FEDERAL STATE AUTONOMOUS EDUCATIONAL INSTITUTION
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Report
on the practical task No. 1
”Experimental time complexity analysis”

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Goal

Experimental study of the time complexity of different algorithms.

Formulation of the problem

For each n in range $[1, 2000]$ the average computer execution time of programs implementing the algorithms and functions below (for five runs) is to be measured using timestamps. The obtained data is to be plotted showing the average execution time as a function of n. Theoretical time complexities are to be calculated and compared to empyrical.

1. Generate a random vector $v = [v_1, v_2, \cdots, v_n]$ with non-negative elements. For v, implement:
   - $f(v) = const$;
   - $f(v) = \sum_{k=1}^{n} v_k$;
   - $f(v) = \prod_{k=1}^{n} v_k$;
   - supposing the elements of v are the coefficients of a polynomial P of degree $n-1$, calculate the value $P(1.5)$ by a direct calculation of $P(x) = \sum_{k=1}^{n} v_k x^{k-1}$ and by Horner's method by representing the polynomial as:

     $$P(x) = v_1 + x(v_2 + x(v_3 + \cdots))$$

   - Bubble Sort of the elements of v;
   - Quick Sort of the elements of v;
   - Timsort of the elements of v.
2. Generate random matrices A and B of size $n \times n$ with non-negative elements. Find the usual matrix product for A and B.
3. Describe the data structures and design techniques used within the algorithms.

Brief theoretical part

Time complexity of an algorithm on a dataset of size n refers to the amount of time that a certain computer requires to execute the algorithm on that dataset. As computers have vastly different computing powers, time complexity is usually represented in the "big O"notation.

Definition:

$$f(n) = O(g(n)) \quad \Leftrightarrow \quad \exists n_0, c > 0 : \quad \forall n > n_0 \quad 0 \leq f(n) \leq cg(n)$$

This represents that $f(N)$ grows no faster than $g(N)$, starting with datasets of size N_0.

Results

Conclusions

Appendix