FRACTAL METHODS IN COMPUTER GRAPHICS
Assignments set 1

1. Implement two basic algorithms of generating fractals given by IFS:

   (a) deterministic algorithm (Algorithm 1),

   (b) random algorithm (Algorithm 2).

Algorithm 1: Deterministic method

Input: $w_1, w_2, \ldots, w_N : \mathbb{R}^2 \to \mathbb{R}^2$ – affine mappings; $B \subset \mathcal{H}(\mathbb{R}^2)$ – the starting set (e.g., point, triangle); M – the number of iterations.
Output: Attractor's approximation.

1   $A = \{B\}$
2   **for** $k = 0, 1, \ldots, M - 1$ **do**
3      $T = \varnothing$
4   **for** $j = 1, 2, \ldots, N$ **do**
5   **for** $i = 0, 1, \ldots, |A| - 1$ **do**
6              $S = w_j(A_i)$
7              $T = T \cup S$
8      $A = T$
9   Draw all sets from A

Algorithm 2: Random method (chaos game)

Input: $w_1, w_2, \ldots, w_N : \mathbb{R}^2 \to \mathbb{R}^2$ – affine mappings; $p_1, p_2, \ldots, p_N$ – probabilities; $q \in \mathbb{R}^2$ – the starting point; $M > 20$ – the number of iterations.
Output: Attractor's approximation.

1   $A = \varnothing$
2   **for** $j = 0, 1, \ldots, M - 1$ **do**
3      $i = $ random number from $\{1, 2, \ldots, N\}$ drawn with the probability distribution $\{p_1, p_2, \ldots, p_N\}$
4      $q = w_i(q)$
5   **if** $j > 20$ **then**
6          $A = A \cup q$
7   Draw all points from A

Exemplary IFSs are in the *ifs_fractals.zip* archive. The data format in the files is the following. The first line contains the number $N \in \mathbb{N}$ of affine mappings that form the IFS. In the next N lines, we have the coefficients of the mappings:
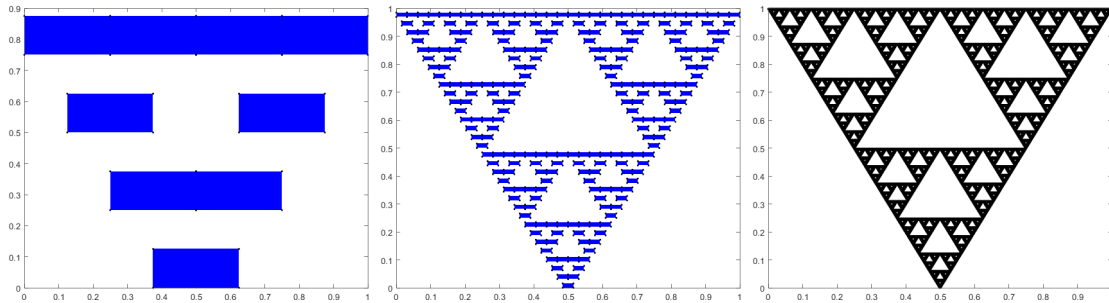
$$a \; b \; c \; d \; e \; f \; p$$

where $a, b, c, d, e, f \in \mathbb{R}$ are the coefficients of an affine mapping:

$$f([x, y]^T) = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} e \\ f \end{bmatrix}$$

and $p > 0$ is the probability.

Example of Sierpinski's triangle (*Sierpinski gasket 1.ifs*) generated by the deterministic method, starting form a quadrilateral. From left, iterations: 2, 5, 8.

Example of Barnsley's fern (*Barnsleys fern.ifs*) generated by the random method. From left, iterations: 10 000, 30 000, 100 000.