Welcome to Third Semester ☺

Program Design

Lecture 1

Course Plan

- About the course
- Course Outcomes
- Course Objectives
- Course syllabus
- Text books
- Grading policy
- Course Schedule
- Standard of Conduct

Basics

- What is a computer?

Computer is a machine which solves problems

What is a problem?

- What is the characteristics of a problem?

  It has input(s) and output(s)
- Example: Given a number, check whether it is an Armstrong number
- What is Armstrong number?
- Sum of cubes of the digits of a Number = Number
- Eg: Let the number be 371, then 3^3+7^3+1^3= 371, so 371 is an Armstrong number
- Input : 371, Output : Yes
- Input : 11, Output: No

How to define “problem” precisely?

- How to define “problem” mathematically ?
- How do we define the previous example problem(P)?
- P = {(371,Yes), (11,No), …}
- A problem is set of ordered pairs of inputs and outputs.
- There are different types of problems
- Decision problems : Yes/ No
- Optimization problems : Optimize the output

Steps to solve a problem using computer

- Understanding the problem ---> Problem statement
- Design a method to solve the problem (Steps to solve the problem)
- Implementation /coding (C Program)
- Testing (Check whether the expected output is obtained)
- Debugging (correcting errors), if errors are there then see whether the error is in the code or in the design

Problem solving using computer and the related concepts

Computer –Physical components

- Central Processing Unit (CPU)
- Monitor
- Keyboard/ Mouse
- What all are there in CPU?
- Processor (m/c)
- Arithmetic/Logic Unit
- Memory unit

Is computer intelligent than us?

- Does computer can do anything?
- Is there any problem which can not be solved by a computer?
- Computer is a dumb machine which does what we instruct it to do.
- It does not do anything other than what we instruct it to do
- Suppose we want to solve a problem, how do we tell/instruct the computer ?

How do we instruct the computer?

- We write set of instructions(program/code) in a programming language like C
- What is a programming language?
- It is a large set of instructions written by somebody else
- Eg: C is a large set of instructions written by /developed by Dennis Ritchie at AT&T Bell Laboratories in the early 1970s

Computer - a dumb machine

- A machine can understand only switch off and switch on states
- Similarly computer also knows only 0 (switch-off) and 1 (switch-on) ie. binary (two) language
- Earlier times, there were only machine level languages ie. collection of 0’s and 1’s
- So programmers have to write their program in a binary language
- Disadvantages : - Very tedious to write & error-prone.
- So, how to make it easy?

Assembly language (low level language)

- Another language which uses symbolic names instead of binary numbers
- Who converts the assembly language to m/c level language?
- Assembler is a program (set of instructions) which converts assembly language to machine level language eg: 8085/8086/MASM
- Disadvantages of assembly language: The instructions in assembly language differs from machine to machine. Hence, the assembly language is not portable.
- How to make it better?

Higher level language

- Language which are not m/c dependent
- Advantages: Easy for the programmer, portability
- Examples of higher level languages?
- FORTRAN, C,C++, JAVA
- Who converts higher level language to the form which computer can understand?
- Compiler : A program which does this conversion
- Interpreter : Line by line conversion

Compilers Vs Interpreters

Compiler	Interpreter
Converts the whole program	Converts line by line
Faster	Slower
Debugging difficult than interpreter	Debugging easy
Egs: Fortran, C ,C++	Egs: BASIC, Python

Operating System(OS)

- Another Program
- Controls the entire operation of a computer system
- What are the operations/activities done on a computer?
- Movies/ Music/ Games/ Programming in C
- Examples of Operating systems
- Windows
- Unix/Linux
- Mac OS
- We use Linux with C

Why do we use Linux with C?

- Linux is a type of Unix OS
- Unix was written primarily in C language
- Very few assumptions on the machine
- It is easy to use Unix or its variants such as Linux in any machine
- Linux & C are portable, good companions

