CS101 Introduction to computing

Function

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Outline

- **Function**
- Calling, Definition
- Parameter Passing

Functions

- Modularize a program
- All variables declared inside functions are local variables : Known only in function defined
- Parameters: Communicate info. between functions
- Function Benefits
  - Divide and conquer : Manageable program development
  - Software reusability : Use existing functions as building blocks for new programs and
  - Abstraction : hide internal details (library functions)
  - Avoids code repetition

Functions

- A C program is made up of one or more functions, one of which is main( ).
- Execution always begins with main( )
  - No matter where it is placed in the program.
- main( ) is located before all other functions.
- When program control encounters a function name, the function is **called** (**invoked**).
  1. Program control passes to the function.
  2. The function is executed.
  3. Control is passed back to the calling function.

Sample Function Call

```
#include <stdio.h>
 int main ( ) {

  printf("Hello World!\n");
  return 0 ;
}
```

printf is the name of a **predefined function** in the stdio library

this statement is is known as a **function call**

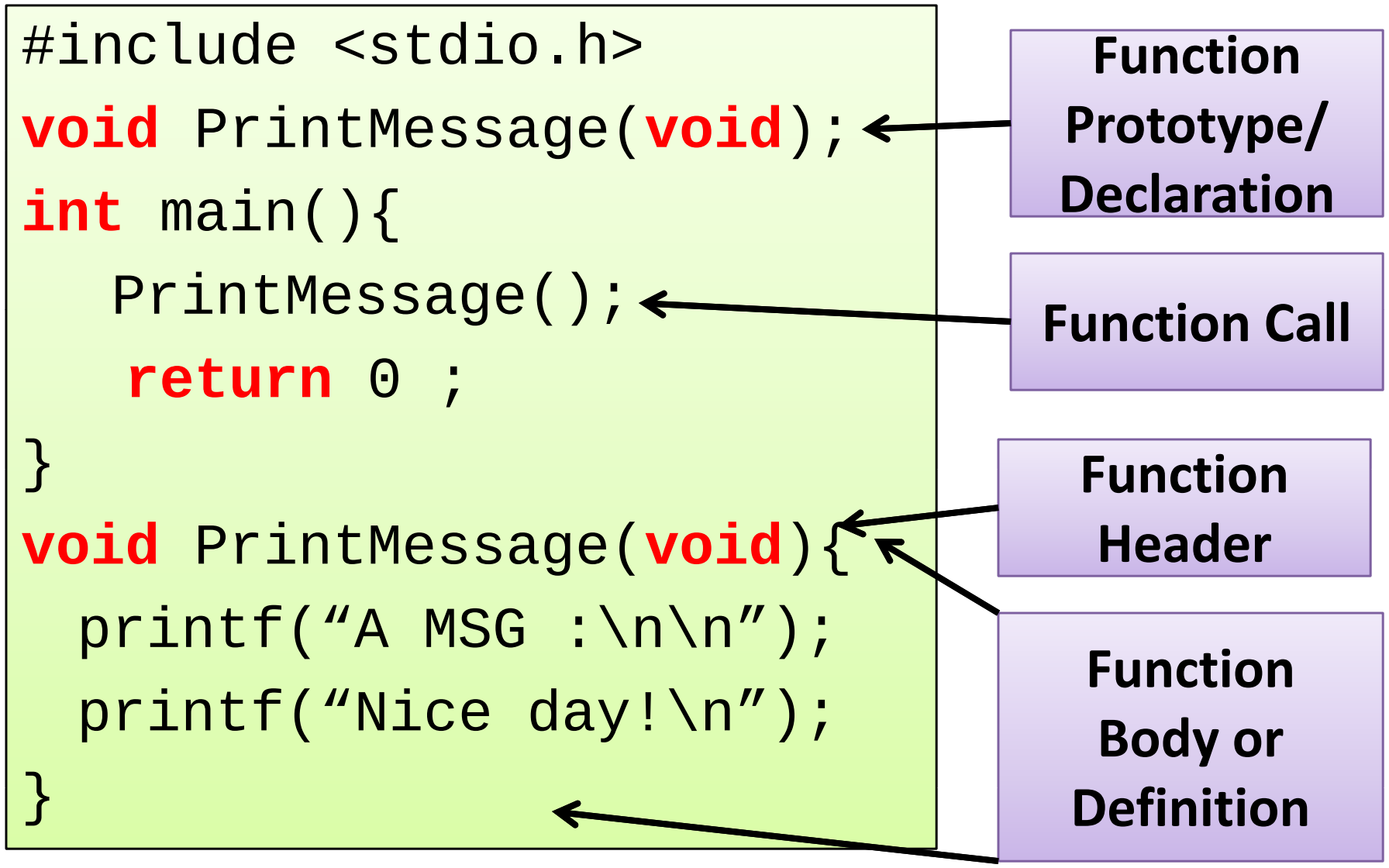
this is a string we are **passing** as an **argument** (**parameter**) to the printf function

