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Business Analytics & Machine Learning
Tutorial sheet 11: Convex Optimization

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January 3, 2024

Exercise T11.1 *Convex function*

You are given the following function:

$$f(x, y) = a \exp(3x) + \frac{b}{2}xy + y^2$$

Determine all parameters $a, b \in \mathbb{R}$ such that f is convex.

Exercise T11.2 *Operations preserve convexity*

You are given the following convex functions $g_1(x), g_2(x)$. Prove that the following functions are also convex functions:

- $h_1(x) = g_1(Ax + b)$ where A is a matrix and b is a vector.
- $h_2(x) = C_1 g_1(x) + C_2 g_2(x)$, where C_1 and C_2 are nonnegative constant.
- $h_3(x) = \max\{g_1(x), g_2(x)\}$.

Exercise T11.3 *Gradient descent*

You are given the following function:

$$f(x, y) = 2x^2 + 0.5y^2 - 3x - y - 2xy + 5$$

With starting point $z^{(1)} = (0, 0)$, conduct two steps of the gradient descent algorithm. Choose the step size α using line search.