Scientific and Technical Computing: SMR3821

Introduction to Scientific computing and Linux - Introduction to C Programing

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End of talk

This materials is part of materials used at the National institute for Mathematical Sciences, Ghana, and have been contributed to over time by the follow authors and instructors:

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Outline

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where are we?

If there is no struggle there is no progress.

Fredrick Douglas.

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The C Module

Module Name :

C Programming

Objective :

Introduce course participants to the first principles of programming using the C Programming language.

Prerequisites:

- Fundamentals Of Computing
- Fundamentals of Programming

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References

The C programming Language Kernighan & Ritchie

Programming with C Byron Gottfried

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Classification Of Programming Languages

High Level / Program Oriented Language

Low Level / Machine Oriented Language

C stands between the two.

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Background of C

C is a programming language developed by Dennis Ritchie in 1972 at the AT&T Lab, USA.

C is a simple and flexible language to use.

C is cross platform

Seminar

For the purpose of this seminar, each course participant would be placed in a group.

Each group has to present a paper on the following languages:

- ALGOL
- CPL
- BCPL
- B
- C

Marks would be awarded to the entire group.
Individual marks would also be awarded.

Seminar is due in 3 working days from today.

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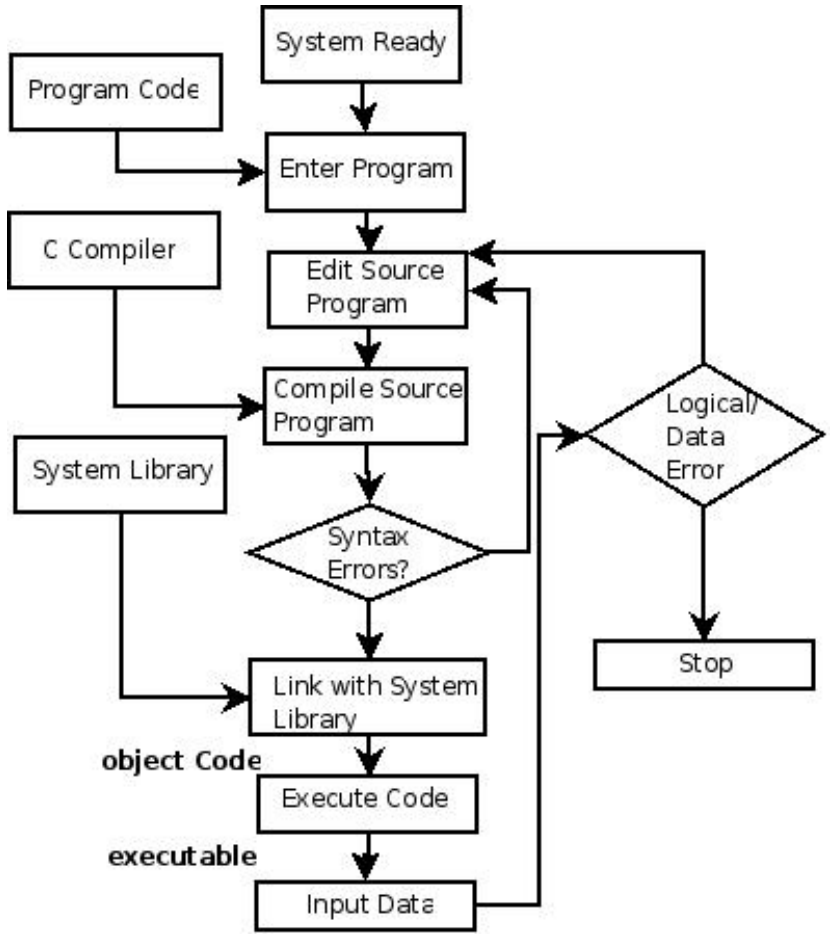
Compilation and Running of a C program



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Hello World Example

```c
#include <stdio.h>

int main()
{
    printf("Hello World!\n");
}
```

