C Programming Basics – Part 2

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Overview of Content

- Writing a Basic C Program
- Understanding Errors
- Comments, Keywords, Identifiers, Variables
- Standard Input and Output
- Operators
- Control Structures
- Functions in C
- Arrays, Structures
- Pointers
- Working with Files

All the concepts are accompanied by examples.

C Language Functions

- Functions are self-contained blocks of statements that perform a specific task

- Written once and can be used multiple times
  - Promote code reuse
  - Make code maintenance easy

- Two steps involved
  - Write the function
    - Function definition
    - Function declaration or prototype
  - Invoke or call the function

- Two types of functions
  - Standard or library or built-in
  - User-Defined

Standard Functions

- These functions are provided to the user in library files
- In order to use the functions, the user should include the appropriate library files containing the function definition
- Example
  - `scanf`
  - `printf`
  - `gets`
  - `puts`
  - `strcpy`

User-Defined Functions: myFunction.c

```
#include <stdio.h>
---------------Defining the function add
void add(){
   int a, b, c;
   printf("\n Enter Any 2 Numbers : ");
   fflush(stdout);
   scanf("%d %d",&a,&b);
   c = a + b;
   printf("\n Addition is : %d",c);
}
int main(){
   add();  <---Invoking the function add twice from
   add();  <---function main
   return 0;
}
```

Function Prototype: myFctPrototype.c

```
#include <stdio.h>

void add();

int main(){
 add();
 return 0;
}

void add(){
int a, b, c;
printf("\n Enter Any 2 Numbers : ");
fflush(stdout);
scanf("%d %d",&a,&b);
c = a + b;
printf("\n Addition is : %d",c);
}
```

Function Prototype or Declaration: useful when the function is invoked before its definition is provided

Invoking the function add

Defining the function add that does not return a value – note void

Categories of Functions

- Functions that take no input, and return no output
- Functions that take input and use it but return no output
- Functions that take input and return output
- Functions that take no input but return output

Sending Input Values To Functions

- Determine the number of values to be sent to the function
- Determine the data type of the values that needs to be sent
- Declare variables having the determined data types as an argument to the function
- Use the values in the function
- Prototype the function if its definition is not going to be available before the place from where it is invoked
- Send the correct values when the function is invoked

Passing Values to Functions: passValue1.c

```
#include <stdio.h>
void add(int a, int b){<-- Formal Parameters: a, b
   int c;
   c = a + b;
   printf("\n Addition is : %d",c);
}
int main(){
   int a, b;
   printf("\n Enter Any 2 Numbers : ");
   fflush(stdout);
   scanf("%d %d",&a,&b);
   add(a, b); <-- Actual Parameters: a, b
   return 0;
}
```

Note: The variables used as formal and actual parameters can have different names.

Passing Values to Functions: passValue2.c

```
#include <stdio.h>
#include <stdlib.h>
void add(int a, int b){
 //same code as in the previous slide
}
int main(int argc, char *argv[]){
 int a, b;
 if ( argc != 3 ){
  printf("\nInsufficient num. of arguments.\n");
  printf( "\nUsage:%s <firstNum> <secondNum>", argv[0]);
 }else{
    a = atoi(argv[1]);
    b = atoi(argv[2]);
    add(a, b);
 }
 return 0;
}
```

Code Snippet From passValue2.c

Notice that main has two arguments

```
int main(int argc, char *argv[]){
 int a, b;
 if ( argc != 3 ){
  printf("\nInsufficient num. of arguments.\n");
  printf( "\nUsage:%s <firstNum> <secondNum>", argv[0]);
 }else{
    a = atoi(argv[1]);
    b = atoi(argv[2]);
    add(a, b);
 }
 return 0;
}
```

argc is the argument count

argv[1] holds the first number typed in at the command-line. Notice the atoi function.

Returning Values from Functions: passValue4.c

```
#include <stdio.h>
int add(int a, int b){ <-- Notice the return type
   int c;
   c = a + b; a=c; b=c;
   printf("\n Addition is : %d",c);
   return c; <-- Return value: c
}
int main(){
   int a, b, c;
   printf("\n Enter Any 2 Numbers : ");
   scanf("%d %d",&a,&b);
   printf("a is: %d, b is: %d\n", a, b);
   c = add(a, b); <--- Value returned from add stored in c
   printf("a is: %d, b is: %d\n", a, b);
   return 0;
}
```

Returning Values from Functions: passValue4.c

- Output:

```
Enter Any 2 Numbers : 5 6
a is: 5, b is: 6
Addition is : 11
a is: 5, b is: 6
```

Note: the values of `a` and `b` remained the same when accessed from function main. More about functions on later slides

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All the concepts are accompanied by examples.

