Matlab 自带 PSO (只能求 fmin)

定义自变量个数与定义域

```
nvars = 2; % 自变量个数
x_lb = [-15 -15];
x_ub = [15 15];
```

求解 Obj_fun 函数

```
[x, fval, exitflag, output] = particleswarm(@Obj_fun, nvars, x_lb, x_ub);
```

```
Optimization ended: relative change in the objective value
over the last OPTIONS.MaxStallIterations iterations is less than OPTIONS.FunctionTolerance.
```

绘制最佳的函数值随迭代次数的变化图

```
options = optimoptions("particleswarm", "PlotFcn", "pswplotbestf");
[x, fval, exitflag, output] = particleswarm(@Obj_fun, narvs, x_lb, x_ub, options);
```

```
Optimization ended: relative change in the objective value
over the last OPTIONS.MaxStallIterations iterations is less than OPTIONS.FunctionTolerance.
```
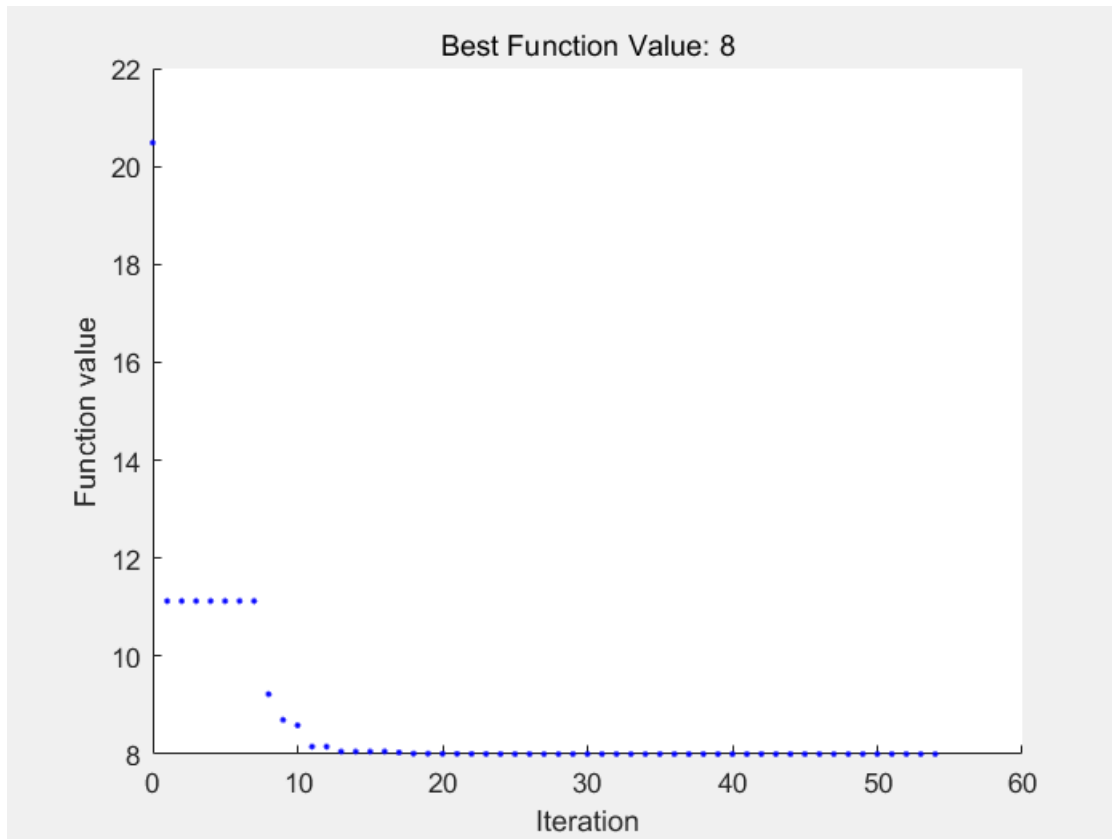

展示函数迭代过程

```
options = optimoptions("particleswarm","Display","iter");
[x, fval, exitflag, output] = particleswarm(@Obj_fun, nvars, x_lb, x_ub, options);
```

