Tutorial & Laboratory

Programming & Data Structure: CS11001/19001

Section - 4/D

DO NOT POWER ON THE MACHINE

Department of Computer Science and Engineering

I.I.T. Kharagpur

Spring Semester: 2013 - 2014 (**23.01.2014**)

Download

Download the file **date230114.pdf** from Programming & Data Structures ... of

http://cse.iitkgp.ac.in/~goutam

View the file using the command acroread & or xpdf &

Protect Your Program!

It is your responsibility to keep your C program read-protected from others. Take the following steps.

- Change the pass-word (do not ask me if you have forgot the new pass-word you have set).
- Reset the read-mode bit for others.

Changing Pass-word

Give the following command and give proper response:

```
$ passwd
```

Reset Read-bit

Let the file name be `D0601.c`. The read mode can be put-off by the following command.

```
$ chmod  600 F0601.c
```

Types of Errors

- Compilation error.
- Linker error.
- Run-time error.
- Logical error.

Compilation Error

```
$ cc -Wall err1.c
err1.c: In function main:
err1.c:6: error: expected ; before printf
```

- The C program is not well-formed.
- Look at line number 5-6 for the error.

Compilation Error

```
#include <stdio.h>
int main() // err1.c
{
    int n;
    n = 10
    printf("n = %d\n", n) ;
    return 0 ;
}
```

Compilation Error

```
$ cc -Wall err2.c
err2.c: In function main:
err2.c:6: error: called object n is not a
                 function
```

```
#include <stdio.h>
int main() { // err2.c
    int n ;

    n = 10 ;
    printf("%d\n",n(n-1)) ;
    return 0 ;
}
```

Compilation Error

```
$ cc -Wall err3.c
err3.c: In function main:
err3.c:11: error: expected declaration or
                        statement at end of input
```

The error message is not very clear.

Compilation Error

```
1       #include <stdio.h>
2       int main() { // err3.c
3           int n, m, p ;
4           scanf("%d", &n) ;
5           if(n > 0) {
6              m = 2*n - 5 ;
7              if(m < 0) {
8                 p = m + 10 ; n++ ;
9              }
10             printf("%d", m * n) ;
11          }
```

Linker Error

```
$ cc -Wall err4.c
err4.c: In function main:
err4.c:10: warning: implicit declaration of
                        function factirial
/tmp/ccpty9FK.o: In function ‘main’:
err4.c:(.text+0x40): undefined reference to
                                ‘factirial’
collect2: ld returned 1 exit status
```

Linker Error

The warning is given by the compiler, but the error message is due to the linker.

The function factirial is not defined. Most likely the function name is written incorrectly.

Linker Error

```
#include <stdio.h>
int factorial(int n) { // err4.c
    if(n == 0) return 0 ;
    else return n*factorial(n-1) ;
}
int main() {
    int n ;
    n = 10 ;
    printf("fact(%d)=%d\n",
              n,factirial(n));
    return 0 ;
}
```

Linker Error

```
$ cc -Wall err5.c
err5.c: In function main:
err5.c:6: warning: implicit declaration of
                     function sqrt
err5.c:6: warning: incompatible implicit
                   declaration of built-in
                   function sqrt
/tmp/cclLxkrp.o: In function ‘main’:
err5.c:(.text+0x2d): undefined reference to ‘sqrt’
collect2: ld returned 1 exit status
```

Linker Error

- Warning by the compiler and the error message by the linker.
- The header file math.h is not included.
- The mathematical library is not linked.

Linker Error

```
#include <stdio.h>
int main() { // err5.c
    float n ;
    n = 10.0 ;
    printf("sqrt(%f)=%f\n",
                n,sqrt(n));
    return 0 ;
}
```

Run-time Error

```
err6.c: In function main:
err6.c:5: warning: format %f expects type float *,
                   but argument 2 has type double
err6.c:5: warning: n is used uninitialized in this
                     function

$ a.out
5.0
Segmentation fault
```

Run-time Error

The compiler warning is ignored and there is a run-time memory violation error.

Illegal memory reference, in this case '&' is missing - scanf("%f", n) ;

Run-time Error

```
$ cc -Wall err7.c
$ ./a.out
1
Floating point exception
```

Run-time Error

```
#include <stdio.h>
int main() { // err7.c
    int n;

    scanf("%d", &n);
    printf("%d\n", n/(n-1));
    return 0;
}
```

Run-time Error

```
$ ./a.out
1
Floating point exception
```

Funny message, actually divide-by zero -
printf("%d",n/(n-1)) ;

Logical Error

The program does not behave the way you thought it should!