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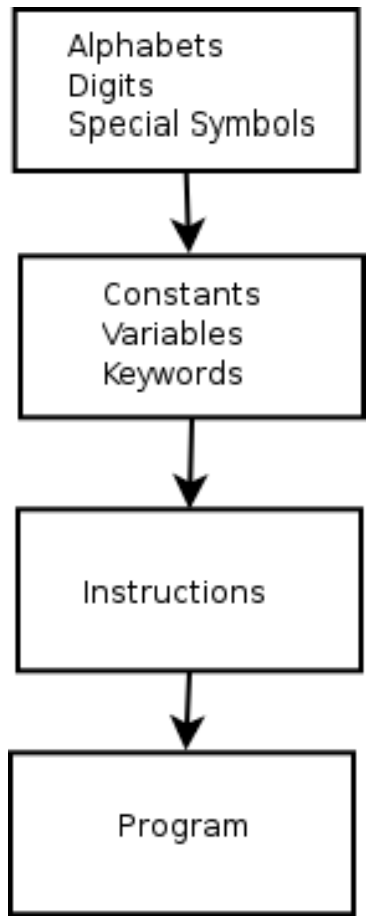
Composition of a C Program



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C Character Set

Alphabets

- A,B,C...Y,Z
- a,b,c,...,y,z

Digits

- 0,1,2,3,4,5,6,7,8,9

Special Symbols

- '@ # % & ( ) _ + = — { } [ ]
- ^ ! \ ~ : ; " , . ? <>

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Keywords

- A keyword is a word which has a special meaning to the C compiler.
- Keywords **should not** be used as variable or constant names.
- Keywords are also known as Reserved words.

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The 32 Keywords in C

auto	double	if	static
break	else	int	struct
case	enum	long	switch
char	extern	near	typedef
const	float	register	union
continue	far	return	unsigned
default	for	short	void
do	goto	signed	while

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C Variables

A variable is a named memory location that can hold data of a particular type.

The value of a variable may be changed during the execution of the program.

Every C variable has the following properties:

- *data type*
- *name*
- *value*
- *memory address*

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Fundamental Data Types in C

Data Type	Keyword	Bits	Range
Integer	int	16	-32,768 to 32767
Character	char	8	-128 to 128
Floating Point	float	32	3.4E-38 to 3.4E+38
Double-precision Float	double	64	1.7E-308 to 1.7E+308

NOTE:

- The size and range enumerated above are for 16 bit word machines.
- The sizes differ from machine to machine.

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Rule for variable names

- Any combination of alphabets, digits and underscore with a length of between 1 and 8. However some compilers allow length of up to 40.
- The first character must be an alphabet.
- With the exception of the underscore character, no special symbol or white space is allowed in variable names.
- Variables in C must always be declared before being used.

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Variable Declaration

Syntax

```
DataType VariableName [=InitialValue];
```

Example

```
1   int sum;
2   float x, y;
3   char letter = 'H';
```

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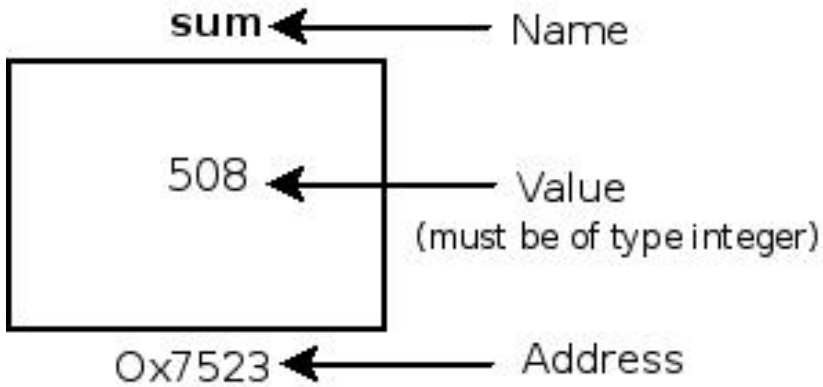
Logical Representation of Variables in Memory

