Top-Down Design with Functions

Comp230

Functions

- Definition:

  A function is a group of statements that together perform a task. Every C program has at least one function, which is main(), and all the most trivial programs can define additional functions.

- Two types:
  1. C library functions (sqrt (x), abs (x),…)
  2. User defined functions (Your own functions)

Some Mathematical Functions

Function	Standard Header File	Purpose: Example	Argument(s)	Result
`abs(x)`	`<stdlib.h>`	Returns the absolute value of its integer argument: if `x is -5`, `abs(x)` is 5	`int`	`int`
`ceil(x)`	`<math.h>`	Returns the smallest integral value that is not less than `x`: if `x` is `45.23`, `ceil(x)` is `46.0`	`double`	`double`
`cos(x)`	`<math.h>`	Returns the cosine of angle `x`: if `x` is `0.0`, `cos(x)` is `1.0`	`double` (radians)	`double`
`exp(x)`	`<math.h>`	Returns e^x where e `= 2.71828...`: if `x` is `1.0`, `exp(x)` is `2.71828`	`double`	`double`
`fabs(x)`	`<math.h>`	Returns the absolute value of its type `double` argument: if `x` is `-8.432`, `fabs(x)` is `8.432`	`double`	`double`
`floor(x)`	`<math.h>`	Returns the largest integral value that is not greater than `x`: if `x` is `45.23`, `floor(x)` is `45.0`	`double`	`double`

Some Mathematical Functions

`log(x)`	`<math.h>`	Returns the natural logarithm of `x` for `x > 0.0`: if `x` is `2.71828`, `log(x)` is `1.0`	`double`	`double`
`log10(x)`	`<math.h>`	Returns the base-10 logarithm of `x` for `x > 0.0`: if `x` is `100.0`, `log10(x)` is `2.0`	`double`	`double`
`pow(x, y)`	`<math.h>`	Returns x^y. If `x` is negative, `y` must be integral: if `x` is `0.16` and `y` is `0.5`, `pow(x,y)` is `0.4`	`double, double`	`double`
`sin(x)`	`<math.h>`	Returns the sine of angle `x`: if `x` is `1.5708`, `sin(x)` is `1.0`	`double` (radians)	`double`
`sqrt(x)`	`<math.h>`	Returns the nonnegative square root of `x` ($\sqrt{x}$) for `x ≥ 0.0`: if `x` is `2.25`, `sqrt(x)` is `1.5`	`double`	`double`
`tan(x)`	`<math.h>`	Returns the tangent of angle `x`: if `x` is `0.0`, `tan(x)` is `0.0`	`double` (radians)	`double`

Functions

- **Why Functions:**
  1) Useful for C programmers to divide their programs into separate functions (instead of big “chunk‘”). This make it easy to debug the code and handling error.
  1) Reusability:
     - Once a function is defined, it can be used over and over and over again.
     - You can invoke the same function many times in your program.
     - Use same function in several different (and separate) programs.

Functions

- **Types of functions:**
  1. Function with no arguments and no return value.
  2. Function with no arguments but return Value.
  3. Function with arguments and no return Value.
  4. Function with argument and a return value
- **How to write a function:**
  1. Function prototype
  2. Function Definition
  3. Function Call

Functions

- How to write a function: Function prototype

  Tells the compiler about a function's name, return type, and parameters.

  return_type function_name (parameter list)

  int sum (int ,int);// with parameters and return value

  void printNum (int);// with parameters and no return value

  float area (); // no parameters and with return value

  double circumference (double);// with parameters and return value

  void printChar (char); // with parameters and no return value

  void printSquare();//no arguments and no return value

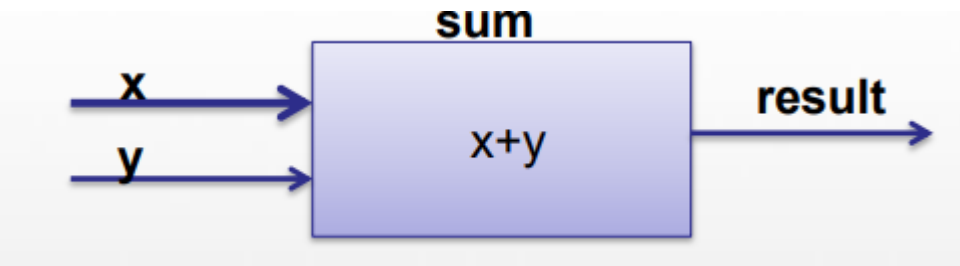
Functions

- How to write a function: Function Definition

  Provides the actual body of the function.

```
return_type function_name ( parameter list )
{
      body of the function
}
```

