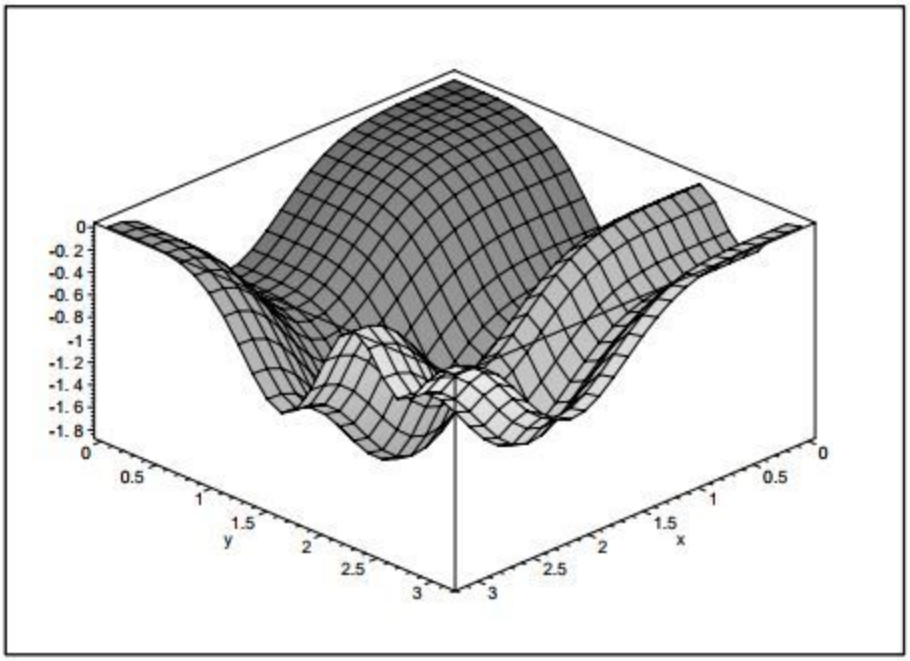
2.11 Michalewicz's function

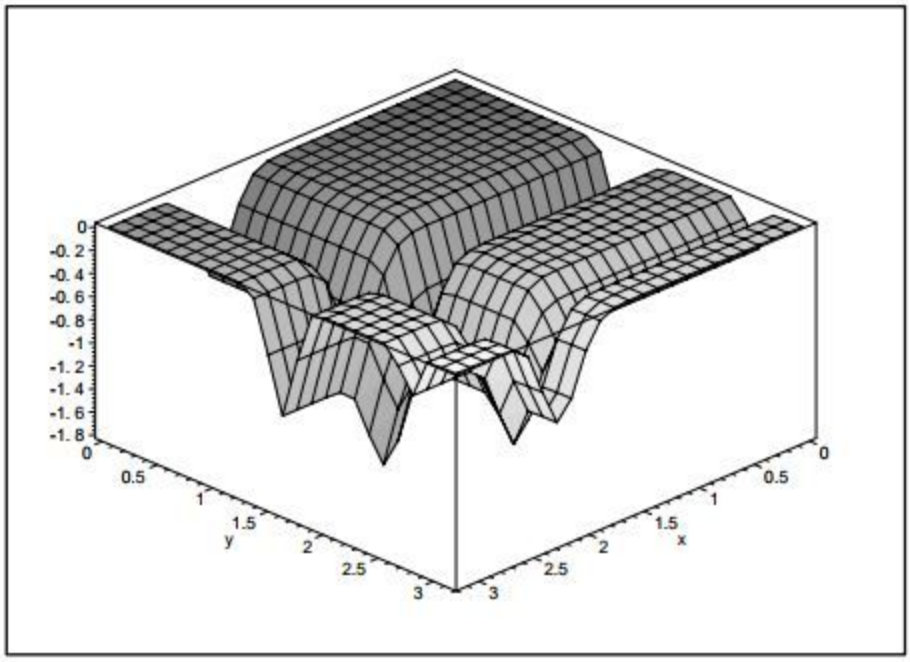
The Michalewicz function is a multimodal test function (owns $n!$ local optima). The parameter m defines the "steepness" of the valleys or edges. Larger m leads to more difficult search. For very large m the function behaves like a needle in the haystack (the function values for points in the space outside the narrow peaks give very little information on the location of the global optimum). Function has the following definition

$$f(x) = -\sum_{i=1}^{n} \sin(x_i) \left[\sin(\frac{ix_i^2}{\pi})\right]^{2m} \tag{11}$$

