YUKI Algorithm test functions

UNIMODAL

Sphere Function

$$f_1(\mathrm{x}) = f(x_1, x_2, \ldots, x_n) = \sum_{i=1}^{n} x_i^2$$
`f(\textbf{x}) = f(x_1, x_2, ..., x_n) = {\sum_{i=1}^{n} x_i^{2}}`

Powell Sum Function

$$f_2(\mathbf{x}) = f(x_1, \ldots, x_n) = \sum_{i=1}^{n} i x_i^2$$
`f(\mathbf{x})=f(x_1, ..., x_n)=\sum_{i=1}^{n}|x_i|^{i+1}`

Ridge Function

$$f_3(\mathrm{x}) = x_1 + d(\sum_{i=2}^{n} x_i^2)^{\alpha}$$
`f(\textbf{x}) = x_1 + d\left(\sum_{i=2}^{n}x_i^2\right)^\alpha`

Brown Function

$$f_4(x) = \sum_{i=1}^{29} (x_i^2)^{(x_{i+1}^2+1)} + (x_{i+1}^2)^{(x_i^2+1)}$$
`f(\textbf{x}) = \sum_{i=1}^{n-1}(x_i^2)^{(x_{i+1}^{2}+1)}+(x_{i+1}^2)^{(x_{i}^{2}+1)}`

Exponential Function

$$f_5(\mathbf{x}) = f(x_1, \ldots, x_{30}) = -exp(-0.5 \sum_{i=1}^{30} x_i^2)$$
`f(\mathbf{x})=f(x_1, ..., x_n)=-exp(-0.5\sum_{i=1}^{n}x_i^2)`

Xin-She Yang N. 3 Function

$f_6(x) = f(x_1, \ldots, x_{30}) = exp(-\sum_{i=1}^{30}(x_i/15)^{10}) - 2exp\left(-\sum_{i=1}^{30} x_i^2\right)\prod_{i=1}^{30} cos^2(x_i)$
f(\mathbf x)=f(x_1, ..., x_n) =exp(-\sum_{i=1}^{n}(x_i / \beta)^{2m}) - 2exp(-\sum_{i=1}^{n}x_i^2) \prod_{i=1}^{n}cos^ 2(x_i)

Zakharov Function

$f_7(x) = f_7(x_1, \ldots, x_{30}) = \sum_{i=1}^{30} x_i^2 + (\sum_{i=1}^{30} 0.5ix_i)^2 + (\sum_{i=1}^{30} 0.5ix_i)^4$
f(\textbf{x})=f(x_1, ..., x_n)=\sum_{i=1}^n x_i^{2}+(\sum_{i=1}^n 0.5ix_i)^2 + (\sum_{i=1}^n 0.5ix_i)^4

Schwefel 2.20 Function

$f_8(x) = f(x_1, \ldots, x_{30}) = \sum_{i=1}^{30} \lvert x_i \rvert$
f(\mathbf x)=f(x_1, ..., x_n)=\sum_{i=1}^n |x_i|

Schwefel 2.21 Function

$f_9(x) = f(x_1, \ldots, x_{30}) = \max_{i=1,\ldots,30} \lvert x_i \rvert$
f(\mathbf{x})=f(x_1, ..., x_n)=\max_{i=1,...,n}|x_i|

Schwefel 2.22 Function

$f_{10}(x) = f(x_1, \ldots, x_{30}) = \sum_{i=1}^{30} \lvert x_i \rvert + \prod_{i=1}^{30} \lvert x_i \rvert$
f(\mathbf{x})=f(x_1, ..., x_n)=\sum_{i=1}^{n}|x_i|+\prod_{i=1}^{n}|x_i|

MULTIMODAL

Rosenbrock Function

$f_{11}(x) = f_{11}(x_1, \ldots, x_{30}) = \sum_{i=1}^{29}[100(x_{i+1} - x_i^2)^2 + (x_i - 1)^2]$
`f(x, y)=\sum_{i=1}^{n}[b (x_{i+1} - x_i^2)^ 2 + (a - x_i)^2]`

Schwefel Function

$f_{12}(x) = f_{12}(x_1, x_2, \ldots, x_{30}) = \sum_{i=1}^{30} -x_i sin(\sqrt{\lvert x_i \rvert})$
`f(\textbf{x}) = f(x_1, x_2, ..., x_n) = {\sum_{i=1}^{n} -x_i sin(\sqrt{|x_i|})}`

