

Package ‘particle.swarm.optimisation’

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Title Optimisation with Particle Swarm Optimisation

Version 1.0

Description A toolbox to create a particle swarm optimisation (PSO), the package contains two classes: the Particle and the Particle Swarm, this two class is used to run the PSO with methods to easily print, plot and save the result.

License GPL-3

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Contents

Particle	2
ParticleSwarm	4
Index	10

Particle

Particle

Description

Class for the Particles used in the Particle Swarm Optimisation, It is call by the Particle Swarm object to make the population.

Active bindings

values_ranges (list) max and min for each value of the particle

values (numeric) values of the particle (his position in space)

fitness (numeric) fitness of the particle (his score)

fitness_function (function) function used to find the fitness

personal_best_values (numeric) Best values of the particle

personal_best_fitness (numeric) Fitness of the best values

velocity (numeric) Velocity of the particle (one velocity for each values)

acceleration_coefficient (numeric) coefficient c1 and c2 (for personal and global best)

inertia (numeric) inertia of the particle

Methods

Public methods:

- `Particle$new()`
- `Particle$get_fitness()`
- `Particle$update()`
- `Particle$update_personal_best_fitness()`
- `Particle$print()`
- `Particle$clone()`

Method new(): Create a new Particle object.

Usage:

```
Particle$new(
  values_ranges,
  values,
  fitness_function,
  acceleration_coefficient,
  inertia
)
```

Arguments:

values_ranges range for each value of the particle (min and max), his size need to be the same as values. (List)

values, values of the particles. (numeric)
 fitness_function function used to test the Particle and find his fitness. (function)
 acceleration_coefficient a vector of two values, one for c1 (the personal coefficient), and one for c2 (the global coefficient). (numeric)
 inertia The inertia of the particle (the influence of the previous velocity on the next velocity). (numeric)

Returns: A new Particle object.

Method get_fitness(): Calculate the fitness of the particle with the fitness function and save it in self\$fitness

Usage:

Particle\$get_fitness()

Returns: self

Method update(): Update Particle's position and velocity.

Usage:

Particle\$update(swarm_best)

Arguments:

swarm_best the best values of the swarm used to update the velocity

Returns: self

Method update_personal_best_fitness(): Update the Particle's best values and fitness.

Usage:

Particle\$update_personal_best_fitness()

Returns: self

Method print(): print the current values of the particle and his fitness

Usage:

Particle\$print()

Method clone(): The objects of this class are cloneable with this method.

Usage:

Particle\$clone(deep = FALSE)

Arguments:

deep Whether to make a deep clone.

Examples

```
# If you use the Particle Swarm Object there is no need to manually create the Particle
# But if you want to use the Particle for another project:
```

```
# In this example we use the PSO to solve the following equation:
#  $a * 5 + b * 25 + 10 = 15$ 
```

```
fitness_function <- function(values){
```

```

    a <- values[1]
    b <- values[2]
    particule_result <- a*5 + b*25 + 10
    difference <- 15 - particule_result
    fitness <- 1 - abs(difference)
    return(fitness)
}

values_ranges <- list(c(-10^3,10^3),c(-10^3,10^3))

particle_example <- Particle$new(values_ranges = values_ranges,
                                values = c(0,0),
                                fitness_function = fitness_function,
                                acceleration_coefficient = c(0.5,0.5),
                                inertia = 0.4)

print(particle_example)
particle_example$get_fitness()
print(particle_example)
particle_example$update(c(10,25))
print(particle_example)

```

ParticleSwarm

Swarm

Description

Particle Swarm, used to launch the Particle Swarm Optimisation, The PSO is used to maximise the fitness.

Active bindings

pop_size (numeric) number of particles in the swarm
 ranges_of_values (list) range for each value for the particle
 values_names (list) list of names for each value (optionnal)
 pop (list) list of particle in the swarm
 fitness_function (function) fitness function used to find the fitness of the particle
 list_fitness (list) list of fitness of the particles
 max_it (numeric) maximum number of iteration
 acceleration_coefficient_range (list) coefficient c1 and c2 for the particles
 swarm_best_fitness (numeric) best fitness of the swarm
 swarm_best_values (numeric) values of the particle with the best fitness
 inertia (numeric) inertia of the particles

Methods

Public methods:

- `ParticleSwarm$new()`
- `ParticleSwarm$run()`
- `ParticleSwarm$generate_pop()`
- `ParticleSwarm$move_the_swarm()`
- `ParticleSwarm$save_pop()`
- `ParticleSwarm$plot_the_swarm_2D()`
- `ParticleSwarm$plot_the_swarm_3D()`
- `ParticleSwarm$print()`
- `ParticleSwarm$clone()`

Method `new()`: Create a new ParticleSwarm object.

Usage:

```
ParticleSwarm$new(
  pop_size,
  values_names,
  fitness_function,
  max_it,
  acceleration_coefficient_range,
  inertia,
  ranges_of_values
)
```

Arguments:

`pop_size` number of individu in the swarm. (numeric)
`values_names` list of names for each value (character)
`fitness_function` function used to test the Particle and find his fitness. (function)
`max_it` Maximum number of iteration for the PSO. (numeric)
`acceleration_coefficient_range` a vector of four values (min and max for c1 and c2) (numeric)
`inertia` The inertia for the particle (the influence of the previous velocity on the next velocity). (numeric)
`ranges_of_values` range for each value of the particle (min and max). (List)

Returns: A new ParticleSwarm object.

