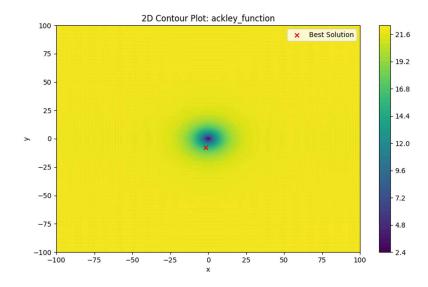
1 ACKLEY FUNCTION

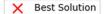
$$f(x,y) = -20 \exp \left[-0.2 \sqrt{0.5 (x^2 + y^2)} \, \right] \ - \exp [0.5 \left(\cos 2\pi x + \cos 2\pi y
ight)] + e + 20$$

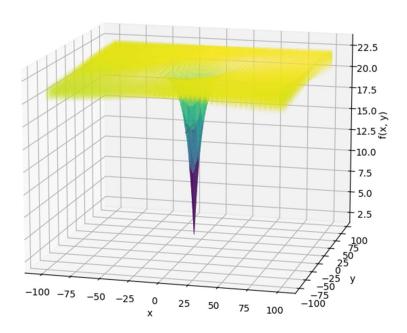
Best Solution: [-1.61391014 -7.97875332]

Best Value: 15.267744148600805



3D Surface Plot: ackley_function



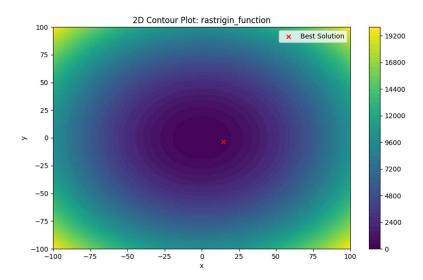


2 RASTRIGIN FUNCTION

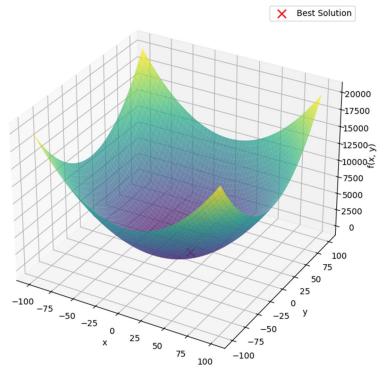
$$f(\mathbf{x}) = An + \sum_{i=1}^n \left[x_i^2 - A\cos(2\pi x_i)
ight]$$

Best Solution: [14.45896631 -3.54019899]

Best Value: 260.94690561070746



3D Surface Plot: rastrigin_function

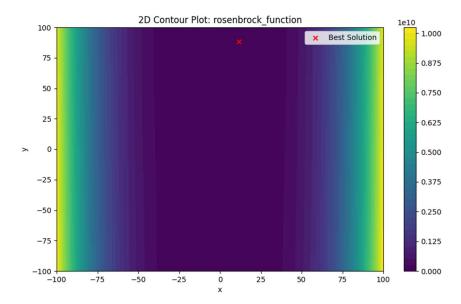


3 ROSENBROCK FUNCTION

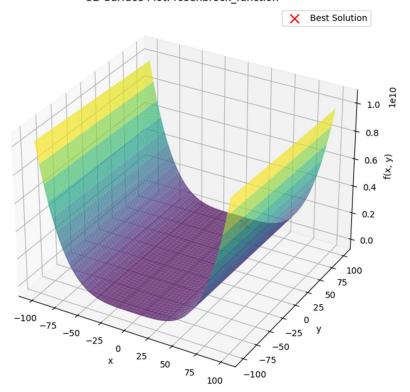
$$f(\mathbf{x}) = f(x_1, x_2, \dots, x_N) = \sum_{i=1}^{N/2} \left[100(x_{2i-1}^2 - x_{2i})^2 + (x_{2i-1} - 1)^2
ight]$$

Best Solution: [11.63927217 88.41616773]

