SSN College of Engineering

Department of Information Technology

UIT2201 — Programming and Data Structures

2022 – 2023

Exercise — 04

- This homework is due by 10PM on May 3, 2022
- Grace period may be given up to midnight of May 3, 2022
- You can upload only one ZIP file
- The naming convention is "<Your first name (first letter capital and all the other letters small)>-UIT2201-ex-02.zip"
- The questions marked as "OPTIONAL" are, as the name implies, optional! Complete your core assignment first and attempt the optional problem only if you have sufficient time
- Judicious use of Python features and standard modules, version control using 'git', adhering to Python coding standards are expected
- You are expected to use PSP0.1 process for all the code that you write!

The purpose of this exercise is to design and analyze algorithms and perform empirical analysis of algorithms as well.

1. Let $p(x)$ be a polynomial of degree n, that is, $p(x) = \sum_{i=0}^{n} a_i x^i$.
   (a) Implement a simple $O(n^2)$-time algorithm using Python for computing $p(x)$, for a given value of x
   (b) Implement a $O(n \log n)$ algorithm for computing $p(x)$, based upon a more efficient calculation of x^i
   (c) Now, consider rewriting $p(x)$ as

$$p(x) = a_0 + x(a_1 + x(a_2 + x(a_3 + \cdots + x(a_{n-1} + xa_n)\cdots)))$$

   which is known as the Horner's method. Write a Python function to compute $p(x)$ using this method. Analyze the time complexity of your code and express the same in asymptotic notation.
   (d) Perform empirical analysis of run time of all the three versions: Execute the functions for different values of n (degree of the polynomial) and tabulate the results (note that each entry should be an average over several runs, say m). Use randomly generated values of $a_0, a_1, \ldots, a_{n-1}$ for each value of n. Perform ratio analysis with well known complexity classes to confirm the growth rateof running times of all the three versions.

(e) Predict the running times (in suitable units) for very large values of n that are not in your table. Execute and find real running times for those values of n (average over several runs). What is your prediction error? [Hint: You may use mean squared error as a metric for the prediction error]. Use paired t-test to show that deviations in your predictions are not significant. [The statistical significance test is OPTIONAL]