

3. 字符函数和字符串函数

本章重点

重点介绍处理字符和字符串的库函数的使用和注意事项

- 求字符串长度
 - strlen
- 长度不受限制的字符串函数
 - strcpy
 - strcat
 - strcmp
- 长度受限制的字符串函数介绍
 - strncpy
 - strncat
 - strncmp
- 字符串查找
 - strstr
 - strtok
- 错误信息报告
 - strerror
- 字符操作
- 内存操作函数
 - memcpy
 - memmove
 - memset
 - memcmp

0. 前言

C语言中对字符和字符串的处理很是频繁，但是C语言本身是没有字符串类型的，字符串通常放在常量字符串中或者字符数组中。

字符串常量适用于那些对它不做修改的字符串函数。

1. 函数介绍

1.1 strlen

```
size_t strlen ( const char * str );
```

- 字符串已经 '\0' 作为结束标志，strlen函数返回的是在字符串中 '\0' 前面出现的字符个数（不包含 '\0'）。
- 参数指向的字符串必须要以 '\0' 结束。
- 注意函数的返回值为size_t，是无符号的（易错）
- 学会strlen函数的模拟实现

注：

```
#include <stdio.h>
int main()
{
    const char*str1 = "abcdef";
    const char*str2 = "bbb";
    if(strlen(str2)-strlen(str1)>0)
    {
        printf("str2>str1\n");
    }
    else
    {
        printf("str1>str2\n");
    }
    return 0;
}
```

1.2 strcpy

```
char* strcpy(char * destination, const char * source );
```

- Copies the C string pointed by source into the array pointed by destination, including the terminating null character (and stopping at that point).
- 源字符串必须以 '\0' 结束。
- 会将源字符串中的 '\0' 拷贝到目标空间。
- 目标空间必须足够大，以确保能存放源字符串。
- 目标空间必须可变。
- 学会模拟实现。

1.3 strcat

```
char * strcat ( char * destination, const char * source );
```

- Appends a copy of the source string to the destination string. The terminating null character in destination is overwritten by the first character of source, and a null-character is included at the end of the new string formed by the concatenation of both in destination.
- 源字符串必须以 '\0' 结束。
- 目标空间必须有足够的大，能容纳下源字符串的内容。
- 目标空间必须可修改。
- 字符串自己给自己追加，如何？

1.4 strcmp

```
int strcmp ( const char * str1, const char * str2 );
```

- This function starts comparing the first character of each string. If they are equal to each other, it continues with the following pairs until the characters differ or until a terminating null-character is reached.
- 标准规定：
 - 第一个字符串大于第二个字符串，则返回大于0的数字
 - 第一个字符串等于第二个字符串，则返回0
 - 第一个字符串小于第二个字符串，则返回小于0的数字

1.5 strncpy

```
char * strncpy ( char * destination, const char * source, size_t num );
```

- Copies the first num characters of source to destination. If the end of the source C string (which is signaled by a null-character) is found before num characters have been copied, destination is padded with zeros until a total of num characters have been written to it.
- 拷贝num个字符从源字符串到目标空间。
- 如果源字符串的长度小于num，则拷贝完源字符串之后，在目标的后边追加0，直到num个。

1.6 strncat

```
char * strncat ( char * destination, const char * source, size_t num );
```

- Appends the first num characters of source to destination, plus a terminating null-character.
- If the length of the C string in source is less than num, only the content up to the terminating null-character is copied.

```
/* strncat example */
#include <stdio.h>
#include <string.h>

int main ()
{
    char str1[20];
    char str2[20];
    strcpy (str1,"To be ");
    strcpy (str2,"or not to be");
    strncat (str1, str2, 6);
    puts (str1);
    return 0;
}
```

1.7 strncmp

```
int strncmp ( const char * str1, const char * str2, size_t num );
```

- 比较到出现另一个字符不一样或者一个字符串结束或者num个字符全部比较完。

Return Value

Returns an integral value indicating the relationship between the strings:

return value	indicates
<0	the first character that does not match has a lower value in <i>str1</i> than in <i>str2</i>
0	the contents of both strings are equal
>0	the first character that does not match has a greater value in <i>str1</i> than in <i>str2</i>

```
/* strncmp example */
#include <stdio.h>
#include <string.h>

int main ()
{
```

```

char str[][5] = { "R2D2", "C3PO", "R2A6" };
int n;
puts ("Looking for R2 astromech droids...");
for (n=0 ; n<3 ; n++)
if (strncmp (str[n],"R2xx",2) == 0)
{
    printf ("found %s\n",str[n]);
}
return 0;
}

```

1.8 strstr

```
char * strstr ( const char *str2, const char * str1);
```

- Returns a pointer to the first occurrence of str2 in str1, or a null pointer if str2 is not part of str1.

```

/* strstr example */
#include <stdio.h>
#include <string.h>

int main ()
{
    char str[] = "This is a simple string";
    char * pch;
    pch = strstr (str,"simple");
    strncpy (pch,"sample",6);
    puts (str);
    return 0;
}