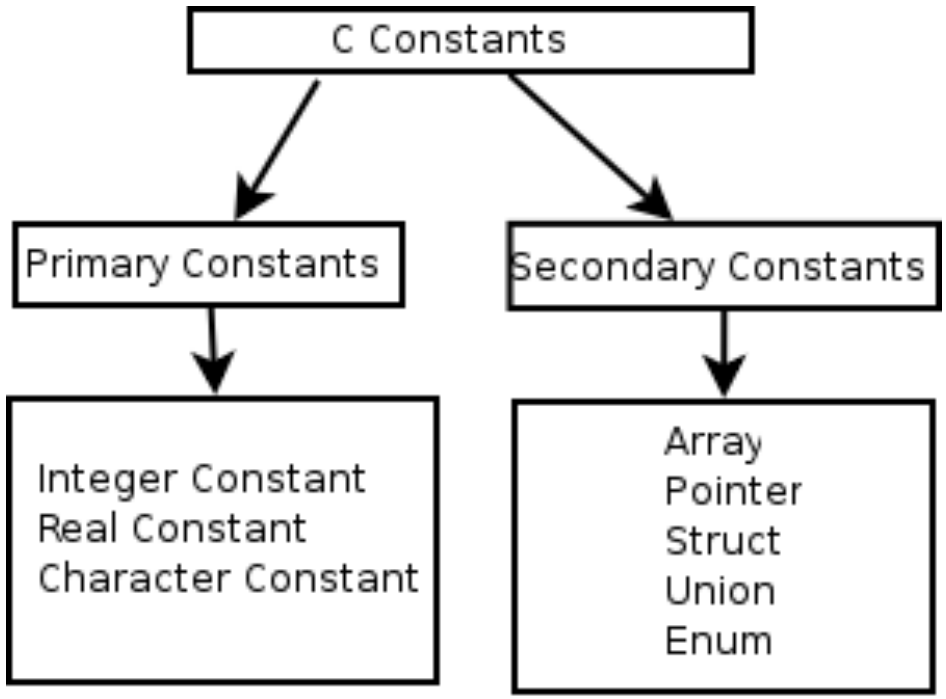
```
int sum =508;
```



Constants

What is a constant?

A quantity whose value never changes.



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Rules for constructing Integer Constants

- Integer Constants must have at least one digit
- It must not have a decimal point
- It could be either positive or negative
- If no sign precedes an integer constant its assumed to be positive
- No commas or blanks are allowed within an integer constant
- Allowable range is 32768 to 32767 for 16 bit word compilers. Eg.410,-162,3696

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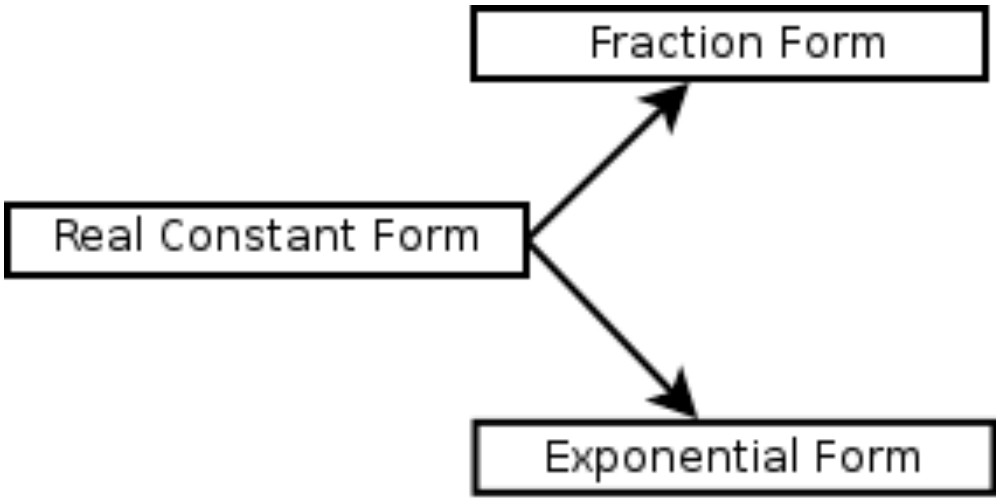
Real Constants

Real constants are also called **Floating Point Constants**



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Constructing Fractional Real Constants

- It must have at least one digit
- It must have a decimal point
- It could be either positive or negative, default is positive
- No commas or blanks are allowed within the real constant
  E.g 410.03, -4562.03, 0

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Constructing Exponential Real Constants

- Mantissa $\rightarrow$ *e* $\rightarrow$exponent
- The mantissa and the exponent should be separated by the letter e
- Mantissa part may be positive or negative, default is positive
- Exponent part must be at least one digit which must be positive or negative
- Range of values is : -3.4e38 to 3.4e38

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Character Constants

Character constant is a single alphabet,a single digit or a single special symbol enclosed within single quotes.

