

Computer Science
Programmatic Assessment

Term: Spring 2023

CS PLO # 1: “Students will be able to apply concepts and techniques from computing and mathematics to both theoretical and practical problems.”

Course: Computer Science 407 (Numerical Analysis)

Rubric:

PLO 1	Spring 2023
3—ADVANCED	Program compiles, runs, and produces the correct result using the algorithm specified in the program statement. Program uses appropriate data types and precision level. Code contains comments and there is analysis in the assignment writeup.
2—COMPETENT	Program compiles, runs, and produces results that are either correct or within a tolerance of the correct result. Program either does not contain explanatory comments or the assignment is missing a writeup of the results compared to the standard approach.
1—BEGINNING	The program has a start at specifying the algorithm, but does not compile and run. This could also be a program that compiles and runs, but does not use the correct approach or gives an incorrect answer (usually due to incorrect data types or lack of precision). No explanatory comments or documentation.

Assignment Question

A fast algorithm for computing $f(x) = \arctan(x)$ to n -bit precision for x in the interval $(0,1)$ is as follows: Set $a = 2^{-\frac{n}{2}}$, $b = \frac{x}{1+\sqrt{1+x^2}}$, $c = 1$, and $d = 1$. Then repeatedly update these variables by these formulas in order from left to right, and top to bottom.

$$c \leftarrow \frac{2c}{1+a}; d \leftarrow \frac{2ab}{1+b^2}; d \leftarrow \frac{d}{1+\sqrt{1-d^2}}$$

$$d \leftarrow \frac{b+d}{1-bd}; b \leftarrow \frac{d}{1+\sqrt{1+d^2}}; a \leftarrow \frac{2\sqrt{a}}{1+a}$$

After each sweep, print $f = c \ln\left(\frac{1+b}{1-b}\right)$. Stop when $1-a \leq 2^{-n}$.

Write a double-precision routine to implement this algorithm and test it for various values of x . Compare the results to those obtained from the arctangent function on your computer.

Evaluation	Reader 1	Reader 2	Average
Program 1	3 – Code submitted with analysis	3	3
Program 2	3 – Code submitted with analysis	3	3
Program 3	2 – Unclear what results mean	2	2
Program 4	2 – Missing Analysis section	2	2
Program 5	1 – Unclear what the results mean	2	1.5
Program 6	2 – Program submitted. No Analysis	2	2
Program 7	3 - Exemplar	3	3
Program 8	2 – Student submitted thorough analysis, but forgot to attach code in laulima.	2	2
Program 9	2 – Sparse Analysis and comments	3	2.5
Program 10	2 – Missing analysis section	2	2
Program 11	3 – Code submitted with analysis	3	3
Program 12	3 – Code submitted with analysis	3	3
Program 13	2 – Code has results that are slightly off.	2	2
Program 14	3 – Code submitted with analysis	3	3
Program 15	2 – Code +analysis. No comments in code.	3	2.5
Program 16	2 – Missing analysis section	2	2
			Reader agreement = 81.25%

Observations: Students were able to complete the program and obtain correct results in most cases. The biggest deficit here was the lack of analysis associated with the program and its results.

Recommendations to improve student performance: Have a separate graded item for the analysis so that students don't forget to include it.