```

1.9 strtok

```
char * strtok ( char * str, const char * sep );
```

- sep参数是个字符串，定义了用作分隔符的字符集合
- 第一个参数指定一个字符串，它包含了0个或者多个由sep字符串中一个或者多个分隔符分割的标记。
- strtok函数找到str中的下一个标记，并将其用 \0 结尾，返回一个指向这个标记的指针。（注：strtok函数会改变被操作的字符串，所以在使用strtok函数切分的字符串一般都是临时拷贝的内容并且可修改。）
- strtok函数的第一个参数不为 NULL，函数将找到str中第一个标记，strtok函数将保存它在字符串中的位置。
- strtok函数的第一个参数为 NULL，函数将在同一个字符串中被保存的位置开始，查找下一个标记。
- 如果字符串中不存在更多的标记，则返回 NULL 指针。

```

/* strtok example */
#include <stdio.h>
#include <string.h>

int main ()

```

```

{
    char str[] = "- This, a sample string.";
    char * pch;
    printf ("Splitting string \"%s\" into tokens:\n",str);
    pch = strtok (str, " ,.-");
    while (pch != NULL)
    {
        printf ("%s\n",pch);
        pch = strtok (NULL, " ,.-");
    }
    return 0;
}

```

```

#include <stdio.h>
int main()
{
    char *p = "zhangpengwei@bitedu.tech";
    const char* sep = ".@";
    char arr[30];
    char *str = NULL;
    strcpy(arr, p); //将数据拷贝一份，处理arr数组的内容
    for(str=strtok(arr, sep); str != NULL; str=strtok(NULL, sep))
    {
        printf("%s\n", str);
    }
}

```

1.10 strerror

```
char * strerror ( int errnum );
```

返回错误码，所对应的错误信息。

```

/* strerror example : error list */
#include <stdio.h>
#include <string.h>
#include <errno.h> //必须包含的头文件

int main ()
{
    FILE * pFile;
    pFile = fopen ("unexist.ent","r");
    if (pFile == NULL)
        printf ("Error opening file unexist.ent: %s\n",strerror(errno));
        //errno: Last error number
    return 0;
}
Edit & Run

```

字符分类函数：

函数	如果他的参数符合下列条件就返回真
isctrl	任何控制字符
isspace	空白字符：空格' '，换页'\f'，换行'\n'，回车'\r'，制表符'\t'或者垂直制表符'\v'
isdigit	十进制数字 0~9
isxdigit	十六进制数字，包括所有十进制数字，小写字母a-f, 大写字母A-F
islower	小写字母a~z
isupper	大写字母A~Z
isalpha	字母a-z或A-Z
isalnum	字母或者数字，a-zA-Z,0~9
ispunct	标点符号，任何不属于数字或者字母的图形字符（可打印）
isgraph	任何图形字符
isprint	任何可打印字符，包括图形字符和空白字符

字符转换：

```
int tolower ( int c );
int toupper ( int c );
```

```
/* isupper example */
#include <stdio.h>
#include <ctype.h>
int main ()
{
    int i=0;
    char str[]="Test String.\n";
    char c;
    while (str[i])
    {
        c=str[i];
        if (isupper(c))
            c=tolower(c);
        putchar (c);
        i++;
    }
    return 0;
}
```

1.11 memcpy

```
void * memcpy ( void * destination, const void * source, size_t num );
```

- 函数memcpy从source的位置开始向后复制num个字节的数据到destination的内存位置。
- 这个函数在遇到 '\0' 的时候并不会停下来。
- 如果source和destination有任何的重叠，复制的结果都是未定义的。

```

/* memcpy example */
#include <stdio.h>
#include <string.h>

struct {
    char name[40];
    int age;
} person, person_copy;

int main ()
{
    char myname[] = "Pierre de Fermat";

    /* using memcpy to copy string: */
    memcpy ( person.name, myname, strlen(myname)+1 );
    person.age = 46;

    /* using memcpy to copy structure: */
    memcpy ( &person_copy, &person, sizeof(person) );

    printf ("person_copy: %s, %d \n", person_copy.name, person_copy.age );

    return 0;
}

```

1.12 memmove

```
void * memmove ( void * destination, const void * source, size_t num );
```

- 和memcpy的差别就是memmove函数处理的源内存块和目标内存块是可以重叠的。
- 如果源空间和目标空间出现重叠，就得使用memmove函数处理。

```

/* memmove example */
#include <stdio.h>
#include <string.h>

int main ()
{
    char str[] = "memmove can be very useful.....";
    memmove (str+20, str+15, 11);
    puts (str);
    return 0;
}

```

1.13 memcmp

```

int memcmp ( const void * ptr1,
             const void * ptr2,
             size_t num );

```

- 比较从ptr1和ptr2指针开始的num个字节

- 返回值如下:

Return Value

Returns an integral value indicating the relationship between the content of the memory blocks:

return value	indicates
<0	the first byte that does not match in both memory blocks has a lower value in <i>ptr1</i> than in <i>ptr2</i> (if evaluated as <i>unsigned char</i> values)
0	the contents of both memory blocks are equal
>0	the first byte that does not match in both memory blocks has a greater value in <i>ptr1</i> than in <i>ptr2</i> (if evaluated as <i>unsigned char</i> values)

```
/* memcmp example */
#include <stdio.h>
#include <string.h>

int main ()
{
    char buffer1[] = "DWgaOtP12df0";
    char buffer2[] = "DWGAOTp12DF0";

    int n;

    n=memcmp ( buffer1, buffer2, sizeof(buffer1) );

    if (n>0) printf ("%s' is greater than '%s'.\n",buffer1,buffer2);
    else if (n<0) printf ("%s' is less than '%s'.\n",buffer1,buffer2);
    else printf ("%s' is the same as '%s'.\n",buffer1,buffer2);

    return 0;
}
```

2. 库函数的模拟实现

2.1 模拟实现strlen

三种方式:

方式1:

```
//计数器方式
int my_strlen(const char * str)
{
    int count = 0;
    while(*str)
    {
        count++;
        str++;
    }
    return count;
}
```

方式2:


```
//不能创建临时变量计数器
int my_strlen(const char * str)
{
    if(*str == '\0')
        return 0;
    else
        return 1+my_strlen(str+1);
}
```

方式3:

```
//指针-指针的方式
int my_strlen(char *s)
{
    char *p = s;
    while(*p != '\0' )
        p++;
    return p-s;
}
```

2.2 模拟实现strcpy

参考代码:

```
//1.参数顺序
//2.函数的功能，停止条件
//3.assert
//4.const修饰指针
//5.函数返回值
//6.题目出自《高质量C/C++编程》书籍最后的试题部分
char *my_strcpy(char *dest, const char*src)
{
    char *ret = dest;
    assert(dest != NULL);
    assert(src != NULL);

    while((*dest++ = *src++))
    {
        ;
    }
    return ret;
}
```

2.3 模拟实现strcat

参考代码:

```
char *my_strcat(char *dest, const char*src)
{
    char *ret = dest;
    assert(dest != NULL);
    assert(src != NULL);
    while(*dest)
    {
        dest++;
    }
    while(*src)
    {
        *dest++ = *src++;
    }
    *dest = '\0';
    return ret;
}
```

```

}
while((*dest++ = *src++))
{
    ;
}
return ret;
}

```

2.4 模拟实现strstr

注：让他们下去自己研究一下KMP算法。

```

char * strstr (const char * str1, const char * str2)
{
    char *cp = (char *) str1;
    char *s1, *s2;

    if ( !*str2 )
        return((char *)str1);

    while (*cp)
    {
        s1 = cp;
        s2 = (char *) str2;

        while ( *s1 && *s2 && !(*s1-*s2) )
            s1++, s2++;

        if (!*s2)
            return(cp);

        cp++;
    }

    return(NULL);
}

```

2.5 模拟实现strcmp

参考代码：

```

int my_strcmp (const char * src, const char * dst)
{
    int ret = 0 ;
    assert(src != NULL);
    assert(dst != NULL);
    while( ! (ret = *(unsigned char *)src - *(unsigned char *)dst) && *dst)
        ++src, ++dst;

    if ( ret < 0 )
        ret = -1 ;
    else if ( ret > 0 )
        ret = 1 ;

    return( ret );
}

```

2.6 模拟实现memcpy

参考代码:

```
void * memcpy ( void * dst, const void * src, size_t count)
{
    void * ret = dst;
    assert(dst);
    assert(src);
    /*
     * copy from lower addresses to higher addresses
     */
    while (count-->0) {
        *(char *)dst = *(char *)src;
        dst = (char *)dst + 1;
        src = (char *)src + 1;
    }

    return(ret);
}
```

2.7 模拟实现memmove

参考代码:

```
void * memmove ( void * dst, const void * src, size_t count)
{
    void * ret = dst;

    if (dst <= src || ((char *)dst + count <= (char *)src)) {
        /*
         * Non-Overlapping Buffers
         * copy from lower addresses to higher addresses
         */
        while (count-->0) {
            *(char *)dst = *(char *)src;
            dst = (char *)dst + 1;
            src = (char *)src + 1;
        }
    }
    else {
        /*
         * Overlapping Buffers
         * copy from higher addresses to lower addresses
         */
        dst = (char *)dst + count - 1;
        src = (char *)src + count - 1;

        while (count-->0) {
            *(char *)dst = *(char *)src;
            dst = (char *)dst - 1;
            src = (char *)src - 1;
        }
    }

    return ret;
}
```

```
return(ret);  
}
```

本章完



比特就业课