Functions (con't)

- We have used three predefined functions so far:
  - –printf, scanf, pow, sqrt, abs, sin, cos
- Programmers can write their own functions.
- Typically, each module in a program's design hierarchy chart is implemented as a function.

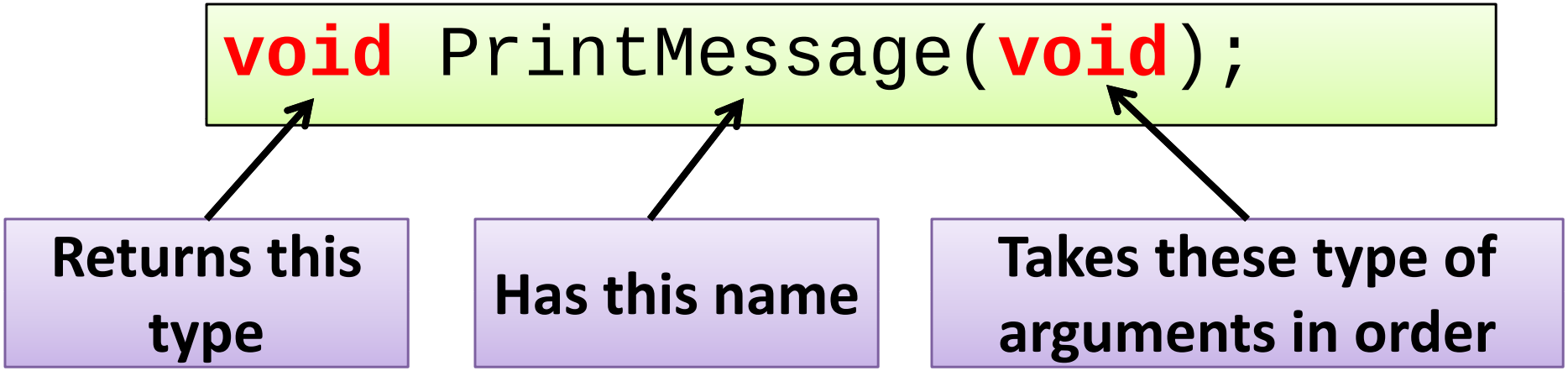
Sample -Defined Function

```
#include <stdio.h>
void PrintMessage(void);
int main(){
   PrintMessage();
    return 0 ;
}
void PrintMessage(void){
  printf("A MSG :\n\n");
  printf("Nice day!\n");
}
```



The Function Prototype

- Informs the compiler that there will be a function defined later that:

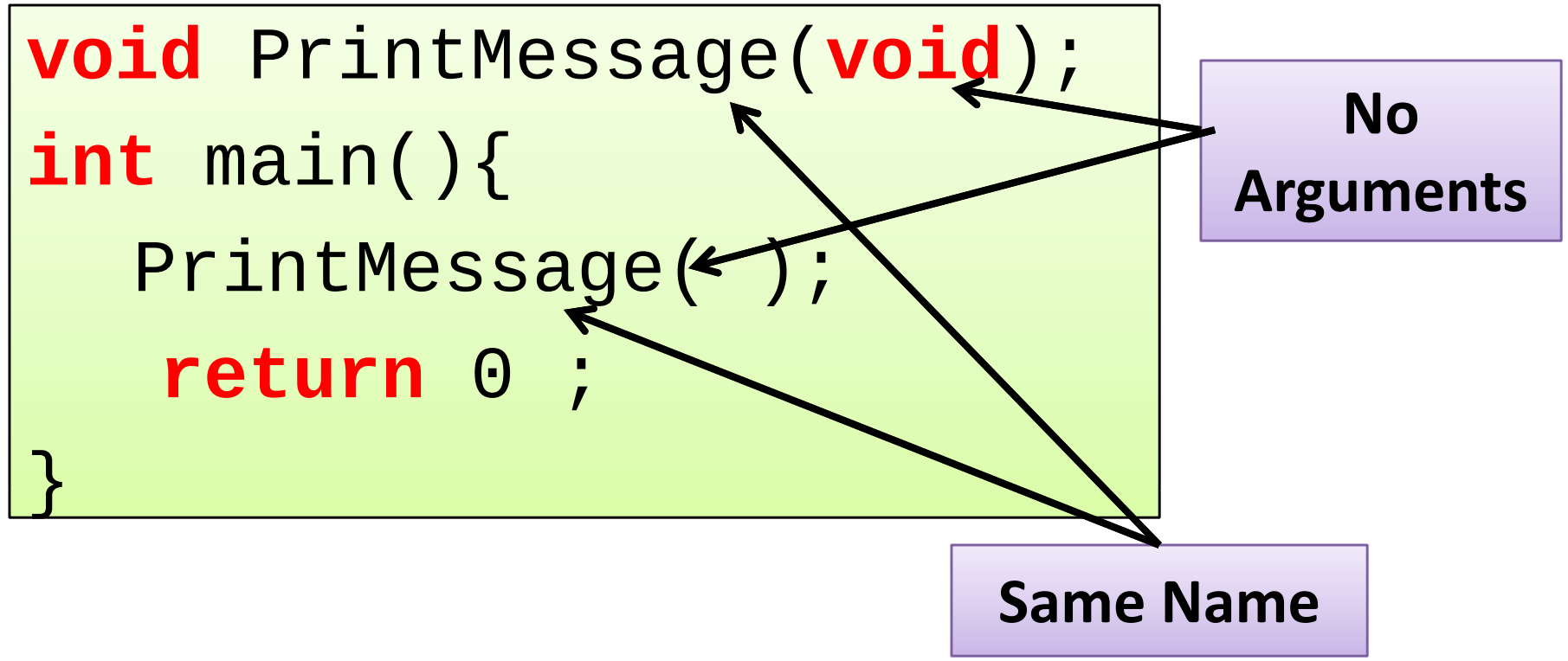


- Needed because the function call is made before the definition -- the compiler uses it to see if the call is made properly

The Function Call

- Passes program control to the function
- Must match the prototype in name, number of arguments, and types of arguments

```
void PrintMessage(void);
int main(){
   PrintMessage( );
    return 0 ;
}
```



The Function Definition

- Control is passed to the function by function call
  - The statements within the function body will then be executed

```
void PrintMessage(void){
  printf("A MSG :\n\n");
  printf("Nice day!\n");
}
```

- After statements in the function have completed
  - Control is passed back to the **calling function**
- In this case main( )
  - Note that the calling function does not have to be main( ) .

General Function Definition Syntax

type functionName (*parameter*$_1$, . . . , *parameter*$_n$) {
    variable declaration(s)
    statement(s)
}

- If there are no parameters
  - either `functionName()` OR `functionName(void)`
- There may be no variable declarations.
- If the **function type** (**return type**) is void, a return statement is not required
  - Permitted: `return;` OR `return();`

Input Parameters to Function

```
void PrintMessage(int counter) ;

int main ( ){
    int 10;
    PrintMessage(num)
    return 0 ;
}

void PrintMessage(int counter) {
    int i ;
    for (i=0;i<counter; i++)
      printf (“Nice day!\n”) ;
}
```

matches the one **formal parameter** of type int

one argument of type int

Functions Can Return Values : Example

```
#include <stdio.h>
float AverageTwo(int num1,int num2);
int main(){
  float ave ;
  int value1 = 5, value2 = 8 ;
  ave=AverageTwo(value1, value2) ;
  printf("The average of %d & %d
       is %f\n",value1,value2,ave);
 return 0 ;
}
float AverageTwo (int num1, int num2) {
  return  (float)((num1+num2)/2.0) ;
}
```

Temp Convert Function in C

```
double CtoF ( double paramCel){
    return paramCel*1.8+32.0;
}
```