Examples:

```
# Create a ParticleSwarm object
swarm <- ParticleSwarm$new(pop_size=20,
                           values_names=c('a','b'),
                           max_it=20,
                           fitness_function = function(values){return(values[1]+values[2])},
                           acceleration_coefficient=list(c(0.5,1),c(0.5,1)),
                           inertia=0.5,
                           ranges_of_values=list(c(-100,100),c(-100,100)))
```

Method run(): Make the Particle Swarm Optimisation

Usage:

```
ParticleSwarm$run(
  verbose = TRUE,
  plot = TRUE,
  save_file = FALSE,
  dir_name = "PSO_pop"
)
```

Arguments:

verbose print the different step (iteration and individu)

plot plot the result of each iteration (only for 2D or 3D problem)

save_file save the population of each Iteration in a file and save the plot if plot=TRUE

dir_name name of the directory, default value is PSO_pop

Returns: self

Examples:

```
# Create a ParticleSwarm object
swarm <- ParticleSwarm$new(pop_size=20,
  values_names=c('a','b'),
  max_it=20,
  fitness_function = function(values){return(values[1]+values[2])},
  acceleration_coefficient=list(c(0.5,1),c(0.5,1)),
  inertia=0.5,
  ranges_of_values=list(c(-100,100),c(-100,100)))

# run the PSO
swarm$run(verbose = FALSE,
  plot = FALSE,
  save_file = FALSE)

# return the best result:
print(swarm$swarm_best_values)
```

Method generate_pop(): create the population of the swarm (this method is automatically called by the run method)

Usage:

```
ParticleSwarm$generate_pop(verbose = TRUE)
```

Arguments:

verbose print the advancement or not

Returns: self

Method move_the_swarm(): The method used to change the location of each particle (this method is automatically called by the run method)

Usage:

```
ParticleSwarm$move_the_swarm(verbose)
```

Arguments:

verbose print or not the advancement

Returns: self

Method `save_pop()`: The method used to save the values and fitness of the population in a CSV file (this method is automatically called by the run method if you have chosen to save the result)

Usage:

```
ParticleSwarm$save_pop(nb_it, dir_name)
```

Arguments:

`nb_it` number of the iteration, used to create the name of the csv file

`dir_name` Name of the directory

Returns: self

Method `plot_the_swarm_2D()`: method used to plot a 2D plot (this method is automatically called by the run method if you have chosen to plot the swarm)

Usage:

```
ParticleSwarm$plot_the_swarm_2D(nb_it, save_file)
```

Arguments:

`nb_it` number of the iteration used to save the plot as a png

`save_file` save the plot as a file

Returns: self

Method `plot_the_swarm_3D()`: method used to plot a 3D plot

Usage:

```
ParticleSwarm$plot_the_swarm_3D(nb_it, save_file)
```

Arguments:

`nb_it` number of the iteration used to save the plot as a png (this method is automatically called by the run method if you have chosen to plot the swarm)

`save_file` save the plot as a file

Returns: self

Method `print()`: Print the current result of the population

Usage:

```
ParticleSwarm$print()
```

Method `clone()`: The objects of this class are cloneable with this method.

Usage:

```
ParticleSwarm$clone(deep = FALSE)
```

Arguments:

`deep` Whether to make a deep clone.

Examples

```
# In this example we use the PSO to solve the following equation:
#  $a * 5 + b * 25 + 10 = 15$ 

fitness_function <- function(values){
  a <- values[1]
  b <- values[2]
  particule_result <- a*5 + b*25 + 10
  difference <- 15 - particule_result
  fitness <- 1 - abs(difference)
  return(fitness)
}

values_ranges <- list(c(-10^3,10^3),c(-10^3,10^3))

swarm <- ParticleSwarm$new(pop_size = 200,
                           values_names = list("a","b"),
                           fitness_function = fitness_function,
                           max_it = 75,
                           acceleration_coefficient_range = list(c(0,1),c(0,1)),
                           inertia = 0.5,
                           ranges_of_values = values_ranges)

swarm$run(plot = FALSE,verbose = FALSE,save_file = FALSE)
# the solution is :
swarm$swarm_best_values
swarm$swarm_best_values[[1]]*5 + swarm$swarm_best_values[[2]] *25 + 10

## -----
## Method `ParticleSwarm$new`
## -----

# Create a ParticleSwarm object
swarm <- ParticleSwarm$new(pop_size=20,
                           values_names=c('a','b'),
                           max_it=20,
                           fitness_function = function(values){return(values[1]+values[2])},
                           acceleration_coefficient=list(c(0.5,1),c(0.5,1)),
                           inertia=0.5,
                           ranges_of_values=list(c(-100,100),c(-100,100)))

## -----
## Method `ParticleSwarm$run`
## -----

# Create a ParticleSwarm object
swarm <- ParticleSwarm$new(pop_size=20,
                           values_names=c('a','b'),
                           max_it=20,
                           fitness_function = function(values){return(values[1]+values[2])},
                           acceleration_coefficient=list(c(0.5,1),c(0.5,1)),
                           inertia=0.5,
                           ranges_of_values=list(c(-100,100),c(-100,100)))
```



```
# run the PSO
swarm$run(verbose = FALSE,
          plot = FALSE,
          save_file = FALSE)
# return the best result:
print(swarm$swarm_best_values)
```

Index

Particle, [2](#)

ParticleSwarm, [4](#)