CSE5004 Scientific Computation with Python

HW1. NumPy and Matplotlib

Due date: April 5, 2023

1. (Matrix Arithmetic)

   Let consider a matrix A and a vector b,

   $$A = \begin{bmatrix} 1 & 1 & -2 \\ 3 & 3 & -5 \\ 3 & 3 & -10 \\ 1 & 1 & -7 \\ -4 & -4 & 11 \end{bmatrix}, \quad b = \begin{bmatrix} 2 & 7 & 2 & -3 & -4 \end{bmatrix}.$$

   (1) Generate arrays for A matrix and b vector using NumPy library.

   (2) Transpose A and apply matrix multiplication with the original matrix $(A^T A)$.

   (3) Calculate x as the solution of $A^T A x = A^T b$.

   (4) Calculate the norm of $Ax - b$ with line-by-line coding and using NumPy library.

2. (Drawing Graphs)

   A two-dimensional Ackley function, $f(x, y)$, has many local minima and one global minimum in the domain, $(x, y) \in [-4, 4] \times [-4, 4]$.

   $$f(x, y) = -a \exp(-b\sqrt{0.5(x^2 + y^2)}) - \exp(0.5(\cos(cx) + \cos(cy))) + a + \exp(1)$$

   where $a = 20$, $b = 0.2$, and $c = 2\pi$.

   (1) Plot a 2D contour of the Ackley function on $(x, y) \in [-4, 4] \times [-4, 4]$.

   (2) Plot a 3D graph of the Ackley function on $(x, y) \in [-4, 4] \times [-4, 4]$.

   (3) Find the global minimum and its position.

   (4) Plot a graph for $f(y|x = -2)$, $f(y|x = 0)$, and $f(y|x = 2)$ in one plot with legends.

   (5) Plot the x-direction averaged one-dimensional graph and the y-direction averaged one-dimensional graph on the same canvas.