Rastrigin Function

$f_{13}(x) = f_{13}(x_1, x_2, \ldots, x_{30}) = \sum_{i=1}^{30}[x_i^2 - 10cos(2\pi x_i) + 10]$
`f(x, y)=10n + \sum_{i=1}^{n}(x_i^2 - 10cos(2\pi x_i))`

Xin-She Yang N. 2 Function

$f_{14}(x) = f(x_1, \ldots, x_{30}) = (\sum_{i=1}^{30} \lvert x_i \rvert) exp(-\sum_{i=1}^{30} sin(x_i^2))$
`f(\mathbf{x})=f(x_1, ..., x_n)=(\sum_{i=1}^{n}|x_i|)exp(-\sum_{i=1}^{n}sin(x_i^2))`

Xin-She Yang N. 4 Function

$f_{15}(x) = f(x_1, \ldots, x_{30}) = (\sum_{i=1}^{30} sin^2(x_i) - e^{-\sum_{i=1}^{30} x_i^2}) e^{-\sum_{i=1}^{30} sin^2\sqrt{\lvert x_i \rvert}}$
`f(\mathbf x)=f(x_1, ..., x_n)=\left(\sum_{i=1}^{n}sin^2(x_i)-e^{-\sum_{i=1}^{n}x_i^2}\right)e^{-\sum_{i=1}^{n}{sin^2\sqrt{|x_i|}}}`

Happy Cat Function

$f_{16}(x) = [(\|\|x\|\|^2 - 30)^2]^{\alpha} + \frac{1}{n}(\frac{1}{2}\|\|x\|\|^2 + \sum_{i=1}^{30} x_i) + \frac{1}{2}$
f(\textbf{x})=\left[\left(||\textbf{x}||^2 - n\right)^2\right]^\alpha + \frac{1}{n}\left(\frac{1}{2}||\textbf{x}||^2+\sum_{i=1}^{n}x_i\right)+\frac{1}{2}

Periodic Function

$f_{17}(x) = f(x_1 \ldots x_{30}) = 1 + \sum_{i=1}^{30} sin^2(x_i) - 0.1e^{(\sum_{i=1}^{30} x_i^2)}$
f(\textbf{x})=\left[\left(||\textbf{x}||^2 - n\right)^2\right]^\alpha + \frac{1}{n}\left(\frac{1}{2}||\textbf{x}||^2+\sum_{i=1}^{n}x_i\right)+\frac{1}{2}

Quartic Function

$f_{18}(x) = f(x_1, \ldots, x_{30}) = \sum_{i=1}^{30} ix_i^4 + \text{random}[0, 1]$
f(\mathbf{x})=f(x_1,...,x_n)=\sum_{i=1}^{n}ix_i^4+\text{random}[0,1]

Shubert 3 Function

$f_{19}(x) = f(x_1, \ldots, x_{30}) = \sum_{i=1}^{30} \sum_{j=1}^{5} jsin((j+1)x_i + j)$
f(\mathbf{x})=f(x_1, ...,x_n)=\sum_{i=1}^{n}{\sum_{j=1}^5{j sin((j+1)x_i+j)}}

Salomon Function

$f_{20}(x) = f(x_1, \ldots, x_{30}) = 1 - cos(2\pi \sqrt{\sum_{i=1}^{D} x_i^2}) + 0.1 \sqrt{\sum_{i=1}^{D} x_i^2}$
f(\mathbf x)=f(x_1, ..., x_n)=1-cos(2\pi\sqrt{\sum_{i=1}^{D}x_i^2})+0.1\sqrt{\sum_{i=1}^{D}x_i^2}

FIXED DIMENTIONS UNIMODAL

Three-Hump Camel Function

$$f_{21}(x,y) = 2x^2 - 1.05x^4 + \frac{x^6}{6} + xy + y^2$$
f(x,y)=2x^2-1.05x^4+\frac{x^6}{6}+xy+y^2

Drop-Wave Function

$$f_{22}(x,y) = -\frac{1 + cos(12\sqrt{x^2 + y^2})}{(0.5(x^2 + y^2) + 2)}$$
f(x, y) = - \frac{1 + cos(12\sqrt{x^{2} + y^{2}})}{(0.5(x^{2} + y^{2}) + 2)}

Leon Function

$$f_{23}(x,y) = 100(y - x^3)^2 + (1 - x)^2$$
f(x, y) = 100(y - x^{3})^2 + (1 - x)^2

Booth Function

$$f_{24}(x,y) = (x + 2y - 7)^2 + (2x + y - 5)^2$$
f(x,y)=(x+2y-7)^2+(2x+y-5)^2

Matyas Function

$$f_{25}(x,y) = 0.26(x^2 + y^2) - 0.48xy$$
f(x, y)=0.26(x^2+y^2) -0.48xy

Brent Function

$$f_{26}(x,y) = (x + 10)^2 + (y + 10)^2 + e^{-x^2 - y^2}$$
f(x, y) = (x + 10)^2 + (y + 10)^2 + e^{-x^2 - y^2}