- This function takes an input parameter
  - Called paramCel (temp in degree Celsius)
- Returns a value
  - that corresponds to the temp in degree Fahrenheit

How to use a function?

```
#include <stdio.h>
double CtoF( double );
/*  Purpose: to convert temperature
* from Celsius to Fahrenheit *****/
int main() {
  double c, f;
  printf("Enter the degree (in Celsius): ");
  scanf("%lf", &c);
  f = CtoF(c);
  printf("Temperature (in Fahrenheit)
                              is %lf\n", f);
}
double CtoF ( double paramCel) {
  return paramCel * 1.8 + 32.0;
}
```

Terminology

- **Declaration**

```
double CtoF(double);
```

- **Invocation (Call)**

```
double CtoF(double);
```

- **Definition**

```
duuble CtoF( double paramCel){
    return paramCel*1.8 + 32.0;
 }
```

Modularity: Example

Declarations

```
#include <stdio.h>

double GetTemp();
double CelsToFahr(double);
void DispRes(double,double);

int main(){
  double TempC, TempF;

  TempC=GetTemp();
  TempF=CelsToFahr(TempC);
  DispRes(TempC,TempF);

  return 0;
}
```

Invocations

```
double CelsToFahr(double Tem){
  return (Tem * 1.8 + 32.0);
}
```

```
double GetTemp (){
  double Temp;
  printf("Please enter temp in
       degrees Celsius:");
  scanf("%lf", &Temp);
  return Temp;
}
```

```
void DispRes(double CTemp,
          double Ftemp){
  printf("Original: %5.2f
         C\n", CTemp);
  printf("Equivalent: %5.2f
         F\n", FTemp);
}
```

Abstractions

- We are hiding details on *how* something is done in the function implementation
  - Put in library ☺ ☺ : do you require to know code for printf ? **No**

```
#include <stdio.h>

int main(){
  double TempC, TempF;

  TempC=GetTemp();
  TempF=CelsToFahr(TempC);
  DispRes(TempC,TempF);

  return 0;
}
```

```
double CelsToFahr(double Tem){
  return (Tem * 1.8 + 32.0);
}
```

```
double GetTemp (){
  double Temp;
  printf("Please enter temp in
        degrees Celsius:");
  scanf("%lf", &Temp);
  return Temp;
}
```

```
void DispRes(double CTemp,
          double Ftemp){
  printf("Original: %5.2f
        C\n", CTemp);
  printf("Equivalent: %5.2f
        F\n", FTemp);
}
```

Parameter Passing

- **Actual parameters** are the parameters that appear in the function call

```
ave =AverageTwo(value1,value2) ;
```

- **Formal parameters** are the parameters that appear in the function header

```
float AverageTwo(int num1,int num2)
```

- Actual and formal parameters are matched by position.
- Each formal parameter receives the value of its corresponding actual parameter.

Parameter Passing (cont..)

- Corresponding actual and formal parameters
  - Do not have to have the same name, but they may.
  - Must be of the same data type, with some exceptions, Exception example

```
int fact(int N){ //Code for Fact;}
main(){
      float X=10.34;
      printf("fact of %f is %d",x, fact( X ));
}
```

auto conversion

Local Variables

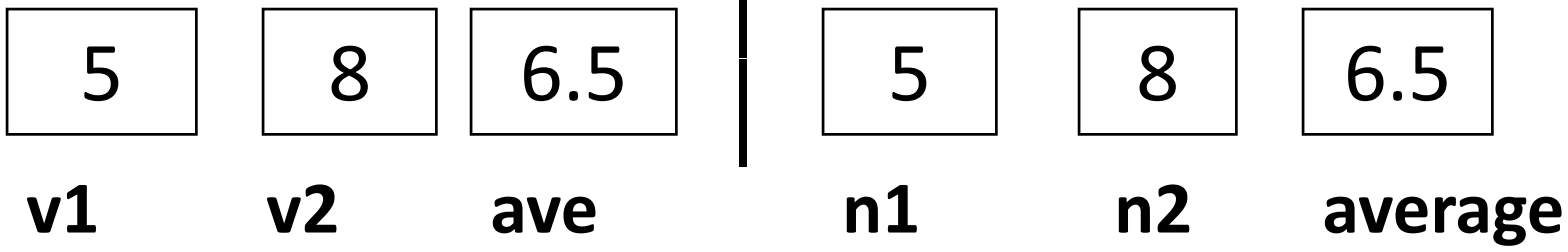
- Functions only “see” (have access to) their own **local variables**. This includes main( )
- Formal parameters are declarations of local variables.
  - The values passed are assigned to those variables.
- Other local variables can be declared within the function body.

