

CA146 Introduction to Programming in C++

CA146 Tutorial 6

Note: As usual, when you have finished the tasks, or at least as many as you were able to do, ask a tutor to sign off to confirm this.

1 Practice with for loops (applied to summation)

1.1 Type in and run the following program which calculates a finite approximation to the sum of the series: $1/2 + 1/4 + 1/8 + 1/16 + 1/32 + \dots$

It stops calculations when the next term in the series is less than **EPS** = 0.0001.

```
#include <iostream>
using namespace std;

const float EPS = 0.0001;
// Print out intermediate calculations to clarify the method
int
main(void)
{
    float term, sum;

    // term holds successive terms i.e. first 1/2, next 1/4, etc.
    // sum holds a running total of the terms
    term = 0.5;
    sum = 0;
    while (term >= EPS) {
        sum = sum + term;
        cout << "Last term = " << term << endl;
        cout << "Current total = " << sum << endl;
        term = term / 2.0;
    }
    return (0);
}
```

NB: As usual, check the results very carefully to make sure you understand exactly how the program works to produce the different outputs.

1.2 Modify the program of 1.1 so that instead of stopping calculations based on the condition “term >= EPS” it calculates the sum for a specified number (n) of terms. For example, if n = 3 it calculates “1/2 + 1/4 + 1/8”. The modified program should:

- Prompt the user to enter a value for “n”, and read in that value (use of cin)
- Replace the “while” loop by a “for” loop.

1.3 Modify program 1.2 so it calculates the sum of the first “n” terms of the series:

- $1/4 + 1/16 + 1/64 + \dots$ [The sum should get closer and closer to $1/3$ as n is increased]
- $1 - 1/3 + 1/5 - 1/7 + \dots$ [The sum should get closer and closer to $\pi/4$ as n is increased]

Hint for b): Use a new int variable (called sign, say) to keep track of the sign of successive terms. Then, sign alternates between +1 and -1.

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2 Practice with one-dimensional arrays

Data below are from http://scrippsco2.ucsd.edu/data/in_situ_co2/monthly_mlo.csv. They define the Keeling Curve which depicts global CO₂ emissions (probably?) due to human emissions. The values are those from the rightmost column.

2.1 Type in, compile and run the following program, the purpose of which is to illustrate some aspects of the Keeling Curve.

```
// Depicting aspects of the Keeling Curve (CO2 units of ppm)
#include <iostream>
using namespace std;
const int MONTHS = 12;

int
main()
{
    float year1960[MONTHS] = {316.44, 316.37, 316.27, 316.72, 317.29, 317.50,
                              317.46, 317.12, 317.02, 316.82, 316.89, 316.99};
    float year1980[MONTHS] = {338.02, 337.70, 338.65, 338.25, 338.48, 338.89,
                              338.78, 338.91, 338.99, 339.26, 339.15, 339.08};
    float year2000[MONTHS] = {369.15, 368.75, 368.97, 368.94, 368.60, 369.24,
                              369.28, 369.54, 369.98, 370.24, 370.51, 370.47};

    float mean1960, mean1980, mean2000;
    float total1960, total1980, total2000;
    int month;

    // Calculate totals and averages for each year:
    total1960 = 0; total1980 = 0; total2000 = 0;
    for (month = 0; month < MONTHS; month++) {
        total1960 = total1960 + year1960[month];
        total1980 = total1980 + year1980[month];
        total2000 = total2000 + year2000[month];
    }

    mean1960 = total1960 / MONTHS;
    mean1980 = total1980 / MONTHS;
    mean2000 = total2000 / MONTHS;

    // Print monthly, annual total and mean concentrations of CO2:
    cout << "Representative Concentrations of CO2 (Keeling)" << endl << endl;
    cout << "Month 1960 1980 2000" << endl;

    for (month = 0; month < MONTHS; month++) {
        cout << month + 1 << " " << year1960[month] << " " <<
            year1980[month] << " " << year2000[month] << endl;
    }
    cout << endl;
    cout << "Totals" << " " << total1960 << " " << total1980 << " " <<
        total2000 << endl;
}
```

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```
cout << "Means " << " " << mean1960 << " " << mean1980 << " " <<
    mean2000 << endl;

return (0);
}
```

2.2 Extend the above program so that it also includes the data for years 1970 and 1990. To obtain the data, refer to the link given above. You should be able to see that there is an acceleration in the concentrations of CO₂!