Schaffer N. 1 Function

$$f_{27}(x,y) = 0.5 + \frac{sin^2(x^2+y^2)^2 - 0.5}{(1+0.001(x^2+y^2))^2}$$
`f(x, y)=0.5 + \frac{sin^2(x^2+y^2)^2-0.5}{(1+0.001(x^2+y^2))^2}`

Ackley N. 2 Function

$$f_{28}(x,y) = -200e^{-0.2\sqrt{x^2+y^2}}$$
`f(x, y) = -200e^{-0.2\sqrt{x^2 + y^2}}`

Bohachevskyn N. 1 Function

$$f_{29}(x,y) = x^2 + 2y^2 - 0.3cos(3\pi x) - 0.4cos(4\pi y) + 0.7$$
`f(x, y) = x^2 + 2y^2 -0.3cos(3\pi x)-0.4cos(4\pi y)+0.7`

Schaffer N. 4 Function

$$f_{30}(x,y) = 0.5 + \frac{cos^2(sin(\lvert x^2 - y^2 \rvert)) - 0.5}{(1+0.001(x^2+y^2))^2}$$
`f(x, y)=0.5 + \frac{cos^2(sin(|x^2-y^2|))-0.5}{(1+0.001(x^2+y^2))^2}`

FIXED DIMENTIONS MULTIMODAL

Keane Function

$f_{31}(x,y) = -\frac{sin^2(x-y)sin^2(x+y)}{\sqrt{x^2+y^2}}$
`f(x,y)=-\frac{\sin^2(x-y)\sin^2(x+y)}{\sqrt{x^2+y^2}}`

Levi N. 13 Function

$f_{32}(x,y) = sin^2(3\pi x) + (x-1)^2(1+sin^2(3\pi y)) + (y-1)^2(1+sin^2(2\pi y))$
`f(x, y) = sin^2(3\pi x)+(x-1)^2(1+sin^2(3\pi y))+(y-1)^2(1+sin^2(2\pi y))`

Bukin N. 6 Function

$f_{33}(x,y) = 100\sqrt{\lvert y-0.01x^2\rvert} + 0.01\lvert x+10\rvert$
`f(x,y)=100\sqrt{|y-0.01x^2|}+0.01|x+10|`

Holder-Table Function

$f_{34}(x,y) = -\lvert sin(x)cos(y)exp(\lvert 1-\frac{\sqrt{x^2+y^2}}{\pi}\rvert)\rvert$
`f(x,y)=-|sin(x)cos(y)exp(|1-\frac{\sqrt{x^2+y^2}}{\pi}|)|`

Cross-in-Tray Function

$f_{35}(x,y) = -0.0001(\lvert sin(x)sin(y)exp(\lvert 100-\frac{\sqrt{x^2+y^2}}{\pi}\rvert)\rvert+1)^{0.1}$
`f(x,y)=-0.0001(|sin(x)sin(y)exp(|100-\frac{\sqrt{x^2+y^2}}{\pi}|)|+1)^{0.1}`

Wolfe Function

$f_{36}(x,y,z) = \frac{4}{3}(x^2+y^2-xy)^{0.75} + z$
`f(x, y, z) = \frac{4}{3}(x^2 + y^2 - xy)^{0.75} + z`

Egg Crate Function

$f_{37}(x,y) = x^2 + y^2 + 25(sin^2(x) + sin^2(y))$
`f(x,y)=x^2 + y^2 + 25(sin^2(x) + sin^2(y))`

McCormick Function

$f_{38}(x,y) = sin(x+y) + (x-y)^2 - 1.5x + 2.5y + 1$
`f(x, y)=sin(x + y) + (x - y) ^2 - 1.5x + 2.5 y + 1`

Deckkers-Aarts Function

$f_{39}(x,y) = 10^5x^2 + y^2 - (x^2 + y^2)^2 + 10^{-5}(x^2 + y^2)^4$
`f(x, y) = 10^5x^2 + y^2 -(x^2 + y^2)^2 + 10^{-5}(x^2 + y^2)^4`

Bartels Conn Function

$f_{40}(x,y) = \|x^2 + y^2 + xy\| + \|sin(x)\| + \|cos(y)\|$
`f(x,y)=|x^2 + y^2 + xy| + |sin(x)| + |cos(y)|`