**YUKI Algorithm test functions**

# UNIMODAL

# Sphere Function

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|  |
| f(\textbf{x}) = f(x\_1, x\_2, ..., x\_n) = {\sum\_{i=1}^{n} x\_i^{2}} |

# Powell Sum Function

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|  |
| f(\mathbf{x})=f(x\_1, ..., x\_n)=\sum\_{i=1}^{n}|x\_i|^{i+1} |

Ridge Function

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|  |
| f(\textbf{x}) = x\_1 + d\left(\sum\_{i=2}^{n}x\_i^2\right)^\alpha |

# Brown Function

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|   |
| 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

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|   |
| f(\mathbf{x})=f(x\_1, ..., x\_n)=-exp(-0.5\sum\_{i=1}^n{x\_i^2}) |

# Xin-She Yang N. 3 Function

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|  |
| 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

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|   |
| 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

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|   |
| f(\mathbf x)=f(x\_1, ..., x\_n)=\sum\_{i=1}^n |x\_i| |

# Schwefel 2.21 Function

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|   |
| f(\mathbf{x})=f(x\_1, ..., x\_n)=\max\_{i=1,...,n}|x\_i|  |

# Schwefel 2.22 Function

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|   |
| f(\mathbf{x})=f(x\_1, ..., x\_n)=\sum\_{i=1}^{n}|x\_i|+\prod\_{i=1}^{n}|x\_i| |

# MULTIMODAL

# Rosenbrock Function

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|   |
| f(x, y)=\sum\_{i=1}^{n}[b (x\_{i+1} - x\_i^2)^ 2 + (a - x\_i)^2] |

# Schwefel Function

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|   |
| f(\textbf{x}) = f(x\_1, x\_2, ..., x\_n) = {\sum\_{i=1}^{n} -x\_i sin(\sqrt{|x\_i|})} |

# Rastrigin Function

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|   |
| f(x, y)=10n + \sum\_{i=1}^{n}(x\_i^2 - 10cos(2\pi x\_i)) |

# Xin-She Yang N. 2 Function

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|   |
| 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

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|   |
| 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

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|   |
| 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

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|   |
| 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

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|  |
| f(\mathbf{x})=f(x\_1,...,x\_n)=\sum\_{i=1}^{n}ix\_i^4+\text{random}[0,1] |

# Shubert 3 Function

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|  |
| 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

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|  |
| 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

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

# Drop-Wave Function

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

# Leon Function

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|   |
| f(x, y) = 100(y − x^{3})^2 + (1 − x)^2 |

# Booth Function

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|  |
| f(x,y)=(x+2y-7)^2+(2x+y-5)^2 |

# Matyas Function

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|  |
| f(x, y)=0.26(x^2+y^2) -0.48xy |

# Brent Function

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| f(x, y) = (x + 10)^2 + (y + 10)^2 + e^{-x^2 - y^2} |

# Schaffer N. 1 Function

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| 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

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|  |
| f(x, y) = -200e^{-0.2\sqrt{x^2 + y^2}} |

# Bohachevskyn N. 1 Function

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| f(x, y) = x^2 + 2y^2 -0.3cos(3\pi x)-0.4cos(4\pi y)+0.7 |

# Schaffer N. 4 Function

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|  |
| 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

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|   |
| f(x,y)=-\frac{\sin^2(x-y)\sin^2(x+y)}{\sqrt{x^2+y^2}} |

# Levi N. 13 Function

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|   |
| 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

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|   |
| f(x,y)=100\sqrt{|y-0.01x^2|}+0.01|x+10| |

# Holder-Table Function

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|   |
| f(x,y)=-|sin(x)cos(y)exp(|1-\frac{\sqrt{x^2+y^2}}{\pi}|)| |

# Cross-in-Tray Function

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

# Wolfe Function

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

# Egg Crate Function

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| f(x,y)=x^2 + y^2 + 25(sin^2(x) + sin^2(y)) |

# McCormick Function

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| f(x, y)=sin(x + y) + (x - y) ^2 - 1.5x + 2.5 y + 1 |

# Deckkers-Aarts Function

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| f(x, y) = 10^5x^2 + y^2 -(x^2 + y^2)^2 + 10^{-5}(x^2 + y^2)^4 |

# Bartels Conn Function

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| f(x,y)=|x^2 + y^2 + xy| + |sin(x)| + |cos(y)| |