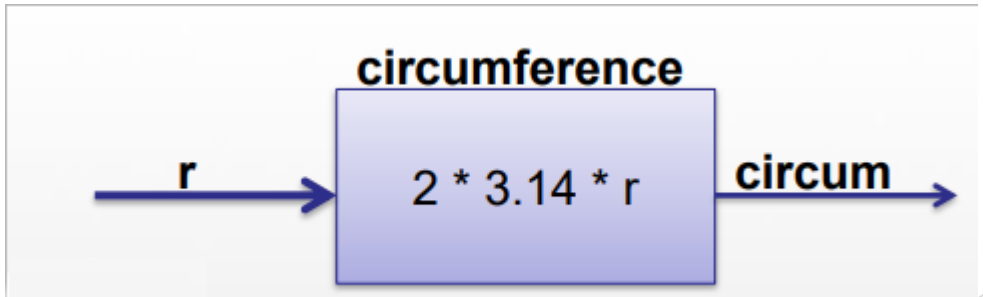
```
int sum ( int x, int y)
{
      int result;
      result= x+y;
      return result;
}
```



Functions

- How to write a function: Function Definition

```
void printNum ( int x)
{
    printf("%d", x);
}
double circumference (double r)
{
    double circum;
    circum= 2 * 3.14 * r;
    return circum;
}
```



Functions

- How to write a function: Function Call

To use a function, you will have to call that function to perform the defined task.

```
int mySum = sum (x,y);
double circum = circumference (r);
printNum(x);
```

Functions

- How to write a function: Terminology

  Return Type: A function may return a value. The return_type is the data type of the value the function returns. Some functions perform the desired operations without returning a value. In this case, the return_type is the keyword **void**.

  Function Name: This is the actual name of the function. The function name and the parameter list together constitute the function signature.

Functions

- How to write a function: Terminology

  Parameters: A parameter is like a placeholder. When a function is invoked, you pass a value to the parameter. This value is referred to as actual parameter or argument. The parameter list refers to the type, order, and number of the parameters of a function. Parameters are optional; that is, a function may contain no parameters.

  Function Body: The function body contains a collection of statements that define what the function does.

Functions (Exercises)

- Write a C program to compute the area of a circle with radius r. (Recall that $A=\pi r^2$.)

- Write a C program to compute the circumference of a circle with radius r. (Recall that circum=$2\pi r$.)

```c
#include <stdio.h>
#include <math.h>
#define PI 3.141593
// function prototype
double computeArea (double);
int main()
{
    double r, area; // Declare variables.
    // Enter the radius.
    printf("Enter the radius of the circle: \n");
    scanf("%lf",&r);
    area= computeArea(r); //call function
    // Print the value of the area..
    printf("The area of a circle with radius %5.3f is %5.3f. \n",r,area);
    // Exit program.
    return 0;
}
// Function Definition
double computeArea (double r)
{
     double area;
     // Compute the area of the circle.
     area = PI*pow (r,2);
     return area;
}
```

```c
#include <stdio.h>
#define PI 3.141593
//  function prototype
double computeCircumference (double,double);
int main()
{
   double r, circum; //  Declare variables.
    // Enter the radius.
   printf("Enter the radius of the circle: \n");
   scanf("%lf",&r);
   circum= computeCircumference(r,PI); //call function
    // Print the value of the circumference
   printf("The circumference of a circle with radius %5.3f is %5.3f. \n",r,circum);
    // Exit program.
   return 0;
}
 // Function Definition
double computeCircumference (double r,double pi)
{
    double circum;
     // Compute the circumference of the circle.
    circum = 2*pi*r;
    return circum;
}
```

```c
#include <stdio.h>
#define PI 3.141593
// function prototype
double computeCircumference (double);
int main()
{
   double r, circum; // Declare variables.
    // Enter the radius.
   printf("Enter the radius of the circle: \n");
   scanf("%lf",&r);
   circum= computeCircumference(r); //call function
    // Print the value of the circumference
   printf("The circumference of a circle with radius %5.3f is %5.3f. \n",r,circum);
    // Exit program.
   return 0;
}
 // Function Definition
double computeCircumference (double r)
{
    double circum;
     // Compute the circumference of the circle.
    circum = 2*PI*r;
    return circum;
}
```

Functions (more practice)

- Write a complete c program that asks the user to enter two numbers, finds and prints the sum of them. Your program should include at least one function called sum to return the sum of the two numbers.

  Function prototype

  ```
  int sum (int x, int y)
  ```

- write the prototype of average, a function that returns the average of its two type double input parameters.

  ```
  double average (double, double );
  ```

- write a definition for the above function prototype.

  ```
  double average (double n1, double n2 )
  {
   return ((n1 + n2) / 2.0);
  }
  ```

Functions (more practice)

- Write a function call for each function prototype.

```
#include <stdio.h>
/*Functions Prototypes */
void draw_top();
void draw_sides(void);
void draw_bottom(void);
int main(void)
{
/*Functions calls */
return (0);
}
/* Functions Definitions */
…….
```

```
draw_top();
draw_sides();
draw_bottom();
```

Functions (more practice)

- Rewrite the following mathematical expression using **C functions**

$x=b^2+c^2-2bc$

```
double x, b, c;
x= pow(b,2)+pow(c,2)-2*b*c;
```

$a^2=b^2+c^2-2bc \cos\alpha$, where α in degree

```
double a, b, c, alpha;
a=sqrt(pow(b,2)+pow(c,2) - 2 * b* c* cos(alpha * PI / 180.0));
```

converting from degrees to radians is to simply multiply the number of degree by Π /180°

Functions (more practice)

1. Write a complete c program to do the following.

$Y = x^3 + x^2 + x$

Your program should include two functions, cubic to return x to the power of three and square to return x to the power of two.