It is usually set $m = 10$. Test area is usually restricted to hyphercube $0 \leq x_i \leq \pi$, $i = 1, \ldots, n$. The global minimum value has been approximated by $f(x) = -4.687$ for $n = 5$ and by $f(x) = -9.66$ for $n = 10$. Respective optimal solutions are not given.



Rysunek 18: Michalewicz's function in 2D for $m = 1$, $f(x, y) = -\sin(x)(\sin(\frac{x^2}{\pi})^{2m} - \sin(y)(\sin(\frac{y^2}{\pi})^{2m}$



Rysunek 19: Michalewicz's function in 2D for $m = 10$, $f(x,y) = -\sin(x)(\sin(\frac{x^2}{\pi})^{2m} - \sin(y)(\sin(\frac{y^2}{\pi})^{2m}$

2.15 Six-hump camel back function

The Six-hump camel back function is a global optimization test function. Within the bounded region it owns six local minima, two of them are global ones. Function has only two variables and the following definition

$$f(x_1, x_2) = (4 - 2.1x_1^2 + \frac{x_1^4}{3})x_1^2 + x_1x_2 + (-4 + 4x_2^2)x_2^2. \tag{15}$$

Test area is usually restricted to the rectangle $-3 \leq x_1 \leq 3$, $-2 \leq x_2 \leq 2$. Two global minima equal $f(x) = -1.0316$ are located at $(x_1, x_2) = (-0.0898, 0.7126)$ and $(0.0898, -0.7126)$.

2.16 Fifth function of De Jong

This is a multimodal test function. The given form of function has only two variables and the following definition

$$f(x_1, x_2) = \{0.002 + \sum_{j=1}^{25} [j + (x_1 - a_{1j})^6 + (x_2 - a_{2j})^6]^{-1}\}^{-1}, \quad (16)$$

where

$$(a_{ij}) = \begin{pmatrix} -32 & -16 & 0 & 16 & 32 & -32 & \dots & 0 & 16 & 32 \\ -32 & -32 & -32 & -32 & -32 & -16 & \dots & 32 & 32 & 32 \end{pmatrix}$$

The function can also be rewritten as follows

$$f(x_1, x_2) = \{0.002 + \sum_{i=-2}^{2} \sum_{j=-2}^{2} [5(i+2) + j + 3 + (x_1 - 16j)^6 + (x_2 - 16i)^6]^{-1}\}^{-1}, \quad (17)$$

Test area is usually restricted to the square $-65.536 \leq x_1 \leq 65.536$, $-65.536 \leq x_2 \leq 65.536$.

2.17 "Drop wave" function

This is a multimodal test function. The given form of function has only two variables and the following definition

$$f(x_1, x_2) = -\frac{1 + \cos(12\sqrt{x^2 + x_2^2})}{\frac{1}{2}(x_1^2 + x_2^2) + 2} \quad (18)$$

Test area is usually restricted to the square $-5.12 \leq x_1 \leq 5.12$, $-5.12 \leq x_2 \leq 5.12$.

2.18 Shubert's function

This is a multimodal test function. The given form of function has only two variables and the following definition

$$f(x_1, x_2) = -\sum_{i=1}^{5} i \cos((i+1)x_1 + 1) \sum_{i=1}^{5} i \cos((i+1)x_2 + 1), \qquad (19)$$

Test area is usually restricted to the square $-5.12 \leq x_1 \leq 5.12$, $-5.12 \leq x_2 \leq 5.12$.