Best Value: 221544.5100245819



3D Surface Plot: rosenbrock_function

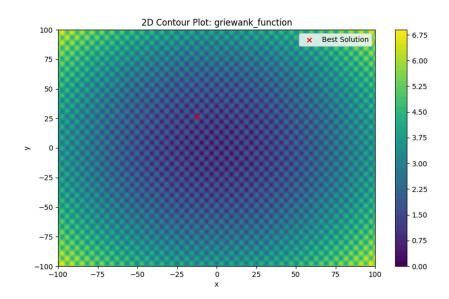


4 GRIEWANK FUNCTION

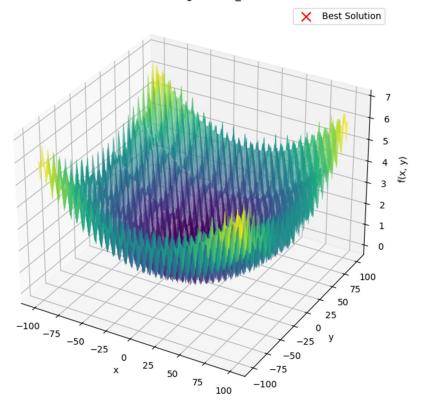
$$1 + rac{1}{4000} \sum_{i=1}^n x_i^2 - \prod_{i=1}^n \cos\!\left(rac{x_i}{\sqrt{i}}
ight)$$

Best Solution: [-12.22985343 26.53658234]

Best Value: 0.2729660804174685



3D Surface Plot: griewank_function

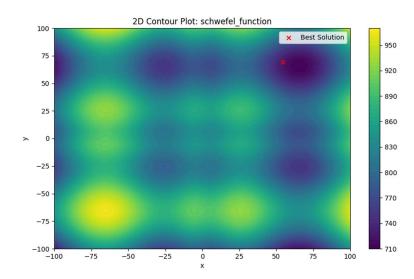


5 SCHWEFEL FUNCTION

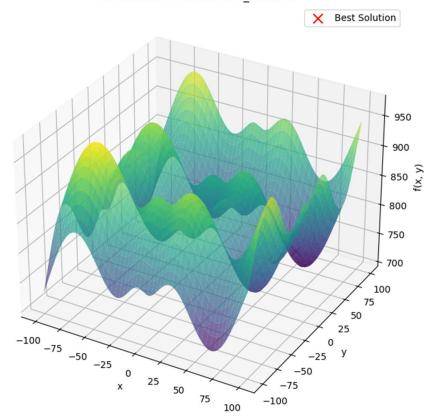
$$f(\mathbf{x}) = 418.9829d - \sum_{i=1}^{d} x_i \sin(\sqrt{|x_i|})$$

Best Solution: [54.46470822 69.42304082]

Best Value: 727.8651453669843



3D Surface Plot: schwefel_function

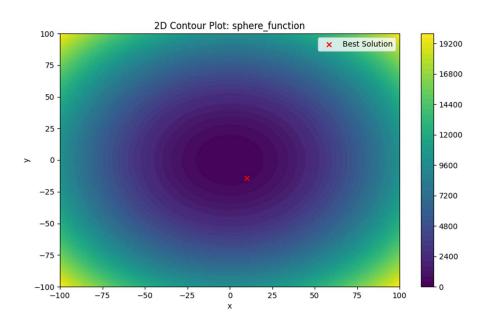


6 SPHERE FUNCTION

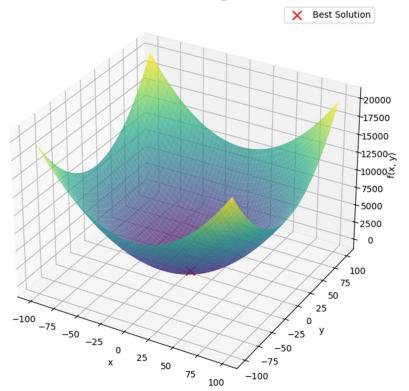
$$f(\mathbf{x}) = \sum_{i=1}^d x_i^2$$

Best Solution: [9.97590373 -14.3056945]