Arrays

- An array allows you to store many different values of same data type in a single unit

- Arrays are declared just like other variables, though the variable name ends with a set of square brackets
  - `char myName[50];` <---- You have seen this before
  - `int myVector[3];`
  - `int myMatrix[3][3];`

Arrays Example: arrayExample.c

```
#include <stdio.h>
int main(){
  int i;
  int age[4];
  age[0]=23;
  age[1]=34;
  age[2]=65;
  age[3]=74;
  for(i=0; i<4; i++){
    printf("age[%d]: %d\n", i, age[i]);
  }
  return 0;
}
```

Notice that count begins at 0

Output:

```
age[0]: 23
age[1]: 34
age[2]: 65
age[3]: 74
```

Structures

- Multiple variables can be combined into a single package called structure
- Members of the structure variable need not be of the same type
- They can be used to do database work in C! Example:

```
struct sample{
   int a;
   char b;
}
struct sample mySample;
```

- `typedef` is the keyword that can be used to simplify the usage of `struct`

```
typedef struct sample newType;
```

Structure Example: structExample.c

```
#include <stdio.h>

typedef struct point{
  double x;
  double y;
}point;

int main(){
  point myPoint;
  myPoint.x = 12.2;
  myPoint.y = 13.3;
  printf("X is %lf and Y is %lf\n",myPoint.x, myPoint.y);
  return 0;
}
```

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Pointers

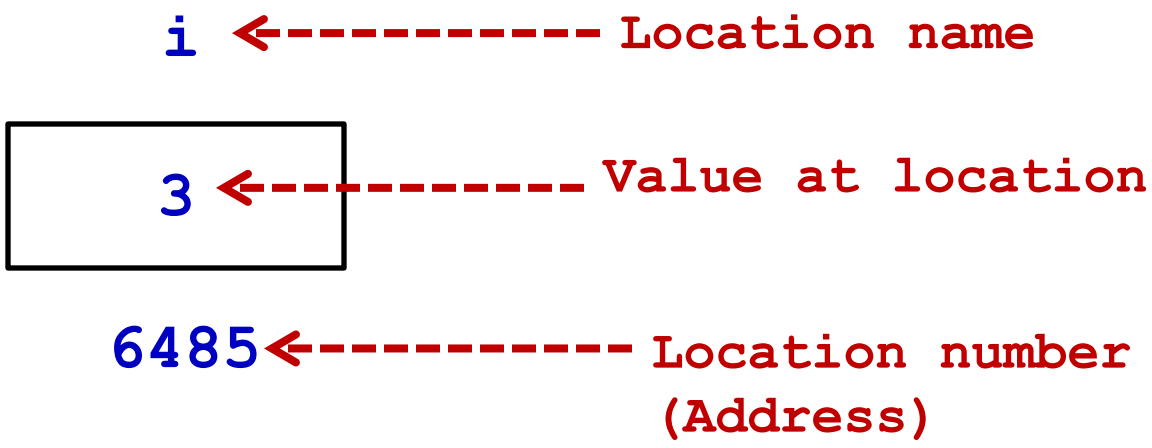
- A pointer is a variable that stores an address in memory - address of another variable
- For instance, the value of a pointer may be 42435. This number is an address in the computer's memory which is the start of some data
- We can dereference the pointer to look at or change the data
- Like variables, you have to declare pointers before you use them
- The data type specified with pointer declaration is the data type of the variable the pointer will point to

Revisiting Variable Declaration

- Consider the declaration

```
int i = 3;
```

- This declaration tells the C compiler to:
  - Reserve space in memory to hold the integer value
  - Associate the name `i` with this memory location
  - Store the value `3` at this location



‘Value at Address’ Operator: printAddress.c

```
#include <stdio.h>
int main(){
   int i=3;
   printf("\nAddress of i = %u", &i);
   printf("\nValue of i = %d", i);
   printf("\nValue of i = %d", *(&i));
   return 0;
}
```

& operator is ‘address of’ operator

* operator is ‘value at address of’ operator

Output:

```
Address of i = 2293532
Value of i = 3
Value of i = 3
```

Note:

&i returns the address of variable i

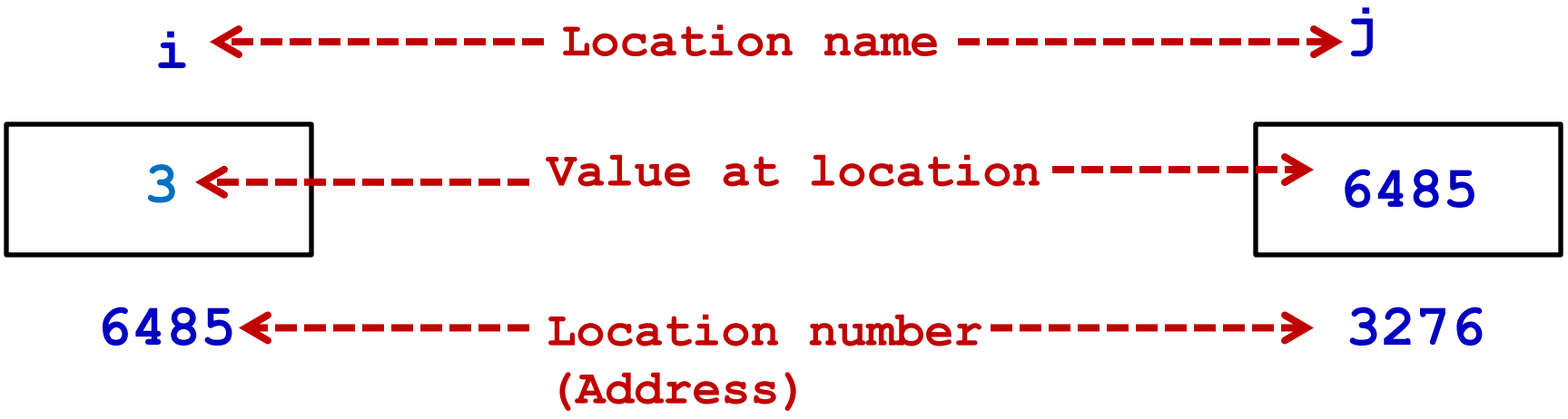
***(&i) returns the value at address of i**

Pointer Expressions

- In the previous example, the expression **`&i`** returns the address of **`i`**.
- This address can be collected in a variable as

```
j = &i;
```

- `j` is a variable which contains the address of another variable and is declared as `int *j;`



Pointers: pointerExample2.c

```
#include <stdio.h>
int main(){
 int i=3;
 int *j;
 j = &i;
 printf("\nAddress of i = %u", &i);
 printf("\nAddress of i = %u", j);
 printf("\nAddress of j = %u", &j);
 printf("\nValue of j = %u", j);
 printf("\nValue of i = %d", i);
 printf("\nValue of i = %d", *(&i));
 printf("\nValue of i = %d", *j);
 return 0;
}
```

Output:

```
Address of i = 2293532
Address of i = 2293532
Address of j = 2293528
Value of j = 2293532
Value of i = 3
Value of i = 3
Value of i = 3
```

Key Concepts Related to Pointers

- Declaring a pointer

```
int *myIntPtr;
int* myIntPtr;
```

- Getting the address of a variable

```
int age = 3;
myIntPtr = &age;
```

- Dereferencing a pointer

```
*myIntPtr = 5;
```

Note: We just changed the value of age!

Pointers Example 2: ptrExample.c

```
#include <stdio.h>
int main(){
    int myValue;
    int *myPtr;
    myValue = 15;
    myPtr = &myValue;
    printf("myValue is equal to : %d\n", myValue);
    *myPtr = 25;
    printf("myValue is equal to : %d\n", myValue);
}
```

Output:

```
myValue is equal to : 15
myValue is equal to : 25
```

Pointers and Arrays

- The square-bracket array notation is a short cut to prevent you from having to do pointer arithmetic

```
char array[5];
array[2] = 12;
```

`array` is a pointer to **`array[0]`**

`array[2] = 12;` is therefore equivalent to

```
*(array+2) = 12;
```

Passing Address to Function: passValue3.c

```
#include <stdio.h>

void addUpdate(int *a, int *b){
   int c;
   c = *a + *b;
   printf("Addition is : %d\n",c);
   *a = c;
   *b = c;
}
int main(){
   int a, b;
   printf("Enter Any 2 Numbers : ");
   scanf("%d %d",&a,&b);
   printf("a is: %d, b is: %d\n", a, b);
   addUpdate(&a, &b);
   printf("a is: %d, b is: %d\n", a, b);
   return 0;
}
```

Notice the pointer

Notice &a, &b

Note: The values of **a** and **b** changed in **addUpdate** function .

