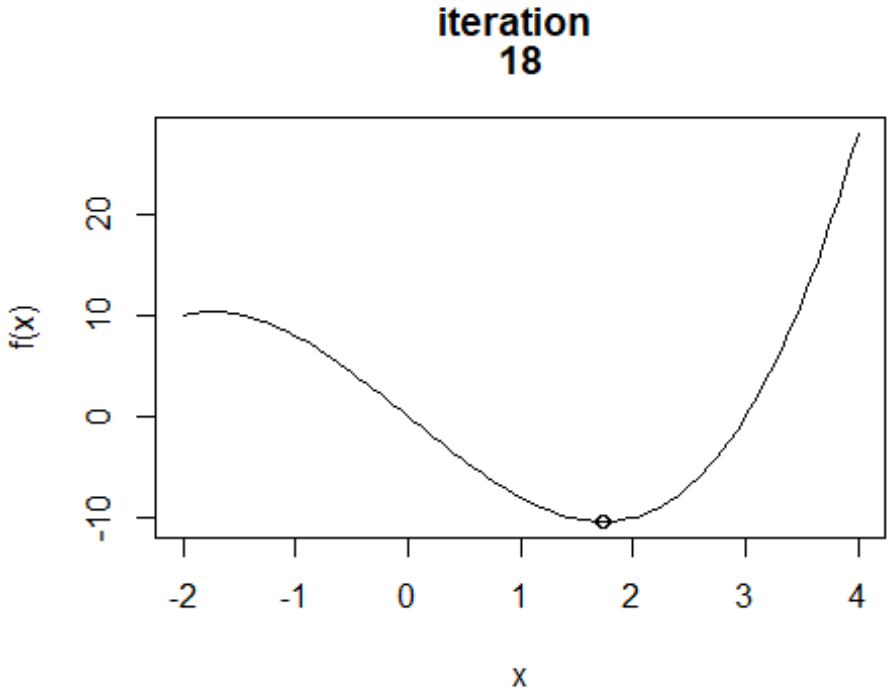

iteration
8
f(x)
20
10
0
-10
-2
-1
0
1
2
3
4
x


iteration
10
f(x)
20
10
0
-10
-2
-1
0
1
2
3
4
x


iteration
12
f(x)
20
10
0
-10
-2
-1
0
1
2
3
4
x


iteration
14
f(x)
20
10
0
-10
-2
-1
0
1
2
3
4
x

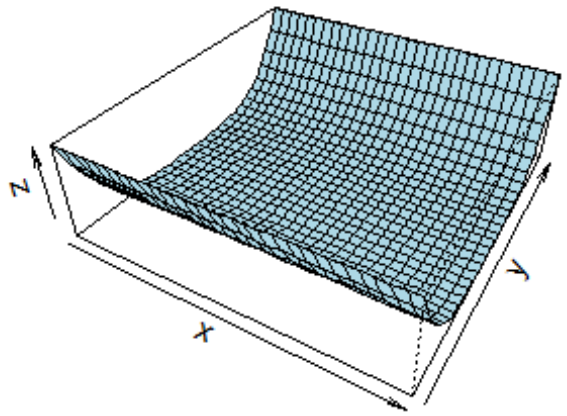





```
## best x value:  1.732051
## minimum:  -10.3923
```

```r
set.seed(1111)


swarm_nd <- function(S,n,lower, upper,omega,phiP,phiG){
  iterations <- 100
  best_swarm <- lower
  #particle positions
  x <- matrix(0,nrow = n,ncol = S)
  #particle best positions
  p <- matrix(0,nrow = n,ncol = S)
  #particle velocities
  v <- matrix(0,nrow = n,ncol = S)

  #for each particle i
  for (i in 1:S){
    #initial position
    for (k in 1:n){
      x[k,i] <- runif(1,lower[k],upper[k])
    }
    p[,i] <- x[,i]

    if(f(p[,i]) < f(best_swarm)){
      best_swarm <- p[,i]
    }

    #initial velocity
    for (k in 1:n){
      v[k,i] <- runif(1,-abs(upper[k]-lower[k]),abs(upper[k]-lower[k]))
    }
  }
  #print(x)
  #print(p)
  #print(v)
  #print(best_swarm)
  for(j in 1:iterations){

    for (i in 1:S){

      for (d in 1:n){
        rp <- runif(1,0,1)
        rg <- runif(1,0,1)

        v[,i] <- omega*v[,i] + phiP*rp*(p[,i]-x[,i]) + phiG*rg*(best_swarm-
x[,i])

      }


      x[,i] <- x[,i] + v[,i]
```

```
      if (f(x[,i]) < f(p[,i])){
        p[,i] <- x[,i]

        #update best position in the swarm
        if (f(p[,i]) < f(best_swarm)){
          best_swarm <- p[,i]
        }
      }
    }

  }
  cat("best x,y value: ",best_swarm,"\n")
  cat(2*best_swarm[1]^2 + 4*best_swarm[2]^2,"\n")
  cat("minimum: ",f(best_swarm),"\n")
  cat("\n")
  return(best_swarm)
}

f <- function(x,y){
  return((4 - x^2 - 2*y^2)^2)
}
x <- seq(-4,4,length = 30)
y <- seq(-100,100,length = 30)
z <- outer(x,y,f)
op <- par(bg= 'white')
persp(x, y, z, theta = 30, phi = 35, expand = 0.3, col = "lightblue")
```




```
f <- function(x){
  return((4 - x[1]^2 - 2*x[2]^2)^2)
}
best_swarm <- swarm_nd(100,2,c(-4,-4),c(4,100),.01,.01,.01)

## best x,y value:  -1.959869 -0.2895273
## 8.017478
## minimum:  7.636615e-05
```