Best Value: 217.13057373859215



3D Surface Plot: sphere_function

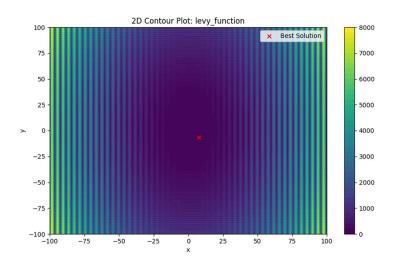


7 LEVY FUNCTION

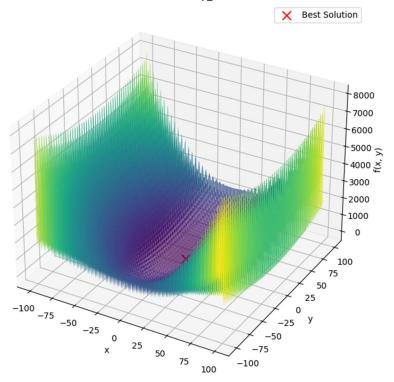
$$\begin{split} f(\mathbf{x}) &= \sin^2(\pi w_1) + \sum_{i=1}^{d-1} (w_i - 1)^2 \left[1 + 10 \sin^2(\pi w_i + 1) \right] + (w_d - 1)^2 \left[1 + \sin^2(2\pi w_d) \right], \text{ where} \\ w_i &= 1 + \frac{x_i - 1}{4}, \text{ for all } i = 1, \dots, d \end{split}$$

Best Solution: [7.71738644 -6.5086629]

Best Value: 8.77416151556682



3D Surface Plot: levy_function

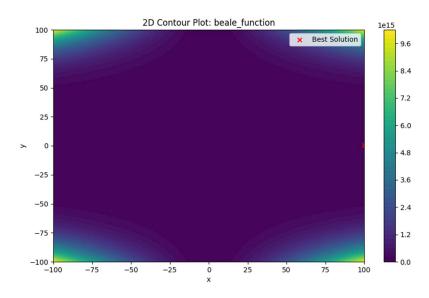


8 BEALE FUNCTION

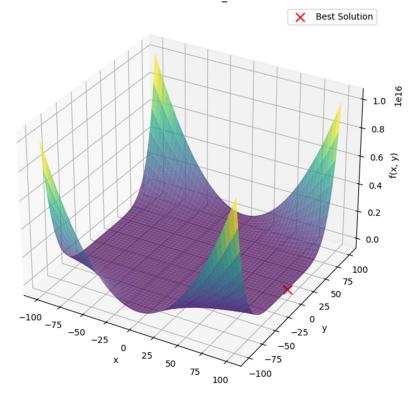
$$f(\mathbf{x}) = (1.5 - x_1 + x_1 x_2)^2 + (2.25 - x_1 + x_1 x_2^2)^2 + (2.625 - x_1 + x_1 x_2^3)^2$$

Best Solution: [100 0.38893169]

Best Value: 18750.30348157828



3D Surface Plot: beale_function

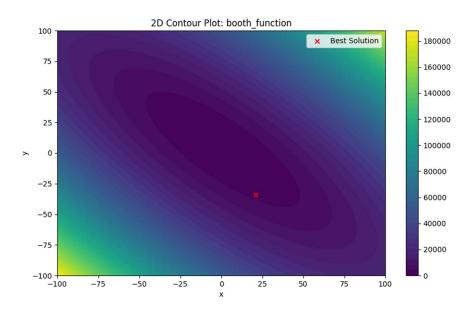


9 BOOTH FUNCTION

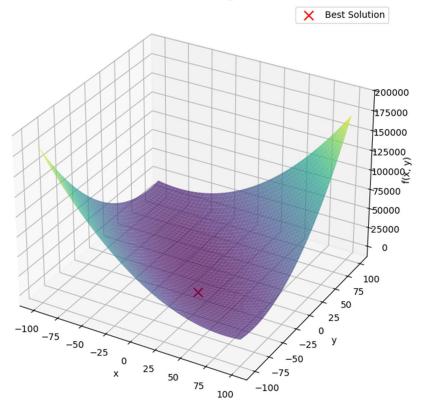
$$f(\mathbf{x}) = (x_1 + 2x_2 - 7)^2 + (2x_1 + x_2 - 5)^2$$