Logical Error

```
#include <stdio.h>
#include <math.h>
int main() { // err8.c
    float n ;
    scanf("%f", &n) ;
    printf("%f\n", pow(n, 1/3)) ;
    return 0 ;
}
```

Logical Error

```
$ ./a.out
8.0
1.000000
$
```

Computation of $sin(x)$

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \frac{x^9}{9!} \cdots$$

Finite number of terms of this infinite series may be used to compute an approximate value of $\sin(x)$, where x is in radian.

$$\begin{aligned}
\sin x &= x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \frac{x^9}{9!} \cdots \\
&= \sum_{i \geq 0} (-1)^i \frac{x^{2i+1}}{(2i+1)!} \\
&= \sum_{i \geq 0} t_i, \text{ where } t_i = (-1)^i \frac{x^{2i+1}}{(2i+1)!}
\end{aligned}$$

Inductive Definition of $t_i(x)$

$$t_i = \begin{cases} x & \text{if } i = 0, \\ -t_{i-1}\dfrac{x^2}{2i(2i+1)} & \text{if } i > 0. \end{cases}$$

This is also called recurrence relation or recursive definition.

Approximation of $\sin(x)$

The sum up to the n^{th} term of the series, $S_n(x)$, gives an approximate value of $\sin(x)$. The inductive definition of S_n is

$$S_n = \begin{cases} t_0 & \text{if } n = 0, \\ s_{n-1} + t_n & \text{if } n > 0. \end{cases}$$

Assignment III

Write a C program that will do the following four tasks. [**Marks:** $3 + 5 + 6 + 6$]

Note: You write only one program.

Task I

Reads an angle Θ in degree and converts it to radian. Use the macro `M_PI`, a macro for an an approximate value of π, defined in `math.h`. Print the actual input and the corresponding radian value x.

Task II

Read a positive integer `n` and compute $t_0(x), \cdots, t_{n-1}(x)$ and the corresponding $s_0(x), \cdots, s_{n-1}(x)$ using a for-loop.
Use the recurrence relation of t_i and s_i. You are not all allowed to use any mathematical library function, you cannot compute $n!$ directly, you cannot use an array.
Print the s_{n-1} as an approximate value of $\sin\Theta$.

Task III

Reads a percentage error `err` and compute $t_0, \cdots, t_{k-1}, t_k$ and corresponding $s_0, \cdots, s_{k-1}, s_k$ while $|t_k| > \frac{\text{err} \times |s_k|}{100}$. Print s_k as an approximate value of $\sin\Theta$ along with the value of k, the number of terms added.
You are not allowed to use any mathematical library function, cannot compute $n!$ directly, you cannot use an array.

Task IV

Copy appropriate portion of code from Task I & III and print a table of $\sin\Theta$ (approximate) for 0° to 90° at an interval of 10°. Use the error value `err` of Task III.

Typical Output

Task I:
Input: `Enter an angle:  30`
Output: `30.000000 Degree = 0.523599 Rad`
Task II:
Input: `Enter a positive integer:  5`
Output: `sin 30.000000 = 0.500000`
Task III:
Input: `Enter % error:  0.001`
Output: `sin 30.000000 = 0.500000, terms: 5`

Task IV Output:

```
Sin(   0.000) =    0.000
Sin(  10.000) =    0.174
Sin(  20.000) =    0.342
Sin(  30.000) =    0.500
Sin(  40.000) =    0.643
Sin(  50.000) =    0.766
Sin(  60.000) =    0.866
Sin(  70.000) =    0.940
Sin(  80.000) =    0.985
Sin(  90.000) =    1.000
```

Submission by ftp

```
$ ftp 10.5.17.186
Connected to 10.5.17.186.
220---------- Welcome to Pure-FTPd ----
220-You are user number 1 of 50 allowed.
220-Local time is now 07:54. ....... 21.
220-IPv6 connections ........
220 ... disconnected .. inactivity.
Name (10.5.17.186:...): pds
```

Submission by ftp

```
331 User pds OK. Password required
Password: pds04
230-User pds has group access to:  pds
230 OK. Current restricted directory is /
Remote system type is UNIX.
Using binary mode to transfer files.
ftp> cd assignment3
250 OK. Current directory is /assignment3
```

Submission by ftp

```
ftp> put D0603.c
local: D0603.c remote: D0603.c
200 PORT command successful
150 Connecting to port 47093
226-File successfully transferred
226 0.001 seconds .. 39.00 Kbytes ..
27 bytes sent in 0.00 secs (1098.6 kB/s)
ftp> bye
21-Goodbye. .....
221 Logout.
$
```

Fibonacci Sequence

The *Fibonacci sequence* $(f_i),\ i = 0, 1, 2, \cdots$ is defined as

$$f_i = \begin{cases} 0 & \text{if } i = 0, \\ 1 & \text{if } i = 1, \\ f_{i-1} + f_{i-2} & \text{if } i > 1. \end{cases}$$

Assignment IV

Write a C program that will read a positive integer $n > 1$ and will print all the Fibonacci numbers in the range 2 to n that are prime.

[**Marks:** 5]

Input: `1000`
Output: `2 3 5 13 89 233`