Middle East Technical University — Department of Computer Engineering

CENG371

Scientific Computing

Fall 2023-2024

Homework 1

Due: October 31st, 2023, Tuesday **23:50**

Question 1 (35 points)

Let $f(n) = n\left(\frac{n+1}{n} - 1\right) - 1$, and $g(n) = f(n)/\epsilon$.

a) **(5 pts)** Plot $g(n)$ for $n \in [1, 1000]$ where n is an integer. Include your plot in your PDFs.

b) **(5 pts)** Which values of n satisfy $g(n) = 0$?

c) **(15 pts)** Explain why $g(n) \neq 0$ for majority of ns.

d) **(10 pts)** The non-zeros of $g(n)$ seems to grow in size as n increases. Why?

Question 2 (65 points)

Generate an array `nums` such that

$$\texttt{nums[n]} = 1 + (10^6 + 1 - n) \times 10^{-8}, \qquad n \in [1, 10^6] \quad \text{where } n \text{ is an integer.}$$

a) **(5 pts)** Calculate the theoretical result for the sum of the elements of `nums`. (you can use a summation formula)

b) **(5 pts)** In no more than 2 sentences explain the idea of *pairwise summation*. (you can find the algorithm online)

c) **(15 pts)** Calculate the sum of the elements of `nums` using

1. naive summation
2. compensated summation
3. pairwise summation

in **both single and double precision**.

d) **(15 pts)** Compare the errors and the run times of the methods.

e) **(25 pts)** Comment on your results. (you can comment on the cause of differences, possible improvements etc.)

Regulations

1. Most of the points will be granted to the **explanation/discussion parts** of the questions. Make sure that you reflect **your own reasoning** in a clean and concise manner.
2. Your submission should include a single PDF and your **runnable** code.
3. Submission will be done via odtuclass.
4. **Late Submission:** Accepted with a penalty of $-5 \times (day)^2$.