Best Solution: [20.93054271 -34.16784648]

Best Value: 2967.1739101552316



3D Surface Plot: booth_function

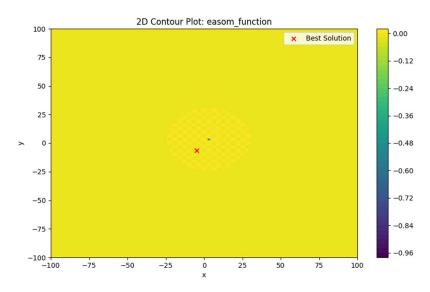


10 EASOM FUNCTION

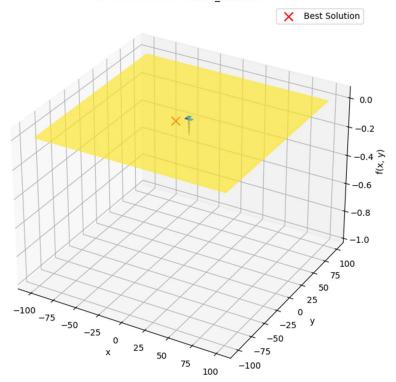
$$f(\mathbf{x}) = -\cos(x_1)\cos(x_2)\exp(-(x_1 - \pi)^2 - (x_2 - \pi)^2)$$

Best Solution: [-4.89221163 -6.49210949]

Best Value: -8.065241156970764e-70



3D Surface Plot: easom_function

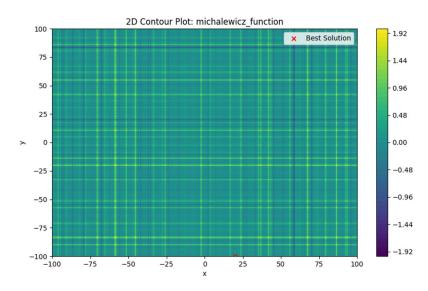


11 MICHALEWICZ FUNCTION

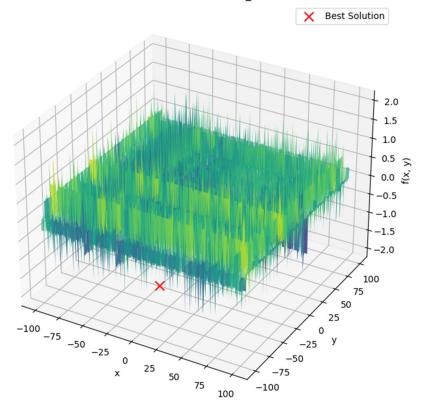
$$f(\mathbf{x}) = -\sum_{i=1}^{d} \sin(x_i) \sin^{2m} \left(\frac{ix_i^2}{\pi}\right)$$

Best Solution: [19.97375517 -100]

Best Value: -0.7764574059398142



3D Surface Plot: michalewicz_function

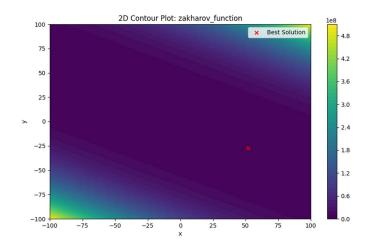


12 ZAKHAROV FUNCTION

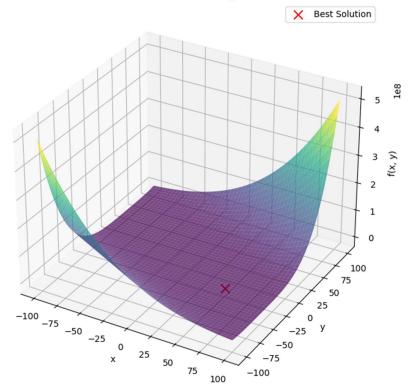
$$f(\mathbf{x}) = \sum_{i=1}^{d} x_i^2 + \left(\sum_{i=1}^{d} 0.5ix_i\right)^2 + \left(\sum_{i=1}^{d} 0.5ix_i\right)^4$$