Output of passValue3.c

- **Output:**

```
Enter Any 2 Numbers : 2 8
a is: 2, b is: 8
Addition is : 10
a is: 10, b is: 10
```

Dynamic Memory Allocation

- Dynamic allocation is the automatic allocation of memory at run-time
- It is accomplished by two functions: `malloc` and `free`
- These functions are defined in the library file `stdlib.h`
- `malloc` allocates the specified number of bytes and returns a pointer to the block of memory
- When the memory is no longer needed, the pointer is passed to `free` which deallocates the memory
- Other functions:
  - `calloc` allocates the specified number of bytes and initializes them to zero
  - `realloc` increases the size of the specified chunk of memory

Note: With arrays, static memory allocation takes place, that is at compile-time.

Example: dynMemAlloc.c (1)

```
#include<stdio.h>
#include<stdlib.h>
int main(){
  int numStudents, avg, *ptr, i, sum = 0;
  printf("Enter the num of students :");
  scanf("%d",&numStudents);
  ptr=(int *)malloc(numStudents*sizeof(int));
  if(ptr == NULL){
    printf("\n\nMemory allocation failed!");
    exit(1);
  }
  for (i=0; i<numStudents; i++){
    printf("\nEnter the marks for the student %d\n", i+1);
    scanf("%d",(ptr+i));
  }
```

Example: dynMemAlloc.c (2)

```
    . . .
    for (i=0; i<numStudents; i++){
       sum = sum + *(ptr + i);
    }
    avg = sum/numStudents;
    printf("\nAvg marks = %d ",avg);
    return 0;
} // end of main function
```

```
Output:
Enter the num of students :3
Enter the marks for the student 1
10
Enter the marks for the student 2
20
Enter the marks for the student 3
30
Avg marks = 20
```

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Including Library File for Maths: mathExample.c

```
#include <stdio.h>
#include <math.h>
int main(){
 double myNum = 2.2;
 int times = 8 ;
 printf("Square root of %lf is: %lf\n",myNum, sqrt(myNum));
 return 0;
}
```

```
Output:
Square root of 2.200000 is: 1.483240
```

User-Defined Header Files

- Useful in multi-module, multi-person software development effort
- Save the following code in a file named head.h and don't compile/run it

```
/* This is my little header file named head.h */
#define HAPPY 100
#define SPIT printf
#define POOL {
#define PEEL }
```

User-Defined Header Files

- This is how the file head.h can be included in any program, here headTest.c

```
#include <stdio.h>
#include "head.h" <-- Notice the quotes around file name
int main()
POOL
SPIT("This guy is happy: %d percent\n", HAPPY);
return(0);
PEEL
```

```
Output:
This guy is happy: 100 percent
```

File I/O

- File pointer is required for accessing files to read, write or append

```
FILE *fp;
```

- **fopen** function is used to open a file and it returns a file pointer

```
FILE *fopen(const char *filename, const char *mode);
```

- The modes in which a file can be opened

```
r  - open for reading
w  - open for writing (file need not exist)
a  - open for appending (file need not exist)
r+ - open for reading and writing, start at beginning
w+ - open for reading and writing (overwrite file)
a+ - open for reading and writing (append if file exists)
```

- To close a file

```
int fclose(FILE *a_file);
```

File I/O: fileExample.c

```
#include <stdio.h>
#include <stdlib.h>
int main() {
  int i, myInt;
  FILE *ifp;
  char *mode = "r";
  ifp = fopen("in.txt", mode);
  if (ifp == NULL) {
    fprintf(stderr, "Can't open input file in.txt!\n");
    exit(1);
  }else{
    for (i=0; i<10; i++){
      fscanf(ifp,"%d", &myInt);
      printf("%d\n",myInt);
    }
  }
  fclose(ifp);
  return 0;
}
```

Write to a File: writeToFile.c

```c
#include <stdio.h>
int main(){
    FILE *fp;
    fp = fopen("in2.txt","a+");
    fprintf(fp,"\n%d",7000);
    fclose(fp);
    return 0;
}
```

Opening the file in append mode

fprintf is used for writing data to a file

References

- C Programming Language, Brian Kernighan and Dennis Ritchie
- Let Us C, Yashavant Kanetkar
- C for Dummies, Dan Gookin
- http://cplusplus.com