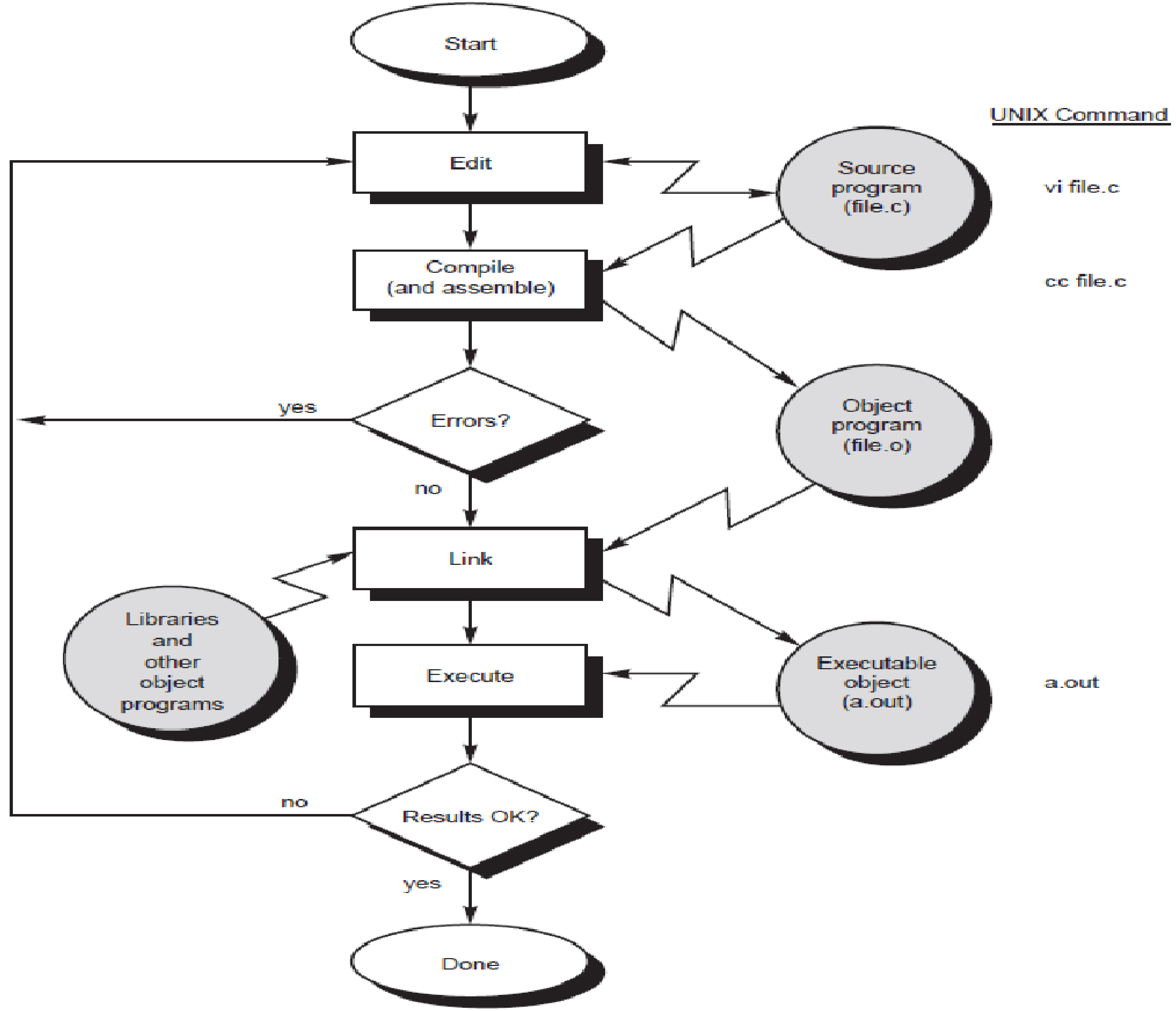
How do we solve a problem using computer ?

- Problem : Print the sentence “ C is a nice programming language.”
- Only one step: Print the sentence
- What all we have to do?
- Write the step in C Language (Edit it)
- Convert it into a form which the m/c can understand (Compile)
- Obtain the output (Execute)

C program to print “ C is a nice programming language.”

```
#include <stdio.h>
main()
{
  printf(“C is a nice programming language”);
}
```

stdio.h is a standard library file written by the developers of C language which helps in printing the statement


Start
UNIX Command
Edit
Source program (file.c)
vi file.c
Compile (and assemble)
cc file.c
yes
Errors?
Object program (file.o)
no
Link
Libraries and other object programs
Execute
Executable object (a.out)
a.out
no
Results OK?
yes
Done

Why do we learn Program Design course?

1. ________

2. ________

3. ________

Question: What did you learn during last year in Computer Programming Course?

1.

2.

3.

Course Outcome -1

Design solutions for simple problems using C Language

Question: How efficiently can you search a name in an array consisting of 10 Million names?

1. ________

2. ________

3. ________

Question: How efficiently can you arrange 100 Million names in alphabetical order?

1. ________

2. ________

3. ________

Course Outcome -2

Understand the standard algorithms for sorting and searching

Question: What is the unit, if any available for expressing the running time of the algorithms?

Course Outcome - 3

Describe the asymptotic notations for expressing the running time of algorithms

Question: What are the essential steps in solving a problem using computer?

1.

2.

3.

Course Outcome - 4

Design, analyse and prove the correctness of simple, iterative and recursive algorithms

Question: Consider 10 Million names stored in an alphabetical order. I want to insert a name in this sorted list at location 10,000. How can we do this?

1. ________

2. ________

3. ________

Question:How to represent the hierarchy of an institute/organization. How do we systematically access every role in the institute/organization?

1. _______

2. _______

3. _______

Course Outcome - 5

Select appropriate data structure for solving a given problem and analyze the running time for performing various operations

Question:How to create a variable sized array? How the different memory management functions are implemented?

1. ____

2. ________

3. ________

Course Outcome - 6

Compare different techniques for memory management

COURSE OBJECTIVES

- To introduce the students to the concept of algorithms, their role in computing and simple data structures.