Example

```
char a;
a='a';
```

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Instructions In C

Instructions in C can be broadly classified into 4 main types:

- Type Declaration Instructions
- Input/Output Instructions
- Control Instructions
- Arithmetic Instructions

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Control Instructions

Control Instructions can be subdivided into

- Sequence Control Instruction
- Selection / Decision Control Instruction
- Repetition / Loop Control Instruction

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Arithmetic Instructions

Integer Mode Arithmetic

An arithmetic statement in which all operands are integers.

Example

```
int age1 = 15;
int age2 = 10;
int sum = 0;
sum = age1+age2;
```

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Arithmetic Instructions

Real Mode Arithmetic

An arithmetic statement in which all operands are real.
The results of a real mode arithmetic is always a real

Example

```
float age1 = 15.5;
float age2 = 17.0;
float avg = 0;
avg = (age1+age2)/2.0;
```

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Arithmetic Instructions

Mixed Mode Arithmetic

An arithmetic statement in which some operands are real and other operands are integers.
The results of a mixed mode arithmetic is always a real.

Example

```
int age1 = 10;
float age2 = 14.0;
float avg = 0;
avg = (age1+age2)/2;
```

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Examples of Arithmetic Mode Operations

Operation	Result
5/2	2
5.0/2	2.5
5/2.0	2.5
5.0/2.0	2.5
2/5	0
2.0/5	0.4
2/5.0	0.4
2.0/5.0	0.4

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Type Casting

Type casting refers to the conversion from one data type to another. Type casting may be done either Implicitly or

Explicitly

Explicit Casting

```
int   x = 10;
float y = (float) x;
```

Implicit Casting

```
float x = 10.256;
int   y = x;
```

To successfully cast from Data Type A to Data Type B, the resultant value of the cast must lie within the accepted data range of Data Type B.

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Type Casting in Assignments

if k is an integer and q is a float then the following applies

Operation	Result	Operation	Result
k=2/9	0	q=2/9	0.0
k=2.0/9	0	q=2.0/9	0.2222
k=2.0/9.0	0	q=2.0/9.0	0.2222
k=9/2	4	q=9/2	4.0
k=9/2.0	4	q=9/2.0	4.5
k=9.0/2.0	4	q=9.0/2.0	4.5

Character Arithmetic in C

The Principle

If a character is used as an *operand* in an arithmetic expression, then it is the ASCII value of the character that would be used during the evaluation of the expression.

Example

```
char letter = 'A';
int sum = 0;
sum = letter +32;
printf("Value of Sum = %d",sum);
```

RESULT: Value of Sum = 97;

Example

```
printf("ASCII value of character 'f' = %d",'f');
```

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Printing to the Standard Output (Monitor)

Syntax

printf(<format string>, <variable list >);

Example

printf("I am %d years old",18);

RESULT: I am 18 years old.

Example

int x=20;
float y=30.5;
printf("%d + %f = %.2f",x,y,x+y);

RESULT: 20 + 30.5 = 50.50

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More on format string

Format	Description
%d	integer values
%f	float values
%c	char values
%s	string values

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Accepting data from the Standard Input (Keyboard)

Syntax

scanf(<format string>, <ampasand prefixed variable list >);

Example

scanf("%d ",&number);
RESULT: An integer value from the keyboard is stored in number

Example

printf("Enter the first and last characters of the alphabet ");
scanf("%c %c ",&first,&last);

RESULT: The two character values from keyboard are stored in first and last respectively.

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Backslash Character Constants

Constant	Meaning
\a	audible alert (bell)
\b	back space
\n	new line
\r	carriage return
\t	horizontal tab
\v	vertical tab
\'	single quote
\"	double quote
\\	backslash
\0	null

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Tips

Blank spaces may be inserted between words to improve the readability of the code.

Usually all statements are entered in a small case letters.

Any C statements always ends with a semi-colon ;

For multiline comments, use /* */

For single line comments use //

Comments can not be nested but can be split over more than a line.

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Tips

Any C program is typically a collection of functions.
main() is one such function.
Empty parenthesis after the main is necessary.

Statements belonging to a function are enclosed within a pair of braces {}

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Assignment 1

Question 1

Write a C program to compute the formula $v = u + at$

u - initial velocity

a - acceleration

t - time

v - final velocity

Question 2

Write a C program to compute the formula $SI = \frac{PXRXT}{100}$

SI - simple interest

P - principal

R - rate

T - time

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How does one master any programming language?

Follow the syntax rules.

Practice! Practice! Practice!

Special thanks to the following for their initial work:

- *Kwesi A. Smith*
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