S&T-1st C Programming Lab 4

Iterative Instructions and
Applications on Numerical Algorithm and Pseudo Stochastic Process

February 2025 6:45pm

Unzip the **Lab4.zip** sent to you by email attachment. Please prepare for your programs in advance of the lab session.

Question 1:

The value of π can be 3.14159265. Use an iterative instruction in your C program to compute the value of the following series up to a tolerance of 10^{-8}.

$$2-\frac{2\pi^2}{2!}+\frac{2\pi^4}{4!}-...+2(-1)^n\frac{\pi^{2n}}{(2n)!}, \text{ where } \quad n\geq 0.$$

Question 2:

The Maclaurin series of the sine function is given as follows:

$$\sin(x)=x-\frac{x^3}{3!}+\frac{x^5}{5!}-\frac{x^7}{7!}+\frac{x^9}{9!}-...=\sum_{k=0}^{\infty}\frac{(-1)^k}{(2k+1)!}x^{2k+1}$$

Use an iterative instruction in your C program to compute the value of $\sin(135°)$ up to a tolerance of 10^{-8}.

Question 3:

Refer to the lecturenotes on numerical algorithm for Newton-Raphson's method. A variation for Newton-Raphson's method is the Secant's method based on two initial points and the new sliding gradient *G* defined as follows:

$$G(x_n)=\frac{f(x_n)-f(x_{n-1})}{x_n-x_{n-1}} \qquad \text{where} \qquad x_{n+1}=x_n-\frac{f(x_n)}{G(x_n)}$$

It is clear that if x_{n-1} is close to x_n, $G(x_n)\approx f'(x_n)$. Thus Secant's method can converge to Newton-Raphson's method.

(i) Write another C program named as **secant.c** which uses the Secant's Method to estimate the root of $f(x)=e^{2x}-x-6$ with two initial points $x_0=0.25$ and $x_1=1.2$.

(ii) Again, use your secant.c to estimate the value of $\sqrt[5]{37}$.

(iii) Again, use your secant.c to estimate a solution for the equation $\cos(x)=x^3$. You can use the cosine function cos (*x*) in Visual C++ where *x* is in radian.

Same as the Newton-Raphson's Method, please take note that Secant's Method does not guarantee the convergence to the solution.

Question 4:

Write a complete C program to generate 20 random numbers which are uniformly distributed from -2.55 to 3.76.

Question 5:

Write a complete C program that uses random numbers to approximate the value of the finite integral $\int_2^5 x^2 dx$, i.e., the program will approximate the value of the area enclosed by $y = x^2$, $x = 2$, $x = 5$ and $y = 0$.

Question 6:

A biased dice has the probability distribution as shown in the following table.

Face	1	2	3	4	5	6
Probability	0.2	0.2	0.05	0.05	0.3	0.2

In every game you place a bet of $2. If the number surfaced on the dice is 6, you win and the return will be $4. If the surfaced number is 5, you win and the return will be $3. If the surfaced number is 3 or 4, you get back your $2. If the surfaced number is 1 or 2, you get back nothing. You play this game 50 times. Write a C program named as **<u>advantage.c</u>** which uses random numbers to estimate your total return. If the regulatory requirement for the house advantage is not more than 6%, your program should check and print on the screen whether this game has met the requirement of regulation. {House Advantage = [(Bet – Expected Return)/Bet] x 100%}

Please take note that the random numbers generated by computer is pseudo. The whole execution of your C program is not real stochastic. It is actually a pseudo stochastic process.

The lab time is only two hours. Please prepare for your programs in advance.

- A/Prof Tay