Iteration	f-count	Best f(x)	Mean f(x)	Stall Iterations
0	20	13.06	172.4	0
1	40	13.06	387	0
2	60	13.06	169.2	1
3	80	9.277	152.7	0
4	100	8.875	129.6	0
5	120	8.875	159.9	1
6	140	8.575	94.48	0
7	160	8.575	137.6	1
8	180	8.575	104.9	2
9	200	8.575	159.4	3
10	220	8.066	88.56	0
11	240	8.066	143.8	1
12	260	8.066	99.84	2
13	280	8.066	165.2	3
14	300	8.066	145.5	4
15	320	8.066	75.49	5
16	340	8.061	34.99	0
17	360	8.061	21.69	1
18	380	8.025	14.34	0
19	400	8	9.42	0
20	420	8	8.432	1
21	440	8	8.201	0
22	460	8	8.058	0
23	480	8	8.008	1
24	500	8	8.002	0
25	520	8	8	0
26	540	8	8	0
27	560	8	8	0
28	580	8	8	1
29	600	8	8	0
30	620	8	8	0

Iteration	f-count	Best f(x)	Mean f(x)	Stall Iterations
31	640	8	8	1
32	660	8	8	2
33	680	8	8	3
34	700	8	8	0
35	720	8	8	1
36	740	8	8	0
37	760	8	8	1
38	780	8	8	2
39	800	8	8	3
40	820	8	8	4
41	840	8	8	5

Optimization ended: relative change in the objective value
over the last OPTIONS.MaxStallIterations iterations is less than OPTIONS.FunctionTolerance.

修改粒子数量

```matlab
% 默认为 min(100, 10*nvars)
options = optimoptions("particleswarm","SwarmSize", 50);
[x, fval, exitflag, output] = particleswarm(@Obj_fun, nvars, x_lb, x_ub, options);
```

Optimization ended: relative change in the objective value
over the last OPTIONS.MaxStallIterations iterations is less than OPTIONS.FunctionTolerance.

算法结束后调用其他函数混合求解

```
% 算法结束后调用 fmincon 继续求解
options = optimoptions("particleswarm","HybridFcn","fmincon");
[x, fval, exitflag, output] = particleswarm(@Obj_fun, nvars, x_lb, x_ub, options);
```

Optimization ended: relative change in the objective value
over the last OPTIONS.MaxStallIterations iterations is less than OPTIONS.FunctionTolerance.

设置最大迭代次数

```
options = optimoptions("particleswarm","MaxIterations", 1000);
[x, fval, exitflag, output] = particleswarm(@Obj_fun, nvars, x_lb, x_ub, options);
```

Optimization ended: relative change in the objective value
over the last OPTIONS.MaxStallIterations iterations is less than OPTIONS.FunctionTolerance.

邻域内粒子比例

```
% 默认 0.25
options = optimoptions("particleswarm","MinNeighborsFraction", 0.2);
[x, fval, exitflag, output] = particleswarm(@Obj_fun, nvars, x_lb, x_ub, options);
```

Optimization ended: relative change in the objective value
over the last OPTIONS.MaxStallIterations iterations is less than OPTIONS.FunctionTolerance.

函数容忍度

```
% 默认 1e-6
options = optimoptions("particleswarm","FunctionTolerance", 1e-8);
[x, fval, exitflag, output] = particleswarm(@Obj_fun, nvars, x_lb, x_ub, options);
```

Optimization ended: relative change in the objective value
over the last OPTIONS.MaxStallIterations iterations is less than OPTIONS.FunctionTolerance.

最大停滞迭代次数

```
% 默认 20
options = optimoptions("particleswarm","MaxStallIterations", 30);
[x, fval, exitflag, output] = particleswarm(@Obj_fun, nvars, x_lb, x_ub, options);
```

Optimization ended: relative change in the objective value
over the last OPTIONS.MaxStallIterations iterations is less than OPTIONS.FunctionTolerance.

上述 options 可叠加在 同一个 options 中

```
% 如：
options = optimoptions("particleswarm","MaxStallIterations", 30,"FunctionTolerance",1e-8);
```

函数定义

```
function y = Obj_fun(x)
    y = x(1)^2 + x(2)^2 - x(1)*x(2) - 10*x(1) - 4*x(2) + 60;
    % 可考虑增加惩罚项 来构造约束条件
```

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```
end
```