- To equip the students to design correct and efficient algorithms for computational problems.

C programming

- Recall some of the concepts through few example codes
- You are requested go through the NPTEL videos and recall and learn what all you have learned in last year and **more**

- https://nptel.ac.in/courses/106/105/106105171/ - Prof Anupam Basu, IIT Kharagpur

- https://nptel.ac.in/courses/106/104/106104128/ - Prof Satyadev Nandakumar, IIT Kanpur

C program to sum two numbers

```
//Program to obtain sum of two numbers
#include <stdio.h>
main()
{
  int x,y,z; //declaration of three variables as integers
   x=12; y=4;// initilaization of x and y
  z= x+y; /*x & y are known as operands , + is an
  operator*/
  printf(“Sum of two numbers is %d”,z); /*  %d  or %i is
  the format specifier for an integer data type. %d is
  associated with the variable after quotes (eg: z in this
  case) */
}
```

Problems

- How do we change the previous program:
  - If we want to use only two variables x & y
  - If we want to obtain the output as sum of two numbers 12 and 4 is 16
- Exercise :
- Write a C program to swap two numbers:

  Input : a=20, b= 30 Output: a=30, b=20

  - with using a temporary variable
  - 2 methods without using temporary variable

Will this work?

```
#include <stdio.h>
main()
{
  int x,y;
  x=12, y=4;
  printf(“Sum of two numbers is %d”, x+y);
}
```

What does this code do?

```
main ()
{
  int a=100;
  if( a == 10 )
          printf("Value of a is 10\n" );
          else
                     if( a == 20 )
                              printf("Value of a is 20\n" );
                              else
                                        if( a == 30 )
                                                  printf("Value of a is 30\n" );
                                        else
                                                  printf("None of the values is
                                                          matching\n" );
  printf("Exact value of a is: %d\n", a );  }
```

What does this code do?

```
main()
{ int n1,n2,n3, largest;
  printf(“enter three numbers\n”);
  scanf(“%d %d %d”, &n1,&n2,&n3);
  if (n1>=n2){
      if (n1>=n3)
      printf(“%d is largest”,n1);}
else if (n2>=n1){
     if (n2>=n3)
      printf(“%d is largest”,n2);}
else if (n3>=n1){
    if (n3>=n2)
      printf(“%d is largest”,n3);}}
```

Find the largest among three numbers

```
main()
{ double n1, n2, n3;
printf("Enter three numbers: ");
scanf("%lf %lf %lf", &n1, &n2, &n3);
if( (n1>=n2) && (n1>=n3) )
printf("%.2f is the largest number.", n1);
if( (n2>=n1) && (n2>=n3) )
printf("%.2f is the largest number.", n2);
if( (n3>=n1) && (n3>=n2) )
printf("%.2f is the largest number.", n3); }
```

Calculator using switch

```
main()
{
  int num1,num2,result; char op;
  printf(“enter the numbers & op”);
  scanf(“%d %d %c”, &num1,&num2,&op);
  switch (op)
{
 case ‘+’:
  printf(“result is %d”, num1+num2); break;
case ‘-’:
printf(“result is %d”, num1-num2);break;
case ‘*’ :
printf(“result is %d”, num1*num2); break;
case ‘/’ :
printf(“result is %d”, num1/num2); break;
default: printf(“operator invalid”);
}
```

Do While Construct

```
main () {
            int a = 0;
            /* do loop execution */
            do {
                  printf("value of a: %d\n", a);
                  a = a + 1;
               }while( a < 3 );
            }
```

- Ans: 0 1 2

Functions

- We already know functions such as??
- main(), printf()
- We also know that we pass parameters to the function
- printf("enter numbers") -- parameter
- main() – no parameter in this case
- We can split the main program also into functions

Program without function

```
main(){
            int a,b,sum;
            printf("enter numbers");
             scanf("%d %d",&a,&b);
             sum =a+b;
            printf("sum is %d",sum);}
```

- Suppose a=1 b=2
- sum is 3

Program with functions

```
#include<stdio.h>
//function definition
addition(int a,int b){
 int sum;
 sum =a+b;
 printf("sum is %d",sum);}
main(){
  int a,b;
  printf("enter numbers");
  scanf("%d %d",&a,&b);
 //function call with parameters a & b
  addition(a,b);}
```

Working of a function

- Execution starts from main function
- When the function call is seen,
  the control flow goes to the function definition
- All the statements in the function
  will be executed either to the last statement
  (if there is no return statement in the function),
  or up to the return statement
- Control returns to the statement in the
  main function just after the main function or
  on to the statement where function is called
  if there is some pending works to be done
- Execution of main function is continued
- Activation record

```
#include<stdio.h>
//function definition
addition(int a,int b){
 int sum;
 sum =a+b;
 printf("sum is %d",sum);}
main(){
  int a,b;
  printf("enter numbers");
  scanf("%d %d",&a,&b);
 //function call with parameters a & b
  addition(a,b);}
```

Thank You