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C: an introduction

Scope basics

Key Point: Modularity

- Functions: permit modularity within a program.
- Writing quality modular software
  - Learning the basic syntax of C is easy. But large-scale software is much more.
  - Modularity is the key to managing complexity.
    - Without care, code becomes highly interconnected.
    - Testing and debugging different components separately. Once you are sure a component is correct, you (almost) never have to test it again. Future bugs are likely to be elsewhere.
    - Grouping related functionality. Controlling visibility.
  - Difficult to teach modularity

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Definitions

- **Scope** refers to an identifier's *visibility* throughout the program: where in the program can it be used.
- **Extent** refers to the *lifetime* of a variable. When is it created and when is it destroyed. (when is memory allocated for it, and when is the memory released).

Global variable

- global variable, is recognized by its name across all functions in the program
- must be declared outside of any function definition, including main(), typically near the top of .c file
- generally discouraged, because their unlimited accessibility can be dangerous

```
double dist = 0.0; // defined outside of any function
int main()
{
double a, b;
…
return 0;
}
```

```c
#include<stdio.h>
#include<math.h>

/*
demo_global.c
taken from Gonzalez, computer programming in C for beginners
*/

void dist(double x1, double y1, double x2, double y2);
double square(double x);

double distance = 0.0; // global variable defined outside of any function

int main()
{
double x_one = 5.37, y_one = 9.6, x_two = 11.16, y_two = 21.78;
dist(x_one, y_one, x_two, y_two);
printf("The distance between the two points is %lf \n", distance);
return 0;
}

void dist(double x1, double y1, double x2, double y2)
// dist() doesn't return anything
// It sets the value of the global distance directly
{
distance = sqrt(square(x1-x2) + square(y1-y2));
// variable distance is global
}

double square(double x)
{
double y = 0.0;
y = x * x;
return y;
}
```

```
frankvp@CRD-L-08004:.../Scope$ gcc demo_global.c -o demo_global -lm
frankvp@CRD-L-08004:.../Scope$ ./demo_global
The distance between the two points is 13.486160
frankvp@CRD-L-08004:.../Scope$
```

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Variable declaration: scope

- The scope of a variable: the part(s) of the program in which it is known.
- **Basic rule 1**: identifiers are accessible only within the block in which they are declared
  - a name is local to the block in which it is declared
  - outside the boundaries of that block it is not known
  - storage space for a local variable is provided when its block is entered and released when the block ends
- **Basic rule 2**: a declaration in an inner block hides all declarations of the same name in surrounding blocks

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Name Hiding

- It is possible to have two variables with same name, and overlapping scope, without conflict.
- C has scope resolution rules that state the variable with more-restricted scope will hide the other.


```c
#include <stdio.h>
// demo_scop01.c

void f(int a);

int a, b;   // global - - test this

void main(void)
{

//int a, b;   // local to main - test this


a = 1;
b = 2;
printf("a = %d, b = %d \n", a, b);
f(a);
printf("a = %d, b = %d \n", a, b);
}

void f(int a)
{
  a = 3;
  {
    int b = 4;
    printf("a = %d, b = %d  \n", a, b);
  }
  printf("a = %d, b = %d  \n", a, b);
  b = 5;
}
```

```
frankvp@CRD-L-08004:.../Scope$ gcc demo_scope01.c -o demo_scope01
frankvp@CRD-L-08004:.../Scope$ ./demo_scope01
a = 1, b = 2
a = 3, b = 4
a = 3, b = 2
a = 1, b = 5
frankvp@CRD-L-08004:.../Scope$
```

```c
#include<stdio.h>

/*
demo_scope02.c
taken from: http://www.c4learn.com/c-programming/c-file-scope/
*/

void message ();
int num1 = 1;     // Global

int main ()
{
  int num1 = 6;
  printf ("%d \n", num1);   // Local variable is accessed
  message ();

  return 0;
}

void
message ()
{
  printf ("%d \n", num1);   // Global variable is accessed
}
```

```
frankvp@CRD-L-08004:.../Scope$ gcc demo_scope02.c -o demo_scope02
frankvp@CRD-L-08004:.../Scope$ ./demo_scope02
6
1
frankvp@CRD-L-08004:.../Scope$
```

The lifetime of the global variable `num1` extends for the duration of the whole program
The scope is however not in main, since it is hidden by the local variable `num1`

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Static Variables

- Variables declared *within* a function are **local** to that function. This is known as **automatic** local variables (they are automatically created and then destroyed as the function is called, and then finishes).
- **Static** local variables: The variable will not be destroyed when the function exits, but it (and its value) will persist. The variable is initialized only once.

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```c
/*
static_var.c
static variable
 taken from http://gribblelab.org/cbootcamp/5_Functions.html
*/
#include <stdio.h>

void myFunc(void);
void myFunc2(void);

int main() {
        myFunc();
        myFunc2();
        myFunc();
        myFunc2();
        myFunc();
//      printf("num = %d\n", num);  // THIS WOULD NOT WORK
        return 0;
}
void myFunc(void) {
        static int num = 0;
//        int num = 0;
        num++;
        printf("myFunc() has been called %d times so far\n", num);
}
void myFunc2(void) {
        int num = 0;
        num++;
        printf("myFunc2() has been called %d times so far\n", num);
}
```

```
frankvp@CRD-L-08004:.../Scope$ gcc static_var.c -o static_var
frankvp@CRD-L-08004:.../Scope$ ./static_var
myFunc() has been called 1 times so far
myFunc2() has been called 1 times so far
myFunc() has been called 2 times so far
myFunc2() has been called 1 times so far
myFunc() has been called 3 times so far
frankvp@CRD-L-08004:.../Scope$
```