Best Solution: [51.86824984 -27.24543573]

Best Value: 3437.3054494549297



3D Surface Plot: zakharov_function

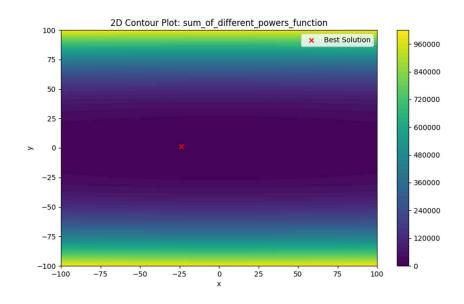


13 SUM OF DIFFERENT POWERS FUNCTION

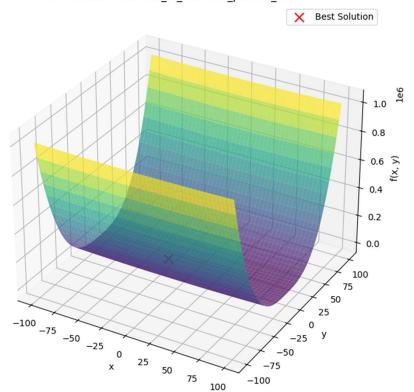
$$f(\mathbf{x}) = \sum_{i=1}^d |x_i|^{i+1}$$

Best Solution: [-23.99138899 1.18024345]

Best Value: 577.2307949410633



3D Surface Plot: sum_of_different_powers_function

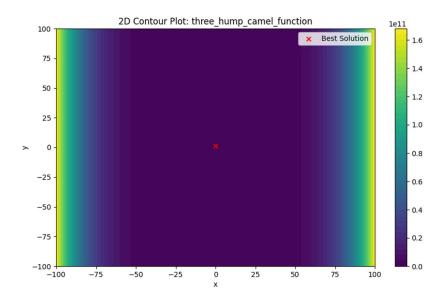


14 THREE-HUMP CAMEL FUNCTION

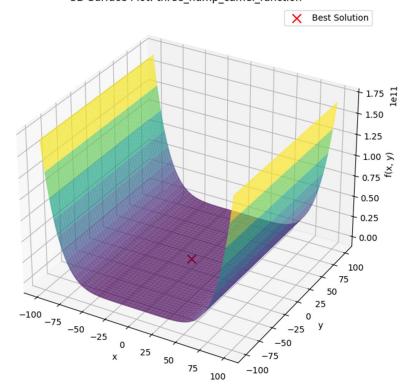
$$f(\mathbf{x}) = -\sum_{i=1}^{d} \sin(x_i) \sin^{2m}\left(\frac{ix_i^2}{\pi}\right)$$

Best Solution: [0.03216035 1.25172646]

Best Value: 1.6091425472282752



3D Surface Plot: three_hump_camel_function

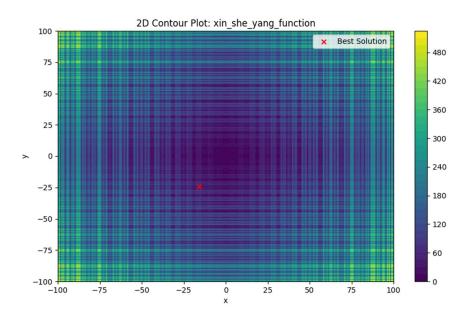


15 XIN-SHE YANG FUNCTION

$$f(x) = f(x_1, ..., x_n) = \sum_{i=1}^{n} (\epsilon_i(|x_i|)^i)$$

Best Solution: [-15.92800396 -24.42901163]

Best Value: 35.65343634033759



3D Surface Plot: xin_she_yang_function