2. Write a complete c program with a function that takes a number and prints it..

3. Write a complete c program with a function that reads a number and then prints it.

```c
#include <stdio.h>
int cubic    (int);
int square   (int);
int main()
{
    int x,y;
    printf("Please enter the value of x: ");
    scanf ("%d",&x);
    y= cubic(x)+ square(x)+x;
    printf("y = %d ",y);
    return 0;
}
int cubic    (int x)
{
  return (x * x * x);
}
int square    (int x)
{
  return (x *x );
}
```

```c
#include <stdio.h>
void printNumber (int);
int main()
{
   int number;
   printf("please enter a number");
   scanf("%d",&number);
   printNumber (number);
   return 0;
}
void printNumber (int x)
{
   printf("%d",x);
}
```

```c
#include <stdio.h>
void printNumber ();
int main()
{

   printNumber ();
   return 0;
}
void printNumber()
{
   int number;
   printf("please enter a number");
   scanf("%d",&number);
   printf("%d",number);
}
```

Functions (more practice)

- What will be the output if you execute the following C code?

```c
#include <stdio.h>
int f(int , int , int );
int main ()
{
    int q;
    q = f(3, 3, 4);
    printf ("q is %d ", q);
}
int f(int q, int b, int c)
{
      int p;
      p = q * b + 2 * c;
      return (p);
}
```

Main function
q

f function
q=3 , b=3 , c=4
p=??

Output (screen):

q is 17

Let us review the concepts:

Choose the best answer :

1. When using a function, what is the first thing you must do?
    a) prototype
    b) declare
    c) initialize
2. Where should the prototype be?
    a) after int main()
    b) before int main()
    c) a prototype isn't necessary
3. Here is a function, double numbers (int x), what is the name of this function?
    a) double
    b) int x
    c) numbers

Let us review the concepts:

Choose the best answer :

4. From question 3, what data type will this function return?
    a) int
    b) double
    c) char
5. From question 4, what data type will this function take in?
    a) int
    b) double
    c) char
6. int my_function (double a), what type of data will this functions take in?
    a) double
    b) int & double
    c) int

Let us review the concepts:

Choose the best answer :

7. Say we have a function, double subtract (double x, double y), what is the correct way to call this function in the main program?

a) subtract (x) b) subtract (y) c) subtract (x,y)

8. If a variable is declared inside a function, what kind of variable is this?

a) global variable b) local variable c) extended variable

9. If we have a function int stop (int n) , are we able to send it a different variable in the main program or does it have to be n. For example,

stop (x) .

a) yes b) no

Let us review the concepts:

Answers :

1) a) prototype
2) b) before int main()
3) c) numbers
4) b) double
5) a) int
6) a) double
7) c) subtract (x,y)
8) b) local variable
9) a) yes

Extra Exercises

Given the following declarations:

double x; int y;

What value is assigned to x and y in the following statements:

1) x= ceil (34.234);
2) x= ceil (34.534);
3) x= ceil (34.0);
4) x= ceil (34);
5) y=abs (-345);
6) x= floor (34);
7) x= floor (34.89);
8) x=fabs(-8.532);
9) x=pow(2,4);
10) x=floor(21.8 + 0.8);
11) x=floor(-7.5) ;
12) x=floor(-7.5) * pow(3.0, 2.0);
13) x=ceil(-7.5) ;
14) x=ceil(-7.5) * pow(3.0, 2.0);

Extra Exercises

- Rewrite the following mathematical expression using **C functions:**

$$root = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Hint: **Compute two roots**

```
double a, b, c;
double  root_1=
double  root_2=
```

Extra Exercises

Choose the best answer :

1. Which is not a proper prototype?
    A. int funct(char x, char y);
    B. double funct(char x)
    C. void funct();
    D. char x();
2. What is the return type of the function with prototype: "int func(char x, float v, double t);"
    A. char
    B. int
    C. float
    D. double
3. Which of the following is a valid function call (assuming the function exists)?
    A. funct;
    B. funct x, y;
    C. funct();
    D. int funct();

Extra Exercises

Choose the best answer :

4. Which of the following is a correct function definition?

   A. int funct();

   B. int funct(int x) {return x=x+1;}

   C. void funct(int) {printf("Hello");}

   D. void funct(x) {printf("Hello")}

Write a function to return the square of an integer number ?

The End