Parameter Passing and Local Variables

```
int main(){
  float ave ;
  int v1=5, v2=8 ;
  ave=AvgOfTwo(v1, v2);
  printf ("The average
       is %f\n", ave);
  return 0 ;
}
```

```
float AvgOfTwo(int n1,
               int n2){
  float average;
   average=(n1+n2)/2;
  return average;
}
```

Local copy of variables

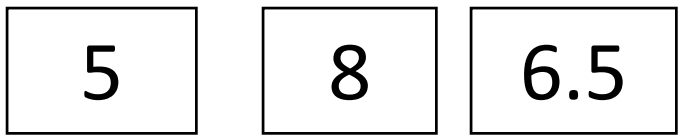


Same Name, Still Different Memory Locations

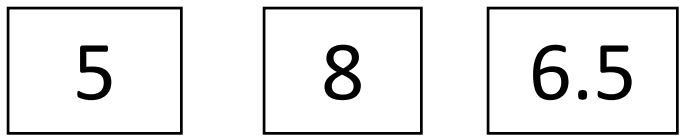
```
int main(){
  float ave ;
  int n1=5, n2=8 ;
  ave=AvgOfTwo(n1, n2);
  printf ("The average
       is %f\n", ave);
  return 0 ;
}
```

```
float AvgOfTwo(int n1,
               int n2){
  float average;
   average=(n1+n2)/2;
  return average;
}
```

Local copy of variables



n1 **n2** **ave**



n1 **n2** **average**

Changes to Local Variables Do NOT Change Other Variables with the Same Name

```
int main(){
   int n1=5;
   AddOne(n1);
   printf ("In main
      n1 is %d\n",n1);
   return 0 ;
}
```

```
void AddOne (int n1){
   n1=n1+1;
   printf ("In AddOneF
      n1 is %d\n",n1);
   return;
}
```

5

n1

6

n1

Local copy of variables

OUTPUT

In AddOneF n1 = 6

In main n1 = 5

Solution : use Pass by reference

```
int main(){
   int n1=5;
   int *Pn1;
   Pn1=&n1;
   AddOne(Pn1);
   printf (“In main
      n1 is %d\n”,n1);
   return 0 ;
}
```

```
void AddOne(
         int *Pn1){
   *Pn1=*Pn1+1;
   printf (“In AddOneF
      n1 is %d\n”,*Pn1);
   return;
}
```

5	&n1
n1	**Pn1**

&n1
Pn1

Local copy of Ptr variables

OUTPUT

In AddOneF n1 = 6

In main n1 = 6

Changes to Local Variables Do NOT Change Other Variables with the Same Name

```
int main(){
   int n1=5, n2=10;
   swap(n1,n2);
   printf ("In main n1=
     %d n2=%d\n",n1,n2);
   return 0 ;
}
```

```
void swap(int n1,
     int n2){
int tmp;
tmp=n1; n1=n2;n2=tmp;
printf ("In main n1=
    %d n2=%d\n",n1,n2);
}
```

Local copy of variables

5	10
n1	**n2**

10	5	5
n1	**n2**	**tmp**

OUTPUT

In swap n1 = 10 n2 =5

In main n1 = 5 n2 =10

Use Pass by Address/Reference

```
int main(){
   int n1=5, n2=10;
   swap(&n1,&n2);
   printf (“In main n1=
     %d n2=%d\n”,n1,n2);
   return 0 ;
}
```

```
void swap(int *Pn1,
     int *Pn2){
int tmp;
tmp=*Pn1;
*Pn1=*Pn2;*Pn2=tmp;
printf (“In main n1=
    %d n2=%d\n”,n1,n2);
}
```

Local copy of variables

5	10
n1	**n2**

&n1	&n2	5
Pn1	**Pn2**	**tmp**

OUTPUT

In swap n1 = 10 n2 =5

In main n1 = 10 n2 =5

Passing Array to Function

```
//(const float *age) (float *age) (float age[6]) same
```

```
 float average(float age[]){
    int i; float avg, sum = 0.0;
    for (i = 0; i < 6; ++i) {
        sum = sum +age[i];  age[i]=1;
    }
    avg = (sum / 6);  return avg;
}
```

```
int main(){
 float avg, age[]={23.4,55,22.6,3,40.5,18};
 int i;
 avg = average(age);
 printf("Average age=%.2f\n", avg);
 for(i=0;i<6;++i) printf("%1.2f“,age[i]);
 return 0 ;
}
```

Storage Classes

- **Storage class specifiers : static, register, auto, extern**
  - Storage duration – how long an object exists in memory
  - Scope – where object can be referenced in program
  - Linkage – specifies the files in which an identifier is known
- **Automatic storage**
  - Object created and destroyed within its block
  - `auto:` default for local variables

```
auto double x, y;
```

  - `register:` tries to put variable into high-speed registers
    - Can only be used for automatic variables

Automatic Storage

- Object created and destroyed within its block
- `auto:` **default for local variables**

```
auto double x, y; //same as double x, y
```

- **Conserving memory**
  - because automatic variables exist only when they are needed.
  - They are created when the function in which they are defined is entered
  - and they are destroyed when the function is exited
- **Principle of least privilege**
  - Allowing access to data only when it is absolutely needed.
  - Why have variables stored in memory and accessible when in fact they are not needed?

Register Storage

- The storage-class specifier **register** can be placed before an automatic variable declaration
  - To suggest that the compiler maintain the variable in one of the computer's high-speed hardware registers.

```
register int counter;
```

  - If intensely used variables such as counters or totals can be maintained in hardware registers
- **Often, register declarations are unnecessary**
  - Today's optimizing compilers are capable of recognizing frequently used variables
  - Can decide to place them in registers without the need for a register declaration

Static storage Classes

- Variables exist for entire program execution
- Default value of zero
- `static`: local variables defined in functions.
  - ***Keep value after function ends***
  - Only known in their own function
- `extern:` default for ***global variables*** and functions
  - Known in any function

Tips for Storage Class

- **Defining a variable as global rather than local**
  - Allows unintended side effects to occur
  - When a function that does not need access to the variable accidentally or maliciously modifies it
- **In general, use of global variables** should be avoided : except in certain situations
- **Variables used only in a particular function**
  - Should be defined as local variables in that function
  - Rather than as external variables.

Scope Rules

- File scope
  - Identifier defined outside function, known in all functions
  - Used for *global variables, function definitions, function prototypes*
- Function scope
  - Can only be referenced inside a function body

Scope Rules

- Block scope
  - Identifier declared inside a block
    - Block scope begins at definition, ends at right brace
  - Used for *variables, function parameters (local variables of function*)
  - **Outer blocks "hidden" from inner blocks if there is a variable with the same name in the inner block**
- Function prototype scope
  - Used for identifiers in *parameter list*

Scope Rule Example

```
int A; //global
int main(){
 A=1;
 MyProc();
 printf("A=%d\n",A);
 return 0 ;
}
void myProc(){
  int A=2;
  while(A==2){
    int A=3;
    printf("A=%d\n",A);
    break;
   }
   printf("A=%d\n",A);
  }
```

Outer blocks "hidden" from inner blocks if there is a variable with the same name in the inner block

Printout:

A = 3

A = 2

A = 1

Scope and Life : Static Vs Global

```
int GA; //global
int main(){
 int i;
 GA=1;
 for(i=1;i<10;i++)
    MyProc();
 printf("GA=%d",GA);
 return 0 ;
}
void myProc(){
   static int SA=2;
   SA=SA+1;
}
```

Both SA and GA Variables exist for entire program execution

- SA initialized once
- SA can be accessible from myProc only
- But GA accessible from any part of Program

Scope Rule Example

```
int FunA(){return 4;}; //global
int main(){

 {
 int FunA(){return 3;};
 pintf("FA=%d\n",FunA());
 }

 pintf("FA=%d\n",FunA());
 return 0 ;
}
```

Outer blocks "hidden" from inner blocks if there is a variable with the same name in the inner block

Printout:

FA = 3

FA = 4

Compile using gcc

This code will not compile using c